COMMISSIONING STANDARDS

Introduction

The purpose of this document is to provide an overview of the standards that should occur during the commissioning of a project(s). The commissioning process is to ensure that upon completion of a major or minor (where warranted) construction project, that buildings are designed, processes and systems are installed and functionally tested at optimal productivity and capable of being operated and maintained which will improve the likelihood that the equipment and/or systems will maintain their level of performance throughout its lifecycle according to the District's overall operational needs.

As we look at construction projects there are five (5) phases of development that will occur, with the fifth phase commissioning the construction project to the District's maintenance and operations team. From the first phase to the final phase the Design Team and District Staff of which consists of the Architect, and related design professionals, the District Team, the Superintendent, Assistant Superintendent, School Site/Department, Facilities, Construction or Program Manager and Maintenance and Operations Representative. This involvement assures the all stakeholders understand their roll in a successful construction project. Throughout the construction phase the architect, contractor, contractor's subcontractor(s) and the Construction Manager or Program Manager will work together to assure the final completion of the construction project. The remaining, the post acceptance involves the Design Team plus District Staff (which may include the District Maintenance and Operations Designee and/or others);

- Pre-Design/Planning Phase I (Design Team and District Staff)
- Design Phase II (Design Team and District Staff)
- Procurement Phase III (Design Team District and District Staff)
- Construction Phase IV (Design Team District and District Staff)
- Post Acceptance/Warranty Phase V (Design Team and District Staff)

It will be the responsibility of the Construction Manager (CM) to ensure that all warranty, operational manuals and warranty documents are transferred to the Maintenance and Operations or other Departments and that training is provided as defined by contract.

Brief Overview

In most if not all aspects of the project, the Project Team (design professionals, engineers, inspectors, contractors, sub-contractors) shall be led by a District representative. This representative will be the CM or PM. This individual is responsible to assure that each phase, from the Pre-Design/Planning Phase, Design Phase, Procurement Phase and Post Acceptance/Warranty Phase are based on unbiased performance without conflict of interest.

Pre-Design/Planning Phase

The pre-design/planning phase is the period which begins the commissioning process. The initial commissioning team is assembled at this time to lay the groundwork for the team effort and to plan the commissioning process. This phase will include the most important component of the early phase of a project; the development of the project documentation necessary for commissioning. This is considered the foundation of the commissioning process, and as the process moves forward the contents of this foundation will evolve over the course of the project.

Design Phase

During the design phase, the commissioning team must perform a design review, this ensures that the District's project requirements are clearly documented and followed. This phase of the commissioning process assures that the efficiency and operational concepts for overall development during the pre-design phase are completed. Finally, the design phase of the commission process also ensure that the next phase, the construction phase is adequately reflected in the bid documents.

Construction Phase

During construction phase of projects, the site(s) facility's systems (including architectural, structural, mechanical, electrical, and controls) are installed, undergo pre-functional performance tests, and then are placed into operation. Once the construction is completed, all the sites, facility's systems are to be operating as designed, both individually and collectively as a whole. In all cases the systems should be ready for functional and performance testing by the design team.

Post Acceptance/Training/Warranty Phase

At this point of the commission process the project is at a point of which all post acceptances will occur. This is where the project in some respect is considered complete and ready to commission (project turnover). The site/facility is now in the hands of the District, the operation department, or others. Though the project is complete and commission has occurred there still may be some commissioning tasks process that will continue throughout the predetermined warranty period.

Training

1. The Commissioning Team will review the proposed training material from the individual contractors.

2. The Commissioning Team will provide comments to supplement training material for operations and maintenance personnel, where appropriate.

3. The Commissioning Team will provide a coordinated training product through supervision.

4. The Commissioning Team will compile electronic copies of training material for the Owner's use and reference. Paper copies will be in 3-ring binders. Electronic copies will be on CD-ROM media, in a format that is searchable and printable, such as Adobe Portable Document Format (PDF).

5. The contractor for the respective system is responsible for the development and implementation of the training material for the system.

6. Training materials and M&O manuals must be submitted to and accepted by the Commissioning Team and accepted prior to commencement of any training.

7. Format for contractor-submitted training material:
    a) Detailed agenda
    b) Contractor contact sheet, including address, phone number, fax number and e-mail.
    c) Detailed training material, divided by sections.
    d) Maintenance checklists/ log sheets.

8. At the Owner's option, training may be videotaped for future reference and training.

9. All training sessions shall be scheduled and coordinated by the General Contractor through the Owner's Representative.

10. Training shall be completed and accepted by the owner prior to substantial completion and occupancy.

11. Supplemental training after building occupancy:
    a) It is intended that one or two supplemental training sessions occur after building occupancy, primarily for the controls system, for the benefit of the M&O staff.

Minimum Allowances for Training Time EDIT

1. Unless Div. 1, Div. 15, or Div. 16 requirements are more strict, provide the following as a minimum:

2. Div. 15 – Mechanical:
   a) Mechanical Systems, air side, water side, equipment: 40 hours
   b) Temperature Controls: 40 hours

3. Div. 16 – Electrical:
   a) Daylighting systems 8 hours
   b) Electrical Systems, normal power, emergency power, lighting, equipment: 24 hours
   c) Specialty – Fire Alarm: 24 hours

Responsibilities of Other Parties

1. A/E
   a) Provide an introductory segment of Owner training to explain the Basis of Design, to familiarize the M &O staff with the design aspects of the building.

2. General Contractor
   a) The GC shall be responsible for training coordination and scheduling and ultimately to ensure that training is completed.

3. Mechanical Contractor
   a) Provide the Commissioning Team with a training plan two weeks before the planned training. Manuals must be approved by the Commissioning Team prior to commencing with training.
   b) The training topics shall include all of the mechanical equipment and systems. The mechanical contractor shall provide training on each piece of equipment. Training syllabus shall include a breakdown of the time allotted for each system.
   c) Provide designated Owner personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of HVAC equipment including, but not limited to, pumps, boilers, furnaces, chillers, heat rejection equipment, air conditioning units, air handling units, fans, terminal units, controls and water treatment systems, etc.
   d) Training shall normally start with classroom sessions followed by hands-on training on each piece of equipment, which shall illustrate the various modes of operation, including startup, shutdown, fire/smoke alarm, power failure, etc.
   e) Training topics shall include safe and proper operating requirements, preventative maintenance, special tools needed, recommended spare parts, common troubleshooting problems and solutions, and any equipment or system peculiarities. The training shall include start-up, operation in all modes possible, shut-down, seasonal changeover and any emergency procedures.

f) Hands-on training shall include start-up, operation in all modes possible, including manual, shut-down and any emergency procedures and preventative maintenance for all pieces of equipment.

4. Controls Contractor

a) The controls contractor shall have the following training responsibilities:

b) Provide the Commissioning Team with a training plan four weeks before the planned training. Manuals must be approved by the Commissioning Team prior to commencing with training.

c) There shall be three training sessions:

d) The first training shall convey the basic system layout and functionality, introduce the basic hardware items, software features, location of documents, special terms, etc. Upon completion, each student, using appropriate documentation, should be able to perform elementary operations and describe general physical layout of the system, and procedures for obtaining vendor assistance. This training session may be held on-site or off-site, as appropriate.

e) The second session shall consist of actual hands-on training. The session shall include specific instruction for operating the installed system, including any interface with other systems such as lighting and Fire Alarm. Software features shall be explained including security levels, alarms, system start-up and shutdown, power fails restart routines, changing set points, acknowledging alarms, overrides, manual operation of equipment, etc. Trainees shall set up and print out trends and reports using actual system data. Trainees shall set up a graphic display using actual system data.

f) The third training will be conducted on-site six months after occupancy and will be structured to address specific topics that trainees need to discuss and to answer questions concerning operation of the system.

Training Agendas

1. Prepared training agenda forms shall be partially filled out by the Commissioning Team and the owner and submitted to the relevant contractors. Contractors shall be instructed to complete certain sections and re-submit to the Commissioning Team for approval. Upon approval, the contractor may then provide copies of the approved training agenda to the trainers and trainees. The agenda shall be followed to assure efficient training and a knowledge level that meets or exceeds the owner’s intent.

2. The trainer, prior to and during each training session, shall complete the prepared training record form. The trainer is responsible for checking the subjects covered from the training agenda and for obtaining signatures from the trainees in attendance.

To assure that all training and warranty conditions are obtained from the contractor, the CM or PM is to arrange training, warranty and hand-off process as defined. There will be a sign-off sheet to document this occurs.

PROJECT SPECIFICATIONS

PREPARED FOR:

COMPTON UNIFIED SCHOOL DISTRICT
501 S. SANTA FE AVENUE
COMPTON, CA 90221

DISTRICT STANDARDS AND PREFERENCES

PREPARED BY:



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COMPTON UNIFIED SCHOOL DISTRICT
DISTRICT STANDARDS AND PREFERENCES
INTRODUCTION

The purpose of this Building Systems Standard Handbook is to establish a point of reference for the beginning of a program for analysis of building design and construction and equipment selection leading to a lowering of long-term maintenance costs. It is planned that the Standards be used in conjunction with the District's educational specifications, together with the most up- to-date design, knowledge and practice of the Districts' Architects/Engineers.

This compilation strongly urges the use of planning techniques, concepts, components, and equipment found in practice to be advantageous to the day-to-day operation of the physical plant and ultimately, to future and long-term maintenance costs.

The contents have been generalized to avoid undue restrictions upon the creativity of the architects and engineers but where it is felt necessary; brand names have been used to establish district standards when desirable features need attention.

In use, the Standards shall be analyzed in association with to Educational Specifications and related to the planning of each new or modified facility. Therefore, a facility audit or complete review is mandatory upon the architect/engineers and their support staff or organizations to complete a viable project.
The interface of existing and new equipment requires technical evaluation and code review. In no sense shall the Standards be used to impede progress or orderly evolution of planning or equipment design. On the contrary, the Standards shall be constantly updated and upgraded to include the latest changes in technology, always keeping in mind the basic relationship between simplification, standardization, and long-term maintenance costs.

It is recognized that highly varies social, political, and psychological influences, as well as dynamic technology, are applicable to each individual school construction project. Also, economical aspects and funding constraints may cause "homegrown" standards to be defined in many ways elementary, unfeasible, illogical, out-of-date, foolish, useful, etc. Standards outlined herein will be subject to that variety of definitions.

A. QUALITY CONSTRUCTION

In the selection and development of sites in designing and construction buildings, it is as important to be concerned with the cost of maintenance and upkeep as with first cost. The selection of design solutions and materials shall be based on the achievement of the lowest long- term costs at the lowest first cost consistent with low maintenance costs. Building codes and education specifications generally establish minimal environmental requirements for all aspects of design except those concerned with maintenance. This coupled with concern about higher construction costs and the need for reduction in "cost per square foot."

B. OVERALL DESIGN FACTORS

The simpler the building system design, in general, the less costly the operational and maintenance procedure. However, schools are not constructed for low maintenance costs alone and a balance of design factors is required to assure that the educational program is enhanced by selection of material and equipment that is appropriate and functional. A thorough consideration of the education environment and aesthetics of the building shall involve the study of design solutions and material sections which result in low long-term maintenance problems. Good school buildings do not just happen; they are the result of careful planning. Money and effort are saved when maintenance personnel have input in the design on new facilities.
The building shall have clean coupled with quality materials detail design will go a long way in reducing initial costs as well as year-by-year maintenance.
Some of the important considerations of overall design are as follows:

1. Durable materials can be both effective and economical, with efficiency of the system built in with no additional frills.
2. Avoid expensive systems and materials. Durable materials cost more initially, but in many cases not much more, and long-term costs are considerably less.
3. To increase the effectiveness of air conditioning and heating systems, minimize the use of glass window areas to reduce both vandalism and exterior maintenance. This will also reduce the amount of exterior surface that require cleaning and painting through compact building design.
4. Design shall prevent access to roof other than by means of planned access for maintenance.
5. Building shall have adequate space and work areas for servicing, repairs and replacement. Also provide for future expansion in sizing and location of utility services.
6. The design shall allow for easy access to the mechanical systems for future repairs, replacement and alteration (as the educational program may require) without substantial damage to surfaces of the building.
7. Consideration shall be given to possible problems with corrosion and electrolysis in the mechanical and electrical system as recommended by consulting specialists in this field.

Because of the high cost of custodial services over the life of the buildings, there is need for serious consideration to be given to the ease of cleaning; servicing and selection of surfaces exposed to conditions for which they were not designed are important considerations to achieving long term economy.

After the school plant is completed, an effective maintenance program is needed to protect the educational value of the school as to appearance, usefulness, and overall atmosphere. Since the longest single item in the school maintenance budget usually involves repainting, it is essential that materials be used which keep painting to a minimum.

C. STANDARDIZATION

Standardize construction items, details and methods insofar as practical and wherever possible without creating unduly high bidding costs. From the standpoint of maintenance, efficiency, and economy, it is advantageous to settle on one kind, type, or brand, particularly with regard to electronic door hardware, CCTV, plumbing, HVAC and electrical systems and devices, fixtures, fittings, lighting fixtures and lighting controls, motors, equipment, etc. Standardization has the advantage of reducing the inventory of spare parts necessary for good maintenance, as well as allowing more adequate training of maintenance personnel. However, standardization shall not be carried to the extreme of hampering the education program, destroying function, or continuing the use of inferior products and systems.

D. VANDALISM CONTROL

It is not feasible to design, build or equip a vandal-proof school building system. The best that can be done is to minimize temptation and erect barriers to those who can be deterred. A realistic approach to the vandalism problem begins with a review of the design, and altering or deleting such items as the following:

1. Light screens, sunshades, decorative brick work, downspouts, screen walls, and all such appurtenances that can serve as natural ladders to the roof areas.
2. “Add-on” installation, such as light fixtures, air conditioners, bells, alarms, aerials, and power panels that provide attractive targets.
3. Ventilation screens, air intakes, air discharge points that provide access to buildings.
4. Curbs that support railings are to be a minimum of ten-inches wide. Gates for school

grounds shall be designed so that they do not serve as ladders and permit easy access to school grounds or roof areas.

Vandalism control can be further enhanced by designing installation of silent alarm detectors where economically feasible, the use of fencing for vandalism, also vehicular control, and elimination of outdoor vending machines, snack bars, and concession stands; also, reducing the number of exterior entrances and windows.

E. UTILITIES

The architect/Engineer and the District representative shall determine whether existing utilities are readily available at site and adequate to serve for the intended program requirements. If in adequate the Architect/Engineer and the District representative shall determine whether existing utilities are readily available in streets bordering the site. If utilities do not exist in the streets bordering the site, the Architect/Engineer and the school District shall obtain a commitment from the serving utility or the governing authority as to when and how their utilities will be installed to serve the site.

F. SYSTEMS

Refer to Individual systems for District preferences and Technical standards/basis of Design (BOD) for Mechanical, Electrical, plumbing, Technology, Fire Alarm, Audio Visual (AV), Access Controls (Electronic Door Access System), Intrusion detection, CCTV (Centralized Video Surveillance with Video Management (VSM) , Classroom technology and Commissioning of MEP systems for District Wide modernization and new facilities.

END OF SECTION

SECTION 01 81 13
MEP COMMISSIONING FOR NEW CONSTRUCTION AND MAJOR RENOVATIONS:

PART 1 - GENERAL

1.01 Reference Documents:

A. ASHRAE Guideline 0, “The Commissioning Process

B. ” ASHRAE Guideline 0.2, “Commissioning Process for Existing Systems and Assemblies

C. ” ASHRAE Guideline 1.1, “HVAC&R Technical Requirements for the Commissioning Process

D. ” ASHRAE Guideline 1.5, “Commissioning Process for Smoke Control Systems

E. ” ASHRAE Standard 202, “Commissioning Process for Buildings and Systems

F. ” Building Commissioning Association, "The Building Commissioning Handbook

G. "NIBS Guideline 3, "Building Enclosure Commissioning Process

H. "USGBC, “LEED® Reference Guide for Green Building Design and Construction”

I. “ NEBB” Procedural Standards for Whole Building Systems Commissioning of New Construction Third Edition

J. California Codes adopted by Division of State Architect (DSA)

PART 2 - COMMISSIONING

2.01 GENERAL

A. All Mechanical, Electrical and Plumbing (MEP) systems, shall undergo building commissioning (Cx) process.

B. The Cx process shall be similar to Cx processes promoted by national trade organizations including ASHRAE, BCxA, NIBS (National Institute of Building Sciences) and USGBC but shall include more comprehensive design management and more extensive construction quality assurance.

C. Related Documents Design Standards, Owner’s Project Requirements (OPR) and Basis of Design (BOD), Sustainable Design, Energy and Water Conservation Building Envelope, Design-Phase Commissioning Procedure, MEP Design Management Procedure, Full Construction-Phase Commissioning Procedure, Commissioning Plan Procedure, General Commissioning Procedures Operation and Maintenance Manuals, Project Commissioning Reference Documents:

1. ASHRAE Guideline 0, “The Commissioning Process
2. ASHRAE Guideline 0.2, “HVAC&R Technical Requirements for the Commissioning Process
3. ASHRAE Guideline 1.5, “Commissioning Process for Smoke Control Systems
4. ASHRAE Standard 202, “Commissioning Process for Buildings and Systems
5. Building Commissioning Association, "The Building Commissioning Handbook
6. NIBS Guideline 3, "Building Enclosure Commissioning Process
7. "USGBC, “LEED® Reference Guide for Green Building Design and Construction”

D. General Commissioning is a systematic quality assurance process to assure a project is designed to meet the needs of District and is built, operated and maintained as intended by its Design Team and the District. •Cx helps a project achieve its schedule, budget and quality goals by utilizing the design, construction, operation and maintenance experience to

proactively identify and help resolve issues as early and inexpensively as possible.

E. Cx generally begins during Programming and ends after Occupancy.

F. Cx focuses primarily on the project's utilities, mechanical systems, electrical systems, plumbing systems and "powered" architectural systems.

G. Cx of the building envelope is also important to minimize air leakage, moisture migration and heat transfer, but Cx activities related to the building envelope require different skills. Thus, building envelope design and construction Cx shall be addressed by Architect.

H. Cx verifies conformance with the project's design intent as documented in the Owner's Project Requirements (OPR) and Basis of Design (BOD) documents.

I. Cx verifies compliance with requirements for effluent, noise, vibration, cleanliness, efficiency, maintainability, operation and maintenance manuals, and District training.

J. Cx verifies that completed systems and equipment perform as intended in all modes of operation and under all operating conditions. However, Cx does not duplicate or substitute for code inspection.

K. Cx does not provide routine quality control such as routine inspections for material substitutions, point-to-point wiring checks or poor-quality workmanship. The Building Commissioning Process with complex and challenging MEP systems shall undergo design-phase and construction-phase Cx.

L. Cx activities shall be coordinated by the Commissioning and Plan Review and District's reviews and value engineering (VE) efforts.

M. The CxA shall make recommendations regarding commissionable architectural and MEP systems and require compliance with industry standards.

N. The CxA will require inclusion of clear sequences of operation, setpoints, acceptance criteria and other details required for construction-phase Cx. Incorporate the CxA's input into the project's design. Final decisions related to the project's scope, schedule and budget will remain the responsibility of the Architect but collaborate with the CxAs for technical direction on MEP issues.

O. During the Construction Documents (CD) design phase, edit the Operation and Maintenance (O&M) Manual and Commissioning Specification Section to make these sections project specific.

P. If a CxA has been hired prior to the CD review the A/E shall obtain review comments on the project specific from the CxA.

Q. Insert these sections into the project's specifications to define the Contractors' O&M manual and Cx requirements during construction.

R. Reference these sections in the appropriate architectural, mechanical and electrical specification sections.

S. To avoid conflicts with these sections, do not include any specific O&M manual or Cx requirements in the individual architectural, mechanical, electrical or plumbing specification sections.

T. Design-phase Cx generally shall begin during the Programming phase and will continue until the project is bid and awarded. Construction-Phase Commissioning MEP scope shall undergo construction-phase Cx.

U. Construction-phase Cx shall be performed by a commissioning team typically consisting of the representatives from the A/E, the Construction Manager or General Contractor, the trade contractors, the District and Plant Operations.

V. The team will be directed by and Cx meetings will be led by the CxA. Assign an A/E Representative to this Cx team.

W. Participate in and assist the CxA with these activities. Construction-phase Cx generally will begin when the project is issued for bids. It will continue through initial occupancy and may continue through the first year of occupancy. Quality Assurance throughout a project's design and construction.

PART 3 - ENERGY AND WATER CONSERVATION

3.01 Incorporate conservation measures as required by the Design applicable to current codes adopted by Division of State Architect (DSA). Throughout the design process, meetings shall be held to evaluate how the project is meeting the project's conservation targets and to review the conservation measures specific to the project. Codes and Regulatory Agencies (for energy code requirements), Owner's Project Requirements and Basis of Design Documents, Energy and Water Conservation, Documents: ASHRAE 90.1-2013, "Energy Standard for Buildings Except Low-Rise Residential Buildings, "ASHRAE 189.1-2009, "Standard for the Design of High-Performance Green Buildings"ASHRAE Handbook-2007, "HVAC Applications "Energy Conservation Compliance. All design shall Incorporate the Mandatory Energy Conservation Measures (ECMs), Evaluate the Potential ECMs and Water Conservation Measures incorporate as appropriate. Perform the following:

A. Exceed ASHRAE 90.1& California T-24 baseline requirements by the percentage established for the project, Performance Rating Method of ASHRAE 90.1, use a computer energy simulation program to establish a baseline energy consumption for the entire building and to calculate the percentage energy cost saved above the baseline.

3.02 Document the impact of the ECMs in accordance with the Documentation Requirements.

3.03 Mandatory Energy Conservation Measures The following ECMs shall be incorporated into project as applicable to the project's scope

A. Window Blinds/Shades: Provide interior blinds/shades on south and west facing windows.

B. Occupancy Schedules: Determine anticipated occupancy schedules in consultation with the District and indicate these in the OPR/BOD Document, in the Energy Impact Statement, and in the energy simulation software output. Based on these schedules, indicate on the project control drawings the initial operating schedule for all mechanical and electrical systems and equipment.

C. Part Load Efficiency: Design mechanical and electrical systems to run efficiently at partial loads.

D. HVAC System Zoning: Zone HVAC systems by occupancy type, ventilation rate, and operating schedule to allow shutdown or setback during no/reduced occupancy. Utilize zoned shutdown for sections of systems where occupancy schedules vary widely, and separate systems are not feasible.

E. DDC VAV Control: Control room air volume and temperature with direct digital controlled variable air volume (VAV) assemblies.

F. Standalone HVAC Systems: Provide standalone HVAC systems for areas that require 24/7 operation, to allow central systems to be shut down.

G. Perform scans of the new building envelope during construction. Correct deficiencies found.

H. Lighting and Power Justification: Provide justification for any area that exceeds ASHRAE 90.1 lighting and electrical CA T-24 limits.

3.04 Mandatory Evaluations of Potential Energy Conservation Measures Evaluate the following ECMs in accordance with the Economic Evaluation of Energy Conservation Measures. Incorporate any ECM into the project that meets the maximum payback criterion.

A. Below-Grade Insulation: Improve the below-grade insulation R-value above the ASHRAE 90.1 required minimum and CA T-24.

B. Wall Insulation: Improve the wall insulation R-value above the ASHRAE 90.1 required minimum and CA T-24.

C. Roof Insulation: Improve the roof insulation R-value above the ASHRAE 90.1 required minimum and CA T-24.

D. Glazing: Provide glass with reduced solar heat gain coefficients and fenestration systems with lower U values than the ASHRAE 90.1 required maximums and CA T-24.

E. Chillers: Exceed ASHRAE 90.1 and CA T-24 chiller efficiency. Include the impact of pump power reductions.

F. Free Cooling: Where there is a year-around chilled water load in the building, use “Free Cooling” as part of the chilled water system. Free Cooling shall utilize an evaporative cooling tower coupled with a heat exchanger, closed circuit evaporative fluid coolers, or dry coolers to produce chilled water when seasonal temperatures permit. Evaporative towers should be separate or be able to be decoupled from the main cooling tower array.

G. Heat Recovery: Where an air handling system’s minimum outside air percentage is greater than 40 percent, use a heat recovery system to transfer heat from exhausted air to the outside air entering the system. Evaluate heat recovery (enthalpy) wheels, flat plate air-to-air heat exchangers, heat pipes (including pumped type), and run-around coils. Include the impact of additional pressure drop through each device type.

H. Envelope Inspections: Increase the inspection of the exterior wall insulation and exterior fenestration systems. Energy savings evaluation to be based on a percentage reduction of the estimated annual energy consumed due to infiltration and thermal conduction through the building envelope.

I. Lighting Controls: Where occupancy in auditoriums, classrooms, conference rooms and offices vary with time of day, provide occupancy sensing and day-lighting control to achieve minimum space lighting times and ventilation rates, and close VAV boxes to zero position if no occupancy is detected.

J. Boilers: Exceed ASHRAE 90.1 and CA T-24 boiler efficiency.

K. HVAC: Exceed ASHRAE 90.1 and CA T-24 mechanical cooling and heating equipment efficiencies.

L. Kitchen Hoods: Provide variable volume kitchen exhaust hood systems. Additional Energy Conservation Opportunities Consider additional energy conservation opportunities for application on the project.

3.05 During the Design Phase, provide:

A. A copy of the completed ASHRAE and CA T-24. compliance report.

B. Explanation of all Water Conservation Measures applied to the project and their predicted results.

C. Explanation of which Mandatory Energy Conservation Measures and Mandatory Energy Evaluations apply to the project and how they will be implemented.

D. Explanation of any other ECMs to be applied to the project. Include summary calculations demonstrating the simple payback period of each measure. When an energy goal above the

ASHRAE 90.1 baseline and CA T-24 requirements has been established for the project, also provide the following:

1. Calculated values for the baseline building performance. The proposed building performance, and the percentage improvement.
2. Complete data files from the energy simulation program including a breakdown of energy usage by at least the following components: lighting, internal equipment loads, service water heating equipment, space heating equipment, space cooling and heat rejection equipment, fans, and other HVAC equipment (such as pumps). The output reports shall also show the amount of time any loads are not met by the HVAC system for the baseline building design and the proposed building design. The proposed building design shall not have more “unmet hours” than the baseline building.
3. An explanation of any error messages noted in the simulation program output.
4. List ECMs planned for the proposed building design and indicate the relative contribution each will make toward exceeding ASHRAE 90.1 and CA T-24. This list shall document all energy features that differ between the baseline building performance and the proposed building performance calculations.

3.06 During the Construction Document phases, provide:

A. MEP Calculated values for the baseline building performance, the proposed building performance, and the percentage improvement, when applicable.

B. Updates of all the energy and water conservation documentation required to be submitted at the CD phase report after project award to reflect accepted Alternates and District 's Options, include updated executable energy model files.

END OF SECTION

SECTION 10 40 00
MARQUEE SIGNS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. LED message centers

B. Control software

1.02 REFERENCES

A. Standard for Electric Signs, UL and CUL Listed

B. Standard for Control Centers for Changing Message Type Signs

C. Federal Communications Commission Regulation Part 15

D. National Electric Code

E. Designed to current UBC or IBC standards

F. FCC Class A Compliant

1.03 SUBMITTAL

A. The electronic LED display manufacturer shall provide a complete technical submittal and shall not proceed with LED Matrix manufacture until the submittal is approved.

B. Submit:

1. All LED display manufacturer qualifications, as specified herein.
2. LED display shop drawing.
3. LED display Riser diagram.
4. AC Site Power Requirements, including legs and Amps per leg.
5. LED display control software operator's manual.
6. LED display installation and maintenance manual.

1.04 QUALIFICATIONS

A. LED Display Manufacturer shall:

1. Have been in the business of manufacturing permanently mounted outdoor LED displays for a minimum period of 15 years prior to the contract bid date. An "LED" display contains pixels constructed solely of high-intensity discrete LEDs

B. Experience with manufacturing the following types of electronic sign products shall not satisfy the requirements of this LED display specification:

1. Indoor displays of any size or type
2. Back-lit displays
3. Any type of matrix display that cannot be programmed to show a nearly infinite quantity of messages

1.05 WARRANTY

A. Provide 5 years of parts & labor coverage for a fully operational sign. Installation sign contractor is responsible for diagnosis issues to determine the parts that have failed.

PART 2 - PRODUCTS

2.01 LED Display

A. Cabinet Construction

1. Cabinet dimensions shall not exceed (X) inches high by (Y) inches wide. The front-to-back cabinet depth shall not exceed 5 inches.
2. The cabinet shall contain a full LED matrix measuring a minimum of (#Lines H/Matrix) pixel rows high by (#Columns W/Matrix) pixel columns wide.
3. Cabinet display configuration is:
   a. Single-Face (SF), one sided display

      or

   b. Two-View (2V), two one sided displays typically installed back-to-back and show same content on both sides.
4. The distance from the center of one line or column of pixels to the center of all adjacent lines or columns shall be (Line Spacing 00.00 mm (0.00 inches both horizontally and vertically.
5. Maximum display power per face shall not exceed [(P)] watts when 100% of the pixels are operating at their maximum possible drive current.
6. Cabinet weight per face shall not exceed [(W) lbs./(W) kg.]
7. Display shall operate from the following power sources: 120/240 VAC, 60 Hz single-phase, including neutral and earth ground.
8. Display shall operate in a minimum ambient temperature range of -40° to +120°F (-40 to +50°C) and to a 95% humidity.
9. Internal display component hardware (nuts, bolts, screws, standoffs, rivets, fasteners, etc.) shall be fabricated from stainless steel, aluminum, nylon, or other durable corrosion-resistant materials suitable for the signage application.
10. Electrical display components shall be 100% solid-state.
11. The presence of ambient radio signals and magnetic or electromagnetic interference, including those from power lines, transformers, and motors, shall not impair performance of the display system.

B. Housing Frame

1. Display materials shall use non-corrosive materials or have a protective coating so they shall be anti-corrosive and not degrade or oxidize.
2. Adequate ventilation shall be provided through convection without the need to provide extra space around the sides or behind the display.
3. Steel mounting points that can be used for mounting purposes shall be provided with the display and have the ability to be adjusted for alternative mounting methods.
4. Shall include lifting supports that can be removed after installation.
5. Exterior Finish

The LED display border pieces shall be coated with an automotive-grade acrylic urethane paint.

C. Front Face Construction

1. To meet the display readability requirements, the front face must be constructed in such

a manner that it provides high contrast, low sunlight reflection and durability in all weather and site conditions.

2. Minimum features of front face shall:

   a. Provide UV resistance to prevent discoloring.

   b. Include horizontal louvers for contrast enhancement.

   c. Include vertical ribbing for contrast enhancement

   d. Use surface materials in the active LED area, such as metal, plastic, or other face materials, designed for low sunlight reflectivity.

D. Serviceability

1. The display housing shall provide safe and convenient front service access for all modular assemblies, components, wiring, and other materials located within the housing.
2. All internal components shall be removable and replaceable by a single technician with basic hand tools.
3. Service access shall be easily obtained by removal of one or more modules in front of the associated internal component.
4. Each module should allow simple removal with a single latch system.
5. Displays shall be designed with service features that minimize potential bodily harm.

2.02 DISPLAY COMPONENTS

A. LED display modules shall be constructed for good readability, long life, and ease of service. Each display module shall be constructed as follows:

1. Each module within the product family shall be designed with the same physical footprint of 12.48” x 15.59”.
2. All modules and their components shall be fully encapsulated and sealed to meet IP-67 standards.
3. An LED module shall consist of LEDs with all drive electronics mounted on a single Printed Circuit Board (PCB).
4. LEDs shall be auto inserted in order to maintain quality and uniformity of the LEDs within each LED module.
5. All PCBs shall be wave-soldered to ensure uniformity, quality, and durability of all solder joints.
6. All PCBs shall be cleaned in a manner so as not to contain more than 2 parts per million contaminants.
7. Module signal and electrical connections shall be of the positive locking and removable type. Removal of a module from the display shall not require a de-soldering operation.
8. Data to the modules shall be redundant in that the signal can reach the module from multiple directions in the event of a loss in signal path from either direction.
9. All LED display modules in a single display shall be identical in construction and interchangeable throughout the display with the ability to be field calibrated.
10. All module rows shall include continuous louvers over the LEDs for sunlight shading and enhanced contrast.
11. Modules shall be individually attached to the cabinet frame.

12. Removal of one or more modules shall not affect the display's structural integrity.
13. The distance from the center of one line or column of pixels to the center of all adjacent lines or columns shall be XX" both horizontally and vertically.
14. The failure of a single pixel, module or power supply shall not cause the failure of any other pixel, module or power supply in the display.
15. All modules shall have no less than a 140° horizontal half-intensity viewing angle and a readability angle of 160° horizontal.
16. The transition of the viewing intensity shall be consistent throughout the viewing cone.

B. Pixels shall be constructed with discrete LEDs, and these discrete LEDs shall conform to the following specifications:

1. LEDs shall be non-diffused, ultra-bright, solid-state light emitting diodes.
2. The red LEDs shall be constructed of AlInGaP technology and the green and blue LEDs shall be constructed of InGaN technology.
3. Each color of LEDs used in all LED displays provided for this contract shall be from the same bin.
4. LED half-life shall be an estimated minimum of 100,000 hours.
5. Display shall have a minimum intensity of 10,000 cd/m2 for RGB maximum light output, 4,500 cd/m2 for Red maximum light output, and 6,000 cd/m2 for Amber maximum light output.

C. Power Supply

1. All power supplies shall be regulated, auto-ranging AC to DC power, with protection for the LED pixel, LED display and driver circuitry in the event of power spikes or surges.
2. Each power supply and their connectors shall be fully sealed to protect from corrosive environmental factors meeting IP-67 standards.

D. Internal Wiring

1. Wiring for LED display modules and other internal components shall be installed in the housing in a neat and professional manner.
2. Wiring shall not impede the removal of display modules, power supplies or other display components.
3. Wires shall not make contact with or be bent around sharp metal edges.
4. All wiring shall conform to the National Electric Code.

E. The display shall be protected from electrical spikes and transients.

F. The manufacturer shall provide an earth-ground lug on the display.

2.03 DISPLAY PERFORMANCE

A. Display Capability

1. The LED display shall present messages that are continuous, uniform, and unbroken in appearance.
2. The LED display shall be capable of producing 281 trillion colors for RGB and 4096 shades of color for monochrome red or amber at all dimming levels.
3. Each display pixel shall be composed of one each – red, green, and blue LEDS or one red or one amber

4. The LED display shall be capable of displaying all true type fonts.
5. The display shall be able to display messages composed of any combination of alphanumeric text, punctuation symbols, graphic images, and pre-canned video files.
6. Video and message files shall have up to a 30 frame per second playback capability.

B. Controller

1. The display's controller shall be able to run independently from a controlling computing device allowing the display to operate even when the controlling device is unhooked or turned off.
2. Communication protocol shall support other matrix products from the vendor such as other outdoor or indoor displays of varying sizes and/or colors.
3. Each controller shall be connected to a light sensor allowing each LED display to automatically adjust brightness according to display direction and lighting conditions.
4. The controller shall allow connection to a temperature sensor that provides accurate site temperatures.
5. Active presentations, stored presentations, schedules, display configuration, time and date shall be stored in non-volatile memory. No external power or battery backup will be required to maintain this data.

C. Control and Communications

1. The display controller should be DHCP-enabled and allow for static IP addressing.
2. Each single-face display shall be controlled and monitored by its own LED controller.
3. The LED controller shall be able to receive instructions from and provide information by accessing the Venus Control Suite using the following communication modes:

a. Select one only:
b. Ethernet Fiber Optic
c. Ethernet Bridge Radio
d. Ethernet Cat6 Wire
e. Ethernet CDMA Modem

2.04 CONTROL SOFTWARE

A. Control Software: Display content and scheduling shall be via Venus Control Suite (VCS) cloud-based solution. Software to be hosted on manufacturer's servers at no cost to the school. Web browser access to the solution to support iOS Safari, Android Chrome, Internet Explorer v11+, Microsoft Edge, Google Chrome and Mozilla Firefox.

B. Basic content creation to be performed via browser-based online editor.

C. Expanded content creation tools available via PC-compatible Content Studio download.

D. Supports import of images (PNG, BMP, GIF, JPG, PSD) and video files (AVI, MPG, MP4, MOV) in both browser-based and downloadable content utilities.

E. Sign to be added to existing School District VCS account.

F. Sign Contractor shall include all required licensing fees if any.

PART 3 - EXECUTION

3.01 EXAMINATION

Mounting structure to be installed by contractor to support desired displays in all locations. Verify that separate conduit is in place for power and data to display, unless fiber is being used. Verify that all control equipment has access to 120 VAC.

3.02 INSTALLATION

A. Support structure design depends on the mounting methods, display size, and weight. The structure design is critical and should be done only by a qualified individual. It is the customer's responsibility to ensure that the structure and mounting hardware are adequate.

B. It is the customer's responsibility to ensure that the installation meet local standards. The mounting hardware shall be capable of supporting all components to be mounted.

C. All mounted displays must be inspected by a qualified structural engineer.

D. Possible power and signal entrances are designated by etched markings. Separate conduit must be used to route the power, signal in wires, and signal out wires.

E. Displays must be grounded according to the provisions outlined in Article 250 of the National Electrical Code. The display must be connected to earth-ground. Proper grounding is necessary for reliable equipment operation and protects the equipment from damaging electrical disturbances and lightning.

3.03 INSTALLATION – CONTROL CENTER

A. Provide boxes, cover plates and jacks in locations per plans.

B. Test connect control unit to all jacks and check for proper operation of control unit, scoreboard and all features. Leave control unit in carrying case and other loose accessories with owner's designated representative.

C. Verify earth ground does not exceed 15 ohms. If 15 ohms is not achievable due to soil conditions – provide additional ground rods or chemical grounding system as applicable.

END OF SECTION

SECTION 21 00 00
GENERAL FIRE SUPPRESSION REQUIREMENTS

PART 1 - GENERAL

1.01 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.02 SUBMITTALS

A. Welding certificates.

B. Qualifications for installing and maintenance technicians.

C. In addition to any fire suppression system documents that are required to be submitted in other Division 21 sections, drawings are also to be submitted review and approval to the designer.

D. In Microsoft Excel, a complete sprinkler device report is required, which covers all sprinkler devices by location, per building served. Report to include all system components identified on the risers, total number of sprinklers per floor, flow switches, tampers, FDC's, inspectors test valves, standpipes, backflow preventers, gauges, hose connections and cabinets, and all other similar and required components.

1.03 QUALITY ASSURANCE AND COORDINATION

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."

2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for Fire-Suppression Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

D. Comply with applicable codes, standards, and requirements of authorities having jurisdiction. For the California Building Code shall be consulted for deviations from NFPA standards.

E. Comply with the California Building Code and Fire Code, and required references, City of Compton Fire Prevention Code, and required references, and with all other requirements of the

local Authority Having Jurisdiction (AHJ). In cases where these requirements deviate from the project contract documents, the most stringent shall govern.

F. System Designs: Shall be provided by a properly qualified and licensed Professional Fire Protection Engineer.

G. All system designs, materials, and installations shall meet applicable FM Global requirements.

H. Comply with most current edition of the California Codes.

PART 2 - PRODUCTS

2.01 EQUIPMENT AND MATERIALS:

A. All equipment and materials shall be furnished in strict accordance with the instructions of the manufacturer of the equipment named, according to NFPA and FM Global requirements and standards, and according to Specification requirements. Bids shall be based upon one of the manufacturers specified.

B. Where multiple manufacturers are named the drawings and specifications are based on the requirements and layouts for the equipment of the first named manufacturer.

C. As system flows, tampers, etc. need to be connected to facility fire alarm system and the DDC/BAS system(s), the flows, tampers, and other similar devices are to be furnished with two sets of contacts so that the fire alarm contractor can tie to one set and the Division 25 contractor can tie to the other set.

2.02 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 21 Sections for pipe, tube, and fitting materials and joining methods. No cast fittings allowed for new piping, all materials must be malleable iron or steel (for couplings), as applicable with specific piping system.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.03 JOINING MATERIALS

A. Refer to individual Division 21 Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8, BCuP Series or BAg1, unless otherwise indicated.

E. Welding Filler Metals: Comply with AWS D10.12.

2.04 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

B. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

C. Pressure Plates: Stainless steel. Include two for each sealing element.

D. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.05 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with

welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral water stop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with set screws.

2.06 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, and tube, that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw.

1. Finish: Polished chrome plated.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.

1. Finish: Polished chrome plated.

2.07 GROUT

A. Description: ASTM C 1107, Grade B, non-shrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, non-staining, noncorrosive, nongaseous, and recommended for interior and exterior applications.

2. Design Mix: 5000-psi, 28-day compressive strength.

3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.01 FIRE-SUPPRESSION DEMOLITION

A. Refer to Division 01 Section covering cutting and patching and the Division 02 Section covering demolition for general demolition requirements and procedures.

B. For renovations/additions, disconnect, demolish, and remove fire-suppression systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.

2. Piping to Be Abandoned in Place: Not allowed, all piping no longer needed is to be removed.

3. Equipment to Be Removed: Disconnect and cap services and remove equipment.

4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.

5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity

and quality.

3.02 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 21 Sections specifying specific systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Select system components with pressure rating equal to or greater than system operating pressure in accordance with applicable NFPA document.

K. Install escutcheons for penetrations of walls, ceilings, and floors.

L. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

M. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Install steel pipe for sleeves smaller than 6 inches in diameter.

2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.

3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

N. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

O. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

P. Verify final equipment locations for roughing-in.

Q. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

R. For all systems utilizing water from a campus main, all connections to same shall include a properly rated check valve and isolation valve, in addition to any required backflow preventers, etc.

S. For water-based suppression systems, for multi-story buildings, each branch off a riser per floor, is to have a properly rated check valve.

3.03 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 21 Sections specifying specific systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube ends. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.04 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.

2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.

3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.

4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

5. Install anchor bolts to elevations required for proper attachment to supported equipment.

6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

7. Use 3000-psi 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete". Pea gravel mix designs are not permitted.

3.05 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor fire-suppression materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.06 GROUTING

A. Mix and install grout for fire-suppression equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

3.07 SYSTEM TESTING

A. All system testing to meet local jurisdiction and firefighting authority, applicable NFPA codes and standards (NFPA 10, 101, 2001, 96, and other as applicable), and FM Global requirements. Testing methods (initial installation for acceptance and then weekly, monthly, quarterly, semi- annually, and annually as required) to be included, and tests to be used are ones that actually flow water (depending on exactly what type of system or component is being tested).

END OF SECTION

SECTION 21 13 14D
AUTOMATIC SPRINKLER SYSTEMS (DRY-PIPE)

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Aboveground fire protection pipe, fittings, and specialties inside the building from 1’-0” above finished floor, 1’-0” inside the exterior wall, or connection provided in the domestic water line as shown on the drawings.
2. Fire-protection valves, and compressors.
3. Fire-department connections.
4. Sprinkler specialty pipe fittings.
5. Sprinklers.
6. Alarm devices.
7. Pressure gages.
8. Backflow preventers.

1.02 SYSTEM DESCRIPTIONS

A. Dry-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing dedicated compressed air. Opening of sprinklers releases compressed air and permits water pressure to open dry-pipe valve. Water then flows into piping and discharges from sprinklers that are open.

1.03 PERFORMANCE REQUIREMENTS

A. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.

B. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a properly licensed and qualified professional engineer, using performance requirements and design criteria indicated. Professional Engineer shall seal (stamp) hydraulic calculations and sprinkler system drawings. Professional Engineer shall be registered in the State of Illinois.

1. The Contractor shall perform a flow test in accordance with NFPA and with FM Global or obtain water design data from the Local Water Department if data is not shown on the drawings.

C. Sprinkler system design shall be approved by authorities having jurisdiction.

1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
2. Sprinkler Occupancy Hazard Classifications, densities, and head spacing shall be as indicated on the drawings.

1.04 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For dry-pipe sprinkler systems. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.

C. Delegated-Design Submittal: For sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified

professional engineer responsible for their preparation.

D. Qualification Data: For qualified Installer and Professional Engineer.

E. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.

F. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."

G. Field quality-control reports.

H. Operation and maintenance data.

1.05 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.

a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified Professional Engineer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. NFPA Standards and Other Requirements: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:

1. NFPA 13, "Installation of Sprinkler Systems."

2. NFPA 14, "Standpipe and Hose Systems."

3. NFPA 70, "National Electrical Code."

4. NFPA 72, "National Fire Alarm and Signaling Code."

5. NFPA 291, "Fire Flow Testing and Marking of Hydrants."

6. NFPA 1963, "Fire Hose Connections."

7. Comply with the Illinois Building Code and Fire Code, and required references, the City of Chicago Building Code, Fire Prevention Code, and required references, and with all other requirements of the local Authority Having Jurisdiction (AHJ).

D. Comply with FM Global requirements for general installation of systems, prevention and control of internal corrosion in automatic sprinkler systems, installations in any residential occupancies, for dry pipe, deluge, and pre-action valves and accessories, for system inspections, testing and maintenance, for pipe friction losses for hydraulics of fire protection systems, for pressure reducing valves for fire protection service, for cross connections, for fire protection pumps, for installation/maintenance of fire service mains, for standpipes and hose systems, and for fire protection water demand for non-storage sprinkled properties.

PART 2 - PRODUCTS

2.01 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article at the end of this Section for applications of pipe, tube, and fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.02 STEEL PIPE AND FITTINGS

A. Standard Weight, Galvanized-Steel Pipe: ASTM A 53 Schedule 40. Pipe ends may be factory or field formed to match joining method.

B. Schedule 30, Galvanized-Steel Pipe: ASTM A 135; ASTM A 795/A 795M; or ASME B36.10M, wrought steel; with wall thickness not less than Schedule 30 and not more than Schedule 40. Pipe ends may be factory or field formed to match joining method.

C. Thin wall Galvanized-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, threadable, with wall thickness less than Schedule 30 and equal to or greater than Schedule 10. Pipe ends may be factory or field formed to match joining method.

D. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.

E. Galvanized, Steel Couplings: ASTM A 865, threaded.

F. Galvanized, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.

G. Malleable- or Ductile-Iron Unions: UL 860.

H. Plain-End-Pipe Fittings: UL 213, ductile-iron body with retainer lugs that require one-quarter turn or screwed retainer pin to secure pipe in fitting.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Anvil International, Inc.
b. Shure joint Piping Products.

I. Grooved-Joint, Steel-Pipe Appurtenances:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Anvil International, Inc.
b. Corcoran Piping System Co.
c. Shure joint Piping Products.
d. Tyco Fire & Building Products LP.
e. Victaulic Company.

2. Pressure Rating: 175 psig minimum.

3. Galvanized, Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.

4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

2.03 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick.

1. Class 125, Flat-Face Flanges: Full-face gaskets.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

2.04 LISTED FIRE-PROTECTION VALVES

A. General Requirements:

1. Valves shall be UL listed or FM approved, and meet FM Global requirements.

2. Minimum Pressure Rating: 175 psig.

B. Check Valves:

1. Standard: UL 312
2. Pressure Rating: 250 psig minimum.
3. Type: Swing check.
4. Body Material: Cast iron.
5. End Connections: Flanged or grooved.

C. Bronze OS&Y Gate Valves:

1. Standard: UL 262.
2. Pressure Rating: 175 psig.
3. Body Material: Bronze.
4. End Connections: Threaded.

D. Iron OS&Y Gate Valves:

1. Standard: UL 262.
2. Pressure Rating: 250 psig.
3. Body Material: Cast or ductile iron.
4. End Connections: Flanged or grooved.

E. Ball Valves 2” and smaller:

1. Standard: UL 1091.
2. Pressure Rating: 175 psig minimum.
3. Body Material: Bronze.
4. End Connections: Threaded.

F. Indicating-Type Butterfly Valves (preferred):

1. Standard UL 1091.
2. Pressure Rating: 175 psig minimum.
3. Valve Type: Butterfly.
4. Body Material: Cast or ductile iron.
5. End Connections: Flanged, grooved, or wafer.
6. Valve Operation: Integral electrical, 115-V ac, prewired, single-circuit, supervisory switch indicating device.

2.05 TRIM AND DRAIN VALVES

A. General Requirements:

1. Standard: UL’s “Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Minimum Pressure Rating: 175 psig.

2.06 SPECIALTY VALVES AND COMPRESSORS

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Minimum Pressure Rating: 175 psig.
3. Body Material: Cast or ductile iron.
4. Size: Same as connected piping.
5. End Connections: Flanged or grooved.

B. Dry-Pipe Valves and Compressors:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Reliable Automatic Sprinkler Co., Inc.
   b. Victaulic Company.
   c. Viking Corporation.
2. Standard: UL 260
3. Design: Differential-pressure type.
4. Include UL 1486, quick-opening devices, trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.
5. Air Compressor:
   a. Standards: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
   b. Motor Horsepower: Fractional.
   c. Power: 120-V ac, 60 Hz, single phase, from normal/emergency circuit.
   d. Type: Tank and dedicated for this duty.

2.07 FIRE-DEPARTMENT CONNECTIONS

A. Flush-Type, Fire-Department Connection:

1. Standard: UL 405.
2. Type: Flush, for wall mounting.
3. Pressure Rating: 175 psig minimum.
4. Body Material: Corrosion-resistant metal.
5. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
6. Caps: Brass, lugged type, with gasket and chain.
7. Escutcheon Plate: Rectangular, brass, wall type.
8. Outlet: With pipe threads.
9. Body Style: Horizontal.
10. Number of Inlets: Two.
11. Outlet Location: Back or Bottom as shown on the drawings.

12. Escutcheon Plate Marking: Similar to " AUTO SPKR,.", and if dual service, mark the 2nd service as well.
13. Finish: Polished chrome plated.
14. Outlet Size: 4".
15. For the Evanston campus, provide a weatherproof, visual fire alarm signal device above the connection along with a weatherproof box/cabinet/panel for a future audible device.

2.08 SPRINKLER SPECIALTY PIPE FITTINGS

A. General Requirements for Dry-Pipe-System Fittings: UL listed for dry-pipe service.

B. Branch Outlet Fittings:

1. Standard: UL 213.
2. Pressure Rating: 175 psig minimum.
3. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
4. Type: Mechanical-T and -cross fittings.
5. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
6. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
7. Branch Outlets: Grooved, plain-end pipe, or threaded.

C. Flow Detection and Test Assemblies:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating: 175 psig minimum.
3. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
4. Size: Same as connected piping.
5. Inlet and Outlet: Threaded.

D. Zone/Floor Control Module:

1. UL listed, FM approved complete with flow switch, pressure gage, and ball valve.

E. Branch Line Testers:

1. Standard: UL 199.
2. Pressure Rating: 175 psig minimum.
3. Body Material: Brass.
4. Size: Same as connected piping.
5. Inlet: Threaded.
6. Drain Outlet: Threaded and capped.
7. Branch Outlet: Threaded, for sprinkler.

F. Sprinkler Inspector's Test Fittings:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.

2. Pressure Rating: 175 psig minimum.
3. Body Material: Cast- or ductile-iron housing with sight glass.
4. Size: Same as connected piping.
5. Inlet and Outlet: Threaded.

G. Adjustable Drop Nipples:

1. Standard: UL 1474.
2. Pressure Rating: 250 psig minimum.
3. Body Material: Steel pipe with EPDM O-ring seals.
4. Size: Same as connected piping.
5. Length: Adjustable.
6. Inlet and Outlet: Threaded.

H. Flexible, Sprinkler Hose Fittings:

1. Standard: UL 1474.
2. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
3. Pressure Rating: 175 psig minimum.
4. Size: Same as connected piping, for sprinkler.

I. Special Electrical Connection Requirements

1. For all devices/components requiring monitoring, etc, provide each with 2 sets of contacts, one for fire alarm system connection and one for Division 25 system connection.

2.09 SPRINKLERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Globe Fire Sprinkler Corporation.
2. Reliable Automatic Sprinkler Co., Inc.
3. Viking Corporation.
4. Victaulic Company.

B. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating for Automatic Sprinklers: 175 psig minimum.

C. Sprinkler Types:

1. Areas with suspended ceilings shall have dry type concealed pendent heads with 155-degree F sprinkler rating and 155-degree F cover plate rating. Cover to be color selected by Architect.
2. All other areas without ceilings shall have standard brass dry type upright sprinklers with 165-degree F rating.
3. Stairwells to have chrome plated dry type sidewall heads with 165-degree F rating.

D. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.

1. Sidewall Mounting: Chrome-plated steel one piece, flat.

2.10 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Water-Flow Indicators:

1. Standard: UL 346.

2. Water-Flow Detector: Electrically supervised.

3. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.

4. Type: Paddle operated.

5. Pressure Rating: 250 psig.

6. Design Installation: Horizontal or vertical.

C. Valve Supervisory Switches:

1. Standard: UL 346.

2. Type: Electrically supervised.

3. Components: Single-pole, double-throw switch with normally closed contacts.

4. Design: Signals that controlled valve is in other than fully open position. Also, external tamper switches or external wired tamper switches are required.

D. Special Electrical Connection Requirements

1. For all devices/components requiring monitoring and/or supervision, provide each with 2 sets of contacts, one for fire alarm system connection and one for Division 25 system connection.

2.11 PRESSURE GAGES

A. Standard: UL 393.

B. Dial Size: 3-1/2- to 4-1/2-inch diameter.

C. Pressure Gage Range: 0 to 300 psig.

D. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.

E. Air System Piping Gage: Include retard feature and "AIR" or "AIR/WATER" label on dial face.

2.12 BACKFLOW PREVENTERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide a Conbraco RPDA reduced pressure detector backflow preventer assemblies. The assemblies shall consist of two independent tri-link check valves within a single housing, sleeve access port, four test cocks and two drip tight shut-off valves. Tri-link checks shall be removable and serviceable, without the use of special tools.

B. The bypass assembly shall consist of a meter, which registers in either gallon or cubic measurement, a double check backflow assembly and required test cocks

C. The housing shall be constructed of 304 Schedule 40 stainless steel pipe with grooved end connections. Tri-link checks shall have chloramine resistant silicone discs and in operation shall produce drip tight closure against reverse flow caused by backpressure or back-siphonage.

D. UL/FM grooved gear operated butterfly valves with tamper switches.

E. Refer to Division 22 for other requirements for when connection to domestic water mains or services. These required backflow preventers shall be furnished by the project plumbing contractor but installed by the Division 21 contractor. Refer to Section 222114.

PART 3 - EXECUTION

3.01 WATER-SUPPLY CONNECTIONS

A. Connect sprinkler piping to building's interior water-distribution piping. Comply with requirements in Division 22 Section "Domestic Water Distribution System" for interior piping.

B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-distribution piping.

3.02 PIPING INSTALLATION

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.

1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.

B. Piping Standard: Comply with requirements in NFPA 13 for installation of sprinkler piping.

C. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

D. Install unions adjacent to each valve in pipes 2” and smaller.

E. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having 2-1/2” and larger end connections.

F. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.

G. Install sprinkler piping with drains for complete system drainage.

H. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

I. Install automatic (ball drip) drain valves to drain piping between fire-department connections and check valves. Drain to floor drain or to outside building.

J. Install alarm devices in piping systems.

K. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements in NFPA 13 for hanger materials.

L. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than ¼” and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal and install where they will not be subject to freezing.

M. Drain dry-pipe sprinkler piping.

N. Pressurize and check dry-pipe sprinkler system piping and air compressor(s).

3.03 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

B. Install unions adjacent to each valve in pipes 2” and smaller.

C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having 2-1/2” and larger end connections.

D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

H. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.

I. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.04 VALVE AND SPECIALTIES INSTALLATION

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

D. Specialty Valves and Switch Requirements:

1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.

2. Dry-Pipe Valves: Install trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.

a. Install air compressor and compressed-air supply piping.

3. Valve supervisory switches shall be provided for each point where the water supply to the system or parts of the system can be shut off. Valves grouped at a common location can be combined into the same zone to a maximum of 5. In no case shall valves be concealed.

E. For multi-story buildings, provide and install properly rated check valves at branches on each floor.

3.05 SPRINKLER INSTALLATION AND APPLICATION, AND SIGNAL MONITORING

A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels unless the sprinklers can otherwise be aesthetically located, but off-center locations must be individually approved ahead of time by the Architect. It is recommended to install sprinkler piping placed in one half of the tile panel to eliminate reworking of piping or other trades in field due to poor coordination.

B. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.

C. Install sprinklers into flexible, sprinkler hose fittings and install hose into bracket on ceiling grid.

D. Quick response sprinklers are required in offices, classrooms, hallways, assembly areas, atriums, sleeping rooms, dining rooms, and most lab areas. Ordinary response sprinklers shall be used in storage areas, mechanical rooms, janitor closets, and areas where special coated sprinklers are required. Temperature ratings shall be the maximum expected ceiling temperatures.

E. Trouble and alarm signals from the fire extinguishing systems shall be connected to the building's fire alarm system. Where not possible, alarm and trouble signals shall be transmitted to the central monitoring station.

3.06 FIRE-DEPARTMENT CONNECTION INSTALLATION

A. Install wall-type, fire-department connections.

B. Install automatic (ball drip) drain valve at each check valve for fire-department connection.

3.07 ESCUTCHEON INSTALLATION

A. Install escutcheons for penetrations of walls, ceilings, and floors.

B. Escutcheons for New Piping:

1. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
2. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
3. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
4. Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome-plated finish.
5. Bare Piping in Equipment Rooms: One piece, cast brass.
6. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

3.08 SLEEVE INSTALLATION

A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.

B. Sleeves are not required for core-drilled holes.

C. Permanent sleeves are not required for holes formed by removable PE sleeves.

D. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.

E. Install sleeves in new partitions, slabs, and walls as they are built.

F. For interior wall penetrations, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint. Comply with requirements for joint sealants in

Division 07 Section "Joint Sealants".

G. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint. Comply with requirements for joint sealants in Division 07 Section "Joint Sealants".

H. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using sleeve seals.

I. Seal space outside of sleeves in concrete slabs and walls with grout. Refer to Section 21 00 00 - 2.07 Grout

J. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe unless otherwise indicated.

K. Install sleeve materials according to the following applications:

1. Sleeves for Piping Passing through Concrete Floor Slabs: Galvanized-steel pipe.

2. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Galvanized-steel pipe.

   a. Extend sleeves 2 inches above finished floor level.
   b. For pipes penetrating floors with membrane waterproofing, extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Comply with requirements for flashing in Division 07 Section "Sheet Metal Flashing and Trim".

3. Sleeves for Piping Passing through Gypsum-Board Partitions:

   a. PVC-pipe sleeves for pipes smaller than 6 inch.
   b. Galvanized-steel-sheet sleeves for pipes 6 inch and larger.
   c. Exception: Sleeves are not required for water-supply tubes and waste pipes for individual plumbing fixtures if escutcheons will cover openings.

4. Sleeves for Piping Passing through Exterior Concrete Walls:

   a. Galvanized-steel-pipe sleeves for pipes smaller than 6 inches.
   b. Cast-iron wall pipe sleeves for pipes 6 inch and larger.
   c. Install sleeves that are large enough to provide 1 inch annular clear space between sleeve and pipe when sleeve seals are used.

5. Sleeves for Piping Passing through Interior Concrete Walls:

   a. Galvanized-steel pipe sleeves for pipes smaller than 6 inch.
   b. Galvanized-steel-sheet sleeves for pipes 6 inch and larger.

L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping" for firestop materials and installations.

3.09 SLEEVE SEAL INSTALLATION

A. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entries into building.

B. Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seal components and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.10 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section covering identification for electrical systems.

3.11 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter, and per FM Global requirements.

4. Energize circuits to electrical equipment and devices.

5. Start and run air compressors.

6. Coordinate with fire-alarm tests. Operate as required.

7. Coordinate with fire-pump tests. Operate as required.

8. Verify that equipment hose threads are same as local fire-department equipment.

C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.12 CLEANING

A. Clean dirt and debris from sprinklers.

B. Remove and replace sprinklers with paint other than factory finish.

3.13 PIPING SCHEDULE

A. Piping between Fire-Department Connections and Check Valves: Galvanized, standard-weight steel pipe with grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.

B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.

C. Dry-pipe sprinkler system, 2 inches and smaller, shall be one of the following:

1. Standard-weight or Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.

2. Standard-weight Schedule 30 or thin-wall, galvanized-steel pipe with plain ends; plain- end-pipe fittings; and twist-locked joints.

3. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

D. Dry-pipe sprinkler system, 2-1/2 inches to 6 inches, shall be one of the following:

1. Standard-weight or Schedule 30, galvanized-steel pipe with threaded ends; galvanized,

gray-iron threaded fittings; and threaded joints.

2. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

END OF SECTION

SECTION 21 13 14W
AUTOMATIC SPRINKLER SYSTEMS (WET PIPE SYSTEMS)

PART 1 - GENERAL

1.01 SYSTEM DESCRIPTIONS

A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply through alarm valve. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.

B. Deluge and/or Pre-Action Systems: Provide as required for specific applications according to NFPA and FM Global requirements.

1.02 PERFORMANCE REQUIREMENTS

A. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.

B. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a properly licensed and qualified Professional Engineer, using performance requirements and design criteria indicated. Professional Engineer shall seal (stamp) hydraulic calculations and sprinkler system drawings. Professional Engineer shall be registered in the State of California.

1. The Contractor shall perform a flow test in accordance with NFPA or obtain water design data from the Local Water Department if data is not shown on the drawings.

C. Sprinkler system design shall be approved by the authorities having jurisdiction.

1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.

2. Sprinkler Occupancy Hazard Classifications, densities, and head spacing shall be as indicated on the drawings.

1.03 QUALITY ASSURANCE

A. Qualifications:

1. Provide professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test with corrections to the flow obtained per NFPA 291 Part 4.12 System Correction. Engineering Responsibility shall include Preparation of working plans, calculations, and field test reports by a properly qualified and licensed California Professional Engineer and approval from Division of State Architect.

B. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. NFPA Standards and Other Requirements: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:

1. NFPA 13, "Installation of Sprinkler Systems."

2. NFPA 14, "Standpipe and Hose Systems."

3. NFPA 70, "National Electrical Code."

4. NFPA 72, "National Fire Alarm and Signaling Code."

5. NFPA 291, "Fire Flow Testing and Marking of Hydrants."

6. NFPA 1963, "Fire Hose Connections."
7. Comply with the California Building Code and Fire Code, and required references, City/County of Los Angeles Building Code, Fire Prevention Code, and required references, and with all other requirements of the local Authority Having Jurisdiction (AHJ).

E. Comply with FM Global requirements for general installation of systems, prevention and control of internal corrosion in automatic sprinkler systems, installations in any residential occupancies, for deluge, and pre-action valves and accessories, for cross connections, for pressure reducing valves for fire protection service, for system inspections, testing and maintenance, for pipe friction losses for hydraulics of fire protection systems, for fire protection pumps, for fixed water spray systems for fire protection, for water mist systems, for installation/maintenance of fire service mains, for standpipes and hose systems, and for fire protection water demand for non-storage sprinkled properties.

PART 2 - PRODUCTS

2.01 REQUIREMENT

A. All materials and components shall meet local jurisdiction, NFPA, and FM Global requirements.

2.02 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article at the end of this Section for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

2.03 STEEL PIPE AND FITTINGS

A. Standard Weight, Black-Steel Pipe: ASTM A 53 Schedule 40. Pipe ends may be factory or field formed to match joining method.

B. Schedule 30, Black-Steel Pipe: ASTM A 135; ASTM A 795/A 795M, or ASME B36.10M, wrought steel; with wall thickness not less than Schedule 30 and not more than Schedule 40. Pipe ends may be factory or field formed to match joining method.

C. Thin wall Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, threadable, with wall thickness less than Schedule 30 and equal to or greater than Schedule 10. Pipe ends may be factory or field formed to match joining method.

D. Black Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.

E. Uncoated, Steel Couplings: ASTM A 865, threaded.

F. Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.

G. Malleable- or Ductile-Iron Unions: UL 860.

H. Cast-Iron Flanges: ASME 16.1, Class 125.

I. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.

J. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.

K. Grooved-Joint, Steel-Pipe Appurtenances:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Corcoran Piping System Co.
b. Tyco Fire & Building Products LP.
c. Victaulic Company.

2. Pressure Rating: 175 psig minimum.
3. Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

2.04 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick.
   1. Full-face gaskets.
B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
C. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.05 LISTED FIRE-PROTECTION VALVES

A. General Requirements:
   1. Valves shall be UL listed or FM approved, and meet FM Global requirements.
   2. Minimum Pressure Rating: 175 psig.
B. Check Valves:
   1. Standard: UL 312.
   2. Pressure Rating: 250 psig minimum.
   3. Type: Swing check.
   4. Body Material: Cast iron.
   5. End Connections: Flanged or grooved.
C. Bronze OS&Y Gate Valves:
   1. Standard: UL 262.
   2. Pressure Rating: 175 psig.
   3. Body Material: Bronze.
   4. End Connections: Threaded.
D. Iron OS&Y Gate Valves:
   1. Standard: UL 262.
   2. Pressure Rating: 250 psig minimum.
   3. Body Material: Cast or ductile iron.
   4. End Connections: Flanged or grooved.
E. Ball Valves 2” and smaller:
   1. Standard UL 1091.
   2. Pressure Rating: 175 psig minimum.
   3. Body Material: Bronze.
   4. End Connections: Threaded.

F. Indicating-Type Butterfly Valves:

1. Standard: UL 1091.
2. Pressure Rating: 175 psig minimum.
3. Valve Type: Butterfly.
4. Body Material: Cast or ductile iron.
5. End Connections: Flanged, grooved, or wafer.
6. Valve Operation: Integral electrical, 115-V ac, prewired, single-circuit, supervisory switch indicating device.

2.06 TRIM AND DRAIN VALVES

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Minimum Pressure Rating: 175 psig.

2.07 SPECIALTY VALVES

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Minimum Pressure Rating: 175 psig.
3. Body Material: Cast or ductile iron.
4. Size: Same as connected piping.
5. End Connections: Flanged or grooved.

B. Riser Check Valves with Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Reliable Automatic Sprinkler Co., Inc.
   b. Victaulic Company.
   c. Viking Corporation.
2. Standard: UL 193.
3. Design: For vertical installation.
4. Trim Package: All necessary nipples and fittings, main drain valve, and gauges.

C. Automatic (Ball Drip) Drain Valves:

1. Standard: UL 1726.
2. Pressure Rating: 175 psig minimum.
3. Type: Automatic draining, ball check.
4. Size: NPS 3/4.
5. End Connections: Threaded.

2.08 FIRE-DEPARTMENT CONNECTIONS

A. Flush-Type, Fire-Department Connection:

1. Standard: UL 405.
2. Type: Flush, for wall mounting.
3. Pressure Rating: 175 psig minimum.
4. Body Material: Corrosion-resistant metal.
5. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
6. Caps: Brass, lugged type, with gasket and chain.
7. Escutcheon Plate: Rectangular, brass, wall type.
8. Outlet: With pipe threads.
9. Body Style: Horizontal.
10. Number of Inlets: Two.
11. Outlet Location: Back.
12. Escutcheon Plate Marking: Similar to " AUTO SPKR", and if dual service, mark the 2nd service as well per requirements.
13. Finish: Polished chrome plated.
14. Outlet Size: 4”.
15. For the Evanston campus, provide a weatherproof, visual fire alarm signal device above the connection along with a weatherproof box/cabinet/panel for a future audible device.

2.09 SPRINKLER SPECIALTY PIPE FITTINGS

A. Branch Outlet Fittings:

1. Standard: UL 213.
2. Pressure Rating: 175 psig minimum.
3. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
4. Type: Mechanical-T and -cross fittings.
5. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
6. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
7. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Flow Detection and Test Assemblies:

1. Standard: UL’s “Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating: 175 psig minimum.
3. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
4. Size: Same as connected piping.
5. Inlet and Outlet: Threaded.

C. Zone/Floor Control Module:

1. UL listed, FM approved complete with flow switch, pressure gage, and ball valve.

D. Branch Line Testers:
   1. Standard: UL 199.
   2. Pressure Rating: 175 psig minimum.
   3. Body Material: Brass.
   4. Size: Same as connected piping.
   5. Inlet: Threaded.
   6. Drain Outlet: Threaded and capped.
   7. Branch Outlet: Threaded, for sprinkler.

E. Sprinkler Inspector's Test Fittings:
   1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
   2. Pressure Rating: 175 psig minimum.
   3. Body Material: Cast- or ductile-iron housing with sight glass.
   4. Size: Same as connected piping.
   5. Inlet and Outlet: Threaded.

F. Adjustable Drop Nipples:
   1. Standard: UL 1474.
   2. Pressure Rating: 250 psig minimum.
   3. Body Material: Steel pipe with EPDM-rubber O-ring seals.
   4. Size: Same as connected piping.
   5. Length: Adjustable.
   6. Inlet and Outlet: Threaded.

G. Braided Flexible, Sprinkler Hose Fittings:
   1. Standard: UL 1474.
   2. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
   3. Pressure Rating: 175 psig minimum.
   4. FM approved.
   5. Size: Same as connected piping, for sprinkler.

2.10 SPRINKLERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Globe Fire Sprinkler Corporation.
   2. Reliable Automatic Sprinkler Co., Inc.
   3. Viking Corporation.
   4. Victaulic Company.

B. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating for Automatic Sprinklers: 175 psig minimum.
3. Sprinklers shall be used in accordance with their listed coverage limitations.
4. Sprinkler temperature classification shall be ordinary **as required.**
5. Sprinklers in high heat areas including attic spaces or in close proximity to unit heaters shall have temperature classification in accordance with NFPA 13.

C. Sprinkler Types:

1. Concealed Sprinkler: Concealed sprinkler shall be chrome-plated quick-response type and shall have a nominal 1/2 inch or 17/32-inch orifice. Cover to be color selected by Architect.
2. Recessed Sprinkler: Recessed sprinkler shall be chrome-plated quick-response type and shall have a nominal 1/2 inch or 17/32-inch orifice.
3. Upright Sprinkler: Upright sprinkler shall be chrome-plated quick-response type and shall have a nominal 1/2 inch or 17/32-inch orifice.
4. Sidewall Sprinkler: Sidewall sprinkler shall have a nominal 1/2-inch orifice. Sidewall sprinkler shall have a polished chrome finish. Sidewall sprinkler shall be the quick-response type.
5. Intermediate Level Rack Sprinkler: Intermediate level rack sprinkler shall be of the upright or pendent type with nominal 13 mm 1/2-inch orifice and minimum "K" factor of 5.5. The sprinkler shall be equipped with a deflector plate to shield the fusible element from water discharged above it.

D. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.

1. Sidewall Mounting: Chrome-plated steel, one piece, flat.

E. Sprinkler Guards

1. Guards shall be a steel wire cage designed to encase the sprinkler and protect it from mechanical damage. Guards shall be provided on sprinklers in sports activity areas, and as otherwise noted on drawings.

2.11 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Water-Flow Indicators:

1. Standard: UL 346.
2. Water-Flow Detector: Electrically supervised.
3. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
4. Type: Paddle operated.
5. Pressure Rating: 250 psig.
6. Design Installation: Horizontal or vertical.

C. Valve Supervisory Switches:

1. Standard: UL 346.
2. Type: Electrically supervised.
3. Components: Single-pole, double-throw switch with normally closed contacts.
4. Design: Signals that controlled valve is in other than fully open position. Also, external tamper switches or external wired tamper switches are required.

2.12 PRESSURE GAGES

A. Standard: UL 393.

B. Dial Size: 3-1/2- to 4-1/2-inch (90- to 115-mm) diameter.

C. Pressure Gage Range: 0 to 300 psig (0 to 2070 kPa).

D. Water System Piping Gage: Include "WATER" label on dial face.

2.13 BACKFLOW PREVENTERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide a Conbraco RPDA reduced pressure detector assembly backflow preventer. The assembly shall consist of two independent tri-link check valves within a single housing, sleeve access port, four test cocks and two drip tight shut-off valves. Tri-link checks shall be removable and serviceable, without the use of special tools.

B. The bypass assembly shall consist of a meter, which registers in either gallon or cubic measurement, a double check backflow assembly and required test cocks

C. The housing shall be constructed of 304 Schedule 40 stainless steel pipe with grooved end connections. Tri-link checks shall have chloramine resistant silicone discs and in operation shall produce drip tight closure against reverse flow caused by backpressure or back-siphonage.

D. UL/FM grooved gear operated butterfly valves with tamper switches.

E. Refer to Division 22 for other requirements for when connection to domestic water mains or services. These required backflow preventers shall be furnished by the project plumbing contractor but installed by the Division 21 contractor. Refer to Section 22 2114.

2.14 SPECIAL COMPONENT ELECTRICAL CONTACT REQUIREMENTS

A. All devices/components required to be monitored electrically for flow, tamper, etc, shall have two sets of contacts, one for the fire alarm system connection and one for the Division 25 system connection.

PART 3 - EXECUTION

3.01 WATER-SUPPLY CONNECTIONS

A. If applicable, connect sprinkler piping to building's interior water-distribution piping. Comply with requirements for interior piping in Division 22 Section "Domestic Water Distribution System."

B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-distribution piping.

3.02 PIPING INSTALLATION

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.

1. Deviations from approved working plans for piping require written approval from authorities

having jurisdiction. File written approval with Architect before deviating from approved working plans.

B. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.

C. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

D. Install unions adjacent to each valve in pipes NPS 2 and smaller.

E. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

F. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.

G. Install sprinkler piping with drains for complete system drainage.

H. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

I. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.

J. Install alarm devices in piping systems.

K. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.

L. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal and install where they will not be subject to freezing.

M. Fill sprinkler system piping with water.

N. For multi-story buildings, refer to Section 21 0000 for floor branch check valve requirements.

3.03 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

D. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

F. Steel-Piping, Pressure-Sealed Joints: Join lightwall steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.

G. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

H. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

I. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.04 VALVE AND SPECIALTIES INSTALLATION

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install backflow preventers at connection to potable-water-supply source.

D. Specialty Valves and Switch Requirements:

1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.

2. Alarm Valves: Include bypass check valve and retarding chamber drain-line connection.

3. Valve supervisory switches shall be provided for each point where the water supply to the system or parts of the system can be shut off. Valves grouped at a common location can be combined into the same zone to a maximum of 5. In no case shall valves be concealed.

E. All devices/components required to be monitored electrically for flow, tamper, etc., shall have two sets of contacts, one for the fire alarm system connection and one for the Division 25 system connection.

3.05 SPRINKLER INSTALLATION AND APPLICATION

A. Install sprinklers in suspended ceilings in center of narrow dimension of acoustical ceiling panels or where indicated on Architectural Reflected Ceiling Plans, unless the sprinklers can be otherwise be aesthetically located, but off-center locations must be approved ahead of time individually by the Architect.

B. Quick response sprinklers are required in offices, classrooms, hallways, assembly areas, atriums, sleeping rooms, dining rooms, and most lab areas. Ordinary response sprinklers shall be used in storage areas, mechanical rooms, janitor closets, and areas where special coated sprinklers are required. Temperature ratings shall be the maximum expected ceiling temperatures.

C. Install sprinklers into flexible, sprinkler hose fittings and install hose into bracket on ceiling grid.

3.06 FIRE-DEPARTMENT CONNECTION INSTALLATION

A. Install wall-type, fire-department connection.

B. Install automatic (ball drip) drain valve at each check valve for fire-department connection.

3.07 ESCUTCHEON INSTALLATION

A. Install escutcheons for penetrations of walls, ceilings, and floors.

B. Escutcheons for New Piping:

1. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
2. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
3. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
4. Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome- plated finish.
5. Bare Piping in Equipment Rooms: One piece, cast brass.
6. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

3.08 SLEEVE INSTALLATION

A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.

B. Sleeves are not required for core-drilled holes.

C. Permanent sleeves are not required for holes formed by removable PE sleeves.

D. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.

E. Install sleeves in new partitions, slabs, and walls as they are built.

F. For interior wall penetrations, seal annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for size, depth, and location of joint. Comply with requirements for joint sealants in Division 07 Section "Joint Sealants."

G. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint. Comply with requirements for joint sealants in Division 07 Section "Joint Sealants."

H. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using sleeve seals.

I. Seal space outside of sleeves in concrete slabs and walls with grout.

J. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation unless otherwise indicated.

K. Install sleeve materials according to the following applications:

1. Sleeves for Piping Passing through Concrete Floor Slabs: Galvanized-steel pipe.

2. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Galvanized-steel pipe.

   a. Extend sleeves 2 inches above finished floor level.
   b. For pipes penetrating floors with membrane waterproofing, extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Comply with requirements for flashing in Division 07 Section "Sheet Metal Flashing and Trim."

3. Sleeves for Piping Passing through Gypsum-Board Partitions:

   a. Galvanized-steel-sheet sleeves for pipes NPS 6 (DN 150) and larger.

4. Sleeves for Piping Passing through Exterior Concrete Walls:

   a. Galvanized-steel-pipe sleeves for pipes smaller than NPS 6.
   b. Cast-iron wall-pipe sleeves for pipes NPS 6 and larger.

c. Install sleeves that are large enough to provide 1-inch annular clear space between sleeve and pipe or pipe insulation when sleeve seals are used.

5. Sleeves for Piping Passing through Interior Concrete Walls:

a. Galvanized-steel-pipe sleeves for pipes smaller than NPS 6.
b. Galvanized-steel-sheet sleeves for pipes NPS 6 and larger.

L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestop materials and installations in Division 07 Section "Penetration Firestopping."

3.09 SLEEVE SEAL INSTALLATION

A. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entries into building.

B. Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seal components and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.10 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section covering identification for electrical systems.

3.11 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter, and to FM global requirements.

4. Energize circuits to electrical equipment and devices.

5. Coordinate with fire-alarm tests. Operate as required.

6. Verify that equipment hose threads are same as local fire-department equipment.

C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.12 PIPING SCHEDULE

A. Piping between Fire-Department Connections and Check Valves: Galvanized, standard-weight steel pipe with grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.

B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.

C. Wet-pipe sprinkler system, NPS 2 and smaller, shall be one of the following:

1. Standard-weight or Schedule 30, black-steel pipe with threaded ends; uncoated, gray- iron threaded fittings; and threaded joints.
2. Standard-weight or Schedule 30, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

D. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 to NPS 6, shall be one of the following:

1. Standard-weight or Schedule 30, black-steel pipe with threaded ends; uncoated, gray- iron threaded fittings; and threaded joints.
2. Standard-weight or Schedule 30, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
3. Thin wall black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3.13 SPRINKLER SCHEDULE

A. Use sprinkler types in subparagraphs below for the following applications:

1. Rooms without Ceilings: Upright sprinklers.
2. Rooms with Suspended Ceilings: **Recessed sprinklers** or **Concealed sprinklers**.
3. Wall Mounting: Sidewall sprinklers.

B. Provide sprinkler types in subparagraphs below with finishes indicated.

1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
2. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
3. **Upright** and **Sidewall** Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

END OF SECTION

SECTION 21 24 00
CLEAN AGENT CHEMICAL SUPPRESSION SYSTEMS

PART 1 - GENERAL

1.01 APPLICABLE STANDARDS AND PUBLICATIONS

A. The design, installation, testing and maintenance of the Clean Agent Extinguishing System shall be in accordance with the applicable requirements set forth in the latest edition of the following codes, standards, and third-party approval agencies:

1. California Building Code, Fire Code, and required references
2. County of Los Angeles Building Code, Fire Prevention Code, and required references.
3. Requirements of the local Authority Having Jurisdiction (AHJ)
4. NFPA 2001: Standard on Clean Agent Fire Extinguishing Systems
5. NFPA 70: National Electrical Code
6. NFPA 72: National Fire Alarm and Signaling Code
7. NFPA 75: Standard for the Protection of Electronic Computer/Data Processing Equipment
8. FM Global
9. Underwriters Laboratories (UL)

1.02 DEFINITIONS

A. AHJ: Authority Having Jurisdiction.

B. ATS: Acceptance Testing Specifications.

1.03 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with FM Global requirements for general installation of clean agent systems, and for system inspections, testing and maintenance.

C. Additional FM Global Compliance: Provide components that are FM Global Approved and that are listed in FM Global's "Approval Guide."

D. UL Compliance: Provide equipment listed in UL's "Fire Protection Equipment Directory."

E. All devices, components, and equipment shall be new, standard products of the manufacturer's latest design and suitable to perform the functions intended. The name of the manufacturer, part number, and serial number shall appear on all major components.

F. Locks for all cabinets shall be keyed alike.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with requirements, provide a Fike; FM-200 system, or an equal system by one of the following manufacturers:

1. Chemetron Fire Systems; a UTC Fire & Security company.
2. Fenwal Protection Systems.

B. Description: Clean-agent fire-extinguishing system shall be an engineered system for total

flooding of the hazard area.

C. Design: Design clean-agent fire-extinguishing system and obtain approval from Authorities Having Jurisdiction. Design system for Class A, B, and C fires as appropriate for areas being protected, and include safety factor. Use clean agent indicated and in concentration suitable for normally occupied areas.

D. Performance Requirements: (FM-200 per NFPA 2001).

1. Minimum design concentration: As calculated, by volume in all areas and/or protected spaces at the minimum anticipated temperature within the protected area.

2. The system design shall not exceed a maximum exposure limit concentration level per NFPA 2001, unless provisions for room evacuation before agent release are provided. All personnel should be able to leave the protected space prior to the discharge or at least within 5 minutes of the commencement of discharge.

E. Verified Detection: Devices located in single zone. Sound alarm on activating single-detection device, and discharge extinguishing agent on actuating second-detection device.

2.02 SYSTEM OPERATING SEQUENCE

A. Verified Detection:

1. Actuating First Detector (Pre-Alarm):

a. Visual and audible indication on local control panel.
b. Energize audible and visual alarms inside the protected hazard area (unique pattern).
c. Transfer relays to shut HVAC duct dampers serving protected area and send "pre-alarm" signal to main fire-alarm system panel.

2. Actuating Second Detector (Pre-discharge):

a. Visual and audible indication on local control panel.
b. Energize audible and visual alarms inside the protected hazard area (unique pattern).
c. Transfer relay to shut down power to protected area man-door security lock, that then allows man-door to be opened from Corridor side (bypassing security system).
d. Transfer relays to shut down recirculating air-conditioning units serving protected area.
e. Start time delay for extinguishing-agent discharge for 30 seconds.
f. Initiate system abort sequence, if abort switch is pressed and held in "abort" position. Release of hand pressure on the abort switch will cause agent discharge if the discharge time delay has expired.

3. Extinguishing-agent discharge (Release Alarm): Pre-discharge time delay expires or manual release switch is operated.

a. Visual and audible indication on local control panel.
b. Energize audible and visual alarms inside and outside the protected area (unique pattern).
c. Transfer relay to send "Extinguishing Agent Release" to main fire alarm system panel.
d. Release clean agent suppression system agent.

B. Supervisory signal initiation shall be by the following device:

1. Either clean agent container low pressure switch.

C. Trouble signal initiation shall be by one or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.

2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.

3. Loss of primary power at fire-alarm control unit.
4. Ground or a single break in fire-alarm control unit internal circuits.
5. Abnormal AC voltage at fire-alarm control unit.
6. Break in standby battery circuitry.
7. Failure of battery charging.
8. Abnormal position of any switch at fire-alarm control unit or annunciator.

D. System Supervisory and Trouble Signal Actions:
1. Visual and audible indication on control panel.
2. Transfer relays to send signal to fire-alarm system.

E. Operating manual release switches will cause the immediate discharge of the extinguishing agent, overriding the system's discharge time delay and abort functions. Panel operation shall duplicate the extinguishing-agent discharge sequence described in the previous paragraphs.
1. Electric manual release switches shall be located at each hazard exit.

F. Operating abort switches will delay extinguishing-agent discharge while being activated. Release of hand pressure on the switch will cause agent discharge if the discharge time delay has expired.

2.03 PIPING MATERIALS

A. Piping, Valves, and Discharge Nozzles: Comply with types and standards listed in NFPA 2001.

B. Plain end couplings are not allowed on any piping systems.

C. No welding allowed.

2.04 VALVES

A. General Valve Requirements:
1. UL listed and FM Global approved for use in fire-protection systems.
2. Compatible with type of clean agent used.
3. Automatic excessive pressure relief provision.
4. Low pressure gauge.

B. Container Valves: With fast acting rupture disc with solenoid actuator, capable of immediate and total agent discharge and suitable for intended flow capacity.

C. Valves in Sections of Closed Piping and Manifolds: Fabricate to prevent entrapment of liquid, or install valve and separate pressure relief device.

D. Valves in Manifolds: Check valve; installed to prevent loss of extinguishing agent when container is removed from manifold.

2.05 EXTINGUISHING AGENT CONTAINERS

A. Description: High strength alloy steel tanks complying with ASME Boiler and Pressure Vessel Code: Section VIII, for unfired pressure vessels. Include minimum working-pressure rating that matches system charging pressure, valve, pressure switch, and pressure gage.
1. Finish: RED, enamel or epoxy paint.
2. Manifold: Fabricate with valves, pressure switches, and connections for multiple storage containers, as indicated.

3. Storage-Tank Brackets: Factory- or field-fabricated retaining brackets consisting of steel straps and channels; suitable for container support, maintenance, and tank refilling or replacement.

B. Location: Located within hazard area, or as near as possible to reduce the required amount of pipe and fittings.

2.06 FIRE-EXTINGUISHING CLEAN AGENT

A. FM-200 Clean Agent: Heptafluoropropane.

1. Basis-of-Design Product: Subject to compliance with requirements, provide FM-200 product by one of the following:

a. DuPont.
b. Great Lakes Chemical Corporation; a Chemtura company.

2.07 DISCHARGE NOZZLES

A. Equipment manufacturer's standard one-piece brass or aluminum alloy of type, size, discharge pattern, and capacity required for application.

2.08 CONTROL PANELS

A. Description: FM Global approved and NRTL listed, including equipment and features required for testing, supervising, and operating fire-extinguishing system. Listed and approved for releasing service, and suitable for deluge/pre-action sprinkler service.

1. Subject to compliance with requirements, provide Fike®; SHP-PRO® or comparable product by one of the following:

a. Chemetron Fire Systems; a UTC Fire & Security company.
b. Fenwal Protection Systems.

B. Power Requirements: 120-V ac; with electrical contacts for connection to system components, fire-alarm system, and Division 25 SCADA system, and transformer or rectifier as needed to produce power at voltage required for initiating devices, notification appliances, trouble signals, supervisory signals, digital alarm communicator transmitter, and auxiliary power.

1. Alarm current draw of the entire clean agent suppression system shall not exceed 80 percent of the control panel’s power supply rating.

C. Enclosure: NEMA ICS 6, Type 1, steel cabinet.

1. Mounting: Surface.

2. Finish: Red baked on enamel finish

D. Supervised Circuits: Wired NFPA 72, Class B

1. Two detection circuits; capable of sequential detector release actuation method.

2. Three initiating device circuits; capable of monitoring contact closure devices.

3. Minimum of three notification appliance circuits.

4. Agent release circuit capable of actuating suppression system.

5. Auxiliary power circuit (resettable/non-resettable) for field devices.

6. Minimum of three Form-C relay contacts for auxiliary control functions.

7. Additional Form-C relay contacts with addition of supplemental relay cards as required.

E. Control-Panel Features:

1. Microprocessor controlled.
2. LED indicators to provide positive indication of system status.
3. Diagnostic LED indicator to display system and trouble events.
4. Configurable via dipswitches.
5. Automatic switchover to standby power at loss of primary power.
6. Storage container, low-pressure indicator.
7. Service disconnect to interrupt system operation for maintenance with visual status indication on the panel.
8. Silence and reset switch.
9. 120 VAC power input.
10. Five optional abort types.

F. Standby Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

1. Batteries: Sealed lead calcium, sized to operate system for 24 hours and alarm for minimum of 15 minutes.

G. Optional Cards: Cards mount directly to and receive their operational power from the Fike SHP PRO® control board (or comparable card by Chemetron or Fenwall).

1. Relay Module: Provide four additional Form-C relay contacts for auxiliary control functions.

2.09 SYSTEM SMOKE DETECTORS

A. General Requirements:

1. Comply with NFPA 2001, NFPA 72, and UL 268.
2. 24-V dc, nominal.
3. Two-wire type.
4. Self-restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
5. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
6. UL Listed.

B. Photoelectric Detectors: LED light source and silicon photodiode receiving element.

C. Base Mounting: Detector shall be mounted on a twist-lock, fixed base.

1. Select according to operational characteristics: Verified detection release.
2. Base provides terminals for connection to control unit.

D. Signals to the Central Fire Alarm Control Panel: Any type of local system Alarm, Trouble, or Supervisory event is reported to the central fire alarm control panel as a composite signal for each event type.

2.10 SWITCHES

A. General Description: Surface FM Global approved and NRTL listed, low voltage, includes contacts for connection to control panel.

B. Manual Release Switch: Unit can manually discharge extinguishing agent with operating device that remains engaged until unlocked.

1. Stainless steel faceplate.
2. Dual action requiring two distinct operations to initiate suppression system release.
3. Red plastic release button, keyed reset.
4. "MANUAL RELEASE" caption.

C. Abort Switch: Unit can manually prevent the release of the suppression system while pressed.

1. Stainless steel faceplate.
2. Red plastic abort button, momentary contact (dead-man type).
3. Available with key-operated switch.
4. "SYSTEM ABORT" caption.

D. Low-Agent Pressure Switches: Installed on extinguishing agent container; pneumatic operation.

E. Suppression Disconnect Switches: Unit enables releasing circuit (i.e., clean agent) to be disconnected from the control panel.

1. Stainless steel faceplate.
2. Key operated selector switch (armed/disarmed).
3. LEDs to provide indication of switch status (armed/disarmed).
4. “SUPPRESSION DISCONNECT” caption.

2.11 ALARM DEVICES

A. General Requirements: Listed and labeled by an NRTL and/or FM Global approved, low voltage, and surface mounting.

B. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly. Connected to notification appliance signal circuits, equipped for mounting as indicated and with screw terminals for system connections.

C. Horns, comply with UL 464: Electric-vibrating-polarized type, 24-V dc. Horns shall produce a sound-pressure level of 90 dB minimum, measured 10 feet (3 m) from horn.

D. Visible Notification Appliances comply with UL 1971: Xenon strobe lights with translucent lens, with "FIRE" or similar caption.

1. Rated Light Output:

a. Indicated on drawings.
b. 15/30/75/110 cd, selectable in the field.

2. Mounting: Indicated on Drawings.
3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
4. Flashing shall be in a temporal pattern, synchronized with other units.
5. Strobe Leads: Factory connected to screw terminals.
6. Mounting Faceplate: Factory finish, red.

2.12 INFORMATIONAL SIGNAGE

A. Provide informational signs as required to comply with NFPA 2001 for the specific agent.

2.13 SPECIAL CONNECTIONS

A. For any devices/components that require monitoring or supervision, provide with at least two sets of contacts, one for connection to the fire alarm system and one for other required systems or spare.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with hazard-area leakage requirements, installation tolerances, and other conditions affecting work performance.

1. The general contractor shall be responsible for sealing and securing the protected enclosure against agent loss and/or leakage during the required agent “hold’ period.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PIPING APPLICATIONS

A. Flanged pipe and fittings and flanged joints may be used to connect to specialties and accessories and where required for maintenance.

B. Comply with types and standards listed in NFPA 2001.

3.03 PIPING APPLICATIONS

A. Comply with types and standards listed in NFPA 2001.

3.04 CLEAN-AGENT PIPING INSTALLATION

A. Install clean-agent extinguishing piping and other components level and plumb, according to manufacturers' written instructions.

B. Each pipe section shall be cleaned internally after preparation and before assembly by means of swabbing, using a suitable nonflammable cleaner. Pipe network shall be free of particulate matter and oil residue before installing nozzles or discharge devices.

C. Install extinguishing-agent containers anchored to substrate.

D. All pipe threads shall be sealed with Teflon tape pipe sealant applied to the male threads only.

E. Install pipe and fittings, valves, and discharge nozzles according to requirements listed in NFPA 2001.

1. Install valves designed to prevent entrapment of liquid or install pressure relief devices in valved sections of piping systems.

2. Support piping using supports and methods according to NFPA 13.

3.05 DETECTION, ACTUATION, ALARM, AND CONTROL SYSTEMS INSTALLATION

A. Install control panels, detection system components, alarms, and accessories, complying with requirements of NFPA 72 and NFPA 2001, Section "Detection, Actuation, and Control Systems," as required for supervised system application.

B. Smoke Detector Spacing:

1. Comply with NFPA 72, “Smoke-Sensing Fire Detectors” Section in the “Initiating Devices” Chapter, for smoke detector spacing.

2. Comply with NFPA 72, “Heat-Sensing Fire Detectors” Section in the “Initiating Devices”

Chapter, for heat detector spacing.

3. Smoke ceiling spacing shall not exceed 30 feet (9 m).
4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Appendix A in NFPA 72.
5. HVAC: Locate detectors not closer than 3 feet (1 m) from air-supply diffuser or return-air opening.
6. Lighting Fixtures: Locate detectors not closer than 12 inches (300 mm) from any part of a lighting fixture.

C. Audible Alarm-Indicating Devices: Wall mounted with tops above the finished floor not less than 90 inches (2.29 m), and below the ceiling not less than 6 in. (150 mm). Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.

D. Visible Alarm-Indicating Devices: Wall mounted with entire lends not less than 80 in. (2.03 m) and not greater than 96 in. (2.44 m) above the finished floor. Where ceiling height does not permit mounting at minimum height, mount within 6 inches (150 mm) of the ceiling.

E. Combination Audible-Visual Devices: Where combination audible and visual devices are used, mount devices according to Visual Alarm-Initiating Device requirements.

F. Control Unit: Surface mount, with top of cabinet not more than 72 inches (1830 mm) above the finished floor.

G. Annunciator: Install with top of panel not more than 72 inches (1830 mm) above the finished floor.

3.06 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to equipment, allow space for service and maintenance.

3.07 IDENTIFICATION

A. Identify system components, equipment, wiring, cabling, and terminals. Comply with requirements for identification specified in applicable Division 26 Section covering identification for electrical systems.

B. Identify piping, extinguishing-agent containers, other equipment, and panels according to NFPA 2001.

C. Install signs at entry doors for protected areas to warn occupants that they are entering a room protected with a clean-agent fire-extinguishing system.

D. Install signs at entry doors to advise persons outside the room the meaning of the horn(s), bell(s), and strobe light(s) outside the protected space.

E. Install framed operating instructions in a location visible from control unit.

3.08 SYSTEM WIRING

A. Wiring shall be installed by qualified individuals, in a neat and workmanlike manner in accordance with the National Electrical Code (NEC), Article 725 and 760, except as otherwise permitted for limited energy circuits as described in NFPA 72. Installation shall meet all local, state, province and/or country codes.

B. All wiring shall be installed in electrical metallic tubing (EMT) or conduit and must be kept separate from all other building wiring. Runs of conduit shall be straight, neatly arranged, properly supported and installed parallel and perpendicular to walls and partitions.

C. Conductors shall be sized according to the design documents and color coded to allow easy circuit identification.

D. All wires shall be tagged at all junction boxes.

E. All wires shall be tested for the presence of opens, shorts and grounds prior to connection to control panel. Final wire terminations to control panel shall be made under the direct supervision of a factory trained representative.

F. All system components shall be securely supported independent of the wiring.

G. Ground control panel and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to control panel.

3.09 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Submit test plan for review and approval by the owner or owner’s designated representative prior to performing tests.

D. Detection, Actuation, Alarm, and Control Systems Tests:

1. Visual Inspection: Conduct the visual inspection prior to testing.

a. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in it “Completion Documents, Preparation” Table in the “Documentation” Section of the “Fundamental of Fire Alarm Systems” Chapter, and as per FM Global requirements.
b. Comply with “Visual Inspection Frequencies” Table in the “Inspection” Section of the “Inspection, Testing and Maintenance” Chapter in FNPA 72; retain the “Initial/Reacceptance” column and list only the installed components.

2. Operational Test: After electrical circuitry has been energized, apply power to control panel and confirm proper unit operation. Comply with “Test Methods” Table in the “Testing” Section of the “Inspection, Testing, and Maintenance” Chapter in NFPA 72, and comply with FM global requirements.

3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Clean-Agent Fire Extinguishing Systems Test:

1. Flow Test: Using nitrogen or other inert gas, perform a flow test on the piping network to verify that flow is continuous and unobstructed through piping and nozzles.

2. Pressure/Leak Test: test the piping in a closed circuit per manufacturer instructions.

3. Room Pressurization Test: After all construction work is complete, conduct a room pressurization test in accordance with NFPA 2001 in each clean agent suppression system hazard area. Test shall confirm enclosures ability to retain the agent concentration level for the required hold time. If the test fails, the suppression system contractor shall coordinate room sealing with the general contractor. Additional tests shall be conducted until successful test results are achieved. Include final test results in project ‘Closeout Submittals’.

F. System will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports: Factory-authorized service representative shall prepare the “Fire Alarm System Record of Completion” in the “Documentation” Section of the “Fundamentals of Fire Alarm Systems” Chapter in NFPA 72 and the “Inspection and Testing Form” in the “Records” Section of the “Inspection, Testing and Maintenance” Chapter in NFPA 72.

3.10 DEMONSTRATION / TRAINING

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the clean-agent fire-extinguishing systems.

B. Training session shall include system control panel operation, manual and abort functions, trouble procedures, auxiliary functions, and emergency procedures. Allow a minimum of 4 hours for training.

C. All training shall be videotaped by the Fire Protection contractor. Two copies shall be turned over to the Owner’s maintenance staff.

D. Prior to final acceptance, provide four copies of a complete operation and maintenance manual to the Architect. The manual shall include the following:

1. All aspects of system operation and maintenance detailed, including piping isometrics, wiring diagrams of all circuits, a written description of system design and sequence of operation.
2. Drawing(s) illustrating control logic.
3. Equipment used in the fire suppression system.
4. Checklists and procedures for emergency situations.
5. Troubleshooting techniques.
6. Maintenance operations and procedures.

3.11 SERVICE CONTRACT DURING WARRANTY PERIOD

A. Suppression system installing contractor shall provide two (2) inspections of the systems installed under this contract, during the warranty period. The first inspection shall be at the six-month interval, and the second shall be at the twelve-month interval after system acceptance.

B. Inspections shall be conducted in accordance with the equipment manufacturer’s guidelines and the recommendations of NFPA 72 and NFPA 2001. Use forms provided in NFPA 72 for initial tests and inspections.

C. Prepare and submit test and inspection reports.

3.12 WARRANTY

A. Clean Agent System manufacturer and installation contractor shall guarantee all labor, material components furnished under this contract against defects in design, materials, and workmanship for no less than five (5) years from the date of handover to Owner at beneficial occupancy.

END OF SECTION

SECTION 22 00 00
PLUMBING SYSTEMS

PART 1 - REQUIREMENTS

1.01 The Plumbing system design shall emphasize on the following criteria:

A. District Goals are stated as follows:

1. ease of Installation.
2. Ease of operation and maintenance.
3. Energy efficient.
4. Proven reliability.
5. Well established design principles.
6. Constructed of standard, use-proven materials.
7. Acceptable procurement lead time.
8. Low initial cost.
9. Low Operating cost.
10. Low Maintenance cost.
11. Low life cycle cost for energy efficient installations that incur a higher initial cost.
12. Environmentally friendly.
13. Acoustically compatible with occupied spaces as described in Architectural requirements.
14. Resistance to vandalism.

B. Building Management System Connections:

1. Equipment specified to have an independent on-board manufacturer- provided control system shall be connected to campus EMS system for monitoring.

PART 2 - STANDARDS AND CODE

2.01 Standards and Code Requirements

A. The Plumbing systems shall comply with the current California Code of Regulations, Title 24, the standards of ASHRAE, SMACNA, IAPMO and NFPA, California Plumbing Code as well as the requirement of the local authorities having jurisdiction.

2.02 Design Criteria

A. Provide seismic restraints for each mechanical equipment and piping systems in accordance with applicable codes and guidelines.

B. For liquid filled steel pipe, use SMACNA “Guidelines for Seismic Restraints of Mechanical Systems and Plumbing Piping” latest edition.

C. All plumbing fixtures/equipment and components shall be UL listed CPC approved including Green building Code and IAPMO listed.

D. Provide Riser Diagrams (Waste & Vent, Hot & Cold Water, Storm Drain, Gas, & other piping systems) for multi-level projects.

E. Seismic Restraints shall not void or degrade the specified performance of the equipment’s vibration isolators, where isolators are used.

2.03 Calculation Requirements

A. Cold and Hot water, including pipe sizing table based on WSFU/GPM.

B. Natural Gas sizing criterion and sizing table based on CFH.

C. Rainfall data for sizing storm and overflow drain systems based on square footage.

D. Waste and vent sizing table based on DFU values.

PART 3 - INSTALLATION

A. Ensure maintenance and accessibility provisions for servicing and replacement.

B. Where active fluid piping is routed through STC rated interior wall partitions use Acoustics Isolators/ mounts (I.E., Clamps, Liner, Brackets and Struts) to minimize the transmission of noise and vibration to the wall structures.

C. All plumbing equipment that is not wall-mounted (e.g. on grade, on floor and on roof) shall be installed on a minimum 4” high concrete housekeeping pad. Refer to Division 3.

D. Where plumbing equipment is located at grade level and/or in an open publicly accessible area, a fence/gate/etc. shall be provided for security and/or visibility purposes.

E. Do not route any plumbing piping over any electrical rooms.

PART 4 - EVALUATION

4.01 List of items or systems requiring testing, evaluation, verification, or commissioning for items are to be commissioned or tested.

4.02 Documentation required:

A. Commissioning reports: All Plumbing equipment using or converting energy from any source (i.e. electricity, gas, utilities) shall fall under the scope of the Commissioning process and be subject to the protocols listed for the Commissioning guidelines.

B. Controls information: shall be provided as required by the independent controls Specifications.

C. Required testing protocols: Code-required Pressure tests for all systems

END OF SECTION

SECTION 22 10 00
PLUMBING PIPING AND PUMPS

PART 1 - REQUIREMENTS

A. Design considerations specific to components in this section:

1. Required:

a. For each type and size of pump specified. Include certified performance curves with operating points plotted on curves and rated capacities of selected models, furnished specialties and accessories
b. Provide pump calculation along with summary rationale on domestic water booster pumps, sewage ejection pumps and/or storm water ejection pumps.

2. Preferred: Where emergency power is available, provide emergency power where applicable.

PART 2 - PRODUCTS

2.01 Sewage pumps

A. Vertical column Sewage ejectors complete with motors, controls and accessories to make a fully automatic system.

B. Factory-assembled and –tested.

C. Duplex at 100% redundancy.

D. The impellers shall be non-clog design incorporating top repelling vanes to minimize pressure against the lower bearing assembly and keep solids from being trapped between impeller and casting and shall be made of bronze.

E. Intermediate and Casing Bearings: Grease lubricated, spaced a maximum of four (4) feet apart. Housing shall contain double bronze sleeve bearings with grease reservoir between them.

F. Thrust Bearings: Grease lubricated adjustable ball type housed in an elevated, sealed chamber.

G. Pumps shafts shall be solid continuous AISI 416 stainless steel. Stub or tapered shafts shall not be considered equal.

H. The shaft hanger pipe assemblies, discharge legs, and floor plates shall be galvanized, or zinc dichromate plated.

I. Motors shall be heavy duty. NEMA Standard, TEFC enclosure with flexible coupling.

J. The pump manufacturer shall warrant the pumps being supplied against defects in workmanship and material for a period of five (5) years under normal use, operation and service.

K. Control panel: UL 698a labeled and listed intrinsically safe control panel for wall mounting, containing fused through-the-door disconnect switches, across-the-line magnetic starters, test-off-automatic switches, running lights, electrical alternator, and 115-volt CC transformer.

L. In-sump controls shall be four (4) mercury float switches, UL listed. Top switch is for high water alarm. Provide wall/cover mounting bracket on 1" galvanized support pipe.

M. The sump basin shall be constructed of concrete. Cover and curb frame shall be furnished by pump manufacturer. Sump frame covers shall be hot dip galvanized. Lid shall be air tight.

N. Basin shall be cleaned thoroughly with all water and debris removed prior to installing the pumps

O. Provide separate conduits for power and sensor cables.

P. Provide remote-mounted alarm panel, consisting of a single NEMA 1 enclosure complete with 3 indicating lights, reset buttons, alarm horn or bell, and silencing switch. Subsequent alarm shall sound even after initial alarm is silenced. Lights shall be normally dim-glow and shall change to full-glow and sound the alarm under any of the following conditions:

1. Power failure to the pump control panel.
2. High water condition.
3. Simultaneous two pump operation or failure of either pump.
4. The panel shall be provided with a dry contact for high water level alarm signal to a Building Management System (BMS) where available.

Q. Pump Discharge Piping: Factory or field fabricated, ASTM A 53/A 53M,

R. Schedule 40, galvanized-steel pipe

S. Provide appropriate control modules so specific control and monitoring points can be hardwired directly from equipment to BMS including start/stop, stats, and alarm. Coordinate for identification of specific points required

T. The entire system shall be capable of being monitored by the BMS interface and all data shall be provided in an open protocol with all necessary BACnet or Modbus gateways provided free of charge.

U. Submersible pumps shall be provided with guide rail support systems for access to pumps.

V. Preferred: Manufactured by Grundfos, Ebara International Corp., Delta “Q” Pump Company and Tramco Pump Technology.

2.02 Sump pumps

A. Vertical column sump pumps complete with motors, controls and accessories to make a fully automatic system.

B. Factory-assembled and tested.

C. Duplex at 100% redundancy.

D. The impellers shall be multi-vane type and shall be made of cast iron.

E. Thrust bearings: Grease lubricated adjustable ball type housed in an elevated, sealed chamber.

F. Pump shafts shall be solid, continuous AISI 416 stainless steel. Stub or tapered shafts shall not be acceptable.

G. The shaft hanger pipe assemblies, discharge legs, and floor plates shall be galvanized, or zinc dichromate plated.

H. Motors shall be heavy duty, NEMA Standard, TEFC enclosure, with flexible coupling.

I. The pump manufacturer shall warrant the pumps being supplied against defects in workmanship and material for a period of five (5) years under normal use, operation and service.

J. Control panel: UL 508 labeled and listed control panel, for wall mounting, containing fused through-the-door disconnect switches, across-the-line magnetic starters, test-off-automatic switches, running lights, electrical alternator, and 115-volt CC transformer.

K. In-sump controls shall be four (4) mercury float switches, UL listed. Top switch is for high water alarm. Provide wall/cover mounting bracket on 1" galvanized support pipe.

L. The sump basin shall be constructed of concrete. Cover and curb frame shall be furnished by pump manufacturer. Sump frame covers shall be hot dip galvanized. Lid shall be air-tight.

M. Basin shall be cleaned thoroughly with all water and debris removed prior to installing the pumps

N. Provide separate conduits for power and sensor cables.

O. Provide remote-mounted alarm panel, consisting of a single NEMA 1 enclosure complete with 3 indicating lights, reset buttons, alarm horn or bell, and silencing switch. Subsequent alarm shall sound even after initial alarm is silenced. Lights shall be normally dim-glow and shall change to full-glow and sound the alarm under any of the following conditions:

1. Power failure to the pump control panel.
2. High water condition.
3. Simultaneous two pump operation or failure of either pump.
4. The panel shall be provided with a dry contact for high water level alarm signal to BMS where available.

P. Pump Discharge Piping: Factory or field fabricated, ASTM A 53/A 53M,

Q. Schedule 40, galvanized-steel pipe

R. Provide appropriate control modules so specific control and monitoring points can be hardwired directly from equipment to Building management System (BMS) including start/stop, stats, and alarm.

S. The entire system shall be capable of being monitored by the BMS interface and all data shall be provided in an open protocol with all necessary BacNet or Modbus gateways provided free of charge

T. Preferred: Manufactured by Grundfos, Ebara International Corp., Delta “Q” Pump Company and Tramco Pump Technology.

2.03 Hot Water circulating pumps

A. In-line direct couple single speed ODP electrical motor

B. Shall comply with AB1953

C. Hot water circulating pumps over 1.5 hp shall have cast iron bodies. Pumps

D. 1.5 hp and less shall have hard bronze water chambers and impellers

E. To be furnished with “Intermatic” 7/24 digital time clock and aquastat.

F. Preferred: Grundfos Magna, no known equal.

2.04 Domestic water booster pumps

A. The packaged water booster pump system shall be a standard product of a single pump manufacturer.

B. The complete packaged water booster pump system shall be certified and listed by UL.

C. The packaged booster pump system shall use advanced variable frequency drive and electronic controller technology to maintain a constant pressure at desired flow.

D. Number of pumps in package should be selected per project requirements.

E. The impellers, pump shaft, diffuser chambers, outer discharge sleeve, impeller seal rings and seal ring retainers shall be constructed of stainless steel.

F. Shall comply with AB1953.

G. Preferred: Grundfos, VC Systems & Controls, Inc., Delta “Q” Pump Company.

H. Pump systems that use pump control valves or pressure reducing valves to maintain a constant water pressure is not permitted.

PART 3 - INSTALLATION

3.01 Sewage pumps

A. Install sewage pumps and arrange to provide access for maintenance including removal of motors, impellers, couplings and accessories.

B. Install discharge piping equal to or greater than size of pump discharge piping.

C. Install vent piping to terminate to atmosphere (above roof outside of building).

D. Install check and gate valves on discharge piping from each pump. Install valves same size as connected piping.

E. If submersible sewage ejectors allowed, provide with Quick-Disconnect and Guide-Rail.

3.02 Sump pumps

A. Install sump pumps and arrange to provide access for maintenance including removal of motors, impellers, couplings and accessories.

B. Install discharge piping equal to or greater than size of pump discharge piping.

C. Install vent piping to terminate to atmosphere (above roof outside of building).

D. Install check and shutoff valves on discharge piping from each pump. Install valves same size as connected piping.

E. If submersible sump pump allowed provide with Quick-Disconnect and Guiderail.

3.03 Hot water circulating pumps

A. Install pump with union connections for maintenance and replacement.

B. Provide 24/7-time clock, thermometer and aquastat.

C. Preferred: Locate said pump, mounted on wall adjacent to water heater. Ceiling mounted is not permitted.

3.04 Domestic water booster pumps

A. Install booster pumps on concrete base using neoprene pads. Refer to Division 3 specifications for concrete equipment pads.

B. Support connected domestic-water piping, so weight of piping is not supported by booster pumps.

C. Engage a factory-authorized service representative to perform startup service.

D. Install suction and discharge pressure gages and shut-off valves.

E. Adjust booster pumps to function smoothly and lubricate as recommended by manufacturer.

PART 4 - EVALUATION

A. List of items or systems requiring testing, evaluation, verification, or commissioning: Required Items: Code-required Pressure tests for all systems.

B. Documentation required:

1. Pressure Test reports.

2. Test and adjust controls and safeties
3. UL listing: all pumps.
4. Lead-free pumps: All fixtures, pipes and plumbing fitting that intended to convey or dispense water for human consumption through drinking or cooking.
5. Code-required Pressure tests for all systems.
6. Provide3 year warranty on labor and materials for servicing pumps.

END OF SECTION

SECTION 22 11 00
WATER DISTRIBUTION

PART 1 - REQUIREMENTS

A. Design considerations specific to components in this section:

1. Maximum flow for fixtures must comply with City and Cal Green and CPC water conservation guidelines and ordinances
2. Conceal and properly secure all piping behind building finishes. Exception, exposed piping may be made in equipment and custodial rooms. Where necessary, exposed piping in renovation projects shall be painted. Insulate hot water and condensate piping.
3. Allowable water velocity shall be 5 feet/second for hot water and 6 feet/second for cold water in copper and non-metallic piping.
4. Size hot water circulating pump and piping for water velocity not to exceed 5 feet/second.
5. In new buildings with commercial kitchens, provide can wash for cleaning of garbage cans. Provide domestic cold and hot water at can wash station. Hot water supply where feasible.
6. In new buildings, or when replacing existing domestic hot water supply equipment, install a hot water supply temperature sensor that may be utilized by the campus BMS system to trend hot water supply temperature.
7. Victaulic piping systems and Pro-press fittings are not permitted.
8. T-DRILL methods for branch piping is not permitted. Wrought copper fittings are required.

PART 2 - PRODUCTS

2.01 Material requirements

Service	Size	Location	Material	Joining Method
Domestic Cold Water	All	Underground	Rigid Copper (Type K)	Brazed
Domestic Cold Water	All	Above Ground	Rigid Copper (Type L)	Soldered
Domestic Hot Water	All	Underground	Rigid Copper (Type K)	Brazed
Domestic Hot Water	All	Above Ground	Rigid Copper (Type L)	Soldered
Domestic Hot Water Return	All	Above Ground	Rigid Copper (Type L)	Soldered

A. Domestic Water Piping

1. Coordinate with civil engineer to define and request water service from utility supplier.
2. All domestic water supply mains shall be designed with an above-ground valve station. The station shall include a reduced pressure principal backflow preventer with strainer and when the street pressure exceeds 80 psig, a two-station minimum pressure regulator with strainer shall be provided.
3. A separate service shall be provided for landscape irrigation, with a reduced pressure principle back flow preventer and strainer.
4. Pressure regulating valve (PRV) stations shall include a minimum of two approved direct acting regulators with strainers. Valves shall be flanged and sized to provide uninterrupted service to the building when the valves are being serviced. Services over 4 inches require

a third, smaller PRV for constant low-flow demands.

5. Use backflow prevention valves having the lowest possible friction loss.
6. Provide sub-meter (water) for as directed by District. Sub-meter shall be connected to BMS.
7. Provide water service to all fixtures and outlets, designed in accordance with National Bureau of Standards Reports 66 and 79 with not less than 30 psi at farthest and highest fixture or the pressure required for the highest and farthest flushometer-operated water closet to operate properly or Emergency shower/eyewash station on roof, whichever is predominant.
8. Size pipe base on the number of fixture units and demand load curves in the current California Plumbing Code.
9. Outside Stem and Yoke (OS & Y) valves may be used in equipment rooms at seven (7) feet or higher for visual identification of Open or Closed conditions. In such cases provide a chain operator to allow for operating the valve without a ladder.
10. Pitch piping as required for proper drainage and flow and elimination of air.
11. Provide Water Hammer Arrestors within wall, behind access panel for lavatories, sinks, fountains, water closets, urinal headers and other fixtures or devices with quick closing valves, such as clothes washers.
12. Each faucet shall have its own angle stop. No angle stop should serve more than one faucet at a time.
13. If feasible, for industrial water needs, provide designated industrial cold-water system.
14. Provide hose bib/wall hydrant in the following areas:
    a. Perimeter of building, 150 ft. on center
    b. Roof for mechanical equipment.
    c. Provide reduce pressure backflow preventer upstream of hose bibs in Mechanical Rooms with sewage/sump pumps.
15. Preferred:
    a. Reduced pressure back flow preventer - Watts 909
    b. Sub-water meter – Zenner lead free Model PPD, Sizes; 1”, 1-1/2” and 2”. Zenner lead free Model ZTMB, Sizes; 3”, 4” & 6”. Provide sub-meters with Zenner ETRU Encoded Type Register and MCS SB-PL-50 pulse lengthener.
    c. Do not run water lines under slab and do not install Water hammer arrestors above ceiling.

B. Hot Water and Hot Water Return Piping

1. Follow all requirements listed under Domestic Water piping.
2. Circulating hot water pumps shall be time clock and controlled so they will operate only when the building is occupied.
3. When Circulation pump connection requires a reduction in size, it shall be made as close as possible to the pump.
4. Insulate hot water return lines as required for domestic hot water systems.
5. Hot water to be provided with single mixing valve station for 120°F hot water distribution.
6. Minimum for hot water return piping shall be ¾” pipe.
7. Where multiple return lines are provided, furnish circuit setters or circuit solvers with shut-

off valve and check valve.

8. Preferred: Mixing Valve: Rada ("Armstrong) Digital. No factory pre-piped assembly permitted.
9. Do not run dead-leg piping over 10 feet circulation system, multiple hot water mixing valve stations throughout building, ½" pipe size for hot water return piping and manual balancing valves.

PART 3 - INSTALLATION

3.01 Domestic Water Piping

A. Install pressure regulating valves with strainers when the street line pressure is over 80 psig to reduce pressure to approximately 79 psig maximum.

B. Provide removable gages with ball valves for isolation stops on both inlet and outlet valve stations (for inlet pressure and reduced pressure).

C. Provide an epoxy coated wye strainer ahead of regulators.

D. Locate pressure regulating assemblies and strainer assemblies above grade in a shielded enclosure and in a serviceable area. Manufacturer: Watts, Cla-Valve.

E. Use reduced-pressure principle backflow assemblies for main line domestic (Laboratory Buildings only) and irrigation services for meter protection.

F. Reduce pressure backflow preventer, 2" and smaller shall be "Apollo" RPLF4A Series.

G. Vacuum breakers or other required reduced pressure backflow prevention valves which are required but not limited to the following locations:

All flush valves	Animal drinking devices
Direct connections to boilers and tanks	Cooling Towers and evaporative coolers (or provide air gap)
Water-cooled refrigerator condensers	Up-stream of Hose Bibb at Sewage and sump pumps.
Soft drink dispensers	Fire Sprinkler Systems
Hose bibs and still cocks. All laboratory equipment	Irrigation Systems

H. All shut-off valves shall be accessible from the room in which fixtures are installed and shall be located at approx. 3'-0" but no more than 7'-0" from the floor. These valves shall control only fixtures in the room in which they are installed.

I. Provide shut-off valves in the following locations:

Each group of fixtures.	Each laboratory or preparation room
Each restroom	Each building, located at the entering point of the building with yard box.
Each floor of each building	

J. Use gate or ball valves for plumbing isolation shut-off.

K. Provide a ball valve to isolate all fixtures in each restroom, laboratory, kitchen and any other room with multiple fixtures. Valves shall be in recessed boxes with locking covers, located above the upper terminal water closet for restrooms and above fixtures in other areas.

L. If backflow prevention devices are located in areas where there are occupants, provide flood protection valve for these devices.

M. In buildings, a water hammer test for cold and hot water piping shall be performed.

N. Provide chained engraved red tag with white lettering on all main utility line building shut-off valves (gas, water, etc.) to designate, “Building Shut-off Valve”.

3.02 Valves

A. 2” & smaller: Apollo 77CLFA series full port ball valves with stainless steel ball and stem

B. 2-1/2” & Larger: Apollo 77CLFA series full port ball valves with stainless steel ball and stem.

C. 2” & smaller: Nibco T/S-113-LF non-rising stem, bronze gate valve.

D. 2-1/2” & larger: Nibco 619 NRSRW series, resilient wedge, epoxy coated ductile iron gate valve.

E. Red & White Valves not permitted.

3.03 Hot water and hot water return piping

A. Install straight length of pipe without bends or restrictions at least 10 diameters long on the suction side of all pumps unless inlet diffusers are used.

B. Provide a check valve after the pump, for the hot water return line.

C. Provide circuit setter assembly with shut-off valve on each return branch if 2 or more branches served by single circulating pump.

PART 4 - EVALUATION

4.01 List of items or systems requiring testing, evaluation, verification, or commissioning: Required Items: Code-required Pressure tests for all systems.

A. Documentation required:

1. Pressure Test reports.
2. UL listing: Hot water pumps.
3. Lead-free fixtures: All fixtures, pipes and plumbing fitting that intended to convey or dispense water for human consumption through drinking or cooking.
4. Code-required Pressure tests for all systems.

END OF SECTION

SECTION 22 13 00
FACILITY SANITARY SEWERAGE

PART 1 - REQUIREMENTS

1.01 Design considerations specific to components in this section:

A. Required:

1. Piping materials shall bear manufacturer's name or manufacturer's registered trade-mark stamp, country of origin and other markings of specified testing agency.
2. Components and installation shall be capable of withstanding 15 psig working pressure.
3. Designed system shall comply with City of Compton and CPC latest edition requirements.
4. Industrial Wastewater Permits must be obtained from the City of Compton Department of Public Works, Bureau of Sanitation, Industrial Waste Management Division, in accordance with the Los Angeles County Waste Control Ordinance. A permit is required for each point of discharge to the City's sewer system. (For other jurisdictions the local ordinance must be addressed, the standards required by the City of Compton shall be the minimum standard for District's Facilities/ Buildings).

PART 2 - PRODUCT S

2.01 Material requirements

Service	**Size**	Location	Material	Joining Method
Sanitary Waste Sewer	All	Underground	Cast Iron Soil Pipe & Fittings, ASTM A 888- 15 or CISPI 301-12	Hubless
Sanitary Waste Sewer	All	Above Ground	Cast Iron Soil Pipe & Fittings, ASTM A 888- 15 or CISPI 301-12	Hubless
Sanitary Waste Vent	All	Above Ground	Cast Iron Soil Pipe Fit-tings, ASTM A 888-15 or CISPI 301-12	Hubless
Sanitary Waste Sewer (Pressurized)	All	Above Ground	Schedule 40 Galva-nized Steel	Screwed
Grease Waste & Vent	All	Underground Above Ground	Cast Iron Soil Pipe & Fittings, ASTM A 888- 15 or CISPI 301-12	Hubless

2.02 Piping grade or slope criteria for complete drainage and venting

Type of Piping	Slope	Direction of Fall
Sanitary Waste Sewer	1/4" per 1'-0"	Down in direction of flow.

A. Provide Holdrite Series 117 no-hub fitting restraint on cast iron pipe joints against separation during high thrust conditions.

B. Transitional fittings on change of pipe sizes.

C. Branch line waste & vent piping serving floor sinks taking drainage from soda machines shall be as follows:

1. Below Ground: Polypropylene
2. Above Ground: PVDF

2.03 General Requirements

A. Food kitchen areas shall comply with the County of Los Angeles' Fats, Oil and Grease (FOG) Control Program. Consult and obtain the approval of Bureau of Sanitation/Industrial Waste/health Department as applicable.

B. Grease interceptors shall comply with the County of Los Angeles' Plumbing Code and must be provided for all grease-producing equipment (pot sinks, floor drains, floor sinks, prep sinks and mop sinks within the kitchen preparation area are to be tied to the grease interceptor).

C. Where floor drains are required, slope floor to drain at 1/8" per foot.

D. Floor drains and floor sinks with trap primers are required at:

1. Restrooms, one floor drain shall be provided front and center for two or more urinals, one floor drain is required for water closets in all restrooms with an additional floor drain when a total of four or more water closets are provided.
2. Shower and locker rooms and adjacent drying rooms.
3. Custodian closet- Located floor drain near mop/service sink.
4. Uncovered trash areas. These areas are required to be provided with a special floor drain system that normally drains to the storm system but diverts the drainage to the sewer system when the trash containers are being washed, using a special valve system.
5. Kitchens, Walk-in Coolers and freezer-boxes.
6. Areas required by the California Plumbing Code and the Compton/los Angeles County Plumbing Code.
7. Can Wash Areas: Drain shall drain to site grease interceptor.
8. In new ground-up projects and major remodels, provide floor drains in the vicinity of new emergency shower/eyewash stations. For projects in existing buildings, at existing emergency shower/eyewash stations to remain, a floor drain is not required but a flow switch is required at the supply line. The flow switch shall be monitored by DPS and alarmed by building management system or fire alarm system.
    a. Waste Piping Traps – All parts of traps shall be cast brass with polished Chromium plated finish. Tubular traps are not allowed.
    b. Interceptors and separators must be located and installed so they are easily accessible for inspection, cleaning and removal of intercepted material.
    c. Underground waste piping with 90 degrees or greater change in direction, shall provide a cleanout to grade.
9. Preferred: Highland Tank Passive Grease Interceptor/Jensen Pre Cast Grease Interceptor.
10. Automatic grease interceptor not permitted.
    a. Elevator pit drains are not required.
    b. Combination waste/vent piping is not allowed on UPC.
    c. Vertical/Horizontal wet venting system is not allowed.

PART 3 - INSTALLATION

3.01 Provide clean-outs above all urinals, lavatories, upper terminal water closets and sinks.

A. For water closets, a clean out shall be provided at the end of run for two or more water closets. Cleanout shall be located 4-6” above the flood level of the water closets. Consider providing clean outs at each water closet for ease of maintenance.

B. For urinals, a cleanout shall be provided above the flush valve for each urinal and at the end run of two or more urinals (located 4-6” above flood level of urinals).

C. For lavatories, a cleanout shall be provided at the end run above counter or at counter height if there is interference with a mirror.

D. Avoid locating cleanouts in ceiling/attic /plenum spaces, locate cleanouts in a wall with access panel above the ceiling/attic /plenum spaces.

E. Provide cleanouts to grade in yard box at:

a. Upper terminal cleanout within 5 feet of building line connection
b. Every 50 feet or change in direction over 135 degrees
c. At property line connection

F. Sewage pit shall be lined with high-density polyethylene (HDPE).

G. Sewage Ejections System control panel shall have equipment markings (tags).

H. Access to sewage ejection pumps and control panel shall be 3’ clear.

I. All condensate and indirect waste piping from air handling/fan coil units located above ceiling/concealed locations shall be insulated with fire rated insulation to its point of discharge.

J. Vent piping from grease interceptor shall be independent and terminate above the roof line with an odor filter.

PART 4 - EVALUATION

A. List of items or systems requiring testing, evaluation, verification, or commissioning:

1. Facility Sanitary Sewer

B. Documentation required:

1. Test reports per CPC.
2. Commissioning report
3. Code required test for waste and vent systems.

END OF SECTION

SECTION 22 00 00
FACILITY STORM DRAINAGE

PART 1 - REQUIREMENTS

1.01 Design considerations specific to components in this section:

A. Piping materials shall bear manufacturer's name or manufacturer's registered trade-mark stamp, country of origin and other markings of specified testing agency.

B. Components and installation shall be capable of withstanding 15psig working-pressure.

C. Designed system shall comply with County of LA and CPC latest edition requirements.

D. Hourly rainfall intensity to match City of Compton requirements.

E. Maximum area served by any single drain must be no more than 6,000 square feet of roof surface.

PART 2 - PRODUCTS

2.01 Material Requirements

Service	Size	Location	Material	Joining Method
Storm Drain	All	Underground	Cast Iron Soil Pipe & Fittings, ASTM A 888-15 or CISPI 301-12	Hubless
Storm Drain	All	Above Ground	Cast Iron Soil Pipe & Fittings, ASTM A 888-15 or CISPI 301-12	Hubless

2.02 Piping grade or slope criteria for complete drainage and venting

Type of Piping	Slope	Direction of Fall
Storm Drain	1/4" per 1'-0"	Down in direction of flow. 1/8" per 1'-0" slope is not allowed unless approved by FMS Engineering Services

PART 3 - INSTALLATION

A. Slope storm and overflow drainpipe downward in direction of flow as required by code and per authority having jurisdiction.

B. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers.

C. Provide additional cleanouts as required.

D. Combining of storm and overflow drain is prohibited

PART 4 - EVALUATION

A. List of items or systems requiring testing, evaluation, verification, or commissioning:

1. Test storm drainage piping as follows:

a. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate

report for each test, complete with diagram of portion of piping tested.

b. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
c. Test Procedure: Test storm drainage piping on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 15 psi of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints forleaks.
d. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
e. Prepare reports for tests and required corrective action.

B. Documentation required:

1. Test reports
2. Code required test

END OF SECTION

SECTION 22 16 00
LABORATORY PLUMBING SYSTEMS

PART 1 - REQUIREMENTS

A. Design considerations specific to components in this section:

1. All piping, fittings, valves, outlets and any equipment through which laboratory gas or vacuum passes shall be supplied by the manufacturer especially cleaned and prepared for gas service in accordance with CGA Pamphlet G-4.1 and received labeled and sealed on the jobsite. On-site cleaning is not acceptable. Any prewashed item on which the seal has been broken before installation shall be removed from the site and shall not be used on this project.
2. Copper tubing fittings: Wrought copper solder-joint pressure fittings for brazed joints, ANSI Designation B16.22
3. Valves: Union type three-piece construction, screwed, 400 lb. rated, with Teflon seat, seals, packing and chrome plated brass ball with service identification on valve handle
4. Brazing alloy and thread sealant: Brazing filler metal ANSI/AWS A5.8 with a melting temperature in excess of 1000°F (538°C).
5. Acid waste and vent system shall be installed in accordance with the latest County of Los Angeles Plumbing Code and Los Angeles County Department of Public Works, Bureau of Sanitation. Confirm that product has associated appropriate nationally recognized laboratory.
6. Backflow devices at every piece of equipment requiring RO or DI water supply system
7. Provide natural gas outlets in laboratories if natural gas available in the designed building.

PART 2 - PRODUCTS

A. Material Requirements

Service	Size	Location	Material	Joining Method
Oxygen, Nitrogen, Laboratory Air, Lab Vacuum and Carbon Dioxide	All	Underground	Seamless Medical Gas Copper Tubing (Type K)	Brazed
Oxygen, Nitrogen, Laboratory Air, Vacuum and Carbon Dioxide	All	Above Ground	Seamless Medical Gas Copper Tubing (Type L)	Brazed
Liquid Nitrogen	All	Above Ground	Insulated Schedule XS 304 L Stainless Steel	
Acid Waste and Vent (All piping excluding trap under lab sink	All	All	Schedule 40 PVDF	Heat fusion fitting

Acid Waste and Vent (Trap under lab sink)	All	All	Schedule 40 PVDF	Mechanical joints
RO & DI Water	All	All	High purity PVDF (SYGEF)	BCF® Joining Technology

B. Shop/Laboratory Vacuum Pump

1. Duplex vacuum pumps with 100% redundancy.
2. Factory-assembled, -wired, -piped and -tested; electric-motor-driven; air- cooled; continuous-duty vacuum pumps and receivers.
3. Motor Overload Protection
4. Provide vacuum pump inlet and receiver vacuum gauges, hour meter, vacuum pump discharge-air and coolant temperature gauges and control transformer.
5. Connect to alarm system to indicate when backup vacuum pump is operating
6. Preferred: Manufactured by Beacon Medaes

C. Oxygen, Nitrogen and Carbon Dioxide

1. Medical gas service connections.
2. Nitrogen pressure control panels.
3. Gas manifolds.
4. Medical gas alarm system components.
5. Preferred: Manifolds manufactured by Beacon Medaes

PART 3 - INSTALLATION

3.01 All pipes:

A. Install piping concealed from view and protected from physical contact by building occupants except in equipment rooms and service areas

B. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space

C. Install nipples, unions and special fittings and valves with pressure ratings same as or higher than system pressure rating used in applications below unless otherwise indicated

D. Install piping to permit valve servicing.

E. Install piping free of sags and bends.

F. Install fittings for changes in direction and branch connections.

G. Connect gas piping to gas sources and to gas outlets and equipment requiring gas service.

H. Install shutoff valve at each connection to gas laboratory and healthcare equipment and specialties.

I. Install check valves to maintain correct direction of gas flow from laboratory and healthcare gas supplies.

J. Install gas manifolds anchored to substrate

K. Install chain restraints for upright cylinders

PART 4 - EVALUATION

4.01 List of items or systems requiring testing, evaluation, verification, or commissioning:

A. Required Items:

1. Medical Gas Piping Testing Coordination: Perform tests, inspections, verifications and certification of medical gas piping systems concurrently with tests, inspections and certification of medical compressed-air piping and medical vacuum piping systems.
2. Standing pressure test for positive pressure medical gas piping.
3. Standing pressure test for vacuum systems.

4.02 Documentation required:

A. Pressure Test reports.
B. Inspections performed.
C. Procedures, materials and gases used.
D. Test methods used.
E. Results of tests.
F. UL listing

4.03 Required testing protocols:

A. NFPA 99
B. ASSE Standard #6020
C. ASSE Standard #6030

END OF SECTION

SECTION 22 34 00
FUEL-FIRED DOMESTIC WATER HEATERS

PART 1 - REQUIREMENTS

A. Design considerations specific to components in this section:

1. Water heaters shall be certified by the California Energy Commission and meet Title-24, AQMD Low NOx Rule 1121 and 1146.2. Water heating boilers 1,000,000 Btu.hr and larger shall be registered with South Coast Air Quality Management District (SCAQMD) per rule 222 to meet 114 6.2 requirements).
2. All gas fired water heaters shall meet the flammable vapors ignition resistance requirements (FVIR).
3. Domestic hot water shall be stored at 140°F.
4. Provide circulating system for hot water systems.
5. Use in series with equal split piped manifold to avoid the use of separate storage tanks.
6. Provide Kitchens with separate redundant water heaters as directed by USC FMS.
7. Preference is for steam heat exchangers a central gas-fired domestic water heater with storage tank shall be provided.
8. Electric water heaters should be avoided. Electric water heaters may be used as a last resort for isolated locations and in small sizes as required by Design.
9. No Heat trace piping is allowed.
10. Do not use multi-flue water heaters, nor booster or instantaneous type water heaters.
11. Instantaneous tank-less water heaters of any kind or size are prohibited unless otherwise directed by District.

PART 2 - PRODUCTS:

2.01 Required:

A. Commercial water heater with coated steel burners.
B. Anodes for cathodic protection.
C. Pressure and temperature relief valve shall be furnished and installed by the factory.
D. Heater tank shall have a minimum 7-year limited warranty against corrosion or sediment buildup.
E. Glass lined; foam insulated with intermittent ignition device.
F. Automatic gas shutoff system to prevent excessive water temperature.
G. Water heater shall be equipped with integrated control system consisting of 180°F adjustable thermostat with upper and lower sensing bulbs.
H. Shall have gas pressure regulator and pilot filter.

2.02 Preferred:

A. Manufactured by Bradford White Water Heaters (Housing only or where first approved by USC FMS Engineering Services).
B. Manufactured by Raypak “Hi Delta” series water heater with separate storage tank (Housing only).

C. Manufactured by PVI “Turbopower” non-condensing, low NOx, stainless steel lined packaged storage type hot water heater.

PART 3 - INSTALLATION:

A. Required:

1. Provide ball valve with plug at water heater drain outlet.
2. Provide seismic anchorage for all equipment.
3. Provide drip pans at all water heaters and drain the pan to an approved receptor.

PART 4 - EVALUATION:

A. List of items or systems requiring testing, evaluation, verification, or commissioning: Required Items: water heaters

B. Documentation required:

1. Commissioning report.
2. South Coast Air Quality Management certificate
3. UL listing: Water heaters.

END OF SECTION

SECTION 22 35 00
DOMESTIC WATER HEAT EXCHANGERS

PART 1 - REQUIREMENTS

A. Calculate required size of unit to produce the output shown after deducting for scale formation of tube surfaces using a fouling factor of 0.0005.

B. Temperature range for operation will be a maximum of 140°F. The circulation pumps on these systems will run for a minimum of 10 minutes after the steam has been shut down to eliminate the possibility of the temperature of the exchanger exceeding the 140°F.

C. Steam relief valves shall be at 125 psi, at size of heat exchanger, with vents piped to the outside of the building above the roof line away from overhangs and air intakes.

D. Hot water relief shall be at 125 psi, at size of heat exchanger, and piped to a sanitary drain.

E. Storage type hot water generator.

F. Provide Kitchens with separate redundant water heaters as required.

G. Remote storage tank not permitted.

PART 2 - PRODUCTS

2.01 Steam-to-water heat exchanger (for domestic water):

A. Manufacturers:

1. Preferred: PVI Industries, LLC, Quickdraw Steam Semi-Instantaneous Water Heater.

B. Component Characteristics:

1. Required:

a. Materials of Construction:

1) Shell: 90/10 copper-nickel, ASME certified for 155 psig working pressure.
2) Tubes: Copper or 90/10 copper-nickel double wall.
3) Tube Sheet: Solid copper alloy.
4) Baffles: Teflon.

b. Shell Connections: Solid copper alloy

c. Shall have factory installed pilot operated control valve able to control water temperature within 2 degrees of set point, T&P gauges, T&P relief valve, single solenoid safety system and be a complete factory finished unit including 3 inch thick fiberglass insulation and heavy gauge sheet steel jacket and comply with current ASHRAE standards.

d. Energy Management System Interface: Normally closed dry contacts for enabling and disabling water heater.

e. Boiler water thermometer (3-1/2” diameter dial minimum) direct mounted with separable thermowell.

f. Domestic water thermometer (3-1/2” diameter dial minimum) direct mounted with separable thermowell.

g. Control Panel:

1) UL listed, NEMA 4 enclosure, mounted and prewired for single point feeder supply connection with across-the-line magnetic type starter with overload protection.
2) HOA switch and green running light for integral circulating pump, circuit breaker switch, 120/24-volt transformer with fused primary and fused secondary protection.
3) High temperature alarm with bell, red light and silence switch.
4) Two pole relays with N/O and N/C contacts for monitoring of the high temperature

shutdown alarm by the remote alarm and the Building Control System.
5) 10-year tank warranty.

2. Preferred: PVI, Industries, LLC

2.02 Hot water storage tank

A. Manufacturers:

1. Preferred: PVI Industries, LLC

B. Component Characteristics:

1. Required

a. Materials of Construction:

1) AquaPlex stainless steel pressure vessel.
2) ASME certified for 150 psig working pressure.
3) Nonferrous fittings
4) Lifting lugs
5) Skidded steel base
6) Thermowell fitting
7) Fiberglass insulation
8) Industrial glass thermometer with well
9) Steel jacket panel with industrial grade finish
10) 1” ASME temperature and pressure relief valve.
11) 2”drain valve.
12) 10-year warranty.

PART 3 - INSTALLATION

A. Required:

1. Gages shall be 3” minimum and placed in a manner that are easily visible from the service area.

2. Frame for support of heat exchanger and associated equipment shall be installed so as to not interfere with the service of the equipment and be structurally sound.

3. Steam traps shall be piped with unions to allow removal and installed in such a manner as to allow ease of removal.

4. Ensure that full tube clearance is available without significant disturbance to adjacent piping or equipment.

PART 4 - EVALUATION

A. List of items or systems requiring testing, evaluation, verification, or commissioning: Required Items: Heat Exchangers.

B. Documentation required:

1. Test reports: Testing, Adjusting, and Balancing.

2. Commissioning report.

3. ASME stamp: Steam-containing Heat Exchangers.

C. Required testing protocols beyond normal Commissioning and TAB protocols.

END OF SECTION

SECTION 22 40 00
PLUMBING FIXTURES

PART 1 - REQUIREMENTS

A. Provide clean-outs above all urinals, lavatories, upper terminal water closets and sinks. Clean-outs for lavatories and sinks may be located to side of the fixture.

B. Provide additional floor drain in restrooms having four (4) or more water closets

C. Emergency Shower/Eyewash Stations: Temperature Mixing Valves (TMV) shall not be required for emergency shower/eyewash stations if the water temperature with-in the building meets the requirements defined in ANSI/ISEA Z358.1 – tepid water (60deg. to 100 deg. F.). Water temperature test data shall be provided and indicated as part of the contract documents. A hot and cold-water source shall be required with a TMV on emergency shower/eyewash stations outside of buildings, on the roof or wherever the water temperature with-in the building does not meet the requirements of ANSI/ISEA Z358.1.

Emergency Shower/Eyewash Requirements/Features			
Emergency Shower/Eye wash Features	Emergency Shower/Eyewash Location		Remarks
	Labs and Cleanrooms ms	Mechanic al Rooms and Rooftop Mechanic al Area	
Local Horn/Strobe	YES	YES	
(2) Dry Contacts Option Kit	YES	YES	(1) Dry Contact for Connection to DPS ; (1) Dry Contact for Local Horn Strobe
E-Power to Horn/Strobe	YES (Condition al - Please see remarks)	YES (Condition al - Please see remarks)	Emergency power (E-power) to Emergency Showers & Eyewashes are not necessarily required. If the intent for the laboratory or building is to have emergency power and be operational, then e-power will be provided.
Contacts for Connection to DPS	YES	YES	Notification to DPS can be made thru the fire alarm. Low voltage wiring from dry contact to fire alarm panel to be provided. Fire alarm contractor to land wiring from Emergency Shower & Eyewashes at fire alarm panel
Floor Drains (Renovations & New Construction)	YES	NO	

PART 2 - PRODUCTS

2.01 Component Characteristics:

A. Provide the following fixtures

Type	Model Number	Color	Additional appurtenances
Water Closet (Non-ADA,Floor Mounted; Only for use where there are structural implications; Requires FMS approval)	American Standard Madera Flow Wise 3451.001	White	Sloan Optima 8111.128 Chrome flush valve (battery powered) and Church 9500 Seat
Water Closet (ADA,Floor Mounted Only for use where there are structural implications; Requires FMS approval)	American Standard Madera Flow wise 3461.001	White	Sloan Optima 8111.128 Chrome flush valve (battery powered) and Church 9500 Seat
Water Closet (Non-ADA, Wall Mounted)	American Standard Millennium Afwall 3351.101.	White	Sloan Optima 8111.128 Chrome flush valve (battery powered) and Church 9500 Seat
Water Closet (ADA, Wall Mounted)	American Standard Millennium Afwall 3351.101.	White	Sloan Optima 8111.128 Chrome flush valve (battery powered) and Church 9500 Seat
Urinals	Zurn “The Small Pint” Z5738.205.00	White	Battery operated integral flush valve
Lavatories: wall hung	American Standard Lucerne 0355.012	White	Lavatory Faucet, mixing valve, grid drain, tailpiece, trap assembly, insulation kit and supply stops.

Type	Model Number	Color	Additional appurtenances
Lavatories : wall hung with soap dispenser	American Standard Lucerne 0355.034	White	Optional soap dispenser 4503.115, Lavatory Faucet, mixing valve, grid drain, tailpiece, trap assembly, insulation kit and supply stops.
Lavatories: Under counter	American Standard Ovalyn 9482.000	White	Lavatory Faucet, mixing valve, grid drain, tailpiece, trap assembly, insulation kit and supply stops.
Faucet for Lavatories	American Standard Inns brook 6055.204	Chrome	Sensor activated faucet (battery powered); Thermostatic mixing valve 605XTMV1070
Emergency shower/eyewash(in door)	Haws 8356WCC or equivalent by Guardian		Axion MSR Stainless steel eye/face wash # SP65SS, Tempered water mixing valve, Haws 9201H or equivalent by Guardian
Emergency showers/eyewash (outdoor)	Haws 8300-8309, 8309WC or equivalent by Guardian		MSR Stainless steel Showerhead, Tempered water mixing valve, Haws 9201H or equivalent by Guardian
Emergency eyewash	Haws 7655WCC or equivalent by Guardian		Axion MSR Stainless steel eye/face wash # SP65SS, Tempered water blending system Haws TWBS.EWE or equivalent by Guardian
Service Sink (corner/floor)	American Standard Florwell 7741.000		3” trap/strainer and Wire Rim Guard.
Service Sink (wall)	American Standard Lakewell 7692		Trap – American Standard 7798.030
Faucet for Service Sinks	American Standard 8354.112		Wall brace, vacuum breaker

B. Coordinate the following fixtures:

Type	Model Number	Color	Additional appurtenances
Kitchen Sink	Elkay, Just		Stainless steel 18 gauge
Garbage Disposal	In-Sink-Erator Evolution		3/4HP
Shower	American Standard,		Pressure balance valve.
Shower (ADA)	American Standard, Powers		Pressure balance valve
Electric Water Cooler	Elkay LZSTL8WSSVP		Stainless Steel 53100 Water Filter
Floor Drain, Floor Sink, Roof, Area and Overflow drains	J.R. Smith, Zurn, Josam		
Hose Bibb	Acorn, Woodford		With non-removable vacuum breaker

PART 3 - INSTALLATION:

A. Required:

1. Provide Hose Bibb:

a. Close vicinity of grease interceptors, sewage and sump pits, if any. Refer to section 22 1100 for additional requirements.

2. Provide trap primer for trap seal:

a. Floor Drains
b. Floor sinks
c. All hub drains

B. Preferred: Floor drains or similar traps directly connected to the drainage system and subject to infrequent use shall be protected with a trap seal primer.

PART 4 - EVALUATION

A. List of items or systems requiring testing, evaluation, verification, or commissioning: None.

B. Documentation required:

1. Lead-free fixtures: All fixtures, pipes and plumbing fitting that intended to convey or dispense water for human consumption through drinking or cooking.

END OF SECTION

SECTION 22 70 00
FACILITY NATURAL GAS DISTRIBUTION

PART 1 - REQUIREMENTS

A. Standards and Code Requirements

1. Submit test reports and inspection certification for all-natural gas system installed.
2. Submit welder's certification prior to any shop or field fabrication. Welder's certifications shall be current within six (6) months of submission.
3. Record actual locations of valves, regulators, etc. and prepare valve charts.
4. Provide full written description of manufacturer's warranty.

B. Calculation Requirements

1. Natural Gas sizing table with total developed length indicated.

PART 2 - PRODUCTS

A. General Requirements:

1. Material Requirements

Service	Size	Location	Material	Joining Method
Low Pressure Gas	All	Underground (Site)	Schedule 40 Black Steel Wrapped.	Welded
Low Pressure Gas	All	Above Ground	Schedule 40 Black Steel	Screwed
Medium Pressure Gas	All	Above Ground	Schedule 40 Black Steel	Welded
Medium Pressure Gas	All	Underground (Site)	Schedule 40 Black Steel Wrapped	Welded
Medium Pressure Gas	All	Underground	Polypropylene "Yellow" PE 2406	Soc ket

B. Gas Piping

1. Locate gas meters where a straight service run from the street can be made by the gas company and where it is accessible by truck for service and replacement, as central as possible to the major gas loads (e.g. Main boiler rooms) to minimize size and length of main pipe runs.
2. Meter locations must coordinate with Architect and approved by the Gas Company.
3. Medium-pressure gas service shall be approved by the Gas Company.
4. Provide a gas-schedule for each meter including future load in CFH and total developed length from gas meter to furthest gas outlet. Individually indicate gas demand for HVAC, domestic, hot water, kitchen and laboratory needs.
5. Design private underground gas piping from meter to building and coordinate location elevation with Architect.

PART 3 - INSTALLATION:

A. Allowable Gas line locations: Locate gas lines above ground in buildings at least 6 inches above floor, it is allowed to run through attic spaces, within covered walkways and in ventilated crawl

spaces.

B. When installed underground, provide 30” minimum cover embedded in 6” of sand all around.

C. For transitions between plastic and metal pipe, connect to steel pipe with Central Plastics Company fabricated transition fittings.

D. Provide an accessible shut-off valve for each gas outlet or group of outlets within a room.

E. Provide individual check valves for gas outlets or turrets adjacent to air or water outlets, such as laboratory stations.

F. Provide a master shut-off valve for labs in a secure area not accessible by students

G. Provide an isolation valve for each building.

H. Provide isolation valve at each regulator. Vent pressure regulator to atmosphere if regulator is located within building.

I. i) Provide approved Earthquake Shut-Off Valve for each gas meter.

J. j) Gas valves shall be lubricated plug valves, full port, semi-steel/cast iron/bronze, U.L. Listed, similar to Homestead Figure 601/602.

K. Avoid lengthy horizontal rooftop mounted piping whenever possible

L. Avoid running gas lines through one building to serve another.

M. Ball valves are not acceptable for natural gas systems.

PART 4 - EVALUATION

A. List of items or systems requiring testing, evaluation, verification or commissioning: Required Items: Code required pressure test.

B. Documentation required:

1. Pressure test report.

END OF SECTION

SECTION 23 00 00
MECHANICAL REQUIREMENTS

PART 1 - OVERVIEW

A. General Information:

1. District Goals: All design shall address design concept based on the ASHRAE Guidelines and its definition of the Basis of Design document. Baseline requirement and the proposed scheme for the relevant criteria as agreed with District.

   a. Easy to install.
   b. Easy to operate and maintain.
   c. Easy to replace.
   d. Energy efficient.
   e. Proven reliability.
   f. Designed upon well-established principles.
   g. Constructed of standard, use-proven materials.
   h. Acceptable procurement lead time.
   i. As low an initial cost as practical.
   j. Low Operating cost.
   k. Low Maintenance cost.
   l. Lowest life cycle cost for highly energy efficient installations that incur a higher initial cost.
   m. Environmentally friendly.
   n. Acoustically compatible with occupied spaces.
   o. Minimize susceptibility to vandalism.
   p. Degree of disruption of occupants during renovations.
   q. Site constraints and impacts on adjacent buildings and uses
   r. Appropriate to stated operating schedules.

2. Site Utilities: New buildings

   a. If building's are connected onto central School campus chilled water utility (if District permits to provide Central plant for HVAC requirements and some of the criteria provided may not apply if Central plant is not used). it shall be assumed that chilled water is available per District's intent to operate the system during Regular School hours/off hours/special events or as directed. Should any equipment in a space is connected to emergency standby power, then the HVAC equipment serving the space shall also be on emergency power and shall be a DX type system.

3. Campus Building Management System Connections: New building/School Campus

   a. Design parameters for the building management system shall be provided.
   b. Equipment specified to have an independent on-board manufacturer- provided control system shall be connected to campus EMS system for monitoring. Contractor to provide all required software licenses for 3 years and provide information on annual software maintenance cost for renewal after 3 years to district. This should be included in closeout documents.

4. Vibration & Acoustics: Coordinate with Architect and Acoustical Consultant.

PART 2 - REQUIREMENTS

A. Standards and Code Requirements:

1. Required:

   a. The HVAC system shall comply with the current California Code of Regulations, Title

24, California Mechanical Code (CMC), California Plumbing Code (CPC), ASHRAE, SMACNA and NFPA standards.

b. Any updates to applicable codes (or appropriate industry standards) not reflected, or Code Change adopted by the California Building Codes shall supersede these requirements at the time of approvals from Division of State Architect. (DSA).

B. Design Criteria:

1. All interior spaces shall be air conditioned unless specifically excluded by the District.
2. Perform a psychrometric analysis of the outdoor, indoor, mixed air and AC equipment leaving air temperatures for selection of air conditioning equipment. The following parameters shall be reviewed to ensure the equipment can meet the projects' specific indoor environmental requirements:

   a. Current California Energy Commission Title 24 - Compton CA data station criteria.
   b. Outdoor data published by ASHRAE for Humidification conditions.
   c. Outdoor data published by ASHRAE for Dehumidification conditions.
   d. The geographical coordinates of Compton are 33.896 deg latitude, -118.220 deg longitude, and 75 ft elevation.

3. Temperature

   The *warm season* lasts for *2.9 months*, from *July 6* to *October 4*, with an average daily high temperature above *78°F*. The hottest day of the year is *August 26*, with an average high of *81°F* and low of *66°F*.

   The *cool season* lasts for *4.1 months*, from *November 29* to *April 1*, with an average daily high temperature below *69°F*. The coldest day of the year is *December 27*, with an average low of *48°F* and high of *66°F*.

4. Humidity

   Base the humidity comfort level on the dew point, as it determines whether perspiration will evaporate from the skin, thereby cooling the body. Lower dew points feel drier and higher dew points feel more humid. Unlike temperature, which typically varies significantly between night and day, dew point tends to change more slowly, so while the temperature may drop at night, a muggy day is typically followed by a muggy night.

   The perceived humidity level in Compton, as measured by the percentage of time in which the humidity comfort level is *muggy*, *oppressive*, or *miserable*, does not vary significantly over the course of the year, staying within *5%* of *5%* throughout.

5. See special requirements for Cooling Tower wet bulb design criteria (if Central Plant is provided).
6. All rooftop air-cooled equipment shall be specified with maximum ambient air temperature of +/- 105°F.
7. A field survey performed by the design team of actual internal heat gains in the field conditions and assessment of current demand is required for existing school building projects such as modernization/remodel and equipment replacement.
8. Provide outside air to each room through the HVAC system in compliance with current California Energy Code and ASHRAE recommendations.
9. Cooling system shall be available year-round, 24-hour operation, for data rooms/ server rooms, elevator equipment rooms (as required by elevator consultant) and ventilation for electrical rooms with transformers. Recommend to provided individual package or split systems for these areas so cooling is localized and can run without cooling the remainder of the building.

10. For large buildings where many fan coil units are used, provide a filtered fresh air fan equipped with heating and cooling coils designed to provide tempered air to the inlet of the fan coil units.
11. Design strategy of both fire separations and ductwork distribution shall be coordinated so as to keep the need for Fire Smoke dampers to a minimum.
12. One Fan Coil Unit (FCU) or CAV/VAV box may serve a zone for each classroom and a maximum of 5 interior offices or 3 exterior offices.
13. Dedicated Fan Coil Units or VAV boxes or packaged AC units shall be provided to conference rooms.
14. Provide reheat coils in all terminal units, including those serving only interior zones.
15. Hallways and corridors shall be served by CAV/VAV zones that may also serve adjacent office areas.
16. Coordinate with the project architect/structural engineer for the following items:
    a. Support and anchorage of all equipment, valving, piping, ductwork, duct silencers and controls equipment and conduit.
    b. Thermal and seismic expansion.
    c. Vibration isolation and seismic anchorage.
17. Allowable mechanical services noise, duct velocity, VAV box selection criteria, air valve selection criteria, equipment vibration isolation and design considerations on placement of equipment and mechanical spaces are to follow Architect's and Acoustical Requirements. Recommend to provide interior duct liners on the exterior of ducting to minimize excessive noise issues.
18. Criteria related to allowable use of ceiling return plenums and details on transfer boots shall be coordinated with architect.
19. For areas that have wood-flooring (Gymnasium's), the designer shall determine if there are any room humidity requirements for the wood flooring. If so, provide the necessary humidity control to avoid damaging wood flooring.
20. New equipment shall be identified with unique mark/tag numbers within floor plans and equipment schedules.
21. DX systems are acceptable only if chilled water is not available during hours of operation for the affected cooling equipment.
22. VAV boxes shall never serve both an exterior zone and an interior zone.
23. Hallways and corridors shall not be served by a dedicated CAV/VAV box.

C. Additional Criteria:

1. Indicate the required equipment energy efficiencies clearly in the equipment schedules.
2. Indicate how outside-air is provided and how much is provided for each HVAC unit in all modes of operation (normal, economizer cycle, demand control ventilation mode, nighttime pressurization, etc.). Provide calculations showing how air is relieved from the building in each mode to balance the fresh outside air make-up with exhaust while maintaining building pressures to ensure compliance with California Building Code door closer settings for accessibility.
3. The designer shall coordinate with utility suppliers to take full advantage of incentives for higher energy efficiency such as Savings by Design Program of Southern California Edison

and The Gas Company.

4. Provide to district all design calculations for equipment and system selection criteria such as life-cycle cost and energy analysis, duct friction and pipe friction loss calculations, fan and pump selection curves, heating and cooling coil selection data, chiller and cooling tower selection data, estimated room noise levels (NC), etc.
5. Coordinate with Architect for proposed screening strategy and address any line of site issues anticipated with proposed location and final anticipated installed height of external equipment.
6. Provide a zoning plan including thermostat locations and associated Fan Coil Unit (FCU) and CAV/VAV box number for review.
7. Identify required equipment service clearance space and associated service path. Indicated equipment service clearances shall be per equipment manufacturers' requirements or per code mandated clearance – whichever is more stringent.
8. Provide a path of travel which would allow for the future replacement of major equipment M & O staff.
9. All equipment shall be housed on the roof or in Mechanical Rooms within the building.

D. Calculations:

1. Heating and cooling calculations shall be performed on an industry recognized computer program such as Trace 700, HAP, or Energy Pro that will demonstrate compliance with Title 24. The calculations shall be done for each room and each system.
2. Life cycle cost calculations shall be performed on an industry-standard program such as Trace 700 or DOE-2. The calculations complete with all input and supporting data shall be reviewed with District.
3. The California Energy Commission's (CEC) Certificate of Compliance for Non- Residential Buildings with the necessary backup forms shall be completed on CEC-approved software using the whole building approach performance basis which integrates the building envelope, mechanical and electrical systems as designed.
4. Cost/Benefit Analysis: Conduct a cost/benefit analysis for all proposed energy conservation measures which are beyond the required systems described in the Design Guidelines. The design team shall demonstrate that the combination of all conservation measures will meet a maximum payback period of 7 years.

PART 3 - PRODUCTS

A. Steam System Design Requirements: (If Central Design is used).

1. A central hot water boiler shall be provided within the building for space heating to hot water heat exchanger shall be installed for the space heating requirements.

B. Chilled Water System Design Requirements: (If Central Design is used).

1. A water-cooled chilled water system shall be provided.
2. Branch chilled water piping shall be connected to the top of horizontal chilled water mains.
3. Air cooled packaged chillers shall not be used for the purpose of building HVAC central chilled water equipment.
4. Liquid coolers are not allowed for HVAC heat rejection systems.

C. Hot Water System:

1. Hot water boilers shall be used where steam requirements are minimal.

2. Hot water boilers and steam-to-water heat exchangers shall be provided with redundancy when used. There shall be a minimum of 2 devices and designed so that if one device fails, the other can maintain 70% of total peak capacity.
3. Boiler equipment layout shall clearly identify tube bundle pull area and shall maintain this area clear of obstructions.
4. Branch heating hot water piping shall be connected to the top of horizontal heating hot water mains.
5. A reverse return system/ strategy shall be employed wherever possible, so pressure drops through piping system and each piece of equipment/circuit is relatively balanced.
6. Primary/secondary operation shall be used when modular boilers are installed.
7. HHW systems shall be primary secondary pumping with 3-way valve to control set-point and reset.
8. Pipes shall be arranged so tubes can be accessed as primary/return common headers.

D. Hydronic Pumped System:

1. All distribution pumps shall be selected and sized based on the following criteria and redundancy:

Motor Size	Pump Sizing	Comments
< 10 Hp	Each at 100% of proposed load	Minimum of two pumps for redundancy
≥ 10 Hp	Select pump sizes to equal no less than 140% total of required capacity	Minimum of two pumps for redundancy

2. Redundant pumps(s) are intended to function as stand-by yet shall be operated on a lead/lag sequence that allows for even sharing of overall run time hours.

E. Air Handling System Design Requirements:

1. Only Custom Air Handling Units shall be used.
2. Provide air handing units with preheat coils for 100% OSA systems.
3. Modular and off-the-shelf semi-custom Air Handling Units are not allowed.
4. Packaged DX Outdoor Air Handlers are not permitted.
5. Water-source heat pumps are not allowed.
6. Ceiling Plenum Systems: Other than approved return air plenums for centralized systems that are collected on a common floor, ceiling plenums are not permitted for distribution of supply, outside, or exhaust air, to or from respective HVAC fan systems.
7. Architectural/General Construction Wall or Ceiling Plenum systems are not to be used as sole means for distributing air to or from any type of HVAC fan systems - air shall not come into direct contact with architectural / structural enclosures.

F. Smoke Detection:

1. The engineer shall coordinate and determine if a total coverage smoke detection system (in all areas served by the subject HVAC system) is present in the building or within the confines of the project. Engineer to determine how the smoke detection devices are to be specified for the project. (By Code all California K-12 schools shall be provided for full coverage of smoke detection).
    a. For a total coverage smoke detection system, it shall be used to trigger air moving

equipment (AHU, FCU, AC Units, Fans, etc.) hard-wired shut down and the closure of fire smoke dampers in response to a smoke alarm. Coordinate with the Fire Alarm Designer as necessary to achieve this goal. For roof mounted equipment – relays used for shut down of HVAC units shall be located inside the building, not within the equipment outside exposed to the elements, preferably in an accessible ceiling or clustered together in an electrical or low voltage room with proper identification of function and location of equipment controlled.

PART 4 - INSTALLATION

A. Provide Utility connections as required.

B. Ensure maintenance and accessibility provisions for servicing and replacement.

C. Provide necessary working area needed for equipment service and repair.

D. Where HVAC equipment is roof mounted or require roof openings, verify that all structural provisions are made to assure adequate capacity for load bearing and diaphragm capacity and noise and vibration attenuations.

E. Where HVAC equipment is located at grade level and/or in an open publicly accessible area, a fence/gate/etc. shall be provided for security and/or visibility purposes. Refer to Architectural drawings and specifications.

F. Provide permanent access to the roof for roof mounted equipment which requires service. The access path shall allow for removal of major / large equipment components through the building to avoid specialized rigging equipment whenever major service/replacement is required.

G. Use of pitch pockets at fixed, roof mounted, pipe and ductwork support is not permitted.

H. Provide a minimum of 8” clear space between finished roof surface and underside of rooftop mounted piping and ductwork, when utilizing fixed pipe supports, to allow future re-roof work.

I. For systems incorporating vibration isolation, manufacturer to provide vibration isolation system adjusted and aligned.

J. Provide Twist timers for lighting at air handler interiors.

PART 5 - EVALUATION

A. List of items or systems requiring testing, evaluation, verification, or commissioning

B. Provide Documentation Required for Commissioning reports

1. Operations and Maintenance Manuals: shall be provided

2. Controls information: shall be provided as required by the independent controls Specifications.

END OF SECTION

SECTION 23 05 13
COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - PRODUCTS

A. Motors: Comply with NEMA MG 1

1. Manufacturers:

   a. Lincoln
   b. Baldor-Reliance-ABB
   c. US Motors
   d. GE

2. Components:

Motor Size	**Premium Efficiency**	**Inverter Duty Rated**	**VFD Required**
<3 HP	**X**	X	For variable flow application only
3 – 5 HP	X	X	For variable flow application only
>5 HP – 10 HP	X	X	For variable flow application only
>10 HP	X	X	In all applications

3. Motors shall be properly rated and enclosed, based on location:

Location	**Motor Type**
Indoors	ODP (1) (2)
Indirectly Exposed Outdoors	TEFC
Completely Exposed to Outdoors	TEFC
(1) Where motor is in mechanical room or wet or saturated airstream, use TEFC. (2) Where flammable content in airstreams is anticipated, use	

PART 2 - EVALUATION

A. List of items or systems requiring testing, evaluation, verification, or commissioning: Required Items: All motors with greater than 100V.

B. Documentation:

1. Test, Adjusting & Balancing Reports.
2. Commissioning report.
3. UL listing.
4. NEMA Rating of Enclosure.

END OF SECTION

SECTION 23 05 14
VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 - REQUIREMENTS

A. A single variable frequency drive shall control only one motor. Individual VFD's shall be provided accordingly in the case of parallel redundant pump/fan motors and with no required by-pass at the VFD.

B. VFD shall be UL listed for a short circuit current rating of 100,000 amps and tested to UL508c.

C. The VFD shall meet the seismic requirements of California Building Code (CBC).

PART 2 - PRODUCTS

A. Variable Frequency Controller:

1. Manufacturers:

a. Danfoss
b. ABB
c. All VFD's serving HVAC equipment as part of a single project shall be provided by a single manufacturer.
d. Private-branded drives not produced by the drive manufacturer are not permitted.

2. Components:

a. Variable frequency drive shall be specified for the correct, NEMA rated enclosure for proposed location as follows:

Location	NEMA Enclosure
Indoors	NEMA 1 (1)
Exposed Outdoors (directly or indirectly)	NEMA 3R
(1) In rooms with water-filled piping use NEMA 3R.	

b. Variable frequency drive shall be provided with 3 - contactor by- passes (in order to by-pass drive, control in hand, or automatic) for mechanical systems in which complete equipment redundancy is not provided. Bypass shall include an external safety interlock that will disable motor operation in either bypass or VFD when open.
c. All power and low voltage terminations into and distribution out of VFD shall be through the bottom of drive cabinet through factory provided knock- outs.
d. Provide control diagrams for VFD monitoring and control points, which shall be hard wired and made available for interface with the building automation or Energy Management systems. Respective internal modules and circuitry necessary to allow for these items to be hard-wired shall be specified accordingly.
e. The VFD shall have a dual 5% impedance DC link reactor on the positive and negative rails of the DC bus. VFD's with saturating (non- linear) DC link reactors shall require an additional 3% AC line reactor. VFDs which do not include an integral 5% DC link impedance shall include 5% AC line reactors in the operations enclosure.
f. The VFD shall contain integral EMI filters.
g. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 120% of rated torque for up to 0.5 seconds wile starting. The VFD shall provide full motor torque at any selected frequency from 20 Hz to base speed while providing a variable torque V/Hz output at reduced speed. Breakaway torque of 160% shall be available.
h. The VFD shall include current sensors on all 3 output phases.

i. The VFD shall continue to operate with reduced output without faulting with input voltage as low as 70% of the nominal voltage and shall provide full rated output for input voltages of 90% of nominal.
j. The VFD shall have a minimum of Class 20 I^2t motor overload protection, which shall automatically compensate for changes in motor speed.
k. All VFDs shall have the same interchangeable customer interface keypad to allow a single programmable keypad to download information to multiple VFDs during startup procedures.
l. The VFD shall accept up to 3 feedback signals, each with independent scaling.
m. The VFD shall be compatible with BACnet protocols as designed for the Building Management systems and provided with the appropriate hardware to communicate operating parameters via protocol. provide required communications controller card.
n. The VFD shall (at minimum) be provided with the necessary hardware to allow for the hardwiring of the following operating parameters; (1) Start / Stop, (2) Status, (3) Speed Output
o. Vertical or horizontal configuration of VFD and its associated by-pass shall be coordinated based on space available for mounting and to maintain code required clearances.
p. Where NEMA 3R applies, provide auxiliary display mounted on enclosure door to allow for external viewing of VFD conditions.

PART 3 - INSTALLATION

A. For VFD's mounted remotely beyond 15 feet from unit and out of direct line of sight from equipment, provide auxiliary disconnect on or adjacent to equipment and necessary contacts to de-energize drive. VFD may not be mounted more than 30 feet from unit.

B. Maintain code required clearances for VFD. Clearance area may overlap other equipment clearances as long as the largest clearance area between the overlapping equipment is maintained.

C. VFD shall be installed so that there is a level finished floor surface (pad).

D. Permanent ladder and walking platform for maintenance access shall be provided for VFD's mounted on equipment where the center of drive cabinet is located at or above 72" AFF.

E. VFD start-up shall be completed by manufacturer trained and certified representatives.

F. Input and output wiring of drive must be in separate conduits.

G. The VFD supplier with the electrical single line diagram shall perform an analysis to demonstrate that the supplied equipment will meet the IEEE 519 requirements using the Point of Common Coupling (PCC) shall be the building side of the utility company transformer.

H. Fire alarm system shall be capable of supporting the additional devices, all VFDs provided for supply and return fan systems shall be tied in accordingly. Fire alarm and HVAC/Plumbing designer shall coordinate final termination locations with either the VFD installation or the certified start-up vendor, in order to integrate these systems into the fire alarm system for appropriate shut down.

I. It is preferred that VFD's for fans within air handling units shall be mounted externally on unit cabinet.

PART 4 - EVALUATION

A. List of items or systems requiring testing, evaluation, verification, or commissioning: Required Items: All Variable frequency drives covered under this section.

1. Test, Adjusting & Balancing Reports.

2. Commissioning report.
3. UL listing.
4. NEMA Rating of Enclosure.
5. Start-up report from certified representative

END OF SECTION

SECTION 23 05 16
EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 - REQUIREMENTS

A. Expansion loops shall be provided for chilled water, heating hot water, steam and steam condensate piping systems, exceeding 100'-0" in horizontal length and as appropriate to control expansion.

B. Determine system's forces and displacements associated with expansion, then design and provide expansion compensation devices, equipment and anchors. Provide for review by District all calculations of anticipated expansion and proposed system for controlling expansion including structural calculations for all anchors. This shall be submitted by 50% Construction Documents phase.

C. Engineering documents shall show expansion loops on plans, provide details regarding size, configuration anchors, guides and means of installation.

PART 2 - PRODUCTS

A. Expansion Joints: Designer to select as required.

1. Expansion loops shall consist of 90° elbows connected by straight length of pipe to form a "U" or "Z".

PART 3 - INSTALLATION

A. Provide mineral wool fiber at underground 90° elbows intended to act as an expansion control system.

END OF SECTION

SECTION 23 05 19
METERS AND GAGES FOR HVAC PIPING

PART 1 - REQUIREMENTS

A. Pressure and temperature gages shall be selected so that the high limit of range does not exceed a factor of 1.5x the standard operating point for that particular system. Gages shall be selected so system operating pressure is found within the middle 1/3 of overall range.

PART 2 - PRODUCTS

A. Gages: Designer to Choose as required.

1. Provide the following materials and components for gages:

Gage Type	Application	Materials	Comments
Pressure	Low Temperatures	Construction: Metal Case Window: Glass Liquid: Silicone Oil	Provide pressure snubbers and gage valves. Select gauge where system operating range lies in middle 1/3 of range for best accuracy.
	Ambient Temperatures	Construction: Metal Case Window: Glass Liquid: Glycerin	
	High Temperatures (HHW, steam, etc.)	Construction: Metal Case Window: Glass Liquid: Sodium-Potassium Eutectic	
Temperature		Construction: Metal Case: Liquid: Mercury Free Window: Glass	Provide coil siphons and gage valves.

B. Flow Meters:

1. Manufacturers:

a. GE
b. Controlotron A Siemens Division

2. Component:

a. Flow meters shall be ultrasonic, single channel type.

PART 3 - INSTALLATION

A. Provide the following ports for purposes of temperature and pressure sensing:

1. Use Pressure and temperature gages at building point of entry for hydronic utilities to measure conditions entering and leaving the building as a whole.
2. Use Temperature gages at air handling unit sections so as to validate mixed air and discharge air temperatures, upstream and downstream of coil respectively.
3. Use P/T test plugs at inlet and outlet of each individual coil connection when coils are stacked to make-up overall coil face area to verify pressure and temperature drops across each individual coil.

Device Type	Required Locations	Comments
Temperature Gages	1. On supply and return at air handling unit coil sections 2. Adjacent to inlet and outlet of hydronic source equipment providing a (e.g. chiller, boiler, cooling tower) 3. Adjacent to building point of entry of all central hydronic utilities 4. Air handling unit mixed air, coil incoming, coil leaving and unit discharge sections	Installation requirements and specifications should specify these requirements, if applicable. Provide appropriate tap offs and gage valves.
Pressure Gages	1. Air handling unit mixed air, coil incoming, coil leaving and unit discharge sections 2. Hydronic equipment inlet and outlet where pressure drop will be experienced 3. Adjacent to inlet and outlet of major hydronic source equipment (e.g. chiller, boiler, cooling tower) 4. Adjacent to building point of entry of all central hydronic utilities	Installation requirements and specifications should specify these requirements, if applicable. Single compound gage shall measure static and differential pressure.

Device Type	Required Locations	Comments
P/T Test Plug	1. Inlet and outlet of all coil connection points including all sub-branches serving stacked coils 2. Adjacent to pressure and temperature gages 3. Adjacent to pressure and temperature control sensor locations	Installation requirements and specifications should specify these requirements, if applicable. Install directly adjacent to manufacturer provided inlet and outlets of each coil connections.
Flow Meter	1. At building point of entry of all central hydronic utilities. 2. At hydronic source plants (e.g. boilers, chillers, cooling towers) 4. Sub-metering locations as directed by Designer.	Locate so that readings can be used for both control and monitoring.

4. Install gages to be serviced without impacting the operation of adjacent or associated equipment.
5. Pressure gages or test ports for reading differential shall be located at same elevation. This also applies to where compound gages are anticipated.
6. Gages shall be mounted to be accessible and easily read by M & O personnel.
7. List of items or systems requiring testing, evaluation, verification, or commissioning and TAB protocols

END OF SECTION

SECTION 23 05 23
GENERAL DUTY VALVES FOR HVAC PIPING

PART 1 - REQUIREMENTS

A. Shut-off valves shall be provided.

B. Automated and manual means of building isolation shall be provided, or a single set of valves can be provided, and this requirement can be consolidated with provisions of mechanical override.

PART 2 - PRODUCTS

A. Above Ground Manual Isolation Valves:

1. Manufacturers (as required by valve type):

a. For a single project, a single manufacturer shall be provided for all like service and valve types.
b. Nibco
c. Crane
d. Grinnell
e. Apollo
f. Watts

2. Components:

a. Provide the following materials and joints for the following valves:

Service	Valve Type	Size	Material	Joining Method
High Pressure Steam (HPS) Steam Condensate (CR)	Gate/Globe	≤2 ½"	Bronze	Screwed
		≥3”	Cast Iron	Flanged/Lug
Low Pressure Steam (LPS) Steam Condensate (CR)	Gate	≤2”	Bronze	Screwed
		≥2 ½“	Steel	Flanged/Lug
	Globe	≤2”	Bronze	Screwed
Chilled Water (CHW) Heating Hot Water (HHW) Condenser Water (CDW)	Ball	≤2”	Bronze	Threaded
	Butterfly / High-Performance (double offset) Butterfly	≥2 ½“	Steel	Flanged/Lug
Note: High-Performance (double offset) Butterfly Valves shall be used in central utility plant applications.				

B. Underground Direct-Buried Manual Isolation Valves (CHW & HHW Only):

1. Manufacturers:

a. Henry Pratt Groundhog Buried Service Butterfly Valves
b. Mueller Lineseal III Butterfly Valves

2. For a single project, a single manufacturer shall be provided for all like service and valve types:
3. Components:
   a. Required:
      1) Sizes: 4" – 20"
      2) Body Style: Cast Iron ASTM A-126 Class B, Flanged Ends
      3) Pressure Class: 150B per AWWA Standard C504
      4) Shaft: One Piece, Type 304 Stainless Steel ASTM A-276
      5) Bearings: Corrosion Resistant, Self-Lubricating
      6) Actuator: Grease Packed, Moisture Intrusion Resistant
      7) Accessories: Valve Position Indicator with adapter, 2" square AWWA nut and extension stems.

C. Automated/Control Valves:
1. Manufacturers:
   a. For a single project, a single manufacturer shall be provided for all similar service and valve types.
   b. Honeywell
   c. Belimo
2. Components:
   a. Actuator shall be provided with appropriate enclosure for outdoor weatherproofing, sun exposure or extreme environments (NEMA 4, etc.).

PART 3 - INSTALLATION

A. Required:
1. Provide devices at a minimum at following locations:

Device Type	Required Locations	Valve Type		
		System	Size	Type
Shut off Valves	1. Supply and return at each piece of equipment 2. At each floor level branch from risers 3. At the base of vertical risers. 4. At each lab module.	Steam	All	Gate
		Hydronic	≤ 2"	Ball
			> 2"	Butterfly
Automated Control Valves	BAS Basic Materials	-	-	-

2. Install valves to be readily accessible by M & O personnel with appropriate means for operating and removing these valves.
3. Provide chain operators for equipment room valves 4" and larger located over 78" above finished floor.
4. If manual air vents are provided at high points of underground hydronic pipe distribution, provide proper extensions to grade and valve covers.

PART 4 - EVALUATION

A. List of items or systems requiring testing, evaluation, verification, or commissioning: Required Items: Control valves as part of commissioning process.

1. Commissioning report: Control valves only.
2. Required testing protocols beyond normal Commissioning and TAB protocols:
3. Normal Hydronic System Pressure Testing.

END OF SECTION

SECTION 23 05 53
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - REQUIREMENTS

A. Final equipment designation/numbering shall be in accordance with available equipment tag sequence, as dictated by District Computerized bar code for Maintenance & Management System for inventory control.

B. Install metal equipment labels for any equipment having moving parts and requiring maintenance or part of central building systems. Exceptions can be made to use plastic equipment labels for items such as TAU's.

PART 2 - PRODUCTS

A. Metal Equipment Labels:

1. Manufacturers:

a. Craftmark Identification Systems
b. Seton Identification Products
c. MSI Marking Services, Inc.

2. Components:

a. Material and Thickness: Brass or anodized aluminum, 0.032-inch (0.8-mm) minimum thickness.
b. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
c. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
d. Fasteners: Stainless-steel rivets or contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Equipment Labels:

1. Manufacturers:

a. Craftmark Identification Systems
b. Seton Identification Products
c. MSI Marking Services, Inc.

2. Components:

a. Material and Thickness: Three-layer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, and having predrilled holes for attachment hardware.
b. Letter Color: White
c. Background Color: Black
d. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
e. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
f. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
g. Fasteners: Stainless-steel rivets or contact-type permanent adhesive, compatible with label and with substrate.

h. Nameplates shall bear notations corresponding to notations on operating instructions.
i. Consideration shall be given to the appropriate product selection, where equipment or piping will reside in wetted indoor environments.

C. Pipe Labels:

1. Manufacturers:

a. Craftmark Identification Systems
b. Seton Identification Products
c. MSI Marking Services, Inc.
d. Setmark

2. Components:

a. Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger pipe sizes may have maximum sheet size with separate fastener.
b. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing. Each marker shall show accepted color-coded background, proper color of legend in relation to background color, accepted legend letter size, accepted marker length.
c. Confirm latest color standard with the District prior to submittal for approval.
d. Color Coding:

HVAC Piping	**Pipe Labels**		**Pipe Cover/Color Scheme**	
	Background Color	**Lettering Color**	**Insulation Jacket Type**	**Paint**
Chilled Water CHW	Green	White	PVC, Dark Blue *	
Heating Hot Water HHW	Yellow	Black	PVC, Orange *	
Steam, Clean Steam, Condensate	Orange	Black	PVC, Orange *	
Condenser Water CW	Green	White		Dark Green
Cold Condensate Drain & Overflow Drain Piping	Green	White		
Temperature Control Air	Green	Black		
Vent & Safety Relief Vent Piping	Yellow	Black		Yellow
Compressed Air (where provided un-	Yellow	Black		
Chemical Feed Supply & Return	Yellow	Black		
Refrigerant Liquid Line & Refrigerant Suction	Yellow	Black		

* Refer to Section pipe insulation and jacket type schemes. Note that colored PVC is not to be used for outdoor/exposed applications.

D. Duct Labels:

1. Manufacturers:

a. Craftmark Identification Systems
b. Seton Identification Products
c. MSI Marking Services, Inc.
d. Setmark

2. Components:

a. Self-Adhesive Duct Labels: Printed plastic with contact-type, permanent-adhesive backing. Each marker shall show accepted color-coded background, proper color of legend in relation to background color, accepted legend letter size, accepted marker length.
b. Duct label Contents: Include identification of duct service using same designations or abbreviations on Drawings, duct size, and an arrow indicating flow direction.
c. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.
d. Lettering Size: At least 2 in. high.
e. Color Coding:

HVAC Ductwork	Background Color	Lettering Color
Exhaust Air Ducts	Yellow	Black
Outside Air Ducts	Green	White
Return Ducts	Green	White
Supply Ducts	Green	White

E. Valve Tags:

1. Manufacturers:

a. Craftmark Identification Systems
b. Seton Identification Products
c. MSI Marking Services, Inc.

2. Components:

a. Attach to handwheel or stem of each control and line shutoff valve installed under this Section. Stamped or engraved with minimum 1-inch high designating numbers.
b. Tag material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
c. Fasteners: Heavy brass or S-hook.
d. Valve Identification tags shall have the following abbreviations plus valve number. Any discrepancies or questions to this guideline shall be coordinated and confirmed with District.
e. Valve tags shall all be of brass material and type, regardless of hydronic system type or service.

Service	Tag Lettering
Chilled Water	CHW
Heating Hot Water	HHW
Condenser Water	CW
High Pressure Steam	HPS
Low Pressure Steam	LPS

Pumped Condensate	PC
Gravity Condensate	GC
Refrigerant	REF

PART 3 - INSTALLATION

1. Thermostats for all de-centralized zones or equipment shall be labeled, on their “face” with the same approved designation of the equipment in controls.
2. Properly identify each piece of equipment and controls pertaining to thereto by nameplates mounted on equipment and controls using round head brass machine screws, pop rivets, or contact cement.
3. Locate equipment labels where accessible and visible.
4. Table for piping, ductwork, and valve labels:

Type	Applicable Locations	Install Locations
Piping	- Exposed or above accessible ceilings in finished spaces - Machine rooms - Accessible maintenance spaces such as shafts, tunnels, and plenums - Exterior exposed locations	1. Within one foot of each valve or control device. 2. Near each branch connection and riser take- off. 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures. 4. Near major equipment items and other points of origination and termination. 5. On all horizontal runs 20 feet maximum but not less than once in each room at entrance and exit of each concealed space. 6. On piping above removable - acoustical ceilings.
Ductwork	- Exposed or above accessible ceilings in finished spaces - Machine rooms - Accessible maintenance spaces such as shafts, tunnels, and plenums - Exterior exposed locations	1. Within one foot of each control device. 2. Near each branch connection and riser takeoff. 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures. 4. Near major equipment items and other points of origination and termination. 5. On all horizontal runs spaced 20 feet maximum but not less than once in each room at entrance and exit of each concealed space. 6. On ducting above removable acoustical ceilings.
Valve Tags	- See install locations.	1. Tag all valves except riser drains, strainer drains, and valves within factory- fabricated equipment units.

5. Provide stick on dots to locate equipment above T-bar type panel ceiling. Dots shall be in corner of panel closest to equipment. Provide the following colors for designation:

Type	Color
HVAC related (equipment, dampers, valves, terminal boxes, etc.)	Blue
Plumbing Valves	Green
Controls	Red

END OF SECTION

SECTION 23 05 93
TESTING, ADJUSTING AND BALANCING FOR HVAC

PART 1 - REQUIREMENTS

A. Submit the Engineer's Test & Air Balance Specification with proposed procedures for all central HVAC systems.

B. The TAB Contractor shall be a sub-contractor to the General Contractor and shall maintain a list of deficiencies for the General Contractor, with review by owner's representative on demand.

C. The Mechanical Contractor shall coordinate his work with the TAB Contractor and correct any system deficiency identified with the General Contractor's TAB agent.

D. TAB contractor shall submit a pre-work set of TAB forms filled in with all design data for systems to be tested.

E. Testing procedures, as outlined within initial TAB contractor submittal approved by designer shall be specific to system and distribution types, as applicable to individual project design.

1.02 PRODUCTS

A. TAB:

1. Manufacturers:

a. Required:

1) Only AABC certified testing, adjusting and balancing agencies are allowed.
2) American Air Balance
3) Approved equal

PART 2 - INSTALLATION

1. Balance air flows to the following tolerances:

System	Tolerance	Comments
Supply Diffuser	0 to +10% of design	Document that intended room pressurization regarding adjacent space-es has been achieved.
Return	+/- 5% of design	
Exhaust	0 to -10% of design	

2. Balance water flows to the following tolerances:

System	Tolerance	Comments
Pumps	0 to +10% of design	
Equipment	0 to 5% of design	

3. Provide Room NC level testing to confirm HVAC noise levels are within requirements.

PART 3 - EVALUATION

A. Documentation:

1. 75%, 95%, 100% Testing Adjusting and Balancing Reports.

2. Continuous System Deficiency Report on site.

3. In-person witnessing: Provide random sampling of the following items as witnessed by the District's Representative:

a. 30 % of diffusers or grilles
b. 30 % of air handling units

c. 50 % of pumps
d. 50 % of terminal air side and hydronic equipment

B. Required testing protocols beyond normal Commissioning and TAB protocols:

1. AABC protocols and forms but adjusted to meet unique needs of project

END OF SECTION

SECTION 23 07 13
DUCT INSULATION

PART 1 - REQUIREMENTS

A. Engineered Documents shall show explicit code compliance regarding energy efficiency and flame spread/smoke development.

B. Continuous insulation on supply ductwork shall be provided along its entire length.

C. Insulation shall be provided whenever outside air, supply, return or elevated temperature exhaust ductwork is within a plenum cavity.

D. Provide interior lining only in cases where specific acoustical requirements are to be met.

E. Interior lining shall not be specified as the sole means of ductwork insulation.

PART 2 - PRODUCTS

A. Duct Insulation:

1. Components:

a. Provide a finishing material around all insulation containing fibers to prevent shedding of fibers into surrounding plenum spaces or cavities.

PART 3 - INSTALLATION

A. Provide special protection for insulating materials from damage:

Location	Insulation Type	Jacket Type
Mechanical rooms (located ≤ 8’ AFF)	Rigid	
Outdoors	Rigid	Metal

B. Provide consistent and appropriate means of attachment for insulation onto ductwork to not compromise how these materials are secured. As a minimum provide 100% coverage on adhesive and weld pins spaced at 16” on center with at least one central line of pins per side of duct for ducts smaller than 18”. Provide pins within 3” of insulation joints/laps.

C. Maintain a continuous vapor barrier so the insulation material integrity shall not be compromised at insulation joint locations.

END OF SECTION

SECTION 23 07 19
HVAC PIPING INSULATION

PART 1 - REQUIREMENTS

A. Engineering Documents shall show explicit code compliance regarding energy efficiency and flame spread/smoke development.

B. Provide appropriate factory kits for the insulation of pipe fittings.

PART 2 - PRODUCTS

A. Above Ground Piping Insulation:

1. Manufacturers:

a. As selected by Designer
b. Elastomeric insulation should not be used. Application of such shall be submitted for approval and should be kept to a minimum when justifying the use of such.

2. Components:

a. Provide appropriate factory kits for the insulation of pipe fittings.
b. Provide a finishing material around all insulation containing fibers to prevent shedding of fibers into surrounding plenum spaces or cavities.
c. Insulation shall be factory fabricated and installed in a manner to allow easy future removal and re-attachment at locations requiring maintenance such as fittings, valves, equipment, etc.

B. Above Ground Vertical Riser Clamp:

1. Manufacturers:

a. Pipe Shields Inc or equal
b. Factory or field assembled riser clamps systems that cause direct contact of pipe support and carrier pipe, does not provide protection to insulation from damage and point of support, and interrupts a continuous insulation system vapor barrier.

PART 3 - INSTALLATION

A. Provide insulation and jacketing materials as follows:

Pipe Type	Location Type	Insulation Type	Jacket Type
Above Ground Piping: CHW and HHW	Exposed in Mechanical rooms 8’ and below	Pre-formed Rigid Fiberglass	PVC (ASTM E84, 20 mil thickness) *
	Parking Garages	Pre-formed Rigid Fiberglass	PVC (ASTM E84, 20 mil thickness) *
	Outdoors	Pre-formed Rigid Fiberglass	Aluminum (stucco embossed, 0.016” or 0.024” depending on impact exposure)
	All piping not covered below	Pre-formed Rigid Fiberglass	None

Pipe Type	Location Type	Insulation Type	Jacket Type
Above Ground Piping: Steam, Condensate	All piping	Pre-formed Rigid Fiberglass or Phenolic Foam	Aluminum (stucco embossed, 0.016" or 0.024" depending on impact exposure)
Above Ground Piping: Refrigerant Suction Lines	Horizontal runs within the building	Pre-formed Rigid Fiberglass	None
	Outdoors	Pre-formed Rigid Fiberglass	Aluminum (stucco embossed, 0.016" or 0.024" depending on impact exposure)
Above Ground Piping: Condensate Drain	Within building (plenum, conditioned space)	Closed-cell Foam	None

Minimum Pipe Insulation Thickness						
Piping System Type	**Temp. Range (°F)**	**< 1"**	**1 to < 1.5"**	**1.5 to < 4"**	**4" to < 8"**	**8" and larger**
Space Heating Systems						
Heating Hot Water	Up to 200	1.5	1.5	2.0	2.0	2.0
Space Cooling Systems						
Chilled Water	40-60	0.5	0.75	1.0	1.0	1.0
Refrigerant	Below 40	1.0	1.5	1.5	1.5	1.5
*Condensate drain lines from HVAC equipment located within buildings, in rooms, inside walls and above ceilings.	N/A	0.5	0.5	0.5	N/A	N/A
*At all locations where condensation on pipe surface may cause damage to surrounding materials or equipment.						

B. A continuous vapor barrier must be maintained and integrity intact for protection from external elements, for both horizontal and vertical pipe installations.

C. Install rigid pre-insulated pipe supports to protect from compression of insulation material due to point loads.

D. Provide aluminum sleeves at all pipe support points, between hanger support and exterior layer of insulating systems, to protect from compression of insulation material due to point loads.

E. Install insulation on piping accessories requiring future re-occurring access and service with factory fabricated insulation covers that are easily removed and re- applied.

F. Insulation shall not be installed until the following have been completed and documentation has been and submitted to engineer for approval and record:

1. Cleaning and flushing

2. Pressure Testing
3. Vertical pipe riser clamp assembly, along with means of insulation and securement.

G. It is preferred for above ground installations to provide prefabricated / preformed fittings, individual valves or valve kits, and accessories. Field-applied insulation should be kept to a minimum.

H. It is preferred that pre-cut flexible fiberglass is used at joints and equipment requiring maintenance to allow ease of removal and replacement without adversely affecting the surrounding insulation.

I. Pre-insulated (as opposed to field insulated) vertical pipe riser clamp assembly, with integrated pipe sleeves and thrust plates shall be provided.

J. Metal jacketing material for all steam and steam condensate piping above ground and within building.

END OF SECTION

SECTION 23 08 01
BUILDING AUTOMATION SYSTEM (BAS) COMMISSIONING

PART 1 - PRODUCTS

1.01 INSTRUMENTATION

A. Instrumentation required to verify readings and test the system and equipment performance shall be provided by Contractor and made available to Commissioning Authority. Generally, no testing equipment will be required beyond that required to perform Contractors work under these Contract Documents. All equipment used for testing and calibration shall be NIST/NBS traceable and calibrated within the preceding 6-month period. Certificates of calibration shall be submitted.

1.02 TAB & COMMISSIONING PORTABLE OPERATORS TERMINAL

A. Contractor shall provide a portable workstation to facilitate Testing, Adjusting, and Balancing (TAB) and calibration. This device shall support all functions and allow querying and editing of all parameters required for proper calibration and start up. Software tool

B. Connections shall be provided local to the device being calibrated. For instance, for VAV boxes, connection of the operator's terminal shall be either at the sensor or at the terminal box. Otherwise a wireless system shall be provided to facilitate this local functionality.

PART 2 - EXECUTION

2.01 BAS START-UP TESTING, ADJUSTING, CALIBRATION

A. Work and/or systems installed under this Division shall be fully functioning prior to functional performance testing phase. Contractor shall start, test, adjust, and calibrate all work and/or systems under this Contract, as described below:

1. Inspect the installation of all devices. Review the manufacturer's installation instructions and validate that the device is installed in accordance with them.
2. Verify proper electrical voltages and amperages and verify that all circuits are free from faults.
3. Verify integrity/safety of all electrical connections.
4. Coordinate with TAB subcontractor to obtain control settings that are determined from balancing procedures. Record the following control settings as obtained from TAB contractor, and note any TAB deficiencies in the BAS Start-Up Report:
    a. Optimum duct static pressure setpoints for VAV air handling units.
    b. Minimum outside air damper settings for air handling units
    c. Optimum differential pressure setpoints for variable speed pumping systems.
    d. Calibration parameters for flow control devices such as VAV boxes and flow measuring stations.
        1) BAS contractor shall provide software tool as a minimum to the TAB and CA to facilitate calibration. Connection for any given device shall be local to it (i.e. at the VAV box or at the thermostat). Hand- held device or portable operator's terminal shall allow querying and editing of parameters required for proper calibration and start-up.
5. Test, calibrate, and set all digital and analog sensing and actuating devices. Calibrate each instrumentation device by making a comparison between the BAS display and the reading at the device, using an instrument traceable to the National Bureau of Standards, which shall be at least twice as accurate as the device to be calibrated (e.g., if field device is +/- 0.5% accurate, test equipment shall be +/- 0.25% accurate over same range). Record the

measured value and displayed value for each device in the BAS Start Up Report.

6. Check and set zero and span adjustments for all transducers and transmitters.
7. For dampers and valves:
   a. Check for adequate installation including free travel throughout range and adequate seal.
   b. Where loops are sequenced, check for proper control without overlap.
8. For actuators:
   a. Check to ensure that device seals tightly when the appropriate signal is applied to the operator.
   b. Check for appropriate fail position, and that the stroke and range is as required.
   c. For pneumatic operators, adjust the operator spring compression as required to achieve close-off. If positioner or volume booster is installed on the operator, calibrate per manufacturer's procedure to achieve spring range indicated. Check split-range positioners to verify proper operation. Record settings for each device in the BAS Start up Report.
   d. For sequenced electronic actuators, calibrate per manufacturer's instructions to required ranges.
9. Check each digital control point by making a comparison between the control command at the controller and the status of the controlled device. Check each digital input point by making a comparison of the state of the sensing device and the Operator Interface display. Record the results for each device in the BAS Start-Up Report.
10. For outputs to reset other manufacturer's devices (for example, VSDs) and for feedback from them, calibrate ranges to establish proper parameters. Coordinate with representative of the respective manufacturer and obtain their approval of the installation.
11. Verify proper sequences by using the approved checklists to record results and submit with BAS Start-Up Report. Verify proper sequence and operation of all specified functions.
12. Verify that all safety devices trip at appropriate conditions. Adjust setpoints accordingly.
13. Tune all control loops to obtain the fastest stable response without hunting, offset or overshoot. Record tuning parameters and response test results for each control loop in the BAS Start Up Report. Except from a startup, maximum allowable variance from set point for controlled variables under normal load fluctuations shall be as follows. Within 3 minutes of any upset (for which the system has the capability to respond) in the control loop, tolerances shall be maintained (exceptions noted):
    a. Duct air temperature: ±1□F.
    b. Space Temperature: ±2□F
    c. Chilled Water: ±1□F
    d. Hot water temperature: ±3□F.
    e. Duct pressure: ± 0.25" w.g.
    f. Water pressure: ±1 psid
    g. Duct or space Humidity: ±5%
    h. Air flow control: ±5% of setpoint velocity. For fume hoods ±10% on full sash travel (from min to max in 3 seconds) within 3 seconds. For minimum OA flow loops being reset from CO_2, response to upset max time is one hour.
    i. Space Pressurization (on active control systems): ±0.05" wg with no door or window movements.
14. For interface and DDC control panels:
    a. Ensure devices are properly installed with adequate clearance for maintenance and

with clear labels in accordance with the record drawings.

b. Ensure that terminations are safe, secure and labeled in accordance with the record drawings.
c. Check power supplies for proper voltage ranges and loading.
d. Ensure that wiring and tubing are run in a neat and workman-like manner, either bound or enclosed in trough.
e. Check for adequate signal strength on communication networks.
f. Check for standalone performance of controllers by disconnecting the controller from the LAN. Verify the event is annunciated at Operator Interfaces. Verify that the controlling LAN reconfigures as specified in the event of a LAN disconnection.
g. Ensure that all outputs and devices fail to their proper positions/states.
h. Ensure that buffered and/or volatile information is held through power outage.
i. With all system and communications operating normally, sample and record update/annunciation times for critical alarms fed from the panel to the Operator Interface.
j. Check for adequate grounding of all DDC panels and devices.

15. For Operator Workstation:

a. Verify that all elements on the graphics are functional and are properly bound to physical devices and/or virtual points, and that hot links or page jumps are functional and logical.
b. Output all specified BAS reports for review and approval.
c. Verify that the alarm logging and or printing is functional and per requirements.
d. Verify that trends are archiving to disk and provide a sample to the Commissioning Authority and District for review.
e. Verify that paging/dial-out alarm annunciation is functional.
f. Verify the functionality of remote Operator Interfaces and that a robust connection can be established consistently.
g. Verify that required third party software applications required with the project are installed and are functional.

16. Verify proper interface with fire alarm system.

B. **Submit Start-Up Test Report**: Report shall be completed, submitted to Commissioning Authority, and approved prior to functional performance testing.

2.02 SENSOR CHECKOUT AND CALIBRATION

A. **General Checkout**: Verify that all sensor locations are appropriate and are away from causes of erratic operation. Verify that sensors with shielded cable are grounded only at one end. For sensor pairs that are used to determine a temperature or pressure difference, make sure they are reading within 0.2°F of each other for temperature and within a tolerance equal to 2% of the reading of each other for pressure. Tolerances for critical applications may be tighter.

B. **Calibration:** Calibrate all sensors using one of the following procedures:

1. Sensors without Transmitters - Standard Application: Make a reading with a calibrated test instrument within 6 inches of the site sensor at various points across the range. Verify that the sensor reading (via the permanent thermostat, gage or BAS) is within the tolerances specified for the sensor. If not, adjust offset and range, or replace sensor. Where sensors are subject to wide variations in the sensed variable, calibrate sensor within the highest and lowest 20% of the expected range.

2. Sensors with Transmitters - Standard Application: Disconnect sensor. Connect a signal generator in place of sensor. Connect ammeter in series between transmitter and BAS control panel. Using manufacturer's resistance-temperature data, simulate minimum desired temperature. Adjust transmitter potentiometer zero until the ammeter reads 4 mA.

Repeat for the maximum temperature matching 20 mA to the potentiometer span or maximum and verify at the operator interface. Record all values and recalibrate controller as necessary to conform to tolerances. Reconnect sensor. Make a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage or BAS) is within the tolerances specified. If not, replace sensor and repeat. For pressure sensors, perform a similar process with a suitable signal generator.

C. **Sensor Tolerance**: Sensors shall be within the tolerances specified for the device.

2.03 COIL VALVE LEAK CHECK

A. Verify proper close-off of the valves. Ensure the valve seats properly by simulating the maximum anticipated pressure difference across the circuit. Calibrate air temperature sensors on each side of coil to be within 0.5°F of each other. Via the Operator Interface, command the valve to close. Energize fans. After 5 minutes observe air temperature difference across coil. If a temperature difference is indicated, and the piping surface temperature entering the coil is within 3°F of the water supply temp, leakage is probably occurring. If it appears that it is occurring, close the isolation valves to the coil to ensure the conditions change. If they do, this validates the valve is not closing. Remedy the condition by adjusting the stroke and range, increasing the actuator size/torque, replacing the seat, or replacing the valve as applicable.

2.04 VALVE STROKE SETUP AND CHECK

A. For all valve and actuator positions checked, verify the actual position against the Operator Interface readout.

B. Set pumps to normal operating mode. Command valve closed, verify that valve is closed, and adjust output zero signal as required. Command valve open, verify position is full open and adjust output signal as required. Command the valve to various few intermediate positions. If actual valve position doesn't reasonably correspond, replace actuator or add pilot positioner (for pneumatics).

2.05 VARIABLE SPEED DRIVE SETUP AND CHECK

A. VFD's shall be properly started and checked out as part of the functional testing of control systems.

2.06 BAS DEMONSTRATION/FUNCTIONAL TESTING

A. Demonstrate the operation of the BAS hardware, software, and all related components and systems to the satisfaction of the Commissioning Authority and District. Schedule the demonstration with the District's representative 1 week in advance. Demonstration shall not be scheduled until all hardware and software submittals, and the Start-Up Test Report are approved. If the Work fails to be demonstrated to conform with Contract specifications, so as to require scheduling of additional site visits by the Commissioning Authority for re-demonstration.

B. The Contractor shall supply all personnel and equipment for the demonstration, including, but not limited to, instruments, ladders, etc. Contractor-supplied personnel must be competent with and knowledgeable of all project-specific hardware, software, and the HVAC systems. All training documentation and submittals shall be at the job site.

C. Demonstration shall typically involve small representative samples of systems/equipment randomly selected by the District and/or Commissioning Authority. defined

D. The system shall be demonstrated following the same procedures used in the Start-Up Test by using the approved Commissioning Checklists. Demonstration shall include, but not necessarily be limited to, the following:

1. Demonstrate that required software is installed on BAS workstations. Demonstrate that graphic screens, alarms, trends, and reports are installed as submitted and approved.
2. Demonstrate that points specified and shown can be interrogated and/or commanded (as applicable) from all workstations, as specified.
3. Demonstrate that remote communication abilities are in accordance with these Specifications.
4. Demonstrate correct calibration of input/output devices using the same methods specified for the Start-Up Tests. A maximum of 10 percent of I/O points shall be selected at random by the Commissioning Authority and/or District for demonstration. Upon failure of any device to meet the specified end-to-end accuracy, an additional 10 percent of I/O points shall be selected at random by Commissioning Authority for demonstration. This process shall be repeated until 100 percent of randomly selected I/O points have been demonstrated to meet specified end-to-end accuracy.
5. Demonstrate that all DDC and other software programs exist at respective field panels. The Direct Digital Control (DDC) programming and point database shall be as submitted and approved.
6. Demonstrate that all DDC programs accomplish the specified sequences of operation.
7. Demonstrate that all DDC programs accomplish alarm and safety functions
8. Demonstrate that the panels automatically recover from power failures, as specified.
9. Demonstrate that the stand-alone operation of panels meets the requirements of these Specifications. Demonstrate that the panels' response to LAN communication failures meets the requirements of these Specifications.
10. Identify access to equipment selected by Commissioning Authority and the Disrtrict. Demonstrate that access is sufficient to perform required maintenance.
11. Demonstrate that required trend graphs and trend logs are set up per the requirements. Provide a sample of the data archive. Indicate the file names and locations.

E. BAS Demonstration shall be completed and approved prior to Substantial Completion.

2.07 BAS ACCEPTANCE PERIOD

A. After approval of the BAS Demonstration and prior to Contract Close Out Acceptance Phase shall commence. Acceptance Period shall not be scheduled until all HVAC systems are in operation and have been accepted, all required cleaning and lubrication has been completed.

B. **Operational Test**: At the beginning of the Acceptance Phase, the system shall operate properly for two weeks without malfunction, without alarm caused by control action or device failure, and with smooth and stable control of systems and equipment in conformance with these specifications. At the end of the two weeks, contractor shall forward the trend logs to the Commissioning Authority/District for review. Commissioning Authority/ District shall document any problems requiring contractor attention.

1. Contractor shall correct problems and provide notification to the District’s representative that all problems have been corrected. The Acceptance Period shall be restarted at a mutually scheduled time for an additional one-week period. This process shall be repeated until Commissioning Authority/District confirms completion of all open items.

C. During the Acceptance Period, the contractor shall maintain a hard copy log of all alarms generated by the BAS. For each alarm received, Contractor shall diagnose the cause of the alarm, and shall list on the log for each alarm, the diagnosed cause of the alarm, and the corrective action taken. If in the Contractor’s opinion, the cause of the alarm is not the

responsibility of the Contractor, Contractor shall immediately notify the District representative.

2.08 TREND LOGS

A. Controls Contractor shall configure and analyze all trends required.

2.09 TREND GRAPHS

A. Controls Contractor working in conjunction with the Engineer of Record shall create trend graphs as defined by commissioning authority shall generally be used during the Acceptance Phase to facilitate and document testing. Prepare controller and workstation software to display graphical format trends during the Acceptance Period. Trend graphs shall demonstrate compliance with contract documents.

B. Each graph shall be clearly labeled with HVAC subsystem title, date, and times.

2.10 WARRANTY PHASE BAS OPPOSITE SEASON TRENDING AND TESTING: OPTIONAL

A. **Trending:** throughout the Warranty Phase, trend logs shall be maintained as required for the Acceptance Period. Contractor shall forward archive trend logs to the Commissioning Authority/District for review upon Commissioning Authority/District request. Commissioning Authority/District will review these and notify contractor of any warranty work required.

B. **Opposite Season Testing**: Within 6 months of completion of the Acceptance Phase, Commissioning Authority/District shall schedule and conduct Opposite Season functional performance testing. Contractor shall participate in this testing and remedy any deficiencies identified.

2.11 SOFTWARE OPTIMIZATION ASSISTANCE

A. The BAS Technician provided shall be thoroughly trained in the programming and operation of the controller and workstation software. If the BAS Technician provided cannot perform every software task requested by the Commissioning Authority/District in a timely fashion, contractor shall provide additional qualified personnel at the project site as requested by the Commissioning Authority/District, to meet the total specified requirement on-site.

2.12 BAS OPERATOR TRAINING AND O&M MANUALS

A. Provide up to 4 complete sets of the approved Operations and Maintenance (O&M) Manuals (hard copy and one electronic copy) to be used for training.

B. Contractor shall submit a Training Plan for the scope of training for which (s)he is responsible. Training Plan shall be forwarded to the Division 25 Contractor who will compile, organize, format, and forward to the Engineer for review.

C. **On-Site & Off – Site Training**: Provide services of controls contractor's qualified technical personnel for four (4) 4 - hour days to instruct the District 's personnel in operation and maintenance of BAS. This shall also include (1) training session by equipment manufacturer's facility or showroom or training Center in a formal classroom setting with pre-approved written curriculum. Instruction shall be in classroom setting at the project site for appropriate portions of the training. Training may be in non-contiguous days at the request of the District. The District's representative shall notify contractor 1 week in advance of each day of requested training. The Contractor's designated training personnel shall meet with the Engineer and District's representative for the purpose of discussing and fine-tuning the training agenda prior to the first training session. Training agenda shall generally be as follows:

1. Basic Operator Workstation (OWS) Training – For all potential users of the OWS:

   a. Brief walk-through of building, including identification of all controlled equipment and condensed demonstration of controller portable and built-in operator interface device display capabilities.

b. Brief overview of the various parts of the O&M Manuals, including hardware and software programming and operating publications, catalog data, controls installation drawings, and DDC programming documentation.
c. Demonstration of workstation login/logout procedures, password setup, and exception reporting.
d. Demonstration of workstation menu penetration and broad overview of the various workstation features.
e. Overview of systems installed.
f. Present all site-specific point naming conventions and points lists, open protocol information, configuration databases, back-up sequences, upload/download procedures, and other information as necessary to maintain the integrity of the BAS.
g. Overview of alarm features.
h. Overview of trend features.
i. Overview of workstation reports.

2. BAS **Hardware Training** – For Maintenance and Control Technicians

   a. Review of installed components and how to install/replace, maintain, commission, and diagnose them

3. BAS Technician Training

   a. Introduction to controller programming and overview of the programming application interface.
   b. General review of sequence of operation and control logic for the project site, including standalone and fail-safe modes of operation.
   c. Uploading/Downloading and backing up programs.
   d. Network administration.
   e. Review of setpoint optimization and fine-tuning concepts.

END OF SECTION

SECTION 23 09 00
BUILDING AUTOMATION SYSTEM (BAS)

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. The distributed digital control (DDC) and Building Automation System (BAS) shall seamlessly interface with the Honeywell Enterprise Building Integrator (EBI) and shall utilize the BACnet communication requirements as defined by ASHRAE/ANSI 135-2016 for all communication between building automation systems and the EBI operator workstation directly. Provide a router/gateway(s) as necessary to facilitate all specified objects and services and have them configured/mapped as applicable. Incorporation of these objects and services into the EBI system is required under this project. EBI point server expansion to cover software and hardware shall be included in the project.

B. Honeywell Building Manager Integration shall provide the solution for open data integration between traditional building systems and essential enterprise systems. Open architecture shall support a wide range of systems and products including: BACnet, OPC, Modbus, integrated Honeywell security Manager, digital video Manager, integrated Honeywell life safety Manager, integrated Honeywell energy Manager, Experion. The system shall be scalable over time.

C. Honeywell Building Manager shall support comprehensive reporting capabilities, both custom and preconfigured. customization should be simpler – just to fill in the blanks on the template reports. and building Manager shall utilizes Microsoft® SQL server® reporting services for standard and custom reporting requirements. Standard user-configurable reports shall include - alarm and event query, after-hours alarm report, operator actions, all-points report, including point attribute – manual mode and off-scan.

D. Furnish and install a direct digital control and Building Automation System (BAS). The BAS shall utilize electronic sensing, microprocessor-based digital control, and electronic actuation of dampers and valves to perform control sequences and functions required. The BAS shall generally consist of monitoring and control of systems listed below. Designer to reference also, control drawings, sequences of operation, and points lists.

1.02 PROCUREMENT

A. The BAS, digital control and communications components installed shall be an integrated distributed processing system by Honeywell Factory Branch

1.03 CODES AND STANDARDS

A. The following codes and standard intended to apply as applicable as not all will apply to all installations

B. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)

1. ASHRAE 135-2016: BACnet - A Data Communication Protocol for Building Automation and Control Networks. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. 2016

C. Electronics Industries Alliance

1. EIA-709.1-A-99: Control Network Protocol Specification
2. EIA-709.3-99: Free-Topology Twisted-Pair Channel Specification
3. EIA-232: Interface Between Data Terminal Equipment and Data Circuit- Terminating Equipment Employing Serial Binary Data Interchange.
4. EIA-458: Standard Optical Fiber Material Classes and Preferred Sizes

5. EIA-485: Standard for Electrical Characteristics of Generator and Receivers for use in Balanced Digital Multipoint Systems.
6. EIA-472: General and Sectional Specifications for Fiber Optic Cable
7. EIA-475: Generic and Sectional Specifications for Fiber Optic Connectors and all Sectional Specifications
8. EIA-573: Generic and Sectional Specifications for Field Portable Polishing Device for Preparation Optical Fiber and all Sectional Specifications
9. EIA-590: Standard for Physical Location and Protection of Below-Ground Fiber Optic Cable Plant and all Sectional Specifications

D. Underwriters Laboratories

1. UL 916: Energy Management Systems.
2. UUKL 864: UL Supervised Smoke Control

E. NEMA Compliance

1. NEMA 250: Enclosure for Electrical Equipment
2. NEMA ICS 1: General Standards for Industrial Controls.

F. NFPA Compliance

1. NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" where applicable to controls and control sequences.
2. NFPA 70 National Electrical Code (NEC)

G. Institute of Electrical and Electronics Engineers (IEEE)

1. IEEE 142: Recommended Practice for Grounding of Industrial and Commercial Power Systems
2. IEEE 802.3: CSMA/CD (Ethernet – Based) LAN
3. IEEE 802.4: Token Bus Working Group (ARCNET – Based) LAN

1.04 SYSTEM ARCHITECTURE

A. The system provided shall incorporate hardware resources enough to meet the functional requirements of these Specifications. The Contractor shall include all items not specifically itemized in these Specifications that are necessary to implement, maintain, and operate the system in compliance with the functional intent of these Specifications.

B. The system shall be configured as a distributed processing network(s) capable of expansion. The BAS will operate on a shared Ethernet LAN including the building's IT LAN.

C. The system architecture shall consist of an Ethernet-based, wide area network (WAN), a single Local Area Network (LAN) or multi-leveled LANs that support BCs, AACs, ASCs, Operator Workstations (OWS), Portable Operators Terminal (POT), and Remote Communication Devices (RCDs) as applicable. The following indicates a functional description of the BAS structure. Level 3 interoperability is specified. It should describe the options for connecting the local LAN to the EBI as part of the EBI integration scope.

1. **Enterprise Building Integrator WAN**: Intranet-based network connecting multiple buildings with a central data warehouse and server. This is an existing infrastructure and contractor is required to connect to this WAN. Contractor is required to provide BACnet Objects and services. Objects at the Local Supervisory LAN via BACnet over IP This Ethernet LAN will be connected to the WAN to manage the exchange of data and alarms

with the EBI Server including, but not limited to, trends, alarms, schedules, parameters, variables, and real time data from the local system. If the Local Supervisory LAN does not inherently use BACnet, LonTalk over IP Contractor shall provide a gateway(s), routers, hardware, software, etc. necessary to translate and facilitate services from the local protocol to the EBI.

2. **Local Supervisory LAN**: The Local Supervisory LAN shall be an Ethernet-based, 100 Mbps LAN connecting Primary Control LANs and OWS/POTs. The LAN serves as the inter-BC gateway and OWS-to-BC gateway and communications path and as the connection point for the EBI. Contractor shall provide this as a dedicated LAN for the control system. LAN shall be IEEE 802.3 Ethernet over Fiber or Category 5 cable with switches and routers that support 100 Mbps or higher throughput. Power-line carrier communication shall not be acceptable for communications. The higher-level layers of this network shall be one of the following at Contractor's option:

    a. BACnet Supervisory LAN: BACnet/IP as defined in Addendum A (Annex J) of the BACnet standard and shall share a common network number for the Ethernet backbone, as defined in BACnet. Point/Object naming conventions are to be used.

3. **Primary Controller LAN ('Primary LAN')**: High-speed, peer-to-peer communicating LAN used to connect AACs, ASCs and Building Controllers (BCs) and communicate exclusively control information. Network speed vs. the number of controllers on the LAN shall be dictated by the response time and trending and other requirements as specified in Section 23 0903. Acceptable technologies include:

    a. Ethernet (IEEE802.3)
    b. ARCNET (IEEE802.4)

4. **Secondary Controller LAN ('Secondary LAN')**: Network used to connect AACs, or ASCs. These can be Master Slave/ Token Passing or polling, in addition to those allowed for Primary Controller LANs. Network speed vs. the number of controllers on the LAN shall be dictated by the response time and trending requirements.

D. Dynamic Data Access: Any data throughout any level of the network shall be available to and accessible by all other devices, Controllers and OWS/POT, whether directly connected or connected remotely.

E. **Remote Data Access**: The system shall support the following methods of remote access to the building data.

1. Browser-based access: A remote user using a standard browser shall be able access all control system facilities and graphics with proper password. District shall provide the required internet connection. The following paradigms are acceptable for browser-based access:

    a. Native Internet-based user interfaces (HTML, Java, XML, etc.) that do not require a plug-in. The user interface must be compatible with the most current stable version of the supporting software (Java, etc.) without requiring the user to downgrade to a lesser version. .

F. The communication speed between the controllers, LAN interface devices, and operator interface devices shall be sufficient to ensure fast system response time under any loading condition. Contractor shall submit guaranteed response times with shop drawings including calculations to support the guarantee. In no case shall delay times between an event, request, or command initiation and its completion be greater than those listed herein. Contractor shall reconfigure LAN as necessary to accomplish these performance requirements.

1. 5 seconds between a Level 1 (critical) alarm occurrence and enunciation at the EBI workstation.

2. 10 seconds between a Level 2 alarm occurrence and enunciation at the EBI workstation.
3. 20 seconds between and a Level 3-5 alarm occurrence and enunciation at the EBI workstation.
4. 10 seconds between an operator command via the EBI workstation to change a setpoint and the subsequent change in the controller.
5. 5 seconds between an operator command via the EBI workstation to start/stop a device and the subsequent command to be received at the controller.
6. 10 seconds between a change of value or state of an input and it being updated on the EBI workstation.
7. 10 seconds between an operator selection of a graphic and it completely painting the screen and updating at least 10 points.

G. **Operator Workstation (OWS) or PORTABLE OPERATOR TERMINAL (POT):** This shall be a computer (or computers) that maintain the systems configuration and programming database. It shall be integrated with the existing EBI system. It shall hold the backup files of the information downloaded into the individual controllers and as such support uploading and downloading that information directly to/from the controllers. It shall also act as a control information server to non-control system-based programs and shall be located at the building or buildings being controlled. It shall allow secure multiple access to the control information. Refer to Section 23 0902 - BAS Operator Interfaces for its requirements. Coordinate with District IT to provide PC hardware requirements.

H. The Operator Interface shall provide for overall system supervision, graphical user interface, management report generation, alarm annunciation, and remote monitoring. Refer to Section 23 0902 – BAS Operator Interfaces.

I. The BCs, AACs, ASCs, shall monitor, control, and provide the field interface for all points specified. Each BC, AAC, or ASC shall be capable of performing all specified energy management functions, and all DDC functions, independent of other BCs, AACs, or ASCs and operator interface devices as more fully specified in Section 23 0903 - BAS Field Panels.

J. **Systems Configuration Database**: The system architecture shall support maintaining the systems configuration database on a server or workstation on the Local Supervisory LAN. User tools provided to the District shall allow configuring, updating, maintaining, etc. current configurations and settings whether they are initiated at the server or the end device.

1. Database Schema shall be published and provided to the District to facilitate easy access to the data.
2. Database shall be ODBC compliant or a data access driver shall be provided to act as an ODBC or OLE DB data provider.

K. Interruptions or fault at any point on any Primary Controller LAN shall not interrupt communications between other nodes on the network. If a LAN is severed, two separate networks shall be formed and communications within each network shall continue uninterrupted.

L. All line drivers, signal boosters, and signal conditioners etc. shall be provided as necessary for proper data communication.

M. Anytime any controller's database or program is changed in the field, the controller shall be capable of automatically uploading the new data to the CSS.

N. Control.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Materials shall be new, the best of their respective kinds without imperfections or blemishes and shall not be damaged in any way. Used equipment shall not used in any way for the permanent installation except where drawings or specs specifically allow existing materials to remain in place.

2.02 UNIFORMITY

A. To the extent practical, all equipment of the same type serving the same function shall be identical and from the same manufacturer.

PART 3 - INSTALLATION

3.01 INSTALLATION OF CONTROL SYSTEMS

A. Install systems and materials in accordance with manufacturer's instructions, roughing-in drawings and details shown on drawings.

3.02 DIGITAL CONTROL STATIONS, CONTROLLER QUANTITY AND LOCATION

A. Note: Engineer shall designate locations for control stations and specifically reserve wall/floor space and indicate it on the drawings and coordinate it with other trades. Digital control stations should specifically be shown on the drawings and select appropriate wall/floor locations that minimize wire and tube runs and coordinate these locations with other disciplines.

B. Individual Digital Control Stations (DCS) are referenced to indicate allocation of points to each DCS and DCS location. Digital control stations shall consist of one or multiple controllers to meet requirements of this specification.

C. Where a DCS is referenced, Contractor shall provide at least one (1) controller, and additional controllers as required, in sufficient quantity to meet the requirements.

D. Engineer shall locate DCSs as referenced on the drawings. It is the Contractor's responsibility to provide enough controllers to ensure a completely functioning system, according to the point list and sequence of operations.

E. Contractor shall provide a minimum of the following:

1. One DCS (including at least one controller) in each chilled water plant mechanical room.
2. One controller for each air handler located in applicable mechanical room.
3. One controller shall be provided for each terminal unit unless indicated otherwise.

3.03 SURGE PROTECTION

A. Specify power supply surge protection, filters, etc. as necessary for proper operation and protection of all BCs, AAC/ASCS operator interfaces, printers, routers, gateways and other hardware and interface devices. All equipment shall be capable of handling voltage variations 10% above or below measured nominal value, with no effect on hardware, software, communications, and data storage.

3.04 CONTROL POWER SOURCE AND SUPPLY

A. General requirements for obtaining power include the following:

1. Obtain power from the electrically most proximate 120v breaker emergency power panel. Connect to a dedicated breaker designated for use by the BAS only. Breaker shall be of the proper size per NEC.
2. Where control equipment is located inside a new equipment enclosure, coordinate with the

equipment manufacturer and feed the control with the same source as the equipment. If the equipment's control transformer is large enough and of the correct voltage to supply the controls, it may be used. If the equipment's control transformer is not large enough or of the correct voltage to supply the controls provide separate transformer.

3. The Engineer shall carefully coordinate the training requirements with the needs of District facilities staff.

END OF SECTION

SECTION 23 09 01
BUILDING AUTOMATION SYSTEM (BAS)
BASIC MATERIALS, INTERFACE DEVICES, AND SENSORS

PART 1 - PRODUCTS

1.01 MATERIALS AND EQUIPMENT

A. General: Provide electronic electric or Pneumatic (at the discretion of designer) control products in sizes and capacities indicated, consisting of valves, dampers, thermostats, clocks, controllers, sensors, and other components as required for complete installation. Except as otherwise indicated, provide manufacturer's standard materials and components as published in their product information; designed and constructed as recommended by manufacturer, and as required for application indicated.

1. **Main Air Piping** (between the compressors and the field control panels): Hard drawn copper tubing, ASTM B 88, Type L.
2. **Branch Air Piping** (to include main air between field control panels and field devices: Seamless copper tubing, Type K or L, ASTM B 88; with cast-bronze solder joint fittings, ANSI B1.18; or wrought-copper solder-joint fittings, ANSI B16.22; except brass compression-type fittings at connections to equipment. Solder shall be 95/5 tin antimony, or other suitable lead-free composition solder.
3. **Branch Air Piping**: Virgin polyethylene non-metallic tubing type FR, ASTM D 2737, and with flame-retardant harness for multiple tubing. Use compression or push-on brass fittings.

B. Instrument Pipe and Tube

1. Hydronic and Instruments
   a. **Connection To Main Piping**: Provide ½ inch minimum size threadolet, ½" x 2 inch brass nipple, and ½" ball valve for connection to welded steel piping. Provide tee fitting for other types of piping.
   b. **Remote Instruments**: Adapt from ball valve to specified tubing and extend to remote instruments. Provide a union or otherwise removable fitting at ball valve so that connection to main can be cleaned with straight rod. Where manifolds with test ports are not provided for instrument, provide tees with ¼" FPT branch with plug for use as test port. Adapt from tubing size to instrument connection.
   c. **Line Mounted Instruments**: Extend rigid piping from ball valve to instrument. Do not use close or running thread nipples. Adapt from ball valve outlet to instrument connection size. Provide a plugged tee if pipe makes 90-degree bend at outlet of valve to allow cleaning of connection to main with straight rod without removing instrument.
   d. **Instrument Tubing**: Seamless copper tubing, Type K or L, ASTM B 88; with cast-bronze solder joint fittings, ANSI B1.18; or wrought-copper solder-joint fittings, ANSI B16.22; or brass compression-type fittings. Solder shall be 95/5 tin antimony, or other suitable lead-free composition solder. Tubing OD size shall be not less than the larger of ¼" or the instrument connection size.
   e. **Rigid Piping for Line Mounted Instruments**: Schedule 40 threaded brass, with threaded brass fittings.
2. Low Pressure Air Instrument Sensing Lines
   a. **Connections:** Use suitable bulkhead type fitting and static sensing tip for static pressure connections. Adapt tubing to instrument connection.
   b. **Tubing**: Virgin polyethylene non-metallic tubing type FR, ASTM D 2737, and with flame-retardant harness for multiple tubing. Use compression or push-on brass fittings.

C. Communication Wiring:

1. Specify all communication wiring between Building Controllers, Routers, Gateways, AAC's, ASC's and local and remote peripherals (e.g., operator workstations, printers, and modems).

2. **Local Supervisory LAN**: For any portions of this network required under this section of the specification, contractor shall use Fiber or Category 5 of standard TIA/EIA 68 (10BaseT). Network shall be run with no splices and separate from any wiring over thirty (30) volts.

3. **Primary and Secondary Controller LANs**: Communication wiring shall be individually 100% shielded pairs per manufacturers recommendations for distances installed, with overall PVC cover, Class 2, plenum-rated run with no splices and separate from any wiring over thirty (30) volts. Shield shall be terminated, and wiring shall be grounded as recommended by BC manufacturer.

D. **Signal Wiring**: Contractor shall run all signal wiring in accordance with California Electric Codes and Division 26 of Specification.

1. Signal wiring to all field devices, including, but not limited to, all sensors, transducers, transmitters, switches, etc. shall be twisted, 100% shielded pair, minimum 18-gauge wire, with PVC cover. Signal wiring shall be run with no splices and separate from any wiring above thirty (30) volts.

2. Signal wiring shield shall be grounded at controller end only unless otherwise recommended by the controller manufacturer.

E. **Low Voltage Analog Output Wiring**: Contractor shall run all low voltage control wiring in accordance with National Electric Codes and Division 16 of this Specification.

1. Low voltage control wiring shall be minimum 16-gauge, twisted pair, 100% shielded, with PVC cover, Class 2 plenum-rated. Low voltage control wiring shall be run with no splices separate from any wiring above thirty (30) volts.

F. **Control Panels**: Provide control panels with suitable brackets for wall mounting for each control system. Locate panel adjacent to systems served.

1. Fabricate panels of 16-gage furniture-grade steel, or 6063-T5 extruded aluminum alloy, totally enclosed on four sides, with hinged door and keyed lock, with manufacturer's standard shop- painted finish and color.

2. Provide UL-listed cabinets for use with line voltage devices.

3. Control panel shall be completely factory wired and piped, and all electrical connections made to a terminal strip. Control panel shall have standard manufacturer's color.

4. All gauges and control components shall be identified by means of nameplates.

5. All control tubing and wiring shall be run neatly and orderly in open slot wiring duct with cover. All control panel conduit penetrations shall occur in the bottom of the panel or within the bottom ¼ of each side.

6. Complete wiring and tubing termination drawings shall be mounted in or adjacent to panel.

1.02 CONTROL VALVES

A. Control valve sizing and selection are the responsibility of the AE and NOT left to the controls subcontractor. AE shall provide a valve schedule that lists the requirements of the valves for Cv, close off, temperature etc. This should be a result of analyzing the valves performance across the range of control.

B. **General**: Provide factory fabricated control valves of type, body material and pressure class indicated. Where type or body material is not indicated, provide selection as determined by

manufacturer for installation requirements and pressure class, based on maximum pressure and temperature in piping system. Provide valve size in accordance with scheduled or specified maximum pressure drop across control valve. Control valves shall be equipped with heavy-duty actuators, and with proper close-off rating for each individual application. Minimum close-off rating shall be as scheduled and adequate for each application and shall generally be considered at dead head rating of the pump.

C. Plug or Cartridge-Type Globe Pattern for Water Service – 50 GPM and less:

1. **Valve Sizing**: Where not specifically indicated on the control drawings, modulating valves shall be sized for maximum full flow pressure drop between 50% and 100% of the branch circuit it is controlling unless scheduled otherwise. Two-position valves shall be same size as connecting piping.
2. **Single Seated (Two-way) Valves**: Valves shall have equal-percentage characteristic for typical heat exchanger service and linear characteristic for building loop connections to campus systems unless otherwise scheduled on the drawings. Valves shall have cage-type trim, providing seating and guiding surfaces for plug on 'top-and-bottom' guided plugs.
3. **Double Seated (Three-way) Valves**: Valves shall have linear characteristic. Valves shall be balanced-plug type, with cage-type trim providing seating and guiding surfaces on 'top-and-bottom' guided plugs.
4. **Temperature Rating**: 36□F minimum, 230□F maximum
5. **Body**: Bronze or Brass body, screwed, 235 psi maximum working pressure for 1/2" to 2"; Cast Iron, flanged, 125 psi maximum working pressure for 2-1/2" and larger.
6. **Valve Trim**: Bronze or brass; Stem: Polished stainless steel.
7. **Packing**: Spring Loaded Teflon or Synthetic Elastomer U-cups, self-adjusting.
8. **Plug or Cartridge**: Brass, bronze or stainless steel, Seat: Brass
9. **Disc**: Replaceable Composition or Stainless Steel Filled PTFE.
10. **Ambient Operating Temperature Limits**: -32 to 122□F (0 to 50 □C)
11. **Acceptable Manufacturers**: Subject to compliance with requirements approved manufacturers are as follows:
    a. Honeywell

D. Control Valves for Water Service – Greater than 50 GPM:

1. Valves shall be pressure independent and shall be used for a water service 2-1/2" and larger unless noted otherwise. The flow through the valve shall not vary more than +/- 5% due to system pressure fluctuations across the valve in the selected operating range. The control valves shall accurately control the flow from 0 to 100% full rated flow. A flow tag, furnished with each valve shall list flows at all the valve positions in 10 degrees rotation increments. A maximum of 5 psi shall be required to operate the valve pressure independently.
2. **Rangeability**: The valves shall have a turndown capability of at least 100:1.
3. **Body**: Bronze, flanged, 125 psi maximum working pressure.
4. **Operating Temperature**: 250°F
5. **Pressure/Temperature ports (Pete's Plugs)**: Taps shall be installed at the factory in each valve to measure the pressure drop through the valves to determine the valve flow rate.
6. **Acceptable Manufacturers**: Subject to compliance with requirements approved

manufacturers are as follows:

a. Delta P Valve by Flow Control Industries, Inc.

E. Plug-Type Globe Pattern for Steam Service:

1. **Valve Sizing**: Where valve size is not specifically indicated on the drawings, size modulating valves for applications of 15 psig or less for 80% of inlet gage pressure unless scheduled otherwise. Modulating valves for applications of greater than 15 psig shall be sized for 42% of inlet absolute pressure unless scheduled otherwise. Two-position valves shall be same size as connecting piping.

2. **Characteristics**: Modified equal-percentage characteristics. Cage-type trim, providing seating and guiding surfaces for plug on "top and bottom" guided plugs.

a. Working Temperature: 250□F minimum for saturated steam applications of 15 psig or less; 366□F minimum for saturated steam applications of greater than 15 psig up to 150 psig.

3. **Body**: Bronze, screwed, 250 psig steam working pressure for 1/2” to 2”; Cast Iron, flanged, 100 psig steam working pressure for 2-1/2” and larger for applications of 50 psig or less.

a. Valve Trim, Plug, Seat and Stem: Polished stainless steel.

4. **Packing**: Spring Loaded Teflon.

5. **Disc**: Replaceable Composition or Stainless Steel Filled PTFE.

6. **Acceptable Manufacturers**: Subject to compliance with requirements approved manufacturers are as follows:

a. Honeywell

F. Butterfly Type:

1. **Body**: Extended neck epoxy coated cast or ductile iron with full lug pattern, ANSI Class 125 or 250 bolt pattern to match specified flanges.

2. **Seat**: EPDM, except in loop bypass applications where seat shall be metal to metal

3. **Disc**: Bronze or stainless steel, pinned or mechanically locked to shaft

4. **Bearings**: Bronze or stainless steel

5. **Shaft**: 416 stainless steel

6. **Cold Service Pressure**: 175 psi

7. **Close Off**: Bubble-tight shutoff to 150 psi

8. **Operation**: Valve and actuator operation shall be smooth both seating and unseating. Should more that 2 psi deadband be required to seat/unseat the valve, valve shall be replaced at no cost to the Government.

9. **Acceptable Manufacturers**: Subject to compliance with requirements approved manufacturers are as follows:

a. Jamesbury WS815
b. Bray Series 31
c. Keystone AR2
d. Honeywell
e. Nibco

G. Ball Type – 50 GPM and Less

1. **Body**: Brass or bronze; one-, two-, or three-piece design; threaded ends.
2. **Seat**: Reinforced Teflon
3. **Ball**: Stainless steel.
4. **Port**: Standard or 'V' style.
5. **Stem**: Stainless steel, blow-out proof design, extended to match thickness of insulation.
6. **Cold Service Pressure**: 600 psi WOG
7. **Steam working Pressure**: 150 psi
8. **Acceptable Manufacturers**: Subject to compliance with requirements approved manufacturers are as follows:
    a. Honeywell
    b. Worcester
    c. Nibco
    d. Jamesbury
    e. PBM
    f. Delta

H. Segmented or Characterized Ball Type - 50 GPM and Less

1. **Body**: Carbon Steel (ASTM 216), one-piece design with wafer style ends.
2. **Seat**: Reinforced Teflon (PTFE).
3. **Ball**: Stainless steel ASTM A351
4. **Port**: Segmented design with equal-percentage characteristic.
5. **Stem**: Stainless steel.
6. **Cold Service Pressure**: 200 psi WOG
7. **Cavitation Trim**: Provide cavitation trim where indicated and/or required, designed to eliminate cavitation and noise while maintaining an equal percentage characteristic. Trim shall be a series of plates with orifices to break the pressure drop into multi-stages.
8. **Acceptable Manufacturers**: Subject to compliance with requirements approved manufacturers are as follows:
    a. Honeywell

1.03 CONTROL DAMPERS

A. **General**: Provide factory fabricated automatic control dampers of sizes, velocity and pressure classes as required for smooth, stable, and controllable air flow. Provide parallel or opposed blade dampers as recommended by manufacturers sizing techniques. For dampers located near fan outlets, provide dampers rated for fan outlet velocity and close- off pressure, and recommended by damper manufacturer for fan discharge damper service. Control dampers used for smoke dampers shall comply with UL 555S. Control Dampers used for fire dampers shall comply with UL 555.

B. For general isolation and modulating control service in rectangular ducts at velocities not greater than 1500 fpm (7.62 m/s), differential pressure not greater than 2.5" w.c. (622 Pa):

1. **Performance**: Test in accordance with AMCA 500.
2. **Frames**: Galvanized steel, 16-gauge minimum thickness, welded or riveted with corner reinforcement.

3. **Blades**: Stainless steel in lab exhausts and galvanized steel elsewhere, maximum blade size 8 inches (200 mm) wide by 48 inches (1219 mm) long, attached to minimum 1/2 inch (12.7 mm) shafts with set screws, 16 gauge minimum thickness.
4. **Blade Seals**: Synthetic elastomer, mechanically attached, field replaceable.
5. **Jamb Seals**: Stainless steel.
6. **Shaft Bearings**: Oil impregnated sintered bronze, graphite impregnated nylon sleeve or other molded synthetic sleeve, with thrust washers at bearings.
7. **Linkage**: Concealed in frame.
8. **Linkage Bearings**: Oil impregnated sintered bronze or graphite impregnated nylon.
9. **Leakage**: Less than one percent based on approach velocity of 1500 ft./min. (7.62 m/s) and 1 inches wg. (249Pa).
10. **Maximum Pressure Differential**: 2.5 inches wg. (622 Pa)
11. **Temperature Limits**: -40 to 200 □F (-40 to 93 □C).
12. Where opening size is larger than 48 inches (1219 mm) wide, or 72 inches (1829 mm) high, provide dampers in multiple sections, with intermediate frames and jackshafts appropriate for installation.

C. For general isolation and modulating control service in rectangular ducts at velocities not greater than 4000 fpm (20.3 m/s), differential pressure not greater than 6" w.c. (1493 Pa):

1. **Performance**: Test in accordance with AMCA 500.
2. **Frames**: Galvanized steel, 16-gauge minimum thickness, welded or riveted with corner reinforcement.
3. **Blades**: extruded aluminum hollow airfoil shape, maximum blade size 8 inches (200 mm) wide by 48 inches (1219 mm) long, attached to minimum 1/2 inch (12.7 mm) shafts, 14 gauge minimum extrusion thickness.
4. **Blade Seals**: Synthetic elastomeric, mechanically attached, field replaceable.
5. **Jamb Seals**: Stainless steel.
6. **Shaft Bearings**: Oil impregnated sintered bronze sleeve, graphite impregnated nylon sleeve, molded synthetic sleeve, or stainless steel sleeve, with thrust washers at bearings.
7. **Linkage**: Concealed in frame.
8. **Linkage Bearings**: Oil impregnated sintered bronze or graphite impregnated nylon.
9. **Leakage**: Less than 0.1 percent based on approach velocity of 4000 ft./min. (20.3 m/s) and 1 inches wg. (249Pa).
10. **Maximum Pressure Differential**: 6 inches wg. (622 Pa)
11. **Temperature Limits**: -40 to 200 □F (-40 to 93 □C).
12. Where opening size is larger than 48 inches (1219 mm) wide, or 72 inches (1829 mm) high, provide dampers in multiple sections, with appropriately intermediate frames, and jackshafts.

D. For general isolation and modulating control service in rectangular ducts at velocities not greater than 4000 fpm, differential pressure not greater than 12" w.c.:

1. **Performance**: Test in accordance with AMCA 500.
2. **Frames**: Galvanized steel, 12-gauge minimum thickness, welded or riveted with corner

reinforcement.

3. **Blades**: Extruded aluminum hollow airfoil shape, maximum blade size 8 inches (200 mm) wide by 48 inches (1219 mm) long, attached to minimum 3/4 inch (19 mm) shafts with set screws
4. **Shaft Bearings**: Oil impregnated sintered bronze or stainless steel, pressed into frame, with thrust washers at bearings.
5. **Linkage**: 10-gauge minimum thickness galvanized steel clevis type crank arms, 3/16" x3/4" (4.76 mm x 19 mm) minimum thickness tie rods.
6. **Linkage Bearings**: Oil impregnated sintered bronze or graphite impregnated nylon.
7. **Leakage**: Less than 0.2 percent based on approach velocity of 4000 ft./min. (20.3 m/s) and 1 inches wg. (249Pa) differential pressure.
8. **Maximum Pressure Differential**: 12 inches wg. (2984 Pa)
9. **Temperature Limits**: -40 to 300 □F (-40 to 149 □C).
10. Where opening size is larger than 48 inches (1219 mm) wide, or 72 inches (1829 mm) high, provide dampers in multiple sections, with appropriately intermediate frames, and jackshafts.

E. For general isolation and modulating control service in round ducts up to 40 inches in size at velocities not greater than 2500 fpm (12.7 m/s), differential pressure not greater than 4" w.c. (994 Pa):

1. **Performance**: Test in accordance with AMCA 500.
2. **Frames**: rolled 12 gauge steel strip for sizes 6 inch and smaller, rolled 14 gauge steel channel for larger sizes, galvanized or aluminum finish.
3. **Blades**: Steel construction, 12 gauge minimum thickness for dampers less than 18 inches (457 mm) in size, 10 gauge minimum thickness for larger dampers.
4. **Blade Seals**: Full circumference neoprene.
5. **Shaft**: ½ inch (12.7 mm) diameter zinc or cadmium plated steel.
6. **Shaft Bearings**: Oil impregnated sintered bronze or stainless steel, pressed into frame, with thrust washers at bearings.
7. **Leakage**: Less than 0.2 percent based on approach velocity of 4000 ft./min. (20.3 m/s) and 1 inches wg. (249Pa) differential pressure.
8. **Maximum Pressure Differential**: 4 inches wg. (994 Pa)
9. **Temperature Limits**: -40 to 300 □F (-40 to 149 □C).

F. For general isolation and modulating control service in round ducts up to 60 inches in size at velocities not greater than 4000 fpm (20.3 m/s), differential pressure not greater than 6" w.c. (1492 Pa):

1. **Performance**: Test in accordance with AMCA 500.
2. **Frames**: rolled 10-gauge steel channel for sizes 48 inch and smaller, rolled 3/16 inch (4.76 mm) thick steel channel for larger sizes, galvanized or aluminum finish.
3. **Blades**: Steel construction, 10-gauge minimum thickness for dampers not greater than 48 inches in size, ¼ inch (6.35 mm) minimum thickness for larger dampers.
4. **Blade stops**: ½ inch x ¼ inch (12.7 mm x 6.35 mm) full circumference steel bar.

5. **Blade Seals**: Full circumference neoprene.
6. **Shaft**: zinc or cadmium plated steel, angle reinforcing as necessary.
7. **Shaft Bearings**: Oil impregnated sintered bronze or stainless steel, pressed into frame, with thrust washers at bearings.
8. **Leakage**: Less than 0.4 percent based on approach velocity of 4000 ft./min. (20.3 m/s) and 1 inches wg. (249Pa) differential pressure.
9. **Maximum Pressure Differential**: 6 inches wg. (1492 Pa)
10. **Temperature Limits**: -40 to 250 □F (-40 to 121 □C).

1.04 ACTUATORS

A. **General**: Size actuators and linkages to operate their appropriate dampers or valves with sufficient reserve torque or force to provide smooth modulating action or 2-position action as required. Select spring-return actuators with manual override to provide positive shut-off of devices as they are applied.

B. **Damper Actuators**

1. Ambient Operating Temperature Limits: -10 to 150□F (-12.2 to 66 □C)
2. **Two Position Electric Actuators**: Line voltage with spring return

   If pneumatic system is used Control drawings should clearly show where pneumatic Positive Positioners are required.
3. **Pneumatic Actuators**: Provide heavy-duty actuators with stroke indication and spring return. When so indicated and where more than 2 actuators are to be operated in sequence to each other, provide position feedback positive positioners with adjustable start point and operating range. Positive Positioners shall be provided on all modulating pneumatic valves larger than 1" and as shown on drawings.
4. **Electronic Actuators**: Provide actuators with spring return for two-position (24v), 0-5 Vdc, 0-10 Vdc, 2-10Vdc, 4-20 mA, or PWM input (subject to restrictions) as required. Actuators shall travel full stroke in less than [90] seconds. Actuators shall be designed for a minimum of 60,000 full cycles at full torque and be UL 873 listed. Provide stroke indicator. Actuators shall have positive positioning circuit. Where two actuators are required in parallel or in sequence, provide an auxiliary actuator driver. Actuators shall have current limiting motor protection. Actuators shall have manual override where indicated. Modulating actuators for valves shall have minimum rangeability of 40 to 1.
   a. **Close-Off Pressure**: Provide the minimum torque required, and spring return for fail positioning (unless otherwise specifically indicated) sized for required close-off pressure. Required close-off pressure for two-way water valve applications shall be the shutoff head of associated pump. Required close-off rating of steam valve applications shall be design inlet steam pressure plus 50 percent for low pressure steam, and 10 percent for high pressure steam. Required close-off rating of air damper applications shall be shutoff pressure of associated fan, plus 10 percent.
   b. **Acceptable Manufacturers**: Subject to compliance with requirements approved manufacturers are as follows:
      1) Honeywell
      2) Belimo

C. Quarter-Turn Actuators (for ball and butterfly valves):

1. Electric

a. **Motor**: Suitable for 120- or 240-Volt single-phase power supply. Insulation shall be NEMA Class F or better. Motor shall be rated for 100 percent duty cycle. Motors shall have inherent overload protection.
b. **Gear Train**. Motor output shall be directed to a self locking gear drive mechanism. Gears shall be rated for torque input exceeding motor locked rotor torque.
c. **Wiring**: Power and control wiring shall be wired to a terminal strip in the actuator enclosure
d. **Failsafe Positioning**: Actuators shall be spring return type for failsafe positioning.
e. **Enclosure**: Actuator enclosure shall be NEMA-4 rated, and shall have a minimum of two threaded conduit entries. Provide an enclosure heater for actuators located outside of buildings.
f. **Limit Switches**: Travel limit switches shall be UL and CSA approved. Switches shall limit actuator in both open and closed positions.
g. **Mechanical Travel Stops**: The actuator shall include mechanical travel stops of stainless steel construction to limit actuator to specific degrees of rotation.
h. **Manual Override**: Actuators shall have manual actuator override to allow operation of the valve when power is off. For valves 4 inches and smaller the override may be a removable wrench or lever or geared handwheel type. For larger valves, the override shall be a fixed geared handwheel type. An automatic power cut-off switch shall be provided to disconnect power from the motor when the handwheel is engaged for manual operation.
i. **Valve Position Indicator**: A valve position indicator with arrow and open and closed position marks shall be provided to indicate valve position.
j. **Torque Limit Switches**: Provide torque limit switches to interrupt motor power when torque limit is exceeded in either direction of rotation.
k. **Position Controller**: For valves used for modulating control, provide an electronic positioner capable of accepting 4-20 mA, 0-10 Vdc, 2-10 Vdc, and 135 Ohm potentiometer.
l. **Ambient Conditions**: Actuator shall be designed for operation from –140 to 150 □F ambient temperature with 0 to 100 percent relative humidity.

2. Pneumatic Single- and Double-Acting Cylinder Type:

a. **Air Cylinder**: Shall consist of steel or aluminum cylinder, dual pistons, double rack and pinion gearing mechanism. Housing shall be protected both internally and externally with corrosion resistant coating. Actuator shall be equipped with piston guide rods or similar mechanism so that seals are not loaded as linear bearings. Single acting units shall have multiple symmetrically arranged springs to apply equal force to piston. Cylinder shall be configurable for direction of fail-safe mode in the field. Actuators shall be spring return type for failsafe positioning.
b. **Position Indication**: Provide extended shaft position indicator that is removable for manual override of valve.
c. **Two-Position Actuators**: Provide appropriate three-way or four-way solenoid valve mounted on the actuator. Solenoid valve electrical enclosure shall meet NEMA-4 requirements. Provide actuator with position switches where required.
d. **Modulating Actuators**: Provide a rotary electronic positioner designed to accept 4-20 mA, 0-10 Vdc, 2-10 Vdc, or 135 Ohm potentiometer and operate integral 3-way or 4-way solenoid valve to position valve rotation angle as sensed by integral position feedback device to match signal input. Enclosure shall meet NEMA-4 requirements. Actuator linearity and resolution shall be 0.5% of span. Hysteresis and dead band shall be adjustable. Provide accessory mechanical or proximity type position switches and position transmitters where required. Actuators shall be spring return type for failsafe positioning. Provide an enclosure heater for positioners located outside of buildings.

1.05 GENERAL FIELD DEVICES

A. Provide field devices for input and output of digital (binary) and analog signals into controllers (BCs, AACs, ASCs). Provide signal conditioning for all field devices as recommended by field device manufacturers, and as required for proper operation in the system.

B. It shall be the Contractor's responsibility to assure that all field devices are compatible with controller hardware and software.

C. Field devices specified herein are generally 'two-wire' type transmitters, with power for the device to be supplied from the respective controller. If the controller provided is not equipped to provide this power, or is not designed to work with 'two-wire' type transmitters, or if field device is to serve as input to more than one controller, or where the length of wire to the controller will unacceptably affect the accuracy, the Contractor shall provide 'four-wire' type equal transmitter and necessary regulated DC power supply or 120 VAC power supply, as required.

D. For field devices specified hereinafter that require signal conditioners, signal boosters, signal repeaters, or other devices for proper interface to controllers, Contractor shall furnish and install proper device, including 120V power as required. Such devices shall have accuracy equal to, or better than, the accuracy listed for respective field devices.

E. **Accuracy**: As stated in this Section, accuracy shall include combined effects of nonlinearity, nonrepeatability and hysteresis.

1.06 TEMPERATURE SENSORS (TS)

A. **Sensor range**: When matched with A/D converter of BC, AAC/ASC, or SD, sensor range shall provide a resolution of no worse than 0.3°F (0.16 □C) (unless noted otherwise). Where thermistors are used, the stability shall be better than 0.25°F over 5 years.

AE shall carefully specify other applications where matched sensors are required for the specific project.

B. **Matched Sensors**: The following applications shall require matched sensors:

1. **Building Loop Connections**: Provide matched loop and building supply sensors where control sequence requires controlling to a temperature rise (differential).

2. **Hydronic Temperature Difference Calculations**: Provide matched supply and return temperature sensors where the pair is used for calculating temperature difference for use in load calculations or sequencing such as across chillers and plants.

3. **Air Handling Unit Sequencing:** Provide matched pair for the cooling and heating coil leaving sensors where the sequence includes calculating an offset from the supply air setpoint to maintain a leaving heating coil temperature.

AE must designate where various amenities to room sensors are required. The following assumes that this will be indicated on the control design drawings. Otherwise AE must add the clarification on the design.

C. **Room Temperature Sensor:** Shall be an element contained within a ventilated cover, suitable for wall mounting. Provide insulated base. Following sensing elements are acceptable:

1. Sensing element shall be platinum RTD, thermistor, or integrated circuit, +/- 0.4°F accuracy at calibration point.

2. Provide setpoint adjustment where indicated. The setpoint adjustment shall be a warmer/cooler indication that shall be scalable via the BAS.

3. Provide an occupancy override button on the room sensor enclosure where indicated. This shall be a momentary contact closure

4. Provide current temperature indication via an LCD or LED readout where indicated.

D. **Single-Point Duct Temperature Sensor:** Shall consist of sensing element, junction box for wiring connections and gasket to prevent air leakage or vibration noise. Temperature range as required for resolution indicated in paragraph A. Sensor probe shall be 316 stainless steel.

1. Sensing element shall be platinum RTD, thermistor, or integrated circuit, +/- 0.2°F accuracy at calibration point

E. **Averaging Duct Temperature Sensor**: Shall consist of an averaging element, junction box for wiring connections and gasket to prevent air leakage. Provide sensor lengths and quantities to result in one lineal foot of sensing element for each three square feet of cooling coil/duct face area. Temperature range as required for resolution indicated in paragraph A.

1. Sensing element shall be platinum RTD, or thermistor, +/- 0.2°F accuracy at calibration point.

F. **Liquid immersion temperature sensor** shall include brass thermowell, sensor and connection head for wiring connections. Temperature range shall be as required for resolution of 0.15□F.

1. Sensing element (chilled water/glycol systems) shall be platinum RTD +/- 0.2°F accuracy at calibration point. Temperature range shall be as required for resolution of 0.15□F.

2. Sensing element (other systems) shall be platinum RTD, thermistor, or integrated circuit, +/- 0.4°F accuracy at calibration point. Temperature range shall be as required for resolution of 0.3□F.

G. **Pipe Surface-Mount Temperature Sensor**: Shall include metal junction box and clamps and shall be suitable for sensing pipe surface temperature and installation under insulation. Provide thermally conductive paste at pipe contact point. Temperature range shall be as require for resolution indicated in paragraph A.

1. Sensing element shall be platinum RTD, thermistor, or integrated circuit, +/- 0.4°F accuracy at calibration point.

H. **Outside air sensors** shall consist of a sensor, sun shield, utility box, and watertight gasket to prevent water seepage. Temperature range shall be as require for resolution indicated in Paragraph A

1. Sensing element shall be platinum RTD, thermistor, or integrated circuit, +/- 0.4°F accuracy at calibration point.

1.07 TEMPERATURE TRANSMITTERS

A. Where required by Controller, or where wiring runs are over 50 feet, sensors as specified above may be matched with transmitters outputting 4-20 mA linearly across the specified temperature range. Transmitters shall have zero and span adjustments, an accuracy of 0.1□F when applied to the sensor range.

1.08 HUMIDITY TRANSMITTERS

A. Units shall be suitable for duct, wall (room) or outdoor mounting. Unit shall be two-wire transmitter utilizing bulk polymer resistance change or thin film capacitance change humidity sensor. Unit shall produce linear continuous output of 4-20 mA for percent relative humidity (% RH). A combination temperature and humidity sensor may be used for zone level monitoring. Sensors shall have the following minimum performance and application criteria:

1. Input Range: 0 to 100% RH.

2. Accuracy(% RH): +/- 2% (when used for enthalpy calculation, dewpoint calculation or humidifier control) or +/- 3% (monitoring only) between 20-90% RH at 77°F, including

hysteresis, linearity, and repeatability.

3. Sensor Operating Range: As required by application
4. Long Term Stability: Less than 1% drift per year.

B. **Acceptable Manufacturers**: Units shall be Vaisala HM Series, General Eastern, Microline, or Hy-Cal HT Series

1.09 DIFFERENTIAL PRESSURE TRANSMITTERS (DP)

A. **General Purpose - Water**: Two-wire transmitter, 4-20 mA output with zero and span adjustments. Plus or minus 0.5% overall accuracy, 450 psig (3103 KPa) maximum static pressure rating, 200 psid maximum overpressure rating for 6 through 60 psid range, 450 psid for 100 through 300 psid range. Acceptable units shall be Kele & Associates Model 360 C. Substitutions shall be allowed per Division 1.

B. **Industrial Application, Liquid, Steam and Gas**:

1. **General**: Two-wire smart DP cell type transmitter, 4-20 mA or 1-5 Vdc user- selectable linear or square root output, adjustable span and zero, stainless steel wetted parts.
2. **Environmental limits**: –40 to 250 □F (-40 to 121□C), 0 to 100% RH..
3. **Accuracy**: less than 0.1 percent of span.
4. **Output Damping**: Time constant user selectable from 0 to 36 seconds.
5. **Vibration Effect**: Less than □0.1% of upper range limit from 15 to 2000 Hz in any axis relative to pipe mounted process conditions.
6. **Electrical Enclosure**: NEMA-4, -4X, -7, -9.
7. **Approvals**: FM, CSA.
8. **Acceptable Manufacturers**: Rosemount Inc. 3051 Series, Foxboro, Johnson-Yokagawa, Setra, or Mamac. Substitutions shall be allowed per Division 1.

C. **General Purpose Low Pressure Air**: Generally for use in static measurement of duct pressure or constant volume air velocity pressure measurement where the range is applicable.

1. **General**: Loop powered two-wire differential capacitance cell-type transmitter.
2. **Output**: two wire 4-20 mA output with zero adjustment.
3. **Overall Accuracy**: Plus or minus 1%.
4. **Minimum Range**: 0.1 in. w.c.
5. **Maximum Range**: 10 inches w.c.
6. **Housing**: Polymer housing suitable for surface mounting.
7. **Acceptable Manufacturers**: Modus T30. Substitutions shall be allowed per Division 1.
8. **Static Sensing Element**: Pitot-type static pressure sensing tips similar to Dwyer model A-301 and connecting tubing.
9. **Range**: Select for specified setpoint to be between 25% and 75% full-scale.

D. **General Purpose Low Pressure/Low Differential Air**: Generally for use in static measurement of space pressure or constant volume air velocity pressure measurement where the range is applicable.

1. **General**: Loop powered, two-wire differential capacitance cell type transmitter.

2. **Output**: Two-wire 4-20 mA output with zero adjustment.
3. **Overall Accuracy**: Plus or minus 1%.
4. **Minimum Range**: 0 in. w.c.
5. **Maximum Range**: 0.1, 0.25, or 0.5 inches w.c.
6. **Housing**: Polymer housing suitable for surface mounting.
7. **Acceptable Manufacturers**: Modus T30. Substitutions shall be allowed per Division 1.
8. **Static Sensing Element**: Pitot-type static pressure sensing tips similar to Dwyer model A-301 and connecting tubing.
9. **Range**: Select for specified setpoint to be between 25% and 75% full-scale.

E. **VAV Velocity Pressure**: Generally for use in variable volume air velocity pressure measurement where the range is applicable.

1. **General**: Loop powered two-wire differential capacitance cell type transmitter.
2. **Output**: Two-wire, 4-20 mA output with zero adjustment.
3. **Overall Accuracy**: Plus or minus 0.25%
4. **Minimum Range**: 0 in. w.c.
5. **Maximum Range**: 1 inch w.c.
6. **Housing**: Polymer housing suitable for surface mounting.
7. **Acceptable Manufacturers**: Setra. Substitutions shall be allowed per Division 1.
8. **Range**: Select for minimum range that will accept the maximum velocity pressure expected.

1.10 VALVE BYPASS FOR DIFFERENTIAL PRESSURE SENSORS

A. Provide a five valve bypass kit for protection of DP sensors where the static on the pipe can cause on over pressure when connected to one port with the other at atmospheric pressure. Kit shall include high and low pressure isolation valves, high and low pressure vent valves, and a bypass valve contained in a NEMA-1 enclosure.

1.11 DIFFERENTIAL PRESSURE SWITCHES (DPS)

A. **General Service - Air**: Diaphragm with adjustable setpoint and differential and snap acting form C contacts rated for the application. Provide manufacturer's recommended static pressure sensing tips and connecting tubing

B. **General Service - Water**: Diaphragm with adjustable setpoint, 2 psig or adjustable differential, and snap-acting Form C contacts rated for the application. 60 psid minimum pressure differential range. 0□F to 160□F operating temperature range.

1.12 PRESSURE SWITCHES (PS)

A. Diaphragm or bourdon tube with adjustable setpoint and differential and snap-acting Form C contacts rated for the application. Pressure switches shall be capable of withstanding 150% of rated pressure.

B. **Acceptable Manufacturers**: Square D, ITT Neo-Dyn, ASCO, Penn, Honeywell, and Johnson Controls. Substitutions shall be allowed per Division 1.

1.13 TRANSDUCERS

A. **Standard Capacity Electronic-to-Pneumatic (E-P) Transducers**: E-P transducers shall be Voltage-to-Pneumatic (V-P) type, Current-to-Pneumatic (I-P) type, and Pulse Width Modulated-to-Pneumatic (PWM-P) type as required:

1. Electrical Power Supply: 24 Vac or 24 Vdc.
2. Pneumatic Air Supply: 30 psig (2.07 bar) maximum.
3. Air Capacity: 1100 scim @ 20 psig (300 cm^3/sec @ 1.4 bar).
4. Air Consumption: Zero at steady state.
5. Output Span: 0-20 psig (0-1.4 bar).
6. Input: 4-20 mA, 0-5 Vdc, 1-5 Vdc, 0-10 Vdc, 2-10 Vdc, 0-15 Vdc, or 3-15 Vdc input. [Pulse width modulated or tri-state input shall be allowed].
7. [Pulse Width Modulated and Tri-state Input Time Base: Dip switch selectable]
8. Enclosure: Polymer designed for surface or panel mount.
9. Air Connections: ¼" (6.35 mm) barbed.
10. Failure Mode on Power Loss: Non-failsafe transducers shall have no output air loss. Failsafe transducers shall exhaust output upon power loss.
11. Acceptable Manufacturers: RE Technologies Model UCP-522.

B. Binary to Analog Transducers Pulse Width Modulating or Tri-State-to-Voltage or -Current):

1. Adjustable zero and span.
2. **Failure Mode on Power Loss**: Shall be provided with memory feature to allow the transducer to return to last value on power failure.
3. **Accuracy**: ± 1% of span
4. 4. **Output Span**: 4-20 mA, 0-5 Vdc, 1-5 Vdc, 0-10Vdc, 2-10Vdc, 0-15Vdc, 3-15Vdc
5. **Input**: 4-20 mA, pulse width modulated or tri-state input.
6. **[Pulse Width Modulated] and Tri-state Input Time Base:** Dip switch selectable.
7. **Enclosure**: Polymer designed for surface or panel mount.
8. **Failure Mode on Power Loss**: Non-failsafe transducers shall have no output air loss. Failsafe transducers shall exhaust output upon power loss.
9. **Acceptable Manufacturers**: RE Technologies Model PWA Series.

C. Electronic-to Electronic (Voltage or Current to Current or Voltage):

1. Adjustable zero and span.
2. **Failure Mode on Power Loss**: Memory feature to allow the transducer to return to last value on power failure.
3. **Accuracy**: ± 1% of span.
4. 4. **Output Span**: 4-20 mA, 0-5 Vdc, 1-5 Vdc, 0-10 Vdc, 2-10 Vdc, 0-15 Vdc, 3-15 Vdc.
5. 5. **Input**: 0-20 Vdc, 0-20 ma, 0-10 kOhm.
6. **[Pulse Width Modulated] and Tri-state Input Time Base**: Dip switch selectable

7. **Enclosure**: Polymer enclosure designed for surface or panel mount.
8. **Acceptable Manufacturers**: RE Technologies Model PWA Series. **CURRENT SWITCHES (CS)**

D. Clamp-On or Solid-Core Design Current Operated Switch (for Constant Speed Motor Status Indication)

1. **Range**: 1.5 to 150 amps.
2. **Trip Point**: Adjustable.
3. **Switch**: Solid state, normally open, 1 to 135 Vac or Vdc, 0.3 Amps. Zero off state leakage.
4. **Lower Frequency Limit**: 6 Hz.
5. **Trip Indication**: LED
6. **Approvals**: UL, CSA
7. **Max. Cable Size**: 350 MCM
8. **Acceptable Manufacturer**s: Veris Industries H-708/908; Inc., RE Technologies SCS1150A-LED.

E. **Clamp-on or Solid-Core Wire Through Current Switch (CS/CR) (for Constant Speed Motors)**: Same as CS with 24v command relay rated at 5A @ 240 Vac resistive, 3A @ 240 Vac inductive, load control contact power shall be induced from monitored conductor (minimum conductor current required to energize relay 5A, max. rating of 135A). Acceptable Manufacturers shall be Veris Industries, Inc., Model # H938/735; or RE Technologies RCS 1150. Substitutions shall be allowed per Division 1.

1. Where used for single-phase devices, provide the CS/CR in a self-contained unit in a housing similar with override switch to Kele RIBX.

F. Clamp-On Design Current Operated Switch for Variable Speed Motor Status Indication

1. **Range**: 1.5 to 135 Amps.
2. **Trip Point**: Self-calibrating based on VA memory associated with frequency to detect loss of belt with subsequent increase of control output to 60 Hz.
3. **Switch**: Solid state, normally open, 1 to 135 Vac or Vdc, 0.3 Amps. Zero off state leakage.
4. **Frequency Range**: 5-75 Hz
5. **Trip Indication**: LED
6. **Approvals**: UL, CSA
7. **Max. Cable Size**: 350 MCM
8. Acceptable Manufacturers: Veris Industries, Inc. H-904.

G. **Clamp-On Wire Through Current Switch (CS/CR) (for Variable Speed Motors)**: Same as CS with 24v command relay rated at 5A @ 240 Vac resistive, 3A @ 240 Vac inductive, load control contact power shall be induced from monitored conductor (minimum conductor current required to energize relay 5A, max. rating of 135A). Acceptable manufacturer shall be Veris Industries, Inc., Model # H934.

H. **Variable Speed Status**: Where current switches are used to sense the status for variable speed devices, the CT shall include on-board VA/Hz memory to allow distinction between a belt break and subsequent ramp up to 60 Hz, versus operation at low speed. The belt break scenario shall be indicated as a loss of status and the operation at low speed shall indicate normal status.

1.14 CURRENT TRANSFORMERS (CT)

A. Clamp-On Design Current Transformer (for Motor Current Sensing)

1. **Range**: 1-10 amps minimum, 20-200 amps maximum
2. **Trip Point**: Adjustable
3. **Output**: 0-5 VDC.
4. **Accuracy**: □0.2% from 20 to 100 Hz.
5. **Acceptable Manufacturers**: KELE SA100.

1.15 OUTDOOR AIR STATIC PRESSURE SENSING TIP

A. **Pressure sensor**: Pressure sensing tip shall be designed to minimize the effects of wind and resulting velocity pressure up to 80 mph. Acceptable manufacturers shall be Dwyer A-306.

B. **Low Air Pressure Surge Dampener**: 30-second time constant. Acceptable manufacturer shall be Modus SD030.

1.16 CONTINUOUS LEVEL TRANSMITTERS

A. Capacitance Type

1. Provide a loop powered, continuous capacitance type level transmitter with adjustable span and zero.
2. **Output**: 4-20 mA.
3. **Probe**: Fluoropolymer coated stainless steel rod or cable. Provide cable probe with end attachment hardware or weight.
4. **Electrical Enclosure**: NEMA-4, -7.
5. **Approvals**: UL or CSA.
6. **Accuracy**: □1% of calibrated span.
7. **Process Connection**: MPT or ANSI Flange as required.
8. **Acceptable Manufacturers**: Drexelbrook, Endress & Hauser.

B. Hydrostatic Pressure

1. Two wire smart d/p cell type transmitter
2. 4-20 mA or 1 to 5 volt user selectable linear or square root output
3. Adjustable span and zero
4. Stainless steel wetted parts
5. Environmental limits: –40 to 250 □F (-40 to 121□C), 0 to 100% RH
6. Accuracy: less than 0.1 percent of span
7. Output Damping: time constant user selectable from 0 to 36 seconds
8. Vibration Effect: Less than □0.1% of upper range limit from 15 to 2000 Hz in any axis relative to pipe mounted process conditions.
9. Electrical Enclosure: NEMA 4, 4X, 7, 9
10. Approvals: FM, CSA
11. **Acceptable Manufacturers**: Rosemount Inc. 3051 Series, Foxboro, Kele, and Johnson-Yokagawa.

AE must clearly indicate which flow meters are acceptable for various dutie on the basis of design.

1.17 ULTRASONIC FLOW METERS FOR LIQUID, STEAM AND GAS SERVICE

A. General Requirements

1. Flow meter shall be permanent multi-function dual channel completely microprocessor based utilizing the transit-time flow measurement technique. Flow meter shall use the phase detection multiple pulse transmit principle in conjunction with multiple frequency axial beam transducer technology.

2. Measured quantities include volume flow, mass flow and flow velocity.

a. Housing: NEMA 4X enclosure powered by 90-240 VAC, 50-60 hz
b. Flow Velocity Range: 0.05 to 75 fps
c. Output: 4-20 maDC, two 0 – to 5000 hz pulse outputs proportional to flow. Two 0-10 Vdc,
d. Accuracy: +/- 1% of flow over a +/- 40 fps flow range with repeatability at +/- 0.15% of flow with a flow sensitivity of 0.04 fps at any flow rate.
e. Inline or permanent strap-on configurations are permitted.
f. All wetted metal parts shall be constructed of 316 stainless steel.

B. Acceptable Manufacturers: Yokogawa Industrial Automation,

1.18 MAGNETIC FLOW METERS FOR WATER SERVICE

A. Acceptable Manufacturers:

1. Engineering Measurements Co. (EMCO MAG 3100 with a model MAG 2500 electronic transmitter and display)

2. Rosemont

3. Toshiba

4. Hersey Measurement

5. Yokogawa Industrial Automation

6. Badger

7. Endress & Hauser

B. General Requirements:

1. Sensor shall be a magnetic flow meter, which utilizes Faraday's Law to measure volumetric fluid flow through a pipe.

2. The flow meter shall consist of 2 elements, the sensor and the electronics. The sensor shall generate a measuring signal proportional to the flow velocity in the pipe. The electronics shall convert this EMF into a standard current output.

3. Electronic replacement shall not affect meter accuracy (electronic units are not matched with specific sensors).

a. Provide a four-wire, externally powered, magnetic type flow transmitter with adjustable span and zero, integrally mounted to flow tube.
b. **Output**: 4-20 mA
c. Flow Tube: Stainless steel
d. **Electrical Enclosure**: NEMA 4, 7.
e. **Approvals**: UL or CSA.
f. **Stability**: 0.1% of rate over six months.

g. **Process Connection**: Carbon steel, ANSI 150 LB, size as required.

C. Meter Accuracy:

1. Under the reference conditions of a 68 °F media temperature, a 68 °F ambient temperature, a +/- 1% nominal power supply voltage, 10 diameters up stream and 5 down of straight piping and a fully developed flow profile; the meter must meet the following requirements:
2. +/- 0.8% of reading accuracy in the flow range of 1.65 - 33 ft/sec +/- (0.66/Velocity actual ft/s +0.4)% of reading accuracy in the flow range of 0-1.65 ft/sec.
3. Meter repeatability shall be +/- 0.1% of rate at velocities > 1.65 ft/sec.

D. **Calibration**: The sensor must be calibrated on an internationally accredited (i.e. NAMAS) flow rig with accuracy better than 0.1%. Calibration shall be traceable to National Institute of Standard and Technology.

E. **Construction**:

1. The meter piping material shall be AISI 304 stainless steel.
2. The meter flange and enclosure material shall be carbon steel.
3. The external surface of the sensor is to be treated with at least .006 in. (150 µm) of Corrosion resistant two-component paint.
4. The inner meter piping shall be protected with a neoprene liner or similar liner.
5. The electrode material shall be AISI 316 Ti or better.
6. The sensor shall be ANSI class 150#.

F. Electronics:

1. The sensor shall contain a SENSOR-PROM, storing calibration and factory default settings, i.e. the identification of the sensor and size.
2. An ISO 9001 approved company shall manufacture the sensor and electronics.
3. As standard, the electronics must be installable directly on the sensor or installable (remote) up to 1500 ft from the sensor as a maximum.
4. With local electronics installation, the electronics shall be able to withstand 3 feet water submersion for up to 30 minutes.
5. The electronics shall be compatible with the following power specifications: a) 15/230 Vac +10% to 15% 50-60 Hz.
   a. The power consumption must be 10 Watts or less independent of meter size.
6. The meter electronics shall be able to produce simultaneous scaleable current and frequency/pulse output. The frequency output shall be linearly proportional to flow rate and scaleable from 0-10 kHz. The pulse output shall be scaleable from 50 to 5000 milliseconds duration, suitable for an electromechanical totalizer in engineering units.
7. The electronics must have an internal totalizer for summation of flow.
8. The output of the electronics must be individually, galvanically isolated with an isolation voltage of more than 500 V.

G. Output:

1. The current signal must be either 0-20 mA or 4-20 mA proportional to the flow velocity.
2. The output current signal must accommodate 20% over range without loss in linearity.

3. The electronics shall have an alphanumeric LCD display showing actual flow and totalized flow in engineering units.
4. The display and keyboard must be rotatable so that the display can be viewed regardless of sensor orientation.

H. Error Detection:

1. The electronics must be able to detect the flowing error conditions:
   a. Signal connection between electronics and sensor interrupted.
   b. Loss of current to the coil circuit.
   c. Load on the current output.
   d. Defective electronics.
   e. Defective sensor.
   f. Empty pipe.
2. The electronics must have an Error Log where all error conditions occurring within a period of 180 days are stored.

I. Electronic Replacement Programming:

1. The electronics must be immediately replaceable without the need of cable disconnection or renewed configuration programming.
2. When the supply voltage is applied, the electronics must self configure and display flow without keyboard contact (no programming required).
3. The electronics must be provided with an automatic zero flow setting.
4. The electronics shall be programmable with respect to:
   a. User display options and menu
   b. Setting data
   c. Configuration of outputs
   d. Zero ‘cut-off’ from 0% to 9.9% of maximum flow.
5. For ease of programming, the electronics shall be programmable away from the meter using the meter Sensor-Prom and a 9 V battery.
6. The electronics shall be suitable for operation in an ambient temperature range of -4°F to 120 °F.

1.19 VENTURI FLOW METER FOR WATER SERVICE

A. **Flow Sensing Element**: Differential-pressure Venturi-type designed for installation in piping.

B. **Construction**: Bronze or cadmium plated steel with brass quick connect fittings and attached tag with flow conversion data and rated flow. Ends shall be threaded for 2” and smaller and flanged or welded for larger than 2”.

1. Differential transmitter shall be dual range industrial grade as specified above.
2. Connect differential pressure to venturi and repipe quick connect fittings for measurement. Provide ball valves to isolate quick connects and differential pressure transmitter.
3. Apply Venturi-type flow meters where minimum flow range is no less than 40% of maximum flow.

AE must clearly indicate which flow meters are acceptable for various duties for intended design.

1.20 AIRFLOW MEASURING STATIONS (AFMS)

A. **Vortex Shedding Grid**: Provide an array of vortex shedding elements designed to produce stable 'Karmen Vortices' that are linear with air velocity. Provide the electronics to totalize the pulses and output average velocity proportional to an output signal of 4-20ma.

1. Sensor Accuracy: ±1.5%
2. Electronics Accuracy: ±0.5%
3. Range: Select minimum range to accommodate the expected flow range of the project
4. Temperature Limits: 20-140□F
5. Acceptable Manufacturer: Tek-Air Systems Inc. 'Vortek' Model. Substitutions shall be allowed per Division 1.

B. **Fan Inlet Vortex Probe**: Provide multi-sensor probes designed to produce stable 'Karmen Vortices' that are linear with air velocity, which are installed in the inlet of the fan. Individual sensors on the probe provide frequency pulse type electronic output signals which are directly proportional and linear to airflow velocity. Provide the electronics to totalize the pulses and output average velocity proportional to an output signal of 4-20ma, 1-5 VDC or 2-10 VDC.

1. Sensor Accuracy: ±2%
2. Electronics Accuracy: ±0.5%
3. Range: Select minimum range to accommodate the expected flow range of the project
4. Temperature Limits: 20-140□F
5. Acceptable Manufacturer: Tek-Air Systems Inc. 'Vortek' Model VT-7000 or equal.

1.21 AIR VELOCITY PRESSURE SENSORS (INSERTION TYPE)

A. **Single or Multi-Point Averaging** (as indicated): Sensing tip shall be for insertion into duct with mounting flange and push on tube connections. Material shall be suitable to the application.

1.22 CO2 SENSORS/TRANSMITTERS (CO2)

A. CO**2** sensors shall use silicon based, diffusion aspirated, infrared single beam, dual-wavelength sensor.

B. **Accuracy**: ±36ppm at 800 ppm and 68□F.

C. **Stability**: 5% over 5 years.

D. **Output**: 4-20 mA, 0-10 Vdc or relay.

E. **Mounting**: Duct or Wall as indicated.

F. **Acceptable Manufacturer**: Vaisala, Inc. GMD20 (duct) or GMW20 (wall).

1.23 PNEUMATIC CONTROL COMPONENTS

A. **Analog Pressure Gauges**: Gauges shall be pneumatic type, minimum 1-1/2" in (38 mm) diameter, with white face and black numerals. Surface-mounted gauges shall have chrome plated trim and be a minimum of 2-1/2" in (64 mm) diameter.

B. **Pneumatic Actuated Pressure Switches (PE)** (for 30 psig max pressure control systems): Pressure ranges and sensitivity of PEs shall match control system sequence of operation. Switch operation shall be externally adjustable over the operating pressure range (nominal 0-20 psig, 0 to 138 KPa). PE switches shall be SPDT type, rated for the particular application, and shall be UL listed. PE shall be as manufactured by Penn. Substitutions shall be allowed as per Division 1

C. **Pilot Positioners**: Operating span adjustment range is from 3 to 13 psi (21 to 91 kPa). Positioner shall be furnished with a mounting bracket for attachment directly to the actuator.

1.24 ELECTRIC CONTROL COMPONENTS

A. **Limit Switches (LS):** Limit switches shall be UL listed, SPDT or DPDT type, with adjustable trim arm. Limit switches shall be as manufactured by Square D, Allen Bradley.

B. **Electric Solenoid-Operated Pneumatic Valves (EP)**: EP valves shall be rated for a minimum of 1.5 times their maximum operating static and differential pressure.. Valves shall be ported 2-way, 3-way, or 4-way and shall be normally closed or open as required by the application. EPs shall be sized for minimum pressure drop, and shall be UL and CSA listed. Furnish and install gauges on all inputs of EPs. Furnish an adjustable air pressure regulator on input side of solenoid valves serving actuators operating at greater than 30 psig.

1. **Coil Enclosure**: Indoors shall be NEMA-1, Outdoors and NEMA-3, 4, 7, 9.
2. **Fluid Temperature Rating**: Valves for compressed air and cold water service shall have 150 □F (66 □C) minimum rating. Valves for hot water or steam service shall have fluid temperature rating higher than the maximum expected fluid temperature.
3. **Acceptable Manufacturers**: EP valves shall be as manufactured by ASCO or Parker.
4. **Coil Rating**: EP valves shall have appropriate voltage coil rated for the application (i.e., 24 VAC, 120 VAC, 24 VDC, etc.).

C. **Low Temperature Detector ('Freezestat') (FZ)**: Low temperature detector shall consist of a 'cold spot' element which responds only to the lowest temperature along any one foot of entire element, minimum bulb size of 1/8" x 20' (3.2mm x 6.1m), junction box for wiring connections and gasket to prevent air leakage or vibration noise, DPST (4 wire, 2 circuit) with manual reset. Temperature range 15 to 55□F (-9.4 to 12.8□C), factory set at 38□F.

D. **High Temperature Detectors ('Firestat') (FS)**: High temperature detector shall consist of 3-pole contacts, a single point sensor, junction box for wiring connections and gasket to prevent air leakage of vibration noise, triple-pole, with manual reset. Temperature range 25 to 215□F (-4 to 102□C).

E. **Surface-Mounted Thermostat**: Surface-mounted thermostat shall consist of SPDT contacts, operating temperature range of 50 to 150□ F (10 to 65□C) , and a minimum 10□F fixed setpoint differential.

F. **Low Voltage Wall Thermostat**: Wall-mounted thermostat shall consist of SPDT sealed mercury contacts, operating temperature range of 50 to 90□F (10 to 32□C), switch rating of 24 Vac (30 Vac max.), and both manual and automatic fan operation in both the heat and cool modes.

G. **Control Relays**: All control relays shall be UL listed, with contacts rated for the application, and mounted in minimum NEMA-1 enclosure for indoor locations, NEMA-4 for outdoor locations.

1. Control relays for use on electrical systems of 120 volts or less shall have, as a minimum, the following:
   a. AC coil pull-in voltage range of +10%, -15% or nominal voltage.
   b. Coil sealed volt-amperes (VA) not greater than four (4) VA.
   c. Silver cadmium Form C (SPDT) contacts in a dustproof enclosure, with 8 or 11 pin type plug.
   d. Pilot light indication of power-to-coil and coil retainer clips.
   e. Coil rated for 50 and 60 Hz service.
   f. **Acceptable Manufacturers**: Relays shall be Potter Brumfield, Model KRPA.

2. Relays used for across-the-line control (start/stop) of 120V motors, 1/4 HP, and 1/3 HP, shall be rated to break minimum 10 Amps inductive load. Relays shall be IDEC. Substitutions shall be allowed per Division 1.

3. Relays used for stop/start control shall have low voltage coils (30 VAC or less), and shall be provided with transient and surge suppression devices at the controller interface.

H. **General Purpose Power Contactors:** NEMA ICS 2, AC general-purpose magnetic contactor. ANSI/NEMA ICS 6, NEMA type 1enclosure. Manufacturer shall be Square 'D', Cutler-Hammer or Westinghouse.

I. **Control Transformers**: Furnish and install control transformers as required. Control transformers shall be machine tool type, and shall be US and CSA listed. Primary and secondary sides shall be fused in accordance with the NEC. Transformer shall be proper size for application, and mounted in minimum NEMA-1 enclosure.

1. Transformers shall be manufactured by Eaton, Square ‘D’, or GE or equal.

J. **Time Delay Relays (TDR)**: TDRs shall be capable of on or off delayed functions, with adjustable timing periods, and cycle timing light. Contacts shall be rated for the application with a minimum of two (2) sets of Form C contacts, enclosed in a dustproof enclosure.

1. TDRs shall have silver cadmium contacts with a minimum life span rating of one million operations. TDRs shall have solid state, plug-in type coils with transient suppression devices.

2. TDRs shall be UL and CSA listed, Crouzet type.

K. **Electric Push Button Switch**: Switch shall be momentary contact, oil tight, push button, with number of N.O. and/or N.C. contacts as required. Contacts shall be snap-action type, and rated for minimum 120 Vac operation. Switch shall be 800T type, as manufactured by Allen Bradley.

L. **Pilot Light**: Panel-mounted pilot light shall be NEMA ICS 2 oil tight, transformer type, with screw terminals, push-to-test unit, LED type, rated for 120 VAC. Unit shall be 800T type, as manufactured by Allen-Bradley.

M. **Alarm Horn**: Panel-mounted audible alarm horn shall be continuous tone, 120 Vac Sonalert solid-state electronic signal, as manufactured by Mallory.

N. **Electric Selector Switch (SS)**: Switch shall be maintained contact, NEMA ICS 2, oil- tight selector switch with contact arrangement, as required. Contacts shall be rated for minimum 120 Vac operation. Switch shall be 800T type, as manufactured by Allen- Bradley.

1.25 REFRIGERANT MONITOR

A. **General**: Provide a refrigerant sensitive infrared-based stationary refrigerant gas leak monitor system designed to continuously measure refrigerants. Refrigerant monitor shall be coordinated to detect refrigerants used in chiller equipment installed under Section. The alarm system shall comply with ANSI/ASHRAE 15-1994 and local code requirements.

B. The refrigerant monitor shall be capable of monitoring multiple refrigerant gas compounds at multiple locations in concentrations of 0 PPM to a minimum of 1000 PPM. The Monitor shall have a low range resolution of 1 PPM in the range of 1 PPM through

C. 100 PPM. Readings above 100 PPM must be accurate to within ±5% of reading. Accuracy shall be maintained within ambient environmental ranges of 0ºC. through 50ºC., (32ºF. through 122ºF.) and 5% through 90% relative humidity, non-condensing.

D. The refrigerant monitor shall automatically and continuously monitor the areas through a

sample draw type tubular pick up system with an internal pump and filter. The installation of the monitoring control and the tubing shall be in strict accordance with the manufactures instructions. The location, routing, and final position of the sample tubes shall be submitted to the engineer with all necessary shop drawings and monitor specifications and installation instructions. Tubing size, tubing material, and tube length limitations shall be within the specifications of the monitor manufacture. The location and method of tube support and hangers must be identified on the shop drawings. Each of the sampling tubes shall have end of line filters.

E. The analyzer will be based on infrared detection technology and will be factory tested and calibrated for the specified refrigerant or refrigerants. Factory certification of the calibrations shall be provided with the O&M manuals. The analyzer shall provide a menu driven or automatic method of checking both zero, span calibration for each sensor, and allow for adjustment.

F. The monitor shall be equipped with 4 outputs. Three relays shall energize at an adjustable user defined set point based on refrigerant concentration levels. The relay threshold adjustment shall be protected by keyed or password access controls. Adjustments and observations shall be made at the front panel operator interface. The relay threshold values can be viewed without a password. The digital display will continuously display the refrigerant concentration level and alarm status. The fourth output shall indicate a monitor malfunction alarm. The monitor shall also have an analog output that will provide a liner scaled reference to the refrigerant concentration in parts per million. The analog output signal shall be an industry standard DC voltage, or mA current signal.

G. The monitor shall have a NEMA-4 moisture resistant enclosure with a gasketed, hinged front cover. Conduits and tube connections shall be located on the bottom of the enclosure. The enclosure shall have a rust and corrosion resistant finish.

H. The following alarm modes will be provided by the refrigerant monitor:

1. ALARM LEVEL ONE – Low level of refrigerant concentration at one of the sampling points has detected the presence of a possible refrigerant leak. The initial alarm threshold shall be set to 5 PPM (adj.) and increased if there are nuisance alarms. This alarm level shall be displayed on the refrigerant monitor interface panel, indicating which sensor has triggered the alarm, and the associated concentration of refrigerant in PPM. This event will also send an Alarm Level One signal to the BAS through a digital output from the monitor relay. This alarm will remain active until the refrigerant concentration is reduced below set point.

2. ALARM LEVEL TWO – This alarm shall indicate that one of the sensors has detected a refrigerant concentration that is approaching dangerous levels in the area being monitored. This alarm shall be set to 25% below the maximum calculated refrigerant level specified in ANSI/ASHRAE 15-1994 and ASHRAE 34-1992. This alarm will be displayed on the monitor interface, and will indicate which of the sensors has caused the alarm, and the highest concentration in PPM. This event will also activate the beacon and audible alarm mounted on the refrigerant monitoring enclosure. This alarm will also be sent to the BAS through the digital output of the relay. In this mode the audible alarm can be silenced, but the beacon shall remain active until the fault is cleared

3. ALARM LEVEL THREE – This alarm shall be set at the maximum calculated refrigerant level specified in ANSI/ASHRAE 15-1994 and ASHRAE 34-1992 whichever is the lowest concentration. The refrigerant monitor interface will display which sensor has caused the alarm, and the associated concentration in PPM. This event will also activate the beacon and audible alarm mounted on the refrigerant monitoring enclosure. If the audible alarm had been silenced by an earlier alarm, the activation of this level three alarm will cause the audible alarm to be activated again. The relay in the refrigerant monitoring panel shall

activate the space ventilation system, and will disable all combustion or flame-producing equipment via hardwired control interlocks. In addition, this event will de-energize the energy source for any hot surface (850□F or 454□C) located in the space. Interlocks must also be provided to close any normally open doors or openings to the space for proper ventilation and isolation during this alarm condition. This alarm level will also signal the BAS through the digital output through the same relay. In this mode, the audible alarm can be silenced, but the beacon shall remain active until the fault is cleared.

I. All alarm conditions shall be report to the BAS system as follows:

1. ALARM LEVEL ONE - The lowest refrigerant alarm level shall detect the presence of refrigerant in low concentrations and energize a relay to signal a low level alarm to the BAS operator terminal(s). The alarm shall display an alarm message stating that there is a potential refrigerant leak in the designated area.

2. ALARM LEVEL TWO - The second refrigerant level alarm shall be a high refrigerant alarm alert. This alarm shall energize a relay to signal the BAS system indicating a high level alarm on the BAS operator terminal(s). This BAS alarm shall state that high levels of refrigerant have been detected in the designated area

3. ALARM LEVEL THREE – The third refrigerant level alarm shall be a space evacuation alarm. This BAS alarm shall state that the chiller room ventilation system has been activated and combustion equipment has been disabled in the designated area.

4. FAULT ALARM – Reports a high-level alarm to the BAS operator terminal(s) that there is a fault in the refrigerant monitoring alarm system.

J. Acceptable Manufacturers

1. Honeywell Analytics

1.26 SMOKE CONTROL/FIREMAN'S OVERRIDE PANEL

A. Integral enunciator/control panel part of complete engineered and UUKL 864 listed system.

B. Provide clear, laminated graphic schematically representing the building air systems. Status LEDs shall be associated with graphic representations of fans. Override switches shall be provided as required by NFPA 110 to allow override of the fans and dampers applicable to the code requirements.

C. Interface with Fire Alarm System as required to implement the requirements specified in the Sequence of Operations.

1.27 NAMEPLATES

A. Provide engraved phenolic or micarta nameplates for all equipment, components, and field devices furnished. Nameplates shall be 1/8 thick, black, with white center core, and shall be minimum 1" x 3", with minimum 1/4" high block lettering. Nameplates for devices smaller than 1" x 3" shall be attached to adjacent surface.

B. Each nameplate shall identify the function for each device.

1.28 TESTING EQUIPMENT

A. Contractor shall test and calibrate all signaling circuits of all field devices to ascertain that required digital and accurate analog signals are transmitted, received, and displayed at system operator terminals, and make all repairs and recalibrations required to complete test. Contractor shall be responsible for test equipment required to perform these tests and calibrations. Test equipment used for testing and calibration of field devices shall be at least twice as accurate as respective field device (e.g., if field device is +/-0.5% accurate, test equipment shall be +/-0.25% accurate over same range).

PART 2 - EXECUTION

2.01 INSTALLATION OF CONTROL SYSTEMS

A. **General**: Install systems and materials in accordance with manufacturer's instructions, roughing-in drawings and details as shown on construction documents. Install electrical components and use electrical products complying with requirements of California Electrical Code and all National Codes.

B. **Main Control Air Piping**: All main air piping between the compressors and the control panels shall be copper, run per ASTM B88

C. **Branch Control Air Piping**: Accessible tubing is defined as that tubing run in mechanical equipment rooms; inside mechanical equipment enclosures, such as heating and cooling units, instrument panels; across roofs, in pipe chases, etc. Inaccessible tubing is defined as that tubing run in concrete slabs; furred walls; or ceilings with no access.

1. Provide copper tubing with maximum unsupported length of 3'-0", for accessible tubing run exposed to view. Polyethylene tubing may be used in lieu of above, when run within adequately supported, rigid enclosure, such as metallic raceways, or EMT. Terminal single-line connections less than 18 in length may be copper tubing, or polyethylene tubing run inside flexible steel protection. Accessible tubing run in concealed locations, such as pipe chases, suspended ceilings with easy access, etc. may be copper or polyethylene bundled and sheathed tubing.
2. Provide copper or polyethylene tubing for inaccessible tubing, other than in concrete pour. If polyethylene tubing is used, install in EMT or vinyl-jacketed polyethylene tubing.
3. Polyethylene piping may be used above suspended ceiling without conduit provided it is run in a neat and orderly fashion, bundled where applicable, and completely suspended (strapped to rigid elements or routed through wiring rings) away from areas of normal access. Tubing shall not be laid on the ceiling or duct.
4. Pressure test control air piping at 30 psi (207 kPa) for 24 hours. Test fails if more than 2 psi loss occurs.
5. Fasten flexible connections bridging cabinets and doors, neatly along hinge side, and protect against abrasion. Tie and support tubing neatly.
6. Number-code or color-code tubing, except local individual room control tubing, for future identification and servicing of control system. Code shall be as indicated on approved installation drawings.

D. **Control Wiring**: The term "control wiring" is defined to include providing of wire, conduit and miscellaneous materials as required for mounting and connection of electric control devices.

1. **Wiring System**: Install complete wiring system for electric control systems. Conceal wiring except in mechanical rooms and areas where other conduit and piping are exposed. Installation of wiring shall generally follow building lines. Install in accordance with National Electrical Code and Division 16 of this Specification. Fasten flexible conductors bridging cabinets and doors, neatly along hinge side, and protect against abrasion. Tie and support conductors neatly.
2. **Control Wiring Conductors**: Install control wiring conductors, without splices between terminal points, color-coded. Install in neat workmanlike manner, securely fastened. Install in accordance with National Electrical Code and Division 16 of this Specification.
3. Communication wiring, signal wiring and low voltage control wiring shall be installed separate from any wiring over thirty (30) volts. Signal wiring shield shall be grounded at controller end only, unless otherwise recommended by the controller manufacturer.

4. All WAN and LAN Communication wiring shield shall be terminated as recommended by controller manufacturer. All WAN and LAN Communication wiring shall be labeled with a network number, device ID at each termination and shall correspond with the WAN and LAN system architecture and floor plan submittals.

5. Install all control wiring external to panels in electric metallic tubing or raceway. However, communication wiring, signal wiring and low voltage control wiring may be run without conduit in concealed, accessible locations if noise immunity is ensured. Contractor will be fully responsible for noise immunity and rewire in conduit if electrical or RF noise affects performance. Accessible locations are defined as areas inside mechanical equipment enclosures, such as heating and cooling units, instrument panels etc.; in accessible pipe chases with easy access, or suspended ceilings with easy access. Installation of wiring shall generally follow building lines. Run in a neat and orderly fashion, bundled where applicable, and completely suspended (strapped to rigid elements or routed through wiring rings) away from areas of normal access. Tie and support conductors neatly with suitable nylon ties. Conductors shall not be supported by the ceiling system or ceiling support system. Conductors shall be pulled tight and be installed as high as practically possible in ceiling cavities. Wiring shall not be laid on the ceiling or duct. Conductors shall not be installed between the top cord of a joist or beam and the bottom of roof decking. Contractor shall be fully responsible for noise immunity and rewire in conduit if electrical or RF noise affects performance.

6. Number-code or color-code conductors appropriately for future identification and servicing of control system. Code shall be as indicated on approved installation drawings.

E. **Control Valves**: Install so that actuators, wiring, and tubing connections are accessible for maintenance. Where possible, install with valve stem axis vertical, with operator side up. Where vertical stem position is not possible, or would result in poor access, valves may be installed with stem horizontal. Do not install valves with stem below horizontal, or down.

F. **Freezestats**: Install freezestats in a serpentine fashion where shown on drawing. Provide one foot of element for each square foot of coil face area. Where coil face area exceeds required length of element, provide multiple devices, wired in parallel for normally open close on trip application, wired in series for normally closed, open on trip application. Adequately support with coil clips.

G. **Averaging Temperature Sensors**: Cover no more than two square feet per linear foot of sensor length except where indicated. Generally where flow is sufficiently homogeneous/adequately mixed at sensing location, consult AE for requirements.

   AE must specifically show locations of all flow meters and design in the straight length of duct of pipe required for accurate sensors. This length must be specifically shown on the drawing.

H. **Airflow Measuring Stations**: Install per manufacturer's recommendations in an unobstructed straight length of duct (except those installations specifically designed for installation in fan inlet). For installations in fan inlets, provide on both inlets of double inlet fans and provide inlet cone adapter as recommended by AFM station manufacturer.

I. **Fluid Flow Sensors**: Install per manufacturer's recommendations in an unobstructed straight length of pipe.

J. **Relative Humidity Sensors**: Provide element guard as recommended by manufacturer for high velocity installations. For high limit sensors, position remote enough to allow full moisture absorption into the air stream before reaching the sensor.

K. **Differential Pressure Transmitters**: Provide valve bypass arrangement to protect against over pressure damaging the transmitter.

L. **Flow Switches**: Where possible, install in a straight run of pipe at least 15 diameters in length

to minimize false indications.

M. **Current Switches for Motor Status Monitoring**: Adjust so that setpoint is below minimum operating current and above motor no load current.

N. **Supply Duct Pressure Transmitters**:

1. **General**: Install pressure tips with at least 4 'round equivalent' duct diameters of straight duct with no takeoffs upstream. Install pressure tips securely fastened with tip facing upstream in accordance with manufacturer's installation instructions. Locate the transmitter at an accessible location to facilitate calibration.

2. **VAV System 'Down-Duct' Transmitters**: Locate pressure tips approximately 2/3 of the hydraulic distance to the most remote terminal in the air system.

O. **Cutting and Patching Insulation**: Repair insulation to maintain integrity of insulation and vapor barrier jacket. Use hydraulic insulating cement to fill voids and finish with material matching or compatible with adjacent jacket material.

2.02 REFRIGERANT MONITOR

A. Install in accordance with the manufacturer's instructions. Place sensing tips in locations to maximize effectiveness.

B. Hard wire interlocks to the emergency ventilation and shutdown of combustion devices.

END OF SECTION

SECTION 23 09 02
BUILDING AUTOMATION SYSTEM (BAS) OPERATOR INTERFACES

PART 1 - DESCRIPTION OF WORK

A. Furnish and install all Operator Interfaces and Control System Servers as required for the BAS functions specified. All computers shall be warranted by the manufacturer for a period of one year after final acceptance.

PART 2 - PRODUCTS

2.01 PORTABLE REMOTE WORKSTATION

A. Operator Workstation PC: Must meet current Windows and Honeywell EBI requirements.

B. Operating system for operator workstation shall be latest version of Microsoft Windows used by the District. Corresponding Microsoft Office is to be provided.

C. Provide software, graphics and programming as required.

D. Provide additional hardware, video drivers, etc., to facilitate all control functions and software requirements specified for the building automation system.

E. Provide all controller configuration and interface software and/or plug ins for all devices applicable. All shall be loaded and functional. Provide all required interface cables required to connect to all networks, routers, controllers, SDs etc.

F. Workstation PC shall have the capability of changing serial port interrupt vectors and IOBASE addresses through software.

G. Provide a data backup system with capacity to store all aspects of the system software and configuration database including control device configuration parameters, graphics, trends, programming, etc to a single removable portable device which can be moved off site.

H. Provide network card approved by BAS manufacturer to support Supervisory LAN communications (Ethernet TCP/IP Minimum) for connection to the Local Supervisory LAN and network card, or LANID where connected to the Primary Controller LAN.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Set up the workstations and printers as indicated on the drawings. Install all software and verify that the systems are fully operational. Ensure licensing is provided for all software.

B. No license, software component, key, etc or any piece of information required to install, configure, operate, diagnose and maintain the system shall be withheld from the District.

C. Install electronic control system Operation and Maintenance Manuals, programming guides, network configuration tools, control shop drawings etc on each OWS/POTand CSS. Provide interface or shortcuts to guide user to the appropriate information.

D. Set up portable operator terminal and configure it as the remote workstation. Install all software and verify that the system is fully operational. Install systems and materials in accordance with manufacturer's instructions.

END OF SECTION

SECTION 23 09 03
BUILDING AUTOMATION SYSTEM (BAS) FIELD PANELS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK:

A. Furnish and install DDC Control units required to support specified building automation system functions.

PART 2 - PRODUCTS

2.01 STAND-ALONE FUNCTIONALITY

A. **General**: These requirements clarify the requirement for stand-alone functionality relative to packaging I/O devices with a controller. Stand-alone functionality is specified with the controller and for each Application Category. This item refers to acceptable paradigms for associating the points with the processor.

B. **Functional Boundary**: Provide controllers so that all points associated with and common to one unit or other complete system/equipment shall reside within a single control unit. The boundaries of a standalone system shall be as dictated in the contract documents. Generally, systems specified for the Application Category will dictate the boundary of the standalone control functionality. See related restrictions below. When referring to the controller as pertains to the standalone functionality, reference is specifically made to the processor. One processor shall execute all the related I/O control logic via one operating system that uses a common programming and configuration tool.

C. The following configurations are considered acceptable with reference to a controller's standalone functionality:

1. Points packaged as integral to the controller such that the point configuration is listed as an essential piece of information for ordering the controller (having a unique ordering number).
2. Controllers with processors and modular back planes that allow plug in point modules as an integral part of the controller.
3. I/O point expander boards, plugged directly into the main controller board to expand the point capacity of the controller.
4. I/O point expansion devices connected to the main controller board via wiring and as such may be remote from the controller and that communicate via a sub LAN protocol. These arrangements to be considered standalone shall have a sub LAN that is dedicated to that controller and include no other controller devices (AACs or ASCs). All wiring to interconnect the I/O expander board shall be contained the same contiguous physical enclosure.
5. General purpose LonMark I/O devices racked with a processor module in the same contiguous physical enclosure. The controller shall also include its own dedicated processor module and bridge or router making the controllers LAN communication a subnet or LAN segment dedicated to that controller. The following are additional requirements of this configuration:
    a. Configuration must meet the requirements for battery backup.
    b. If processor fails, the I/O devices shall go to their fail condition.
    c. Contractor shall provide a network bandwidth analysis of the controller segment or subnet. The analysis shall document network bandwidth does not exceed 70% of its saturation value including during trend file upload.
    d. Logic must provide for orderly sequencing of I/O during a power interruption and restart of program logic upon restoration of power.

e. Trending must be buffered in the processor or dedicated data logging module and programming must facilitate a robust uploading scheme using LonMark File Transfer Protocol and limit available bandwidth during upload.

D. The following configurations are considered unacceptable with reference to a controller's standalone functionality:

1. General-purpose LonMark I/O devices or Smart Devices located around the unit or system.

2.02 BUILDING CONTROLLER (BC)

A. General Requirements:

1. The BC(s) shall provide fully distributed control independent of the operational status of the OWSs and CSS. All necessary calculations required to achieve control shall be executed within the BC independent of any other device. All control strategies performed by the BC(s) shall be both operator definable and modifiable through the Operator Interfaces.

2. BCs shall perform overall system coordination, accept control programs, perform automated HVAC functions, control peripheral devices and perform all necessary mathematical and logical functions. BCs shall share information with the entire network of BCs and AACs/ASCs for full global control. Each controller shall permit multi-user operation from multiple workstations and portable operator terminals connected either locally or over the Primary Controller LAN. Each unit shall have its own internal RAM, non-volatile memory, microprocessor, battery backup, regulated power supply, power conditioning equipment, ports for connection of operating interface devices, and control enclosure. BCs shall be programmable from an operator workstation, portable operator's terminal, or handheld operating device. BC shall contain sufficient memory for all specified global control strategies, user defined reports and trending, communication programs, and central alarming.

3. BCs shall be connected to a controller network that qualifies as a Primary Controlling LAN.

4. All BCs shall be protected from any memory loss due to a loss of power by one or a combination of the following:

a. Volatile RAM shall have a battery backup using a lithium battery with a rated service life of fifty (50) hours, and a rated shelf life of at least five years. Self-diagnostic routine shall report an alarm for a low battery condition.

5. EEPROM, EPROM, or NOVROM non-volatile memory In addition BCs may provide intelligent, standalone control of HVAC functions. Each BC may be capable of standalone direct digital operation utilizing its own processor, non-volatile memory, input/output, wiring terminal strips, A/D converters, real-time clock/calendar and voltage transient and lightning protection devices. Refer to standalone functionality specified above.

6. The BC may provide for point mix flexibility and expandability. This requirement may be met via either a family of expander boards, modular input/output configuration, or a combination thereof. Refer to stand alone functionality specified above.

7. All BC point data, algorithms and application software shall be modifiable from the Operator Workstation.

8. Each BC shall execute application programs, calculations, and commands via a microprocessor resident in the BC. The database and all application programs for each BC shall be stored in non-volatile or battery backed volatile memory within the BC and will be able to upload/download to/from the OWS/POTand/or CSS.

9. BC shall provide buffer for holding alarms, messages, trends etc.
10. Each BC shall include self-test diagnostics, which allow the BC to automatically alarm any malfunctions, or alarm conditions that exceed desired parameters as determined by programming input.
11. Each BC shall contain software to perform full DDC/PID control loops.
12. For systems requiring end-of-line resistors those resistors shall be located in the BC.
13. Input-Output Processing
    a. Digital Outputs (DO): Outputs shall be rated for a minimum 24 Vac or Vdc, 1 amp maximum current. Each shall be configurable as normally open or normally closed. Each output shall have an LED to indicate the operating mode of the output and a manual hand off or auto switch to allow for override. If these HOA switches are not provided on the main board they shall be provided via isolation relays within the control enclosure. Each DO shall be discrete outputs from the BC's board (multiplexing to a separate manufacturer's board is unacceptable). Provide suppression to limit transients to acceptable levels.
    b. Analog Inputs (AI): AI shall be O-5 Vdc, 0-10 Vdc, 2-10 Vdc, 0-20 Vdc, 0-
    c. 20 mA, and 4-20 mA. Provide signal conditioning, and zero and span calibration for each input. Each input shall be a discrete input to the BC's board (multiplexing to a separate manufacturers board is unacceptable unless specifically indicated otherwise). A/D converters shall have a minimum resolution of 12 bits.
    d. Digital Inputs (DI): Monitor dry contact closures. Accept pulsed inputs of at least one per second. Source voltage for sensing shall be supplied by the BC and shall be isolated from the main board. Software multiplexing of an AI and resistors may only be done in non-critical applications and only with prior approval of Architect/Engineer.
    e. Universal Inputs (UI-AI or DI): To serve as either AI or DI as specified above.
    f. Electronic Analog Outputs (AO): Voltage mode: 0-5 Vdc and 0-10 Vdc; Current mode: 4-20 mA. Provide zero and span calibration and circuit protection. Pulse Width Modulated (PWM) analog via a DO and transducer is acceptable only with the Distrcit's approval (Generally these will not be allowed on loops with a short time constant such as discharge temperature loops, economizer loops, pressure control loops and the like. They are generally acceptable for standard room temperature control loops.). Where these are allowed, transducer/actuator shall be programmable for normally open, normally closed, or hold last position and shall allow adjustable timing. Each DO shall be discrete outputs from the BC's board (multiplexing to a separate manufacturers board is unacceptable). D/A converters shall have a minimum resolution of 10 bits.
    g. Analog Output Pneumatic (AOP), 0-20 psi: Pneumatic outputs via an I/P transducer, PWM/P transducer, or digital to pneumatic transducer are acceptable. Multiplexed digital to pneumatic transducers are acceptable provided they are supplied as a standard product and part of the BC and provide individual feedback. Multiplexed pneumatic outputs of a separate manufacturer are unacceptable.
    h. Pulsed Inputs: Capable of counting up to 8 pulses per second with buffer to accumulate pulse count. Pulses shall be counted at all times.
14. A communication port for operator interface through a terminal shall be provided in each BC. It shall be possible to perform all program and database back-up, system monitoring, control functions, and BC diagnostics through this port. Standalone BC panels shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers, or workstations.
15. Each BC shall be equipped with loop tuning algorithm for precise proportional, integral, derivative (PID) control. Loop tuning tools provided with the Operator Workstation software is acceptable. In any case, tools to support loop tuning must be provided such that P, I,

and D gains are automatically calculated.

16. Slope intercepts and gain adjustments shall be available on a per-point basis.
17. BC Power Loss:
    a. Upon a loss of power to any BC, the other units on the primary controlling network shall not in any way be affected.
    b. Upon a loss of power to any BC, the battery backup shall ensure that the energy management control software, the Direct Digital Control software, the database parameters, and all other programs and data stored in the RAM are retained for a minimum of fifty (50) hours. An alarm diagnostic message shall indicate that the BC is under battery power.
    c. Upon restoration of power within the specified battery backup period, the BC shall resume full operation without operator intervention. The BC shall automatically reset its clock such that proper operation of any time dependent function is possible without manual reset of the clock. All monitored functions shall be updated.
    d. Should the duration of a loss of power exceed the specified battery back-up period or BC panel memory be lost for any reason, the panel shall automatically report the condition (upon resumption of power) and be capable of receiving a download via the network, and connected computer. In addition, the Distrcit shall be able to upload the most current versions of all energy management control programs, Direct Digital Control programs, database parameters, and all other data and programs in the memory of each BC to the operator workstation via the local area network, or via the telephone line dial-up modem where applicable, or to the laptop PC via the local RS-232C port.
18. BC Failure:
    a. Building Controller LAN Data Transmission Failure: BC shall continue to operate in stand-alone mode. BC shall store loss of communication alarm along with the time of the event. All control functions shall continue with the global values programmable to either last value or a specified value. Peer BCs shall recognize the loss, report alarm and reconfigure the LAN.
    b. BC Hardware Failure: BC shall cease operation and terminate communication with other devices. All outputs shall go to their specified fail position.
19. Each BC shall be equipped with firmware resident self-diagnostics for sensors and be capable of assessing an open or shorted sensor circuit and taking an appropriate control action (close valve, damper, etc.).
20. BCs may include LAN communications interface functions for controlling secondary controlling LANs Refer to Section 23 0904 - BAS System Communications Devices for requirements if this function is packaged with the BC.
21. A minimum of four levels of password protection shall be provided at each BC.
22. BCs shall be mounted on equipment, in packaged equipment enclosures, or locking wall mounted in a NEMA 1 enclosure, as specified elsewhere.

B. BACnet Building Controller Requirements:

1. The BC(s) shall support all BIBBs defined in the BACnet Building Controller (B- BC) device profile as defined in the BACnet standard.
2. BCs shall communicate over the BACnet Building Controller LAN.
3. Each BC shall be connected to the BACnet Building Controller LAN communicating to/from other BCs.

2.03 ADVANCED APPLICATION SPECIFIC CONTROLLER (AAC) AND APPLICATION SPECIFIC CONTROLLER (ASC)

A. General Requirements:

1. AACs and ASCs shall provide intelligent, standalone control of HVAC equipment. Each unit shall have its own internal RAM, non-volatile memory and will continue to operate all local control functions in the event of a loss of communications on the ASC LAN or sub-LAN. Refer to standalone requirements by application specified in Part 3 of this section. In addition, it shall be able to share information with every other BC and AAC /ASC on the entire network.

2. Each AAC and ASC shall include self-test diagnostics that allow the AAC /ASC to automatically relay to the BC, LAN Interface Device or workstation, any malfunctions or abnormal conditions within the AAC /ASC or alarm conditions of inputs that exceed desired parameters as determined by programming input.

3. AACs and ASCs shall include sufficient memory to perform the specific control functions required for its application and to communicate with other devices.

4. Each AAC and ASC must be capable of stand-alone direct digital operation utilizing its own processor, non-volatile memory, input/output, minimum 8 bit A to D conversion, voltage transient and lightning protection devices. All volatile memory shall have a battery backup of at least fifty- (50) hrs with a battery life of five years.

5. All point data; algorithms and application software within an AAC /ASC shall be modifiable from the Operator Workstation.

6. AAC and ASC Input-Output Processing

a. Digital Outputs (DO): Outputs shall be rated for a minimum 24 VAC or VDC, 1 amp maximum current. Each shall be configurable as normally open or normally closed. Each output shall have an LED to indicate the operating mode of the output and a manual hand off or auto switch to allow for override. If these HOA switches are not provided on the main board they shall be provided via isolation relays within the control enclosure. Each DO shall be discrete outputs from the AAC/ASC's board (multiplexing to a separate manufacturer's board is unacceptable). Provide suppression to limit transients to acceptable levels.

b. Analog Inputs (AI): AI shall be O-5 Vdc, 0-10Vdc, 2-10 Vdc, 0-20Vdc, 0-20 mA and 4-20 mA. Provide signal conditioning, and zero and span calibration for each input. Each input shall be a discrete input to the BC's board (multiplexing to a separate manufacturers board is unacceptable unless specifically indicated otherwise). A/D converters shall have a minimum resolution of 8-10 bits depending on application.

c. Digital Inputs (DI): Monitor dry contact closures. Accept pulsed inputs of at least one per second. Source voltage for sensing shall be supplied by the BC and shall be isolated from the main board. Software multiplexing of an AI and resistors may only be done in non-critical applications and only with prior approval of Architect/Engineer

d. Universal Inputs (UI-AI or DI): To serve as either AI or DI as specified above.

e. Electronic Analog Outputs (AO) as required by application: voltage mode, 0- 5VDC and 0-10VDC; current mode (4-20 mA). Provide zero and span calibration and circuit protection. Pulse Width Modulated (PWM) analog via a DO and transducer is acceptable only with the Distrcit's approval (Generally, PWM will not be allowed on loops with a short time constant such as discharge temperature loops, economizer loops, pressure control loops and the like. They are generally acceptable for standard room temperature control loops.). Where PWM is allowed, transducer/actuator shall be programmable for normally open, normally closed, or hold last position and shall allow adjustable timing. Each DO shall be discrete outputs from the BC's board (multiplexing to a separate manufacturers board is unacceptable). D/A converters

shall have a minimum resolution of 8 bits.

f. Analog Output Pneumatic (AOP), 0-20 psi: Pneumatic outputs via an I/P transducer, PWM/P transducer, or digital to pneumatic transducer are acceptable. Multiplexed digital to pneumatic transducers are acceptable provided they are supplied as a standard product and part of the AAC /ASC and provide individual feedback. Multiplexed pneumatic outputs of a separate manufacturer are unacceptable.

B. BACnet AAC(s) and ASC(s) Requirements:

1. The AAC(s) and ASC(s) shall support all BIBBs defined in the BACnet Building Controller (B-AAC and B-ASC) device profile as defined in the BACnet standard.

2. AAC(s) and ASC(s) shall communicate over the BACnet Building Controller LAN or the ASC LAN or sub-LAN.

3. Each BC shall be connected to the BACnet Building Controller LAN communicating to/from other BCs.

C. Terminal Box Controllers:

1. Terminal box controllers controlling damper positions to maintain a quantity of supply or exhaust air serving a space shall have an automatically initiated function that resets the volume regulator damper to the fully closed position on a scheduled basis. The controllers shall initially be set up to perform this function once every 24 hours. The purpose of this required function is to reset and synchronize the actual damper position with the calculated damper position and to assure the damper will completely close when commanded. The software shall select scheduled boxes randomly and shall not allow more than 5% of the total quantity of controllers in a building to perform this function at the same time. When possible, the controllers shall perform this function when the supply or exhaust air system is not operating or is unoccupied.

PART 3 - EXECUTION

3.01 HARDWARE APPLICATION REQUIREMENTS

A. **General**: The functional intent of this specification is to allow cost effective application of manufacturers standard products while maintain the integrity and reliability of the control functions. A Building Controller as specified above is generally fully featured and customizable whereas the AAC/ASC refers to a more cost- effective unit designed for lower-end applications. Specific requirements indicated below are required for the respective application. Manufacturer may apply the most cost-effective unit that meets the requirement of that application.

B. **Standalone Capability**: Each Control Unit shall be capable of performing the required sequence of operation for the associated equipment. All physical point data and calculated values required to accomplish the sequence of operation shall originate within the associated CU with only the exceptions enumerated below. Refer to Item

C. 2.01 above for physical limitations of standalone functionality. Listed below are functional point data and calculated values that shall be allowed to be obtained from or stored by other CUs via LAN.

D. Where associated control functions involve functions from different categories identified below, the requirements for the most restrictive category shall be met.

E. **Application Category 0** (Distributed monitoring)

1. Applications in this category include the following:

a. Monitoring of variables that are not used in a control loop, sequence logic, or safety.

2. Points on BCs, AACs, and ASCs may be used in these applications.

3. Where these points are trended, contractor shall verify and document that the network bandwidth is acceptable for such trends and is still capable of acceptable and timely control function.

F. **Application Category 1** (Application Specific Controller):

1. Applications in this category include the following:

   a. Fan Coil Units
   b. Airflow Control Boxes (VAV and Constant Volume Terminal Units)
   c. Misc. Heaters
   d. Unitary equipment <15 tons (Package Terminal AC Units, Package Terminal Heat Pumps, Split-System AC Units, Split-System Heat Pumps, Water- Source Heat Pumps)
   e. Induction Units

2. ASCs may be used in these applications.

3. **Standalone Capability**: Provide capability to execute control functions for the application for a given setpoint or mode, which shall generally be occupied mode control. Only the following data (as applicable) may be acquired from other controllers via LANs. In the event of a loss of communications with any other controller, or any fault in any system hardware that interrupts the acquisition of any of these values, the ASC shall use the last value obtained before the fault occurred. If such fault has not been corrected after the specified default delay time, specified default value(s) shall then be substituted until such fault has been corrected.

Physical/Virtual Point	Default Value
Scheduling Period	Normal
Morning Warm-Up	Off (cold discharge air)
Load Shed	Off (no shedding)
Summer/Winter	Summer
Trend Data	N/A
Smoke Pressurization Mode	Normal Mode

4. Mounting:

   a. ASCs that control equipment located above accessible ceilings shall be mounted on the equipment in an accessible enclosure and shall be rated for plenum use.
   b. ASCs that control equipment mounted in a mechanical room may either be mounted in, on the equipment, or on the wall of the mechanical room at an adjacent, accessible location. Equipment is to be mounted within a NEMA 12 water tight enclosure.
   c. ASCs that control equipment mounted outside or in occupied spaces shall either be located in the unit or in a proximate mechanical/utility space.
   d. Section 23 0903 contractor may furnish ASCs to the terminal unit manufacturer for factory mounting.

5. **Programmability**: Operator shall be able to modify all setpoints (temperature and airflow), scheduling parameters associated with the unit, tuning and set up parameters, interstage timing parameters, and mode settings. Application-specific block control algorithms may be used to meet the sequence of operations. The ability to customize the control algorithm is not required unless specifically indicated otherwise.

6. **LAN Restrictions**: Only Application 1 equipment listed in Item 1 above shall reside on this LAN. Limit the number of nodes servicing any one of these applications on the AAC/ASC LAN to 32.

G. **Application Category 2** (General Purpose Terminal Controller)

1. Applications in this category include the following:
   a. Unitary Equipment >= 15 tons (Air Conditioners, Heat Pumps, Packaged Heating/Cooling Units, and the like)
   b. Small, Constant Volume Single Zone Air Handling Units
   c. Constant Volume Pump Start/Stop
   d. Variable Speed Drive (VSD) controllers not requiring safety shutdowns of the controlled device.
   e. Misc. Equipment (Exhaust Fan) Start/Stop
   f. Misc. Monitoring (not directly associated with a control sequence and where trending is not critical)
2. BCs may be used in these applications.
3. ASC's may be used in these applications provided the ASC meets all requirements specified below. This category requires a general-purpose ASC to which application-specific control algorithms can be attached.
4. **Standalone Capability**: Only the following data (as applicable) may be acquired from other ASCs via LANs. In the event of a loss of communications with any other ASCs, or any fault in any system hardware that interrupts the acquisition of any of these values, the AAC/ASC shall use the last value obtained before the fault occurred. If such fault has not been corrected after the specified default delay time, specified default value(s) shall then be substituted until such fault has been corrected.

Physical/Virtual Point	Default Delay Time	Default Value
Outside Air Temperature	3 minutes	80□F
Outside Air Humidity	3 minutes	60%RH
Outside Air Enthalpy	3 minutes	30 Btu/lb
Trend Data		N/A
Cooling/Heating Requests	3 minutes	None
Smoke Pressurization Mode	3 minutes	Normal Mode
Smoke Exhaust Command	3 minutes	Normal Mode

5. Mounting:
   a. ASCs that control equipment located above accessible ceilings shall be mounted on the equipment and shall be rated for plenum use.
   b. ASCs that control equipment located in occupied spaces or outside shall either be mounted within the equipment enclosure (responsibility for physical fit remains with the contractor) or in a nearby mechanical/utility room in which case it shall be enclosed in a NEMA 12, locking enclosure.
6. **Programmability**: Operator shall be able to modify all setpoints (temperature and airflow), scheduling parameters associated with the unit, tuning and set up parameters, interstage timing parameters, and mode settings. Operator shall be able to address and configure spare inputs for monitoring. Operator shall be able to address and configure spare outputs for simple single loop control actions or event initiated actions. Application-specific block control algorithms shall used to meet the sequence of operations. The ability to customize the control algorithm is not required unless specifically indicated otherwise.
7. **LAN Restrictions**: Only Application 2 equipment listed in Item 1 above shall reside on this LAN. Limit the number of nodes servicing any one of these applications on the AAC/ASC LAN to 16.

H. Application Category 3
1. Applications in this category include the following:
   a. Large Constant Volume Air Handlers (>5000 CFM) or Constant Volume Air Handlers

serving critical areas
b. VAV Air Handlers
c. Dual Duct Air Handlers
d. Multizone Air Handlers
e. Self Contained VAV Units
f. Central Cooling Plant and all associated components
g. Central Heating Plant and all associated components
h. Local Free Cooling Heat Exchanger Control

2. BCs shall be used in these applications.

END OF SECTION

SECTION 23 09 04
BUILDING AUTOMATION SYSTEM (BAS) COMMUNICATION DEVICES

PART 1 - DESCRIPTION OF WORK

A. Provide all interface devices and software to provide an integrated system connecting BCs, AACs, ASCs and Gateways to the Honeywell Enterprise Buildings Integrator (EBI) network located in the BAS Control Center.

PART 2 - PRODUCTS

2.01 EBI NETWORK CONNECTION

A. **EBI WAN**: Intranet-based network connecting multiple buildings with a central data warehouse and server. This is an existing infrastructure and contractor is required to connect to this WAN. Contractor is required to provide BACnet Objects and services and/or LonMark Objects at the Local Supervisory LAN via BACnet over IP or LonTalk over IP. The contractor will connect to this Ethernet LAN to manage the exchange of data and alarms with the EBI Server including, but not limited to, trends, alarms, schedules, parameters, variables, and real time data from the local system. If the Local Supervisory LAN does not inherently use BACnet over IP or LonTalk over IP, this Contractor shall provide a gateway(s), routers, hardware, software, etc. necessary to translate and facilitate services from the local protocol to the EBI.

B. When utilizing a BACnet Gateway the following BIBBs must be supported on the Local Supervisory LAN using Ethernet:

1. Read Property (DS-RP-A) Initiate
2. Read Property (DS-RP-B) Execute
3. Read Property Multiple (DS-RPM-A) Initiate
4. Read Property Multiple (DS-RPM-B) Execute
5. Write Property (DS-WP-A) Initiate
6. Write Property (DS-WP-B) Execute
7. Write Property Multiple (DS-WPM-A) Initiate
8. Write Property Multiple (DS-WPM-B) Execute
9. COV Unsubscribed (COVU-A) Initiate
10. COV Unsubscribed (COVU-B) Execute
11. Dynamic Device Binding - A (DM-DDB-A)
12. Dynamic Object Binding – A (DM-DOB-A)
13. DeviceCommunicationControl – A (DM-DCC-A)
14. TimeSynchronization – A (DM-TS-A)
15. UTCTimeSynchronization – A (DM-UTC-A)
16. ReinitializeDevice - A (DM-RD-A)
17. Connection Establishment - A (NM-CE-A)
18. List Manipulation-B (DM-LM-B)
19. Object Creation and Deletion – B (DM-OCD-B)
20. Dynamic Device Binding - A (DM-DDB-A)

21. Alarm and Event-Notification-A (AE-N-A)
22. Alarm and Event-ACK-A (AE-ACK-A)
23. Alarm and Event-Summary-A (AE-ASUM-A)
24. Bacnet Schedules

2.02 EBI NETWORK GATEWAYS

A. This is applicable when the Local Supervisor LAN is not BACnet over IP or LonTalk over IP. A Gateway shall be provided to link non-BACnet and non LonMark Compliant control products to the EBI. The Gateway shall include all necessary gateway(s), routers, hardware, software, etc. necessary to meet the requirements listed. All of the functionality described in this section is to be provided by using the capabilities of BACnet. Each Gateway shall have the ability to expand the number of BACnet objects of each type supported by 20% to accommodate future system changes.

B. Each Gateway shall provide values for all points on the non-BACnet side of the Gateway to BACnet devices as if the values were originating from BACnet objects. The Gateway shall also provide a way for BACnet devices to modify (write) all points specified using standard BACnet services. All points are required to be writable for each site.

C. The Gateway shall implement BACnet schedule objects and permit both read and write access to the schedules from the workstation.

D. The Gateway shall provide a way to collect and archive or trend (time, value) data pairs.

E. Each Gateway and any devices that the Gateway represents which have time of day information shall respond to workstation requests to synchronize the date and time. Each Gateway and any devices that the Gateway represents shall support dynamic device binding and dynamic object binding. Refer to the BIBBs listed above for other minimum requirements of the Gateway.

F. All points in the system shall be made network-visible through the use of standard BACnet objects or through proprietary BACnet extensions that the workstation also supports. All points shall be writable using standard BACnet services.

G. All devices have a Device Object instance number that is unique throughout the entire EBI network. All BACnet devices shall be configured with a Device Object instance number that is based on the format specified (shown in decimal notation). This includes all physical devices as well as any logical BACnet devices that are physically represented by gateways.

2.03 CONTROLLER LOCAL AREA NETWORK INTERFACE DEVICES (LANID)

A. The Controller LANID shall be a microprocessor-based communications device which acts as a gateway/router between the Primary LAN, Secondary LAN, an operator interface, modem to support remote operator interface, or printer. These may be provided within a BC or as a separate device.

B. The LANID shall perform information translation between the Primary LAN and the Secondary LAN, supervise communications on a polling secondary LAN, and shall be applicable to systems in which the same functionality is not provided in the BC. In systems where the LANID is a separate device, it shall contain its own microprocessor, RAM, battery, real-time clock, communication ports, and power supply as specified for a BC in Section 23 0903. Each LANID shall be mounted in a lockable enclosure.

C. Each LANID shall support interrogation, full control, and all utilities associated with all BCs on the Primary LAN, all AACs and ASCs connected to all secondary LANs under the Primary Controller LAN, and all points connected to those PCUs and SCUs.

D. Upon loss of power to a LANID, the battery shall provide for minimum 100-hour backup of all programs and data in RAM. The battery shall be sealed and self- charging.

E. The LANID shall be transparent to control functions and shall not be required to control information routing on the Primary LAN

F. All BACnet Interoperability Building Blocks (BIBBs) are required to be supported for each native BACnet device or Gateway. The Gateway shall support all BIBBs defined in the BACnet Gateway's device profile as defined in the BACnet standard.

2.04 LOCAL SUPERVISORY LAN GATEWAY/ROUTERS

A. The Supervisory Gateway shall be a microprocessor-based communications device that acts as a gateway/router between the Supervisory LAN, OWS/POT and the Primary LAN.

B. The Gateway shall perform information translation between the Primary LAN which may be proprietary and the Local Supervisory LAN, which is 100 Mbps Ethernet TCP/IP and shall preferably use BACnet over IP. When BACnet is used, refer to the requirements of the BACnet Gateways specified herein.

C. The gateway shall contain its own microprocessor, RAM, battery, real-time clock, communication ports, and power supply as specified for a BC in Section 23 0903. Each gateway/router shall be mounted in a lockable enclosure unless it is a PC that also serves as an OWS/POT. .

D. The gateway/router shall allow centralized overall system supervision, operator interface, management report generation, alarm annunciation, acquisition of trend data, and communication with control units. It shall allow system operators to perform the following functions from the OWS and POTs:

1. Configure systems.
2. Monitor and supervise control of all points.
3. Change control setpoints.
4. Override input values.
5. Override output values
6. Enter programmed start/stop time schedules.
7. View and acknowledge alarms and messages.
8. Receive, store and display trend logs and management reports.
9. Upload/Download programs, databases, etc. as specified.
10. BBMD capability

E. Upon loss of power to the Gateway, the battery shall provide for minimum 100 hour backup of all programs and data in RAM. The battery shall be sealed and self- charging.

F. The Gateway shall be transparent to control functions and shall not be required to control information routing on the Primary LAN

2.05 CHILLER CONTROLS INTERFACE DEVICE (CID)

A. The CID shall be a microprocessor-based communications device that acts as a gateway between the control protocol and the applicable chiller controller.

B. The CID shall contain its own microprocessor, RAM, battery, communication ports and, power supply.

C. Each CID shall support full bi-directional communications translation as more fully specified in

Section 23 0905.

D. The following points shall be mapped as a minimum:
   1. CHW Supply and Return Temperatures
   2. CW Supply and Return Temperatures
   3. Power Consumption (kW)
   4. Percent of Power Consumption (compared to maximum)
   5. Bearing Temperature
   6. Suction and Head Pressures
   7. Suction and Head Temperatures
   8. All available alarms; common alarm as minimum
   9. Chiller Status
   10. Enable/Disable
   11. Current Limit Percent
   12. CHW Setpoint and Setpoint Reset
   13. Oil pressure
   14. Evaporator Approach
   15. Condenser Approach
   16. Proof of CHW and CW Flow

PART 3 - EXECUTION

3.01 INSTALLATION OF CONTROL SYSTEMS:

A. General: Install systems and materials in accordance with manufacturer's instructions, roughing-in drawings and details shown on drawings.

B. Contractor shall provide all interface devices and software to provide an integrated system.

C. Contractor shall closely coordinate with the District, or designated representative, to establish IP addresses and communications to assure proper operation of the building control system with EBI.

END OF SECTION

SECTION 23 09 05
BUILDING AUTOMATION SYSTEM (BAS) SOFTWARE AND PROGRAMMING

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK:

A. Fully configure systems and furnish and install all software, programming and dynamic color graphics for a complete and fully functioning system as specified.

B. Refer to *Building Automation System (BAS)* for general requirements as well as requirements for interface with the Enterprise Buildings Integrator (EBI) Network.

C. Refer to *Sequence of Operation* for specific sequences of operation for controlled equipment.

1.02 LICENSING

A. Include added point licensing for all software packages at all required workstations.

B. All operator interfaces, programming environment, networking, database management and any other software used by the Contractor to install the system or needed to operate the system to its full capabilities shall be licensed and provided to the District.

C. All software should be available on all Portable Operator Terminals (POTs). Hardware and software keys to provide all rights shall be installed on all workstations. At least 2 sets of CDs shall be provided with backup software for all software provided, so that the District may reinstall any software as necessary. Include all licensing for workstation operating systems, and all required third-party software licenses.

D. Provide licensing and original software copies for each POTs.

E. Provide licensing and original software copies for each remote graphic workstation. Licenses for remote graphic workstations shall allow for access to any site and shall not be restricted to accessing only the LANs included in this project.

F. Upgrade all software packages to the release (version) in effect at the end of the Warranty Period.

G. Refer to *Section 23 0900 – Building Automation System (BAS) General* for further requirements.

PART 2 - PRODUCTS

2.01 SYSTEM SOFTWARE-GENERAL

A. **Functionality and Completeness**: The Contractor shall furnish and install all software and programming necessary to provide a complete and functioning system as specified. The Contractor shall include all software and programming not specifically itemized in these Specifications, which is necessary to implement, maintain, operate, and diagnose the system in compliance with these Specifications.

B. **Configuration**: The software shall support the system as a distributed processing network configuration.

2.02 CONTROLLER SOFTWARE

A. **BC Software Residency**: Each BC as defined below shall be capable of control and monitoring of all points physically connected to it. All software including the following shall reside and execute at the BC:

1. Real-Time Operating System software
2. Real-Time Clock/Calendar and network time synchronization

3. BC diagnostic software
4. LAN Communication software/firmware
5. Direct Digital Control software
6. Alarm Processing and Buffering software
7. Energy Management software
8. Data Trending, Reporting, and Buffering software
9. I/O (physical and virtual) database
10. Remote Communication software

B. **AAC/ASC Software Residency**: Each AAC/ASC as defined below shall be capable of control and monitoring of all points physically connected to it. As a minimum, software including the following shall reside and execute at the AAC/ASC. Other software to support other required functions of the AAC/ASC may reside at the BC or LAN interface device per application provided in Section 23 0903:

1. Real-Time Operating System software
2. AAC/ASC diagnostic software
3. LAN Communication software
4. Control software applicable to the unit it serves that will support a single mode of operation
5. I/O (physical and virtual) database to support one mode of operation

C. **Stand Alone Capability**: BC shall continue to perform all functions independent of a failure in other BC/AAC/ASC or other communication links to other BCs/AACs/ASCs. Trends and runtime totalization shall be retained in memory. Runtime totalization shall be available on all digital input points that monitor electric motor status. Refer also to Section 23 0903 for other aspects of standalone functionality.

D. **Operating System**: Controllers shall include a real-time operating system resident in ROM. This software shall execute independently from any other devices in the system. It shall support all specified functions. It shall provide a command prioritization scheme to allow functional override of control functions.

E. **Network Communications**: Each controller shall include software/firmware that supports the networking of CUs on a common communications trunk that forms the respective LAN. Network support shall include the following:

1. Building Controller/Primary LAN shall be a high-speed network designed and optimized for control system communication. If a Primary LAN communications trunk is severed, BCs shall reconfigure into two separate LANs and continue operations without interruption or Operator intervention.
2. Controller communication software shall include error detection, correction, and re-transmission to ensure data integrity.
3. Operator/System communication software shall facilitate communications between other BCs, all subordinate AACs/ASCs, Gateways and LAN Interface Devices or Operator Workstations. Software shall allow point interrogation, adjustment, addition/deletion, and programming while the controller is online and functioning without disruption to unaffected points. The software architecture shall allow networked controllers to share selected physical and virtual point information throughout the entire system.

F. **EBI Network Point Database/Summary Table**: All points included in the typical equipment

point list must be represented to the EBI Network in a common, open protocol format. All points should be provided as BACnet standard analog, binary, schedule, or trend objects. Naming conventions for these points and network addressing. Point/system database creation and modification shall be via a user- friendly, menu-driven program. System software shall support virtual or logic point (points not representing a physical I/O) creation. Software shall support virtual points with all services specified herein. Database software shall support definition of all parameters specified for a given point type. If database does not support all of these parameters, a software module shall be created and attached to the points which accomplish the respective function.

G. **Diagnostic Software**: Controller software shall include diagnostic software that checks memory and communications and reports any malfunctions.

H. **Alarm/Messaging Software**: Controller software shall support alarm/message processing and buffering software as more fully specified below.

I. **Application Programs**: CUs shall support and execute application programs as more fully specified below:

1. All Direct Digital Control software, Building Automation software, and functional block application programming software templates shall be provided in a 'ready-to-use' state, and shall not require (but shall allow) District programming.

2. Line programs shall supply preprogrammed functions to support these energy management and functional block application algorithms. All functions shall be provided with printed narratives and/or flow diagrams to document algorithms and how to modify and use them.

J. **Security**: Controller software shall support multiple level password access restriction as more fully specified below.

K. **Direct Digital Control**: Controller shall support application of Direct Digital Control Logic. All logic modules shall be provided pre-programmed with written documentation to support their application. Provide the following logic modules as a minimum:

1. Proportional-Integral-Derivative (PID) control with analog, PWM and floating output

2. Two Position control (Hi or Low crossing with deadband)

3. Single-Pole Double-Throw relay

4. Delay Timer (delay-on-make, delay-on-break, and interval)

5. Hi/Low Selection

6. Reset or Scaling Module

7. Logical Operators (And, Or, Not, Xor)

L. **Psychrometric Parameters**: Controller software shall provide preprogrammed functions to calculated and present psychrometric parameters (given temperature and relative humidity) including the following as a minimum: Enthalpy, Wet Bulb Temperature.

M. **Updating/Storing Application Data**: Site-specific programming residing in volatile memory shall be uploadable/downloadable from an OWS connected locally, to the Primary LAN, to the Local Supervisory LAN and remotely via the internet and modem and telephone lines as applicable but all must be available. Initiation of an upload or download shall include all of the following methods; Manually, Scheduled, and Automatically upon detection of a loss or change.

N. **Restart**: System software shall provide for orderly shutdown upon loss of power and automatic restart upon power restoration. Volatile memory shall be retained; outputs shall go to programmed fail (open, closed, or last) position. Equipment restart shall include a user

definable time delay on each piece of equipment to stagger the restart. Loss of power shall be alarmed at operator interface indicating date and time.

O. **Time Synchronization**: Operators shall be able to set the time and date in any device on the network that supports time-of-day functionality. The operator shall be able to select to set the time and date for an individual device, devices on a single network or all devices simultaneously. Automatic time synchronization shall be provided using BACnet services.

P. **Misc. Calculations**: System software shall automate calculation of psychometric functions, calendar functions, kWh/kW, and flow determination and totalization from pulsed or analog inputs, curve-fitting, look-up table, input/output scaling, time averaging of inputs and A/D conversion coefficients.

2.03 APPLICATION PROGRAMMING DESCRIPTION

A. The application software shall be user programmable.

B. This specification generally requires a programming convention that is logical, easy to learn, use, and diagnose. General approaches to application programming shall be provided by one, or a combination, of the following conventions:

1. **Point Definition**: provide templates customized for point type, to support input of individual point information. Use standard BACnet Objects as applicable.

2. **Graphical Block Programming**: Manipulation of graphic icon ‘blocks’, each of which represents a subroutine, in a functional/logical manner forming a control logic diagram. Blocks shall allow entry of adjustable settings and parameters via pop-up windows. Provide a utility that shall allow the graphic logic diagrams to be directly compiled into application programs. Logic diagrams shall be viewable either off-line, or on-line with real-time block output values.

3. **Functional Application Programming**: Pre-programmed application specific programs that allow/require limited customization via ‘fill-in-the- blanks’ or "question/answer" edit fields. Typical values would be setpoints gains, associated point names, alarm limits, etc.

4. **Line Programming**: Textual syntax-based programming in a language similar to BASIC designed specifically for HVAC control. Subroutines or functions for energy management applications, setpoints, and adjustable parameters shall be customizable, but shall be provided preprogrammed and documented.

C. Provide a means for testing and/or debugging the control programs both off-line and on-line.

2.04 ENERGY MANAGEMENT APPLICATIONS

A. System shall have the ability to perform all of the following energy management routines via preprogrammed function blocks or template programs. As a minimum provide the following whether or not required in the software:

1. Time-of-Day Scheduling

2. Calendar-Based Scheduling

3. Holiday Scheduling

4. Temporary Schedule Overrides

5. Optimal Start/Optimal Stop-based on space temperature offset, outdoor air temperature, and building heating and cooling capacitance factors as a minimum

6. Night Setback and Morning Recovery Control, with ventilation only during occupancy

7. Economizer Control (enthalpy or dry-bulb)

8. Peak Demand Limiting / Load Shedding
9. Dead Band Control
10. Discharge Air Temperature Reset based on return air temperature and room temperature (option for both).
11. Static Pressure Reset based on VAV box position and scheduled (option for both)
12. Occupancy based VAV box operation (alternative).

B. All programs shall be executed automatically without the need for operator intervention, and shall be flexible enough to allow operator customization. Programs shall be applied to building equipment as described in the Section entitled *'Sequence of Operation'*.

2.05 PASSWORD PROTECTION

A. Multiple-level password access protection shall be provided to allow the District's authorized BAS Administrator to limit workstation control, display and database manipulation capabilities as (s)he deems appropriate for each user, based upon an assigned username with a unique password.

B. All passwords for the system shall be provided to the District including administrator, dealer, or factory level passwords for the systems provided under this project.

C. Passwords shall restrict access to all Control Units.

D. Each username shall be assigned to a discrete access level. A minimum of five levels of access shall be supported. Alternately, a comprehensive list of accessibility/functionality items shall be provided, to be enabled or disabled for each user.

E. A minimum of 20 usernames shall be supported and programmed per the District's direction.

F. Operators shall be able to perform only those commands available for the access level assigned to their username.

G. User-definable, automatic log-off timers of from 1 to 60 minutes shall be provided to prevent operators from inadvertently leaving interface device software on-line.

2.06 ALARM AND EVENT MANAGEMENT REPORTING

A. Alarm management shall be provided to monitor, buffer, and direct alarms and messages to operator devices and memory files. Each BC shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non- critical alarms, minimize network traffic, and prevent alarms from being lost. At no time shall a BCs ability to report alarms be affected by either operator activity at an Operator Workstation or local handheld device, or by communications with other panels on the network.

1. **Alarm Descriptor**: Each alarm or point change shall include that point's English language description, and the time and date of occurrence. In addition to the alarm's descriptor and the time and date, the user shall be able to print, display and store an alarm message to more fully describe the alarm condition or direct operator response.
2. **Alarm Prioritization**: The software shall allow users to define the handling and routing of each alarm by their assignment to discrete priority levels. A minimum of ten priority levels shall be provided. For each priority level, users shall have the ability to enable or disable an audible tone whenever an alarm is reported and whenever an alarm returns to normal condition. Users shall have the ability to manually inhibit alarm reporting for each individual alarm and for each priority level. Contractor shall coordinate with the District on establishing alarm priority definitions.
3. **Alarm Report Routing**: Each alarm priority level shall be associated with a unique user-

defined list of operator devices including any combination of local or remote workstations, printers and workstation disk files. All alarms associated with a given priority level shall be routed to all operator devices on the user-defined list associated with that priority level. For each priority level, alarms shall be automatically routed to a default operator device in the event that alarms are unable to be routed to any operator device assigned to the priority level.

4. **Auto-Dial Alarm Routing**: For alarm priority levels that include a remote workstation (accessed by modem) as one of the listed reporting destinations, the BC shall initiate a call to report the alarm, and shall terminate the call after alarm reporting is complete. System shall be capable of multiple retries and buffer alarms until a connection is made. If no connection is made, system shall attempt connection to an alternate dial- up workstation. System shall also be able to dial multiple pagers upon alarm activation.

5. **Alarm Acknowledgment**: For alarm priority levels that are directed to a workstation screen, an indication of alarm receipt shall be displayed immediately regardless of the application in use at the workstation, and shall remain on the screen until acknowledged by a user having a password that allows alarm acknowledgment. Upon acknowledgment, the complete alarm message string (including date, time, and user name of acknowledging operator) shall be stored in a selected file on the workstation hard disk.

B. It shall be possible for any operator to receive a summary of all alarms regardless of acknowledgement status; for which a particular recipient is enrolled for notification; based on current event state; based on the particular BACnet event algorithm (e.g., change of value, change of state, out of range, and so on); alarm priority; and notification class.

C. **BACnet Alarming Services**: Where possible all alarms and events shall be implemented using standard BACnet event detection and notification mechanisms. The workstation shall receive BACnet alarm and event notifications from any gateway or BACnet controller in the system and display them to an operator. Either intrinsic reporting or algorithmic change reporting may be used but the intrinsic reporting method is preferred. The workstation shall also log alarms and events, provide a way for an operator with sufficient privilege to acknowledge alarms, and log acknowledgements of alarms. It shall be possible for an operator to receive, at any time, a summary of all alarms that are currently in effect at any site whether or not they have been acknowledged. Operators shall also be able to view and change alarm limits for any alarm at the appropriate password level.

D. **EBI Alarming Services**: Real-time alarming shall be available to the EBI Network. This shall be either accomplished by (i) having the Local Supervisory LAN utilize LonTalk or BACnet over IP, at which point the EBI Router will pick up and forward the alarms; or (ii) by providing a gateway forming that BACnet over IP LAN to which the EBI Network router can connect. The BACnet Alarm and Event Object shall be supported as specified in Section 23 0904.

E. **Alarm Historical Database**: The database shall store all alarms and events object occurrences in an ODBC or an OLE database-compliant relational database. Provide a commercially available ODBC driver or OLE database data provider, which would allow applications to access the data using standard Microsoft Windows Data Services.

2.07 TRENDING

A. The software shall display historical data in both a tabular and graphical format. The requirements of this trending shall include the following:

1. Provide trends for all physical points, virtual points and calculated variables.

2. LonTalk trends or BACnet Trend Objects are preferred but where not possible trend data shall be stored in relational database format as specified in herein under Data Acquisition and Storage.

3. In the graphical format, the trend shall plot at least 4 different values for a given time period superimposed on the same graph. The 4 values shall be distinguishable by using unique colors. In printed form the 4 lines shall be distinguishable by different line symbology. Displayed trend graphs shall indicate the engineering units for each trended value.
4. The sample rate and data selection shall be selectable by the operator.
5. The trended value range shall be selectable by the operator.
6. Where trended values on one table/graph are COV, software shall automatically fill the trend samples between COV entries.

B. **Control Loop Performance Trends**: Controllers incorporating PID control loops shall also provide high resolution sampling in less than six second increments for verification of control loop performance.

C. **Data Buffering and Archiving**: Trend data shall be buffered at the BC, and uploaded to hard disk storage when archival is desired. All archived trends shall be transmitted to the on-site OWS or CSS as applicable. Uploads shall occur based upon a user-defined interval, manual command, or automatically when the trend buffers become full.

D. **Time Synchronization**: Provide a time master that is installed and configured to synchronize the clocks of all LonTalk or BACnet devices supporting time synchronization. Synchronization shall be done using Coordinated Universal Time (UTC). All trend sample times, both BACnet and LonTalk, shall be able to be synchronized. The frequency of time synchronization message transmission shall be selectable by the operator.

2.08 DYNAMIC PLOTTING

A. Provide a utility to dynamically plot in real-time at least 4 values on a given 2- dimensional dynamic plot/graph with at least two Y-axes. At least 5 dynamic plots shall be allowed simultaneously.

2.09 DATA ACQUISITION AND STORAGE

A. All points included in the typical equipment point list must be represented in a common, open or accessible format. All points should be provided as BACnet standard analog, binary, schedule, or trend objects when possible. Naming conventions for these points and network addressing are discussed in the ‘Point Naming Conventions’ paragraph below.

B. Non-BACnet data from the BAS shall be stored in relational database format. The format and the naming convention used for storing the database files shall remain consistent across the database and across time. The relational structure shall allow for storage of any additional data points, which are added to the BAS in future. The metadata/schema or formal descriptions of the tables, columns, domains, and constraints shall be provided for each database.

C. The database shall allow applications to access the data while the database is running. The database shall not require shutting down in order to provide read-write access to the data. Data shall be able to be read from the database without interrupting the continuous storage of trend data being carried by the BAS.

D. The database shall be ODBC or OLE database compliant. Provide a commercially- available ODBC driver or OLE database data provider, which would allow applications to access the data via Microsoft Windows standard data access services.

2.10 TOTALIZATION

A. The software shall support totalizing analog, digital, and pulsed inputs and be capable of accumulating, storing, and converting these totals to engineering units used in the documents. These values shall generally be accessible to the Operator Interfaces to support management-reporting functions.

B. Totalization of electricity use/demand shall allow application of totals to different rate periods, which shall be user definable.

C. When specified to provide electrical or utility Use/Demand, the Contractor shall obtain from the local utility all information required to obtain meter data, including k factors, conversion constants, and the like.

2.11 EQUIPMENT SCHEDULING

A. Provide a graphic utility for user-friendly operator interface to adjust equipment- operating schedules.

B. All schedules shall be implemented using LonTalk schedules or BACnet objects and messages. All building systems with date and time scheduling requirements shall have schedules represented by the BACnet Schedule object. All operators shall be able to view the entries for a schedule. Operators with sufficient privilege shall be able to modify schedule entries from any BACnet workstation.

C. Scheduling feature shall include multiple seven-day master schedules, plus holiday schedule, each with start time and stop time. Master schedules shall be individually editable for each day and holiday.

D. Scheduling feature shall allow for each individual equipment unit to be assigned to one of the master schedules.

E. Timed override feature shall allow an operator to temporarily change the state of scheduled equipment. An override command shall be selectable to apply to an individual unit, all units assigned to a given master schedule, or to all units in a building. Timed override shall terminate at the end of an operator selectable time, or at the end of the scheduled occupied/unoccupied period, whichever comes first. A password level that does not allow assignment of master schedules shall allow a timed override feature.

F. A yearly calendar feature shall allow assignment of holidays, and automatic reset of system real time clocks for transitions between daylight savings time and standard time.

2.12 POINT STRUCTURING AND NAMING

A. **General**: The intent of this section is to require a consistent means of naming points across the District Enterprise. Contractor shall configure the systems from the perspective of the Enterprise, not solely the local project/building. The following requirement establishes a standard for naming points and addressing Buildings, Networks, Devices, Instances, and the like. The convention is tailored towards the BACnet-based *EBI Network* and as such, the interface shall always use this naming convention. Native BACnet systems shall also use this naming convention. For non- native BACnet systems, the naming convention shall be implemented as much as practical, and any deviations from this naming convention shall be approved by the District.

B. **Point Summary Table**

1. The term ‘Point’ is a generic description for the class of object represented by analog and binary inputs, outputs, and values.

2. With each schematic, Contractor shall provide a Point Summary Table listing:

   a. Building number and abbreviation
   b. System type
   c. Equipment type
   d. Room number
   e. Point suffix
   f. Full point name (see Point Naming Convention paragraph)

g. Point description
h. Ethernet backbone network number,
i. Network number
j. Device ID
k. Device MAC address
l. Object ID (object type, instance number)
m. Engineering units.

3. Additional fields for non-BACnet systems shall be appended to each row. Point Summary Table shall be provided in both hard copy and in electronic format (ODBC-compliant).

4. Point Summary Table shall also illustrate Network Variables/BACnet Data Links.

5. The BAS Contractor shall coordinate with the District's representative and compile and submit a proposed Point Summary Table for review prior to any object programming or project startup.

6. The Point Summary Table shall be kept current throughout the duration of the project by the Contractor as the Master List of all points for the project. Project closeout documents shall include an up-to-date accurate Point Summary Table. The Contractor shall deliver to the District the final Point Summary Table prior to final acceptance of the system. The Point Summary Table shall be used as a reference and guide during the commissioning process.

7. The Point Summary Table shall contain all data fields on a single row per point. The Point Summary Table is to have a single master source for all point information in the building that is easily sorted and kept up-to-date. Although a relational database of Device ID-to-point information would be more efficient, the single line format is required as a single master table that will reflect all point information for the building. The point description shall be an easily understandable English-language description of the point.

Point Summary Table Example Row Headers and Examples
(Transpose for a single point per row format)

Building Name	XYZ_
System Type	Cooling
Equipment Type	Chiller
Point Suffix	CHLR1KW
Point Name (Object Name)	XYZ_COOLING.CHILLER.CHLR1KW
Point Description (Object Description)	Chiller 1 kW
Ethernet Network Number	600
Network Number	610
Device ID	1024006
Device MAC address	24
Object Type	AI
Instance Number	4
Engineering Units	KW
Network Variable?	True
Server Device	1024006
Client Devices	1028006
Included with Functional	

C. Point Naming Convention

1. All point names shall adhere to the format as established below. Said objects shall include all physical I/O points, calculated points used for standard reports, and all application program parameters. For each BAS object, a specific and unique name shall be required.

2. For each point, four (4) distinct descriptors shall be linked to form each unique object name:

Building, System, Equipment, and Point. All keyboard characters except a space are allowable. Each of the four descriptors must be bound by a period to form the entire object name. Reference the paragraphs below for an example of these descriptors.

3. The District shall designate the *Building* descriptor. The *System* descriptor shall further define the object in terms of air handling, cooling, heating, or other system The *Equipment* descriptor shall define the equipment category; e.g., Chiller, Air Handler, or other equipment. The *Point* descriptor shall define the hardware or software type or function associated with the equipment; e.g., supply temperature, water pressure, alarm, mixed air temperature setpoint, etc. and shall contain any numbering conventions for multiples of equipment; e.g., CHLR1KW, CHLR2KW, BLR2AL (Boiler 2 Alarm), HWP1ST (Hot Water Pump 1 Status).

4. A consistent object (point) naming convention shall be utilized to facilitate familiarity and operational ease across the EBI Network. Inter-facility consistency shall be maintained to ensure transparent operability to the greatest degree possible. The table below details the object naming convention and general format of the descriptor string.

BACnet Object Name Requirements

Descriptors		**Comment**
Building Name	XYZ	The Master Building List also has the correct abbreviations for each building.
System	AIRHANDLING EXHAUST HEATING COOLING UTILITY ENDUSE MISC	Boilers and ancillary equipment Chillers and ancillary equipment Main electrical and gas meters Specific building loads by type
Equipment	BOILERS CHILLERS FACILITY TOWERS WEATHER	Non-specific boiler system points Non-specific chiller system points
Point Suffix	See Input/Output point summary table for conventions	

5. **Examples**: Within each object name, the descriptors shall be bound by a period. Within each descriptor, words shall not be separated by dashes, spaces, or other separators as follows:

   a. XYZ_COOLING.CHILLERS.CHWP1ST
   b. XYZ_HEATING.BOILERS.BLR1CFH

D. Device Addressing Convention:

1. Network numbers and Device Object IDs shall be unique throughout the network.

2. All assignment of network numbers and Device Object IDs shall be coordinated with the District.

3. Each Network number shall be unique throughout all facilities and shall be assigned in the following manner unless specified otherwise:

   a. **BBBFF**, where: BBB = 1-655 assigned to each building, FF = 00 for building backbone network, 1-35 indicating floors or separate systems in the building.

      1) Each Device Object Identifier property shall be unique throughout the system and shall be assigned in the following manner unless specified otherwise:

b. **XXFFBBB**, where: XX = number 0 to 40, FF = 00 for building backbone network, 1-35 indicating floors or separate systems in the building. BBB = 1-655 assigned to each building.

1) The BAS Contractor shall coordinate with the District or a designated representative to ensure that no duplicate Device Object IDs occur.
2) Alternative Device ID schemes or cross project Device ID duplication if allowed shall be approved before project commencement by the District.

2.13 OPERATOR INTERFACE GRAPHICS DEVELOPMENT AND SOFTWARE

A. Graphic software shall facilitate user-friendly interface to all aspects of the EBI System Software. The intent of this specification is to require a graphic package that shall facilitate logical and simple system interrogation, modification, configuration, and diagnosis.

B. Graphic software shall support multiple simultaneous windows to be displayed and resizable in a 'Windows'-like environment. All functions excepting text entry functions shall be executable with a mouse, finger or stylus for touch screen capabilities.

C. Graphic software shall provide for multitasking such that third-party programs can be used while the graphics software is on line. Software shall provide the ability to alarm graphically even when operator is in another software package.

D. Operating system software shall be most current version of *Microsoft Windows, used by the District*.

E. District will provide Graphic Standards and Formats to be used for generating graphics for the specific building systems and floor plans.

F. The BAS Contractor shall create detailed and accurate color graphic displays of building plans, floor plans, room environment (i.e., room temp, humidity, CO2, etc.) and mechanical and electrical systems. All web pages shall have the stylesheet applied to them in order to display the graphics accordingly. These graphics shall display all point information from the database including any attributes associated with each point (i.e., engineering units, etc.). In addition, operators shall be able to command equipment or change set points from a graphic through the use of the mouse, finger or stylus.

G. **Display Penetration**: The operator interface shall allow users to access the various system graphic displays via a graphical penetration scheme by using the mouse, finger or stylus to select from menus or 'button' icons. Each graphic display shall be capable of having a unique list of other graphic displays that are directly linked through the selection of a menu item or button icon.

H. **Dynamic Data Displays**: Dynamic physical point values shall automatically updated at a minimum frequency of 6 updates per minute without operator intervention. Point value fields shall be displayed with a color code depicting normal, abnormal, override and alarm conditions.

I. **Point Override Feature**: Each displayed point shall be individually enabled/disabled to allow mouse-driven override of digital points or changing of analog points. Such overrides or changes shall occur in the control unit, not just in the workstation software. The graphic point override feature shall be subject to password level protection. Points that are overridden shall be reported as an alarm, and shall be displayed in a coded color. The alarm message shall include the operator's user name. A list of points that are currently in an override state shall be available through menu selection.

J. **Dynamic Symbols**: Symbols will change in appearance based on the value of an associated point.

1. Analog symbol: A line or linear bar symbol will be used to represent the value of an analog point.

2. Digital symbol: Symbols such as switches, pilot lights, rotating fan wheels, will be used to represent the value of digital input and output points.

3. Point Status Color: Graphic presentations shall indicate different colors for different point statuses. (For instance, green = normal, red = alarm, gray (or '???') for non-response.

K. **Graphics Development**: Graphic generation software shall be provided to allow the user to add, modify, or delete system graphic displays.

1. The Contractor shall develop and deliver building specific graphics compatible with the Honeywell EBI system. Control points shall be mapped to the corresponding system specific graphics. Graphics are to be provided depicting air handling unit components (e.g. fans, cooling coils, filters, dampers, etc.), mechanical system components (e.g., pumps, chillers, cooling towers, boilers, etc.), complete mechanical systems (e.g. constant volume-terminal reheat, VAV, etc.) and electrical symbols.

2. The graphics package shall use a mouse, finger, stylus or similar pointing device to allow the user to perform the following:

a. Define symbols
b. Position items on graphic displays
c. Attach physical or virtual points to a graphic
d. Define background displays
e. Define connecting lines and curves
f. Locate, orient and size descriptive text
g. Define and display colors for all elements
h. Establish correlation between symbols or text and associated system points or other displays.
i. Create hot spots or hyperlinks to other graphic displays or other functions in the software.

2.14 REMOTE PERSONAL COMPUTER WORKSTATION GRAPHIC SOFTREMOTE PERSONAL COMPUTER WORKSTATION GRAPHIC SOFTWARE

A. Remote graphic operator software shall provide all the functionality specified for the local graphic software. It shall also provide for dial-up communications using the specified modems via commercial telephone lines to connect to the Local Supervisory or Primary LAN and using the Internet.

B. Software shall not require graphic images to be sent across the phone lines or 56Kbps or slower Internet connection. Graphic images shall reside on the remote operator workstation hard drive and all licenses must be provided for the graphic software on the remote machine. . Exceptions to this requirement include:

1. System configuration uses an Internet server and presents web pages that can be pulled up using a standard browser.

2. System configuration uses an Internet server and presents the standalone application running locally but controlled via a remote browser. Operator Interface Graphical Software application must therefore support multi- instancing to allow multiple simultaneous remote connections and use of the graphic software.

C. Software shall be capable of initiating communication to the any LAN, upon user command, to perform all specified functions. Software shall be capable of initiating communication to the LANs in accordance with user-programmed time schedules to upload trend and report data. Software shall be capable of communicating from the LAN in accordance with user-programmed time schedules to report alarms, upload trend, and report data. Software shall automatically terminate the communication whenever all applications requiring modem connection are closed.

PART 3 - EXECUTION

3.01 SYSTEM CONFIGURATION

A. Thoroughly and completely configure BAS system software, supplemental software, network communications, OWS/POT, and remote communications.

3.02 SITE-SPECIFIC APPLICATION PROGRAMMING

A. Provide all database creation and site-specific application control programming as required by these Specifications, national and local standards and for a fully functioning system. Contractor shall provide all initial site-specific application programming and thoroughly document programming in meeting the intent of the written sequences of operation. It is the Contractor's responsibility to request clarification on sequence issues that require such clarification.

B. All site-specific programming shall be fully documented and submitted for review and approval, both prior to downloading into the panel, at the completion of functional performance testing, and at the end of the warranty period.

C. All programming, graphics and data files must be maintained in a logical system of directories with self-explanatory file names. All files developed for the project will be the property of the District and shall remain on the workstation(s)/server(s) at the completion of the project.

3.03 PASSWORD SETUP

A. Set up the following password levels to include the specified capabilities:

1. Level 1: (Distrcit's BAS Administrator)
    a. Level 2 capabilities
    b. View, add, change and delete usernames, passwords, password levels
    c. All unrestricted system capabilities including all network management functions.
2. Level 2: (Programmer)
    a. Level 3 capabilities
    b. Configure system software
    c. Modify control unit programs
    d. Modify graphic software
    e. Essentially unrestricted except for viewing or modifying user names, passwords, password levels
3. Level 3: (Senior HVAC Technician)
    a. Level 4 capabilities
    b. Override output points
    c. Change setpoints
    d. Change equipment schedules
    e. Exit BAS software to use third party programs
4. Level 4: (Junior HVAC Technician)
    a. Level 5 capabilities
    b. Acknowledge alarms
    c. Temporarily override equipment schedules
5. Level 5: (HVAC Technician Trainee)
    a. Display all graphic data
    b. Trend point data

B. Contractor shall assist the Distrcit's operators with assigning user names, passwords and password levels.

3.04 POINT PARAMETERS

A. Provide the following minimum programming for each analog input:

1. Name
2. Address
3. Scanning frequency or COV threshold
4. Engineering units
5. Offset calibration and scaling factor for engineering units
6. High and low alarm values and alarm differentials for return to normal condition
7. High and low value reporting limits (reasonableness values), which shall prevent control logic from using shorted or open circuit values.
8. Default value to be used when the actual measured value is not reporting. This is required only for points that are transferred across the primary and/or secondary controlling networks and used in control programs residing in control units other than the one in which the point resides. Events causing the default value to be used shall include failure of the control unit in which the point resides, or failure of any network over which the point value is transferred.
9. Selectable averaging function that shall average the measured value over a user selected number of scans for reporting.

B. Provide the following minimum programming for each analog output:

1. Name
2. Address
3. Output updating frequency
4. Engineering units
5. Offset calibration and scaling factor for engineering units
6. Output Range
7. Default value to be used when the normal controlling value is not reporting.

C. Provide the following minimum programming for each digital input:

1. Name
2. Address
3. Engineering units (on/off, open/closed, freeze/normal, etc.)
4. Debounce time delay
5. Message and alarm reporting as specified
6. Reporting of each change of state, and memory storage of the time of the last change of state
7. Totalization of on-time (for all motorized equipment status points), and accumulated number of off-to-on transitions.

D. Provide the following minimum programming for each digital output:

1. Name
2. Address

3. Output updating frequency
4. Engineering units (on/off, open/closed, freeze/normal, etc.)
5. Direct or Reverse action selection
6. Minimum on-time
7. Minimum off-time
8. Status association with a DI and failure alarming (as applicable)
9. Reporting of each change of state, and memory storage of the time of the last change of state.
10. Totalization of on-time (for all motorized equipment status points), and accumulated number of off-to-on transitions.
11. Default value to be used when the normal controlling value is not reporting.

3.05 TRENDS

A. Contractor shall establish and store trend logs. Trend logs shall be prepared for each physical input and output point, and all dynamic virtual points such as setpoints subject to a reset schedule, intermediate setpoint values for cascaded control loops, and the like as directed by the District.

B. The District will analyze trend logs of the system operating parameters to evaluate normal system functionality. Contractor shall establish these trends and ensure they are being stored properly.

1. Data shall include a single row of field headings and the data thereafter shall be contiguous. Each record shall include a date and time field or single date stamp. Recorded parameters for a given piece of equipment or component shall be trended at the same intervals and be presented in a maximum of two separate 2-dimensional formats with time being the row heading and field name being the column heading.

C. Sample times indicated as COV (□) or change-of-value mean that the changed parameter only needs to be recorded after the value changes by the amount listed. When output to the trending file, the latest recorded value shall be listed with any given time increment record. The samples shall be filled with the latest values also if the points include different time intervals. If the BAS does not have the capability to record based on COV, the parameter shall be recorded based on the interval common to the unit.

D. Trending intervals or COV thresholds shall be dictated by the District upon system start-up.

E. The Contractor shall demonstrate functional trends as specified for a period of 30 days after successful system demonstration before final acceptance of the system.

3.06 TREND GRAPHS

A. Prepare controller and workstation software to display graphical format trends. Trended values and intervals shall be the same as those specified

B. Lines shall be labeled and shall be distinguishable from each other by using either different line types, or different line colors.

C. Indicate engineering units of the y-axis values; e.g. degrees F., inches w.g., Btu/lb, percent open, etc.

D. The y-axis scale shall be chosen so that all trended values are in a readable range. Do not mix trended values on one graph if their unit ranges are incompatible.

E. Trend outside air temperature, humidity, and enthalpy during each period in which any other

points are trended.

F. All points trended for one HVAC subsystem (e.g. air handling unit, chilled water system, etc.) shall be trended during the same trend period.

G. Each graph shall be clearly labeled with HVAC subsystem title, date, and times.

3.07 ALARMS

A. **Override Alarms**: Any point that is overridden through the override feature of the graphic workstation software shall be reported as a Level 3 alarm.

B. **Analog Input Alarms**: For each analog input, program an alarm message for reporting whenever the analog value is outside of the programmed alarm limits and the system is scheduled to be operating. Report a 'Return-to-Normal' message after the analog value returns to the normal range, using a programmed alarm differential. The alarm limits shall be individually selected by the Contractor based on the following criteria:

1. Space temperature, except as otherwise stated in sequence of operation:

   a. Level 3
   b. Low alarm: 64□F
   c. Low return-to-normal: 68□F
   d. High alarm: 80□F
   e. High return-to-normal: 75□F

2. Controlled media temperature other than space temperature (e.g. AHU discharge air temperature, steam converter leaving water temperature, condenser water supply, chilled water supply, etc.): Level 3 (If controlled media temperature setpoint is reset, alarm setpoints shall be programmed to follow setpoint)

   a. Low alarm: 4□F below setpoint
   b. Low return-to-normal: 2□F below setpoint
   c. High alarm: 4□F above setpoint
   d. High return-to-normal: 2□F above setpoint.

3. AHU mixed air temperature: Level 4

   a. Low alarm: 45□F
   b. Low return-to-normal: 46□F
   c. High alarm: 90□F
   d. High return-to-normal: 89□F

4. Duct Pressure:

   a. Low alarm: 0.25"w.g. below setpoint
   b. Low return-to-normal: 0.15"w.g. below setpoint
   c. High alarm: 0.25"w.g. above setpoint
   d. High return-to-normal: 0.15"w.g. above setpoint

5. Space humidity (critical spaces only):

   a. Low alarm: 35%
   b. Low return-to-normal: 40%
   c. High alarm: 75%
   d. High return-to-normal: 70%

C. **HOA Switch Tampering Alarms**: The Sequences of Operation are based on the presumption that motor starter Hand-Off-Auto (HOA) switches are in the 'Auto' position. BAS shall also enunciate the following Level 5 alarm message if status indicates a unit is operational when the run command is not present:

1. *DEVICE XXXX* FAILURE: Status is indicated on *{the device}* even though it has been commanded to stop. Check the HOA switch, control relay, status sensing device, contactors, and other components involved in starting the unit. Acknowledge this alarm when the problem has been corrected.

D. **Maintenance Alarms**: Enunciate Level 5 alarms when runtime accumulation exceeds a value specified by the operator

1. *DEVICE XXXX REQUIRES MAINTENANCE*. Runtime has exceeded specified value since last reset.

3.08 GRAPHIC SCREENS

A. **Floor Plan Displays**: The contract document drawings will be made available to the Contractor in AutoCAD latest release format upon request. These drawings may be used only for developing backgrounds for specified graphic displays; however the District does not guarantee the suitability of these drawings for the Contractor's purpose.

1. Provide graphic floor plan displays for each room of each of the building. Indicate the location of all equipment that is not located on the equipment room displays. Indicate the location of sensors (i.e., temperature, humidity, etc.) associated with each temperature-controlled zone (i.e., VAV terminals, fan-coils, single-zone AHUs, etc.) on the floor plan displays. Zone background color shall change based on the temperature offset from set point. Display the space temperature point adjacent to each temperature sensor symbol. Use a distinct line symbol to demarcate each terminal unit zone boundary. Use distinct colors to demarcate each air handling unit zone. Mechanical floor plan drawings will be made available to the contractor upon request for the purpose of determining zone boundaries. Indicate room numbers as provided by the District. Provide a drawing link from each space temperature sensor symbol and equipment symbol shown on the graphic floor plan displays to each corresponding equipment schematic graphic display.

2. Provide graphic floor plan displays for each mechanical equipment room and a plan display of the roof. Indicate the location of each item of mechanical equipment. Provide a drawing link from each equipment symbol shown on the graphic plan view display to each corresponding mechanical system schematic graphic display.

3. If multiple floor plans are necessary to show all areas, provide a graphic building key plan. Use elevation views and/or plan views as necessary to graphically indicate the location of all of the larger scale floor plans. Link graphic building key plan to larger scale partial floor plans. Provide links from each larger scale graphic floor plan display to the building key plan and to each of the other graphic floor plan displays.

4. Provide a graphic site plan with links to and from each building plan.

B. **System Schematic Displays**: Provide graphic system schematic display for each HVAC subsystem controlled with each I/O point in the project appearing on at least one graphic display. System graphics shall include flow diagrams with status, set points, current analog input and output values, operator commands, etc. as applicable. General layout of the system shall be schematically correct. Input/output devices shall be shown in their schematically correct locations. Include appropriate engineering units for each displayed point value. Verbose names (English language descriptors) shall be included for each point on all graphics; this may be accomplished by the use of a pop-up window accessed by selecting the displayed point with the mouse, finger or stylus. Indicate all adjustable set points on the applicable system schematic graphic display or, if space does not allow, on a supplemental linked-set point display.

1. Provide graphic displays for each air handling system. Indicate outside air temperature and enthalpy, and mode of operation as applicable (i.e., occupied, unoccupied, warm-up, cool-down). Link displays for air handlers to the heating system and cooling system graphics.

Link displays for supply and exhaust systems if they are not combined onto one display.

2. Provide a graphic display for each zone. Provide links to graphic system schematic displays of air handling units that serve the corresponding zone.

3. Provide a cooling system graphic display showing all points associated with the chillers, cooling towers and pumps. Indicate outside air dry-bulb temperature and calculated wet-bulb temperature. Link displays for chilled water and condenser water systems if they cannot fit onto one cooling plant graphic display.

4. Link displays for heating and cooling system graphics to utility history reports showing current and monthly electric uses, demands, peak values, and other pertinent values.

C. **Bar Chart Displays**: On each graphic Bar Chart Display, provide drawing links to the graphic air handling unit schematic displays.

1. Provide a graphic chilled water valve display showing the analog output signal of all chilled water valves in a bar chart format, with signals expressed as percentage of fully open valve (percentage of full cooling). Indicate the discharge air temperature and set point of each air handling unit, cooling system chilled water supply and return temperatures and the outside air temperature and humidity on this graphic. Provide drawing links between the graphic cooling plant display and this graphic display.

2. Provide a graphic heating water valve display showing the analog output signal of all air handling unit heating water valves in a bar chart format, with signals expressed as percentage of fully open valve (percentage of full heating). Indicate the temperature of the controlled medium (such as AHU discharge air temperature or zone hot water supply temperature) and the associated set point and the outside air temperature and humidity.

D. **Alarms**: Each programmed alarm shall appear on at least one graphic display. In general, alarms shall be displayed on the graphic system schematic display for the system that the alarm is associated with (for example, chiller alarm shall be shown on graphic cooling system schematic display). For all graphics, display analog values that are in a ‘high alarm’ condition in a red color, ‘low alarm’ condition in a blue color. Indicate digital values that are in alarm condition in a red color.

E. **Graphic Standards**: District will provide templates, stylesheet and description of standard graphics used for representation of the building systems and floor plans.

END OF SECTION

SECTION 23 09 93
SEQUENCE OF OPERATION

PART 1 - GENERAL

1.01 GENERAL:

A. The BAS shall monitor the following items of equipment:

1. Standby Generator through the local control panel contacts for activation of generator.

1.02 SYSTEM STARTUP:

A. After a power outage the equipment shall be reenergized based on a predetermined schedule.

B. Sufficient time delay shall be allowed between each phase of the start-up to prevent overload of the electrical system.

1.03 BUILDING HEATING HOT WATER SYSTEM:

A. CV-HHW shall modulate towards open on command from the BAS based upon a pre-programmed schedule.

B. The building heating hot water pumps HHWP-1 and HHWP-2 shall be energized by the BAS based on a pre-programmed schedule. Each pump is furnished with a variable speed drive. Pump status shall be monitored through differential pressure switch across the pump and the differential pressure switch across the existing building. If no flow is detected, pump HHWP-1 shall be de-energized and an alarm raised at the BAS workstation and pump HHWP-2 shall be energized. Pumps shall be lead lagged through the BAS to ensure equal run time.

C. Variable speed drives shall be provided with a Bacnet or Lon “chip” for direct connection to the BAS for monitoring and commanding variable speed drive points from the BAS workstation.

D. When the lead pump is started by the BAS and does not start, the BAS will de-energize the pump, and energize the lag pump.

E. Building heating hot water supply and return water temperature shall be monitored by the BAS.

F. Building heating hot water return water flow rate shall be monitored by the BAS.

G. The lead pump shall run continuously to maintain heating hot water differential setpoint. The lag pump shall be energized for pump efficiency or when the lag pump is needed to maintain the water differential setpoint. The pumps shall continue to run until heating hot water differential pressure setpoint can be maintained by a single pump. The BAS shall schedule the pumps on and off to maintain the most efficient system operating point.

1.04 BUILDING CHILLED WATER SYSTEM:

A. CV-CHW shall modulate towards open on command from the BAS based upon a pre-programmed schedule.

B. Building chilled water supply and return water temperature shall be monitored by the BAS.

C. Building chilled return water flow rate shall be monitored by the BAS.

D. Building chilled hot water supply and return water temperature shall be monitored by the BAS. Building chilled water flow status shall be monitored through differential pressure switch located across the building. If no flow is detected, an alarm raised at the BAS workstation.

1.05 VARIABLE VOLUME AIR HANDLING UNITS:

A. Each air handling unit shall consist of supply fan, return fan, pre and final filters, heating coil, cooling coil and economizer mixing box.

B. Each unit shall be energized through the energy management control system (BAS) in the automatic mode based on a predetermined schedule. Provide capability for a time based override of the schedule, the time shall be variable between 1 and 4 hours. In the hand position the fan shall run bypassing all external interlocks. In the off position the fans shall not run. In the auto position the fans shall run provided all safety provisions are satisfied. Fan status shall be monitored through current sensing relays in the fan starter bucket. A high pressure safety cutout located in the air handling unit shall deactivate to unit upon a static pressure of 6.5" w.c. being detected in the cabinet.

C. The discharge air temperature signal shall position the cooling valve to maintain discharge air temperature setpoint. This shall be reset upwards when all zone thermostats are calling for heat and downwards when all zone thermostats are calling for cooling and all VAV boxes are 100% open.

D. When outside air enthalpy is less than return air enthalpy, the economizer dampers shall be positioned for maximum "free cooling" using outside air to maintain mixed air temperature set point. Once the outside air enthalpy is greater than the return air enthalpy the modulating economizer outside air damper shall fully close to provide minimum outside air only. The outside air shall not drop below the minimum level as detected by the OSA flow sensor. The minimum OSA damper shall modulate to maintain the minimum OSA flow setpoint as detected by OSA flow sensor.

E. A supply duct static pressure sensor shall control the supply air fan variable speed drive to maintain supply duct static air pressure at its setpoint. The return fan shall track the supply fan through air flow measurement in the supply and return fans. Variable speed drive shall be provided with a BAS “chip” for direct connection to the BAS for monitoring and commanding the variable speed drive points from the BAS workstation.

F. Smoke detectors located in the supply air duct shall indicate an alarm at the BAS workstation when an alarm condition is detected for secondary monitoring. The wiring and conduit for secondary monitoring, from the duct smoke detector’s auxiliary contact to the BAS shall be provided by the division 16 contractor. The wiring and conduit from the duct detector for fan shut down shall be provided by the division 16 contractor.

G. The return air carbon dioxide level will be monitored. If the return air carbon dioxide level reaches 1000 ppm (adjustable) and is greater than the outside air carbon dioxide level, the economizer will be overridden to bring in 100% outside air. Once the level drops to 800 ppm, the normal controls will operate.

H. A differential pressure sensor monitoring pressure drop across the filter bank shall indicate an alarm at the BAS workstation if pressure settings are exceeded.

I. Actuation for the chilled water control valve and outside air dampers shall be normally closed. Actuation for heating water control valve shall be normally open.

J. Refer to Paragraph 3.06 for details of variable air volume box control.

1.06 VAV TEMPERATURE CONTROL:

A. Room temperature sensor shall modulate the VAV box actuator to maintain room temperature setpoint. On a further call for heating, the room temperature sensor shall modulate the hot water reheat valve to maintain room temperature setpoint.

1.07 CONSTANT VOLUME AIR HANDLING UNITS:

A. Each air handling unit shall consist of supply fan, return fan or associated remote relief fan, pre and final filters, cooling coil, heating coil and economizer mixing box.

B. Each unit shall be energized through the energy management control system(BAS) in the automatic mode based on a predetermined schedule. Provide capability for a time based override of the schedule, the time shall be variable between 1 and 4 hours. In the hand position the fan shall run bypassing all external interlocks. In the off position the fans shall not run. In the auto position the fans shall run provided all safety provisions are satisfied. Fan status shall be monitored through current sensing relays in the fan starter bucket.

C. The discharge air temperature signal shall position the cooling valve to maintain discharge air temperature setpoint. The discharge air temperature shall be reset upwards based on the outside air temperature. The discharge air temperature shall also be reset upwards upon all zone thermostats are calling for heat and downwards when all zone thermostats are calling for cooling.

D. When outside air enthalpy is less than return air enthalpy, the economizer dampers shall be positioned for maximum "free cooling" using outside air to maintain mixed air temperature set point. Once the outside air enthalpy is greater than the return air enthalpy the modulating economizer outside air damper shall fully close to provide minimum outside air only. The outside air shall not drop below the minimum level as detected by the OSA flow sensor. The minimum OSA damper shall modulate to maintain the minimum OSA flow as detected by the OSA flow sensor.

E. In the event more than 10% of the zone sensors within a floor zone sensor group call for heating, the reheat coil hot water control valve shall modulate towards open. The reheat coil valve shall modulate to maintain a leaving coil temperature of 70°F (adjustable).

F. In the event that all zones are calling for heating, the air handling unit heating coil shall reset and modulate to maintain a leaving air temperature of 65°F. The floor zone reheat coils shall reset to and modulate the reheat coil valves to maintain a leaving coil temperature of 80°F (adjustable).

G. Smoke detectors located in the supply air duct shall indicate an alarm at the BAS workstation when an alarm condition is detected for secondary monitoring. The wiring and conduit for secondary monitoring, from the duct smoke detector's auxiliary contact to the BAS shall be provided by the Division 15 contractor. The wiring and conduit from the duct detector for fan shut down shall be provided by the Division 16 contractor.

H. The return air carbon dioxide level will be monitored. If the return air carbon dioxide level reaches 1000 ppm (adjustable) and is greater than the outside air carbon dioxide level, the economizer will be overridden to bring in 100% outside air. Once the level drops to 800 ppm, the normal controls will operate.

I. A differential pressure sensor monitoring pressure drop across the filter section shall indicate an alarm at the BAS workstation if pressure settings are exceeded.

J. Actuation for the chilled water control valve and outside air dampers shall be normally closed.

1.08 BYPASS VAV TEMPERATURE CONTROL:

A. Room temperature sensor shall modulate the VAV box actuator to maintain room temperature set-point. On a further call for heating, the room temperature sensor shall modulate the hot water reheat valve to maintain room temperature set-point.

1.09 UNDERFLOOR AIR DISTRIBUTION CONSTANT VOLUME AIR HANDLING UNITS SINGLE ZONE:

A. Each air handling unit shall consist of supply fan, return fan or associated remote relief fan, pre and final filters, runaround coil (one heat reclaim coil, one reheat coil), cooling coil, heating coil and economizer mixing box.

B. Each unit shall be energized through the Energy Management Control System (BAS) in the

automatic mode based on a predetermined schedule. Provide capability for a time based override of the schedule, the time shall be variable between 1 and 4 hours. In the hand position the fan shall run bypassing all external interlocks. In the off position the fans shall not run. In the auto position the fans shall run provided all safety provisions are satisfied. Fan status shall be monitored through current sensing relays in the fan starter bucket.

C. The cooling coil discharge air temperature signal shall position the chilled water valve to maintain a discharge air temperature setpoint. The unit discharge air temperature signal shall modulate the speed of the runaround coil pump to maintain a discharge air temperature setpoint. The unit discharge temperature shall be reset upwards upon all zone temperature sensors calling for heat and downwards when all zone temperature sensors are calling for cooling.

D. Each zone sensor shall modulate the flow to each zone to satisfy the required room temperature set-point. Return air dampers shall be two position and open and close in response to the open position of the supply air dampers.

E. When outside air enthalpy is less than return air enthalpy, the economizer dampers shall be positioned for maximum "free cooling" using outside air to maintain mixed air temperature set point. Once the outside air enthalpy is greater than the return air enthalpy the modulating economizer outside air damper shall fully close to provide minimum outside air only. The outside air shall not drop below the minimum level as detected by the OSA flow sensor. The minimum OSA damper shall modulate to maintain the minimum OSA flow as detected by the OSA flow sensor.

F. Smoke detectors located in the supply air duct shall indicate an alarm at the BAS workstation when an alarm condition is detected for secondary monitoring. The wiring and conduit for secondary monitoring, from the duct smoke detector's auxiliary contact to the BAS shall be provided by the Division 15 contractor. The wiring and conduit from the duct detector for fan shut down shall be provided by the Division 16 contractor.

G. The return air carbon dioxide level will be monitored for each zone. If the return air carbon dioxide level reaches 1000 ppm (adjustable) as measured in any of the spaces and is greater than the outside air carbon dioxide level, the economizer will be overridden to bring in 100% outside air. Once the level drops to 800 ppm, the normal controls will operate.

H. A differential pressure sensor monitoring pressure drop across each filter shall indicate an alarm at the BAS workstation if pressure settings are exceeded.

I. Actuation for the chilled water control valve and outside air dampers shall be normally closed.

1.10 RADIANT FLOOR CONTROL:

A. The pumps designated for the radiant floor systems are started on a command from the BAS. The heating and cooling two way valves regulate the surface temperature of the floor to provide either heating, 80°F (adjustable) or cooling, 69°F (adjustable). In heating mode the floor surface temperature is regulated to maintain space set point temperatures. If during non-occupied periods the space temperature drops below the minimum space temperature than the radiant floor is activated in heating mode for a period until the required space temperature is met. This operation is directed from the BAS.

B. In cooling mode the surface temperature of the floor is maintained at 69°F constantly. The humidity level in each space is measured by a dew point sensor located in the space, if the space humidity ratio in lb/lb approaches the dew-point of the radiant surface then the cooling valve is closed. The valve is commanded to open when the humidity ratio of the space air is higher than the cooling surface dew point temperature. This operation is directed from the BAS.

1.11 RADIANT CHILLED WATER LOOP CONTROL:

A. The pumps of the radiant ceiling systems are started on a command from the BAS. Control valve CV-CHW modulates to maintain a constant supply temperature of 58°F (adjustable) to the zone radiant panels as measured by the temperature sensor downstream.

1.12 RADIANT HOT WATER LOOP CONTROL:

A. The pumps of the radiant ceiling systems are started on a command from the BAS. Control valve CV-HHW modulates to maintain a constant supply temperature of 100°F (adjustable) to the zone radiant panels as measured by the temperature sensor downstream.

1.13 RADIANT PANEL ZONE CONTROL:

A. The zone two way valves regulate the space temperature to provide heating and cooling as required.

B. In heating mode the output from the radiant ceiling panels is regulated to maintain space set point temperatures. If during non-occupied periods the space temperature drops below the minimum space temperature than the radiant ceiling is activated in heating mode for a period until the required space temperature is met. This operation is directed from the BAS.

C. An application specific controller is used to maintain space temperature in each zone by individually controlling each radiant chilled water and radiant hot water valve in sequence, without overlap, to maintain space temperature.

1. The controller shall have outputs to the radiant chilled water and radiant hot water isolation valve. Sensing of condensation on the radiant panel shall cause the controller to close the radiant chilled water isolation valve.

1.14 COMPUTER ROOM AIR CONDITIONING UNITS (CRAC):

A. CRAC units shall be provided with independent standalone controllers to maintain space temperature and relative humidity set points.

B. The standalone controller shall modulate the chilled water valve, the humidifier to maintain the space conditions at 72°F/ 50% RH (adjustable).

C. The BAS shall monitor the status, common trouble, space temperature and space relative humidity.

D. The BAS shall be capable of resetting the space temperature, relative humidity and on/off status from the central BAS control station.

E. Upon detection of common trouble, an alarm shall sound at the BAS control station.

1.15 PROJECTOR ROOM EXHAUST SYSTEMS:

A. The exhaust fans shall be energized through the BAS as required during the occupied periods of the respective screening room or multimedia classroom.

1.16 PROJECTOR ROOM EXHAUST SYSTEMS:

A. The exhaust fans shall be energized through a wall mounted switch located in the projector room.

B. The By-pass VAV serving the respective multimedia classroom, shall modulate towards open to provide a minimum of 700 CFM to the space to prevent under pressurization.

1.17 EXHAUST FANS WITH SCHEDULE CONTROL:

A. The exhaust fans shall be energized through the BAS on a scheduled basis. The fan status shall be monitored through current sensing relay mounted in the fan starter bucket.

1.18 FANS WITH MANUAL CONTROL:

A. Manually Controlled fans shall be energized through the BAS on a scheduled basis. A local manual override switch will be provided to override the BAS command. The fan status shall be monitored through current sensing relay mounted in the fan starter bucket.

1.19 PLUMBING EQUIPMENT:

A. The BAS shall monitor the following plumbing equipment:

1. Fluid levels in the sewage ejector pits and the sump pits through the local control panel contacts for trouble alarm.

2. Hot Water Heat Exchanger Flow rates and temperatures through the local control panel contacts.

1.20 FAN COIL UNITS:

A. Various spaces are cooled using small fan coil units. These rooms are typically electrical rooms, mechanical rooms, tele/data rooms, and equipment closets. The majority of these units will be on emergency power. See the equipment schedule on the mechanical drawings to identify which systems require emergency power.

B. Unit On/Off:

1. The fan coils shall run 24 hr/day, as required, to maintain space temperature and shall be controlled by the building automation system (BAS).

C. Temperature Control – Normal Operation:

1. A temperature sensor shall report zone temperature back to the BAS. The BAS shall control the chilled water control valve. When the zone temperature rises above the set point, the CHW control valve shall modulate open. When the zone temperature is below the set point, the CHW control valve will close.

2. In some cases, a fan coil unit will be a 4-pipe type with a heating coil. When space temperature is below the thermostat setpoint, the hot water supply valve modulates open and hot water flows through the heating coil. As space temperature increases, the hot water valve modulates closed.

3. As space temperature rises above setpoint, the thermostat signal starts to open the chilled water valve. The room thermostat throttling range and valve actuator movement should be selected to provide a “dead band” between heating and cooling so that both valves are closed when space temperature is satisfied.

END OF SECTION

SECTION 23 21 13
HYDRONIC PIPING

PART 1 - GENERAL

1.01 REQUIREMENTS

A. Design considerations specific to components in this section:

1. Required:

a. Piping systems, both new and existing, shall be designed to not exceed the following pressure drop and velocity criteria at specified locations:

Piping Location	Pressure Drop`	Velocity
Building laterals from site utility source	2 feet / 100 feet	8 FPS
Building risers and floor / level main headers	3 feet / 100 feet	8 FPS
Equipment branches / circuits or sub-headers	4 feet / 100 feet	8 FPS

b. Minimum pipe sizing shall be as follows:

Description	Minimum Pipe Size
Individual branch circuit piping	Greater of ¾" or equipment size connection
Common branch serving multiple connections	1"

c. Provide trapping, venting of air and drainage of system. Location of all such devices shall be shown in the plans.

d. Provide single line pipe and instrumentation diagrams (PI&D) of the entire length back to source for all affected systems to reflect new installation or connections to existing piping systems, in order to identify major system components (coils, heat exchangers, chillers, pumps, expansion tanks, etc.) to be affected/added/deleted and changes to piping distribution that serve them.

e. It is required that all valve sets include independent valves, strainers and devices separated by flanges or unions so that any device can be removed and replaced for maintenance.

f. Coordinate with the work for main chilled water entry to the building. Structural engineer shall be responsible to provide appropriate anchorage and expansion to be consistent with but taking into account what residual forces and expansion may be occurring in the outdoor buried installation. Link-Seal at the entry point shall account for the outdoor buried pre-fabricated pipe remaining insulated and passing into the building. Link-Seal shall be provided under this Section and its specification shall be appropriate to the temperature of the carrier pipe.

g. Branch piping connections should be made at top of piping mains to avoid sediment buildup within vertical branch piping connections.

h. Provide structural calculations and details for supports that are utilized for suspended piping that is ≥6" nominal diameter.

i. Mechanical grooved systems are not allowed, except at the piping connections of chillers to allow piping to swing out of the way during maintenance and tube removal operations.

j. Pre-manufactured / Pre-packaged valve sets with combination valves or configurations that cannot be field-dismantled are not allowed. This clause does not preclude pre-fabricated valve sets built up out of individual components separated with flanges or

unions.

PART 2 - PRODUCT

A. Above ground HVAC piping:

1. Manufacturers:

a. Steel piping products to be manufactured domestically (Made in USA).

2. Component Characteristics:

a. Required:

1) Provide the following materials for piping and fittings:

Service	Size	Material	Joining Method
Chilled Water	≤2”	ASTM B88 Rigid Copper (Type L)	Brazed
	>2”	ASTM A53 Type E Schedule 40 Black Steel	Welded
Heating Hot Water	≤2”	ASTM B88 Rigid Copper (Type L)	Brazed
	>2”	ASTM A53 Type E Schedule 40 Black Steel	Welded
Cooling Coil Condensate	All	ASTM B88 Rigid Copper (Type M)	Soldered
Condenser Water	All	ASTM A53 Type E Schedule 40 Black Steel	Welded
Cooling Tower Chemical Feed Lines	All	PVC Schedule 80	Fused
Boiler Chemical Feed Lines	All	Schedule 10 Stainless Steel	Welded

2) Carbon steel piping shall comply with ASTM/ANSI standards.

PART 3 - INSTALLATION

A. Required:

1. Provide the following piping grade or slope for complete drainage and venting:

Piping Type	Slope	Direction of Fall
Hot water heating (supply and return)	1” per 40’-0”	Provide slope arrows on plan and provide drain valve at low points of system
Chilled Water and Condenser Water	1” per 40’-0”	Down in direction of flow
Cold condensate	1” per 40’-0”	Down in direction of flow

2. Install piping systems parallel to building walls.

3. Do not utilize pitch pockets at roof mounted, fixed, piping supports.

4. Provide a minimum of 8” to the underside of rooftop mounted piping, when utilizing fixed pipe supports, to allow future re-roof work.

5. Maintain piping within or distributed through building equipment rooms exposed and not concealed within or imbedded into Architectural/Structural systems (wall, floors, etc.)
6. Provide right angle (90°) fittings for changes of direction in the horizontal plane.
7. Provide industry standard pre-manufactured fittings for all piping distribution system changes in direction, changes in size, branch connections, or at final equipment connections.
8. Provide expansion devices as per Section 23 05 16.
9. Provide shut off devices as noted in section 23 05 23 and control valves as noted in the independent controls guidelines.
10. Refer to Section 23 21 16 for hydronic specialties related to air vents and drain valves.
11. Install above grade piping to be serviceable at points of isolation through and accessible ceiling system or other appropriate means.
12. Provide unions or flanges adjacent to valves, control instrumentation, regulators and at final equipment connections for removal of all appurtenances that may require maintenance or replacement.
13. Dielectric Isolation Assembly:

Pipe Size	**Application (Steel to Copper Transition)**	**Components**
2-1/2" and larger	Piping run (no disassembly requirement)	Review application with Engineer
	Piping run with valve and/or equipment connection (disassembly requirement)	Pipe flanges with dielectric gaskets.
2" and smaller	Piping run (no disassembly requirement)	Steel Pipe -> Brass Coupling / Steel Pipe Fitting -> 12" Brass Nipple -> Brass Coupling -> Copper Pipe
	Piping run with valve and/or equipment connection (disassembly requirement)	Steel Pipe -> Brass Coupling / Steel Pipe Fitting -> 12" Brass Nipple -> Valve -> Brass Union -> Copper Pipe
Note: 12" brass nipple (single piece) between dissimilar metal pipes serve as means of separation between dissimilar metals mitigate dielectric deterioration. Avoid piping and conduit systems for differ- ent services coming into physical contact with one another.		

14. Piping shall be pressure tested prior to application of insulation to any piece of the piping system.
15. Coordinate with controls contractor and install all controls instrumentation required so as to be accessible and provided with proper clearance to service and/or replace.
16. Provide rigid inserts at all pipe support points to prevent compression of insulation.
17. Provide pipe roller supports as necessary to accommodate expansion.
18. Pipes shall have their ends kept capped and be stored on pallets until the point at which the pipe is installed in its final location. When the pipe is installed in its final location, it shall have a temporary plastic cap put in place whenever active construction is not requiring access to the open end.

B. Preferred:

1. Provide 45° fittings for changes of direction in the vertical plane, when possible, otherwise use right angle (90°) fittings.
2. Distribute main utility pipe headers in corridors or common areas for ease of access outside of occupied spaces
3. Weldolets and Threadolets are acceptable
4. Branch piping connections should be made at top of piping mains to avoid sediment buildup within vertical branch piping connections.
5. Stab-in welded pipe or t-drill branch tees are not allowed.
6. Bull head fitting connections are not allowed.
7. Distribution of piping systems through electrical or telecommunication utility rooms is not allowed, unless to provide service to HVAC system designed to control temperature of these rooms.
8. Flexible pipe isolators are not to be used as a means of correcting the misalignment of piping and shall not exceed 12 inches in length.

PART 4 - EVALUATION

A. List of items or systems requiring testing, evaluation, verification, or commissioning: Required items: Hydrostatic Pressure Testing. Coil balancing report.

B. Documentation required:

1. Test reports: Hydrostatic Pressure Testing. Coil balancing report.
2. Commissioning report.

C. Required testing protocols beyond normal Commissioning and TAB protocols:

1. Hydrostatic Testing Procedures:

a. Use ambient temperature water as a testing medium.
b. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
c. Isolate expansion tanks and cooling towers and determine that hydronic system is full of water.
d. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure, but meeting code requirements as noted below. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
e. As indicated in latest California Mechanical Code piping shall be tested with a hydrostatic pressure of not less than 100 psig, but at least 50psig greater than operating pressure. Required tests shall be conducted by the owner or contractor in the presence of an authorized inspector. The piping being tested shall remain exposed to the inspector and shall not leak during the test.
f. After hydrostatic test pressure has been applied for at least 2 hours, examine piping, joints and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components and repeat hydrostatic test until there are no leaks.
g. Prepare written report of testing to District’s Representative, including description of repairs made. Include test Bristol recording.

END OF SECTION

SECTION 23 21 16
HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

1.01 REQUIREMENTS

A. Design considerations specific to components in this section:

1. Required:

a. Safety valves and pressure vessels shall bear the appropriate ASME label.

1) Expansion tanks: Boiler and Pressure Vessel Code: Section VIII, Division 1.
2) Safety Valves
3) Pressure Reducing Valves

b. Provide manual air vents at all system high points and de-centralized hydronic coil connections.
c. Provide automatic air vents at all centralized hydronic coil connections or other hydronic systems exposed and located in service/equipment rooms.
d. Provide air separators and expansion tanks on all chilled water and heating hot water systems.
e. Provide proper sloping for positive drainage of system, associated low points shall be identified on documents.

2. Preferred: No preferences

3. Disallowed: None

B. Quality Assurance requirements beyond standard 1 year warranty: None required

PART 2 - PRODUCT

2.01 PRODUCT REQUIREMENTS

A. Air Separator:

1. Manufacturers:

a. Bell and Gossett
b. Taco
c. Armstrong
d. Spirotherm

2. Component Characteristics:

a. Steel, tested and stamped in accordance with ASME Section VII
b. Tangential inlet and outlet connections, internal stainless-steel air collector tube.

B. Preferred:

1. Integral strainer

C. Expansion Tank:

1. Manufacturers:

a. Bell and Gossett
b. Wessels
c. Taco

2. Component Characteristics:

a. Welded steel, tested and stamped in accordance with ASME Section VIII; supplied with

National Board Form U-1, rated for working pressure
b. Flexible butyl diaphragm sealed into tank
c. Pressure gage and air-charging fitting, tank drain

D. Flow-Limiting Valves:

1. Manufacturers:

a. Griswold
b. Delta P (control valve with built-in flow limiting device)

2. Component Characteristics:

a. Valves may be incorporated into circuit control valves or shall otherwise be pressure independent type.
b. Provide the following flow limiting devices for water balance of the individual circuits for air coils:

System Size	System Coil Type	Flow Limiting Device
< 40 gpm	De-centralized coils	Spring loaded Griswold (automatic) type controller
≥ 40 gpm	Centralized AHUs	Delta P controller – separate flow limiting device not required

E. Calibrated Balancing Valves:

1. Manufacturers:

a. TA Hydronics
b. Bell and Gossett
c. Taco
d. Armstrong

2. Component Characteristics:

a. Pressure dependent circuit-setter type balancing valves
b. All balancing valves shall include a concealed memory with a locking tamperproof setting.
c. All balancing valves shall be furnished with valve manufacturer's preformed rigid polyurethane thermal insulation and extended level stem.

F. Safety Pressure-Relief Valves:

1. Manufacturers:

a. If the safety relief valve comes as an on-board or field-installed accessory to a piece of protected equipment provided by the equipment manufacturer, there is no specific manufacturer requirement.
b. Preferred:

1) Watts
2) Kunkle
3) Consolidated

2. Component Characteristics:

a. For heated liquids and gases.
b. ASME certified and labeled.
c. Bronze body, Teflon seat, stainless steel valve spring and trim, automatic direct pressure actuated

d. Valves suitable and rated for proper temperatures; for "safety relief valves" minimum temperature rating is saturated steam temperature corresponding to pressure 10 percent higher than valve set pressure.
e. Valves shall have set pressure indicated but not more than working pressure of protected equipment.
f. Valves shall open, under test, at set pressure, with tolerance of plus or minus 2 psi for set pressures up to 70 psig and plus or minus 3 percent for set pressures in excess of 70 psig.
g. Valves shall have capacity to relieve maximum possible generated energy while maintaining pressure in protected equipment at no more than 10 percent above vessel working pressure.

G. Pressure-Reducing Valves:

1. Manufacturers:

a. Watts
b. Kunkle
c. Consolidated

2. Component Characteristics:

a. For unheated liquids
b. ASME certified and labeled.
c. Bronze body, Teflon seat, stainless steel valve spring and trim, automatic direct pressure actuated
d. Valves suitable and rated for proper temperatures;
e. Valves shall have set pressures indicated
f. Valves shall have capacity to relieve maximum possible generated energy while maintaining pressure in protected equipment at no more than 10 percent above vessel working pressure.

H. Drain Valves:

1. Manufacturers:

a. Nibco
b. Crane
c. Grinnell
d. Apollo

2. Required:

a. For sizes up to 3”, ball valve with lever handle hose bibb, cap and chain. For sizes larger than 3”, butterfly valve with flanged opening.
b. Size as follows:

Line size	¾ to 1 ¼	1 ½	2	3	4	6	8
Drain size	¾	1	1 ¼	1 ½	2	2	2

I. Manual Air Vents:

1. Manufacturers:

a. Nibco
b. Crane
c. Grinnell
d. Apollo

2. Component Characteristics:

   a. 3 inch tall vertical sections of 2 inch diameter pipe to form air chamber, with 1/4 inch ball valve at top of chamber with hose bibb and cap.

J. Automatic Air Vents:

1. Manufacturers:

   a. Bell and Gossett
   b. Taco
   c. Armstrong

2. Component Characteristics:

   a. Brass or semi-steel body, solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure.

K. Strainers:

1. Manufacturers:

   a. O.C. Keckley Company.
   b. Mueller.
   c. Spirax Sarco.
   d. C.M. Bailey.

2. Component Characteristics:

   a. Provide drain line, with hose bibb, cap and chain.
   b. Provide the following materials and joints:

Service	Valve Type	Size	Material	Joining Method
Chilled Water (CHW) Heating Hot Water (HHW) Condenser Water (CDW)	Strainers	≤2”	Bronze	Threaded
		>2 ½“	Steel	Flanged
	Strainers – Basket Type (CDW only)	All	Steel	Flanged

L. Check Valves:

1. Manufacturers:

   a. Nibco
   b. Crane
   c. Hammond
   d. Milwaukee

2. Component Characteristics:

   a. Provide the following materials and joints:

Service	Valve Type	Size	Material	Joining Method
Chilled Water (CHW) Heating Hot Water (HHW) Condenser Water (CDW)	Swing Check Valve	≤2”	Bronze	Threaded
		>2 ½“	Steel or Cast Iron	Flanged
	Non-Swing Check Valve	≤2”	Bronze	Threaded
		>2 ½“	Steel or Cast Iron	Flanged

M. Pump Suction Diffusers:

1. Manufacturers:
   a. Match to pump manufacturer.
2. Preferred:
   a. Design and install systems so as to not require pump suction diffusers.
3. Component Characteristics:
   a. Angle type body with carbon steel inlet straightening vanes and carbon steel combination Diffuser-Strainer-Orifice Cylinder with 3/16inch diameter strainer openings for pump protection. Permanent magnet located within flow stream removable for cleaning. Equip orifice cylinder with disposable 16 mesh bronze start-up strainer. For condenser water pumps use stainless steel strainers.
   b. Orifice cylinder to withstand pressure differential equal to pump shutoff head. Free area to be five times cross section area of pump suction opening. Vane length no less than 2-1/2 times pump connection diameter.
   c. Adjustable support foot to carry weight of suction.
   d. Pump suction diffusers are only allowed when a separate strainer is provided on the inlet piping of pump.

PART 3 - INSTALLATION

A. Required:

1. Automatic air vents shall be piped and discharged at nearest approved receptor.
2. Provide devices at a minimum at following locations:

Device Type	Required Locations	Comments
Automatic Air Vents	1. At centralized air-handlers only 2. At all high points where exposed within a mechanical room or roof and can be properly discharged to a receptor.	Pipe to plumbing receptor.
Flow-Limiting Valves	1. At each piece of equipment having a modulating control valve.	
Calibrated Bal- ancing Valves	1. At each floor level branch from ris- ers on return leg.	
Drain Valves	1. At low points leaving each piece of equipment 2. At each floor level branch from risers 3. At all low points in piping 4. At least one per isolated section caused by shut-off valve placement	At bottom of riser: provide full line size.
Manual Air Vents	1. At high points leaving each piece of equipment 2. At each floor level branch from risers 3. At all high points in piping 4. At least one per isolated section caused by shut-off valve placement	

PART 4 - EVALUATION

A. List of items or systems requiring testing, evaluation, verification, or commissioning: Required

Items: Expansion tank, Pressure relief/ Pressure reducing valves.

B. Documentation required:

1. Test reports: Testing, Adjusting and Balancing.
2. Commissioning report.
3. ASME label or stamp: Expansion Tanks, Pressure Reducing Valves, Safety Relief Valves

END OF SECTION

SECTION 23 21 23
HYDRONIC PUMP

PART 1 - GENERAL

1.01 REQUIREMENTS

A. Design considerations specific to components in this section:

1. Required:

a. Specify closed coupled, end suction pumps for ranges of 5 Hp or less.
b. Base mounted, end suction, coupled pumps shall be used. Select automatic condensate pump to overcome estimated pressure drop to anticipated condensate point of termination.
c. Provide on documents if automatic condensate pump is integral to unit/equipment they serve or specified separate to associated equipment and whether powered through unit/equipment they serve or powered independently.

2. Preferred:

a. Base mounted, end suction, coupled pumps should be selected to provide efficiency of 75% or greater.
b. Do not specify pumps with impellers exceeding 90% of the impeller diameter range for the pump casing.
c. Triple-Duty valves are not allowed.
d. Pump suction diffusers are not allowed by design and may only be used when field conditions require it.

1.02 PRODUCT REQUIREMENTS

A. Hydronic Pumps

1. Manufacturers:

a. Bell and Gossett
b. Armstrong

2. Component Characteristics:

a. Provide coupled pumps with manufacturer’s standard steel base.
b. Provide mechanical type seals.

PART 2 - INSTALLATION

A. Required:

1. Suction piping shall be at least one pipe size larger than pump section.
2. Install eccentric reducers for all horizontal suction piping at inlet of pump.
3. Install piping to allow 5 diameter straight length of pipe before connecting to pump suction end.
4. Install piping and valves so that pump suction and discharge pressures may be read from a single pressure gage.
5. Install pump so removal can be accomplished without significant piping disassembly.
6. Install using flexible type coupling with EPDM sleeve, solid foot mounted volute.
7. Entering and leaving flanges shall be drilled and tapped for gage connections.
8. Installation requirements for Automatic Condensate Pumps:

a. Install pump on level support.
b. Locate pump inlet lower than condensate pan discharge connection.
c. Install pump in location maintaining adequate service clearances.
d. Install pump to allow for simple removal or repair of existing or replacement of pump unit.

9. Pump control packaged systems which are independent from the base building automation system shall be provided.
10. Pumps shall be properly re-aligned in the field as part of start-up with activities noted in the dynamic balancing test report.
11. Flexible pipe isolators are not to be used as a means of correcting the misalignment of piping.

PART 3 - EVALUATION

A. List of items or systems requiring testing, evaluation, verification, or commissioning: Required Items: Pumps.

B. Documentation required:

1. Testing, Adjusting and Balancing Reports
2. Commissioning report.
3. Dynamic balancing Test Report
4. In-person witnessing: Visual proof of water drainage at end of automatic condensate pump discharge pipe.
5. UL listing: All pumps.
   a. Automatic condensate pump and enclosure to meet UL listing code requirements, if unit is not integral to unit/equipment they serve.

END OF SECTION

SECTION 23 22 13
STEAM AND CONDENSATE HEATING PIPING

PART 1 - GENERAL

1.01 REQUIREMENTS

A. Design considerations specific to components in this section:

1. Required:

a. New piping systems shall be designed to avoid exceeding the pressure drop and velocity criteria at specified locations as listed in the table below. Existing piping systems affected by retrofit shall maintain the current velocity in the system (by calculation) or meet the criteria noted below, whichever is greater.

Piping Location	Pressure Drop`	Velocity
Building laterals from site utility source	2 feet / 100 feet	4000FPM
Building risers and floor / level main headers	3 feet / 100 feet	4000FPM
Equipment branches / circuits or sub-headers	4 feet / 100 feet	4000FPM

b. Pre-manufactured / Pre-packaged valve sets with combination valves or configurations that cannot be field-dismantled are not allowed. This requirement does not preclude pre-fabricated valve sets built up out of individual components separated with flanges or unions.

c. Only 90-degree fittings/transitions shall be used for steam piping and the elbows shall be of long-radius type.

d. No 45 degree fittings/ transitions allowed for steam piping.

PART 2 - PRODUCT

A. Above ground HVAC piping:

1. Provide the following materials for piping and fittings:

Service	Size	Material	Joining Method
Steam	All	ASTM A53 Type S (Seamless) Schedule 40 Black Steel Domestic Source	Welded
Steam Condensate	All	ASTM A53 Type E Schedule 80 XS (Extra Strong) Black Steel Domestic Source	Welded

2. Provide the following grading and slope criteria for drainage and venting:

Piping Type	Slope	Direction of Fall
Steam (runout to equipment)	1” per 10’-0”	Back to mains
Steam (main)	1” per 10’-0”	Down in direction of flow

PART 3 - INSTALLATION

A. Special attention must be paid to the sloping and trapping of steam lines. Slope in the direction of steam flow. Provide drip legs as necessary at all low points, drops to equipment and lifts in piping elevation.

B. Provide rigid pipe inserts at all pipe supports in order to prevent compression of insulation.

C. Provide pipe roller supports as necessary to accommodate expansion as per the design.

D. All steam utilizing equipment shall be mounted / raised at proper height, so as to allow for trap discharge lines (low pressure condensate) to drain by gravity to nearby designated condensate receiver.

PART 4 - EVALUATION

A. Documentation required:

1. Test reports: Pressure Testing.

2. Hydronic Cleaning

END OF SECTION

SECTION 23 22 16
STEAM AND CONDENSATE PIPING SPECIALTIES

PART 1 - GENERAL

1.01 REQUIREMENTS

A. Design considerations specific to components in this section:

1. Safety valves and pressure vessels shall bear the appropriate ASME label per Boiler and Pressure Vessel Code: Section VIII, Division 1.

   a. Safety Valves
   b. Pressure Reducing Valves

2. The specialties shall be rated for pressure equal to the pressure of the piping system to which it is attached, and safety valves shall be sized as required benchmarked against the associated equipment's normal operating pressure and input capacity.

3. Design documents shall state the minimum working pressures, temperatures and safety valve setpoints for each system.

4. Provide steam trap monitoring stations and system, similar to Spirax Sarco SPIRA-tec Sensor Chamber. Local read-out vs. Interface with EMS/BMS.

5. Only 90 degree fittings/transitions shall be used for steam piping and the elbows shall be of long-radius type.

B. Preferred:

1. It is preferred that flash tanks be avoided for low pressure systems (below 15 PSI) and that a vented receiver at the steam condensate recovery pump be used.

2. Where possible, consideration should be given for the re-use of flash steam prior to venting.

3. Where central steam utility is provided for the purpose of serving more than space heating building loads (for example, domestic and industrial hot water heating, an appropriate meter and accompanying instrumentation, shall be provided, in order to attain the full building steam demand, in an effort to measure and monitor energy in terms of BTUs.

4. No 45-degree fittings/ transitions allowed for steam piping.

PART 2 - PRODUCT REQUIREMENTS

2.01 Specialties:

A. Manufacturers:

1. Spirax Sarco (in particular, Spirax Sarco steam traps are preferred)

2. Armstrong

3. Watts

4. Kunkle Valve

5. Hoffman Specialties.

B. Component Characteristics:

1. Provide the following materials and joints for the following valves:

Service	Valve Type	Size	Material	Joining Method

High Pressure Steam (HPS) Steam Condensate (CR)	Strainer	All	Steel	Screwed or Flanged
Low Pressure Steam (LPS) Steam Condensate (CR)	Check	≤2”	Cast Iron	Screwed
		≥2 ½“	Steel	Flanged
	Strainer	≤2”	Steel	Screwed
	Strainer	≥2 ½“	Steel	Flanged

2. The following specialties shall be used:

Y pattern strainers	250 CWP rating Stainless steel mesh Blow off plug	Threaded ends 2” and below, flanged ends for larger sizes. Provide blowdown connection with drain line, hose bibb, cap and chain.
Basket strainers	250 CWP rating Stainless steel mesh	Threaded ends 2” and below, flanged ends for larger sizes. Provide blowdown connection with drain line, hose bibb, cap and chain.
Bronze safety valves	Class 250, forged copper alloy disc, fully enclosed steel spring	adjustable pressure range and positive shutoff, factory set and sealed.
Cast-iron safety valves	Class 250, forged copper alloy disc with bronze nozzle, fully enclosed cadmium-plated steel spring	Raised flange connections, adjustable pressure range and positive shutoff, factory set and sealed.
Drip Pan Elbow	Cast iron complying with ASME B1.20.1	Threaded inlet and outlet
Pressure reducing valves	Pilot-actuated, diaphragm type, cast iron with hardened stainless steel trim, non-asbestos gasket material.	Threaded ends 2” and below, flanged ends for larger sizes, adjustable pressure range and positive shutoff Factory set for inlet and outlet pressures.
Float and thermostatic traps	Cast iron with bolted cap, balanced pressure type, stainless steel head and seat, stainless steel bellows, with vacuum breaker.	Threaded connections, capable of withstanding 45°F of superheat and resisting water hammer without sustaining damage. Provide with trap monitoring system.
Inverted bucket traps	Cast iron, stainless steel head and seat, stainless steel bucket, integral strainer. Stainless steel thermostatic air vent.	Threaded connections. Provide with trap monitoring system.
Thermostatic air vents	Stainless steel body, stainless steel float, valve and seat.	Threaded connections

	Phosophor bronze bellow in stainless steel cage	
Vacuum breakers	Stainless steel body, stainless steel sealing ball, retainer, spring and screen.	Threaded connections
Flash tanks	150 psig	Taps for low pressure steam and condensate outlets, high pressure condensate inlet, air vent and safety valve

C. Flexible Connectors:

1. Manufacturers:

a. Hyspan Precision Industries
b. Mason Industries
c. Metraflex Company

2. Component Characteristics:

a. Stainless steel bellows with woven, flexible bronze wire-reinforced protective jacket
b. Capable of ¾ inch misalignment.
c. Threaded or flanged connections to match equipment requirements.

PART 3 - INSTALLATION

A. Required:

1. Specialties shall be installed at the following locations:

Shut off valves	At Branch connections At Steam supply connections At outlet of steam traps Upstream of each dielectric fitting.	Install unions at valves 2” and small, flanges for larger pipe sizes
Strainers	At supply side of control valves Upstream of pressure reducing valves At steam traps	Install ¾” nipple and full port ball valve in blowdown connection for strainers 2” and large, match pipe size for smaller sizes
Safety valves	Downstream of pressure-reducing valve	Pipe discharge piping without valves to nearest floor drain. For valves larger than 2.5”, install exhaust head with drain to waste.
Drip Pan Elbow	Adjacent to safety valve	Pipe drain connection to nearest floor drain.
Pressure reducing valves	At pressure-reducing stations	Pipe discharge piping without valves to nearest floor drain. Install unions or flanges and gate valves on both sides of valve. Provide bypass piping around pressure-reducing valve with globe valve equal in size to area of pressure reducing valve

		seat ring.
Float and thermostatic trap – for all heat exchangers, modulating equipment and low-pressure drip legs	As close as possible to connected equipment	Install full port ball valve, strainer and union upstream of trap, union, check valve and full port ball valve downstream
Inverted bucket steam traps – for all high-pressure drip legs	As close as possible to connected equipment	Install full port ball valve, strainer and union upstream of trap, union, check valve and full port ball valve downstream
Control valves	At supply to equipment	Install bypass piping with globe valve around control valve. If parallel control valves are provided, only one bypass is required
Vacuum breakers	Downstream from control valve	Install close to equipment inlet connection.
Flash tanks	Use for high pressure steam systems only	Provide venting directly to outdoors.
Check Valves	Downstream from steam traps, yet prior to isolation valve on condensate side.	

B. Preferred:

1. Strainers on steam systems to be installed in a horizontal configuration, so as to avoid potential accumulation of condensate a low point in piping system

PART 4 - EVALUATION

A. List of items or systems requiring testing, evaluation, verification, or commissioning: Required Items: Safety Valves, Pressure Reducing Valves

B. Documentation required:

1. ASME label and listing: Safety Valves, Pressure-Reducing Valves

END OF SECTION

SECTION 23 22 23
STEAM CONDENSATE PUMPS

PART 1 - GENERAL

1.01 REQUIREMENTS

A. Design considerations specific to components in this section:

1. Required:

a. All steam condensate pumps shall be a Griswold-type flow control valve to limit the flow independent of pressure.

PART 2 - REQUIREMENTS

A. Steam condensate pump:

1. Manufacturers:

a. Hoffman
b. Roth

2. Component Characteristics:

a. Requirements:

1) Packaged duplex-type with common base, with vented receiving tank, requested accessories and controls.
2) Pump shall be bronze fitted throughout and rotating parts dynamically balanced.
3) Motors shall be 1750 rpm whenever possible.
4) Unit shall be furnished with condensate and air discharge valves, vacuum relief valve, compound gage, thermometer and companion connection flanges.
5) Pump shall be close-coupled with strainer and bronze isolation valve between receiver and pump.
6) Receiving tank shall be cast iron with inlet strainer, gage glass, air discharge separator and automatic ball float operated valve.
7) Provide single power connection point.
8) Provide electric alternators (or other acceptable control means) to automatically transfer operating sequence of pumps. Entire controller shall be a UL rated assembly.
9) Provide float type level switches for mid and high level alarms. Local alarm annunciation and alarm silencing shall be provided.
10) Provide separate mid and high level alarm dry contacts for building automation system.
11) Overflow from receiver / condensate pump shall be coordinated and piped to nearby approved receptor.

PART 3 - INSTALLATION

A. Required:

1. Pumps shall be mounted on a minimum 6” high pad.

2. Pumps shall be located with adequate clearances for regular service and future replacement.

3. Receiver shall be properly vented to atmosphere, the final termination of which shall be coordinated to assure no injury to persons or damage to property.

B. Preferred:

1. Receiver to be distributed up throughout building and vented to nearest roof level, and terminated in such a way, so to assure no injury to persons or damage to property.

PART 4 - EVALUATION

A. List of items or systems requiring testing, evaluation, verification, or commissioning: Required Items: Steam Condensate Pumps.

B. Documentation required:

1. Test reports: Testing Adjusting and Balancing.
2. Commissioning report.
3. UL listing: Steam condensate pumps.

END OF SECTION

SECTION 23 22 23
STEAM CONDENSATE PUMPS

PART 1 - GENERAL

1.01 REQUIREMENTS

A. Design considerations specific to components in this section:

1. Required:

a. Size piping and design actual piping layout, including oil traps, double risers, specialties and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator and length of piping to ensure proper operation and compliance with warranties of connected equipment.

b. Comply with the following standards:

1) Welding: ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
2) ASHRAE 15, "Safety Code for Refrigeration Systems."
3) ASME B31.5, "Refrigeration Piping and Heat Transfer Components."
4) Liquid Accumulators: Comply with ARI 495.
5) Receivers: Comply with ARI 495, ASME Boiler and Pressure Vessel Code, UL 207.
6) Permanent Filter Dryers: Comply with ARI 730.
7) Replaceable-Core Filter Dryers: Comply with ARI 730
8) Hot-Gas Bypass Valves: Comply with UL 429
9) Thermostatic Expansion Valves: Comply with ARI 750.
10) Solenoid Valves: Comply with ARI 760 and UL 429;
11) Safety Relief Valves: ASME Boiler and Pressure Vessel Code, UL 207.

c. Select system components with pressure rating equal to or greater than system operating pressure, ensuring that they will withstand the required test pressure.

d. Refrigerant R-22 is not allowed for new equipment.

e. Pre-manufactured line sets are not allowed.

PART 2 - PRODUCT REQUIREMENTS

A. Piping:

1. Manufacturers:

a. Required: No requirements
b. Preferred: No preferences
c. Disallowed: None

2. Component Characteristics:

a. Required:

1) Piping shall be as follows:

Service	Size	Material	Joining Method
Liquid, Hot-gas and Suction lines for air-conditioning and heat pump applications	≤2”	Copper, ACR , drawn-tempered tubing and wrought-copper fittings	Brazed
	>2”	Schedule 40, black-steel	Welded

Safety Valve Relief discharge (for chiller vent applications)	≤2”	Copper, ACR drawn-tempered tubing and wrought-copper fittings	Soldered
	>2”	Schedule 40, black-steel	Welded

PART 3 - INSTALLATION

A. Required:

1. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.
2. Install refrigerant piping in protective conduit where installed belowground.
3. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
4. Slope refrigerant piping as follows:
   a. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
   b. Install horizontal suction lines with a uniform slope downward to compressor.
   c. Install traps and double risers to entrain oil in vertical runs.
   d. Liquid lines may be installed level.
5. Install piping free of sags and bends.
6. Install fittings for changes in direction and branch connections.
7. Adjust thermostatic expansion valve to obtain proper evaporator superheat, high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure and set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.
8. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
   a. Open shutoff valves in condenser circuit.
   b. Verify that compressor oil level is correct.
   c. Open compressor suction and discharge valves.
   d. Open refrigerant valves except bypass valves that are used for other purposes.
   e. Check open compressor-motor alignment and verify lubrication for motors and bearings.
9. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.
10. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.
11. Install the following specialties as noted:

Compressor	- Angle valves in suction and discharge lines - Strainer upstream - Filter dryers in liquid line between compressor and thermostatic expansion valve and in the suction line at the compressor - A check valve at the compressor discharge and a liquid accumulator at the compressor suction connection

	-
Filter dryers	- Angle valves on inlet and outlet side - Full-sized, three-valve bypass
Strainers	- Service valves for gage taps at inlet and outlet
Thermostatic expansion valve	- Solenoid valves upstream - Moisture/liquid indicators in liquid line at the inlet - Strainer upstream - As close as possible to distributors on evaporators. - Install valve so diaphragm case is warmer than bulb. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps.
Hot-gas bypass valve	- Solenoid valves upstream - Strainer upstream - Service valves for gage taps at inlet and outlet
Solenoid valve	- Strainer upstream - Install solenoid valves in horizontal lines with coil at top
Receivers	- Size to accommodate pump-down charge

12. Do not apply heat near specialties and the expansion-valve bulb when soldering or brazing. Remove solenoid-valve coils, sight glasses, valve stems, seats and packing and accessible internal parts of refrigerant specialties.
13. Bends shall be accomplished by fittings: bends in tubing are not allowed.
14. Do not mount expansion valve bulb in a trap or at bottom of the line.

PART 4 - EVALUATION

A. List of items or systems requiring testing, evaluation, verification, or commissioning: Required Items: Piping Pressure Test and Charging

B. Documentation required:

1. Test reports: Pressure test/ leakage test results.
2. Commissioning report.
3. UL listing: Receivers, Hot-Gas Bypass Valves, Solenoid Valves
4. ASME Pressure Vessel Testing report: Safety relief valve, receivers,

C. Required testing protocols:

1. Comply with ASME B31.5, Chapter VI.
   a. Test refrigerant piping, specialties and receivers. Isolate compressor, condenser, evaporator and safety devices from test pressure if they are not rated above the test pressure.
   b. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated below.

Refrigerant	R-22	R-134a	R-407C	R-410A
Suction lines for Air Conditioning	185 psig	115 psig	230 psig	300 psig
Suction Lines for Heat Pumps	325 psig	225 psig	380 psig	535 psig

Hot-Gas and Liquid Lines	325 psig	225 psig	380 psig	535 psig

1) Fill system with nitrogen to the required test pressure.
2) System shall maintain test pressure at the manifold gage throughout duration of test.
3) Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
4) Remake leaking joints using new materials and retest until satisfactory results are achieved.

c. Charge system using the following procedures:

1) Install core in filter dryers after leak test but before evacuation.
2) Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
3) Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
4) Charge system with a new filter-dryer core in charging line.

END OF SECTION

SECTION 23 25 00
HVAC WATER TREATMENT

PART 1 - GENERAL

A. Distruct Goals:

1. For Water Treatment: Intent of this Section is to provide complete chemical treatment to protect piping systems from scale formations, corrosion, algae and slime growth in the following systems: heating hot water, chilled water, condenser water, steam and steam condensate return, steam boilers.
2. For Pre-operational cleaning:
    a. The purpose of pre-operational cleaning of newly installed mechanical systems and piping is the removal of preservatives, cutting oils, pipe dope and other contaminates prior to the injection of corrosion and deposit inhibiting chemicals and startup operation. This process is critically important to the success of the continuing water treatment program.
    b. All cooling condenser, closed chilled, closed hot and boiler water systems and related piping shall be thoroughly flushed out with a specially formulated cleaner.
    c. Since these types of cleaners will raise the pH of the water to which they are added, they must not be introduced to cooling towers or evaporative condensers manufactured of galvanized sheet metal as “white rust” may develop on the metal surfaces.

PART 2 - REQUIREMENTS

A. Design considerations specific to components in this section:

1. Water treatment firm shall size condenser and boiler treatment proportioning pumps feed rate to match project requirements.
2. Water treatment firm shall recommend sizes for the bleed manifold configuration.
3. Water treatment firm shall recommend sizes for the sample stream injection assembly.
4. All products and chemicals shall meet federal, state and local government regulations
5. Include in design of systems, the necessary provisions, such as additional piping, valves, and connections for temporary pumping; required for proper circulation of chemicals during water treatment.
6. Provisions for a LAN connection within 12” of each Aquatrac controller shall be coordinated by the appropriate design consultant and installed by the project designated and responsible telecommunications sub-contractor.
7. Designer to provide specific plan for pre-operational cleaning strategy. This shall include steps and temporary measures required to address new piping.
    a. Pre-operational cleaning plan should also take into account the implications of pressure testing and the goal to avoid stagnant water or corrosion in hydronic pipe systems which are not to be placed into operation immediately.

PART 3 - PRODUCT

A. Water Treatment Chemicals & Service:

1. Manufacturers:
    a. Trident Technologies, Inc.
2. Component Characteristics:

a. Provide the following chemicals and equipment (as applicable):

System	Chemicals
Condenser water treatment, open systems	▪ Trident Prod # CL49 Microbiocide, or Trident Prod # CL2212-5 Microbiocide, or Trident Prod # CL2189
Closed system treatment: Chilled water, heating hot water, closed condenser water	▪ Trident Prod # 5304 Closed system inhibitor. ▪ Trident Prod # 8002-5 Cleaner ▪ Trident Prod # 2301 & CL4125 blend (specific to UPC TES system)
Boiler water treatment	Trident Prod # 2002 Oxygen Scavenger Trident Prod #1102 Organic Inhibitor Trident Prod #1605 Sludge Conditioner Trident Prod #1003 Alkalinity Supplement Trident Prod #3506 Condensate Treatment

1) Chemicals shall not flow through galvanized steel cooling towers or evaporative condensers.
2) High alkaline cleaner

B. Metering Pumps, Tanks and Water Meters:

1. Manufacturers:

a. All items of a given type shall be the products of the same manufacturer.
b. Prominent
c. Pulsa Feeder
d. LMI
e. Neptune
f. Clawson
g. Peabody
h. Carlon
i. Seametrics
j. Hersey

2. System Components for Condenser and Boiler Treatment Systems:

a. Water Meters: Turbine or rotating disk positive displacement type with integral pulse unit, bronze base and bronze internal carbon ball design to totalize water input in gallons with a 99 percent minimum accuracy.
b. Chemical Storage systems: Provide secondary containment for all chemicals. Size tanks proportional to system tonnage or horsepower, with minimum of 50 gallons required.
c. Injection assembly: Chemical injector/check valve assemblies to be supplied with each chemical pump. Stainless steel corp stops are to be provided for acid and inhibitor feeds. Solenoid valves:
d. Power operated NC valves installed in condenser bleed off line.
e. Motorized Ball valves: Motorized blowdown valves (min 3/4”) 120vac, rated 250 psi steam for boiler blowdown.
f. Coupon Racks: Each rack shall have three coupon holders. Minimum flow rate of 5gpm.
g. Piping: All water treatment piping (sensors, coupon racks, etc) shall be minimum schedule 80 PVC. All chemical injection lines shall be schedule 80 CPVC.
h. Brominator: Solenoid operated valve for solid bromine feed of a minimum of 5 gallons,

along with necessary PVC corp stops for injection.

C. Automatic Control Systems:

1. Manufacturers:

a. Required:

1) Aquatrac Instruments Model # MULTI-FLEX M10T0-CP-T2-OR-F-RC for Condenser Water System (per tower).
2) Aquatrac Instruments Model # MULTI-FLEX M5B-B2-TB2-RC for Boilers (to control up to 2 boilers)

D. Bypass Feeder:

1. Manufacturers:

a. J.L. Wingert, Co.

2. Component Characteristics:

a. Steel shell and heads, suitable for operating conditions up to 175 psi and 212°F.
b. Cap: Cast iron with Buna N "O" ring. Quarter-turn to open, 3/4” tappings for water in and out and drain.
c. For chilled water system, insulated.
d. Provide 1 feeder for each closed circulating system.

PART 4 - INSTALLATION

A. Required:

1. Water treatment:

a. Provide the following water treatment services:

1) Perform analysis of water conditions.
2) Supervise installation of water treatment equipment. Approve in field all system connections and feeder location before installation is begun.
3) Furnish and apply all chemicals from startup thru acceptance by owner.

2. Water Meter installation: Locate in cooling tower makeup and bleed and chilled water makeup line. Note: Aquatrac will log all meter readings.

3. Coupon Racks: Install coupon rack in condenser and chilled water systems.

4. Condenser water and boiler treatment feed pumps: For each system, provide separate proportioning pumps for each chemical used. Pumps shall be mounted at height suitable for pumping chemical treatment solutions from secondary containment tanks.

5. Condenser Water Control: Provide controller interlocked with condenser water pumps to automatically control pH, conductivity and chemical feed in response to makeup, bleed off, or total dissolved solids content of water.

6. Boiler Water Treatment Controls: Provide controller interlocked with boiler on/off operation to automatically control boiler water conductivity and chemical feed in response to makeup, timed feed, or blowdown.

7. Bypass Feeder shall be installed in convenient location where it may be easily accessed. Provide approved bleed manifold with:

a. Solenoid bleed valve.
b. Manual by-pass valve.
c. Piping to waste.
d. Bleedoff rate controllable.

8. Provide accessible City water hose connection at bypass feeder system basins for cleaning and flushing.
9. Provide sample stream injection assembly.
10. Provide installation supervision and start-up of automatic water treatment systems by qualified representative of equipment manufacturer. Provide minimum of 4 hours instruction in each system operation to District's operating personnel.
11. Feed system piping, connections, valves, wiring, cables, controllers, and feeder locations shall be reviewed by district .
12. Mechanical contractor shall be responsible to direct, supply or sub-contract trade work (not including water treatment vendor) to accomplish the complete installation of all piping, connections, valves and fittings, wiring, cabling, conduit, and raceways; as necessary complete and turn over a fully functioning system.
13. Emergency shower/eyewash shall be provided at chemical treatment equipment serving Cooling Towers, Chillers, Boilers, Pumps, etc. per Los Angeles Municipal Code and OSHA 29 CFR 1910.151 requirements.

PART 5 - EVALUATION

A. List of items or systems requiring testing, evaluation, verification, or commissioning: Required Items: Pre-operational cleaning.

B. Activation and confirmation of functional LAN outlets, where provided for communication with systems covered under this section.

C. Documentation required:

1. Test reports: System Cleaning and Passivation Report must be completed.
2. Commissioning report.
3. Onsite test results: Eddy current testing of condenser and evaporator heat exchangers.
4. Manufacturer's Field Reports: Indicate start-up of treatment systems when completed and operating properly. Indicate analysis of system water after cleaning and after treatment.
5. UL listing: All electric components.

D. Required testing protocols:

1. Preoperational System Cleaning
   a. Procedures, Closed Systems:
      1) Once the system has been completely installed, with temporary strainers in place, the proper amounts of Trident 8002 cleaner should be added through the one shot chemical feeder. The cleaner should raise the pH of the system to 10.0-11.0.
      2) The cleaning solution should be circulated for 24-48 hours depending on the type of system. The success of preoperational cleaning procedures is largely dependent on flow velocities. The flow velocity should be a minimum of 5 feet per second. This velocity criterion, shall be considered when sizing of necessary by-pass piping. Please refer to further guidance provided on minimum by-pass line sizing.
      3) Installed pipe distribution smaller than and up to 2 inches in diameter shall have full line size by-passes provided for cleaning purposes. Installed pipe distribution of larger than 2 inches in diameter shall conform to both the minimum velocity criteria provided and the following; by-pass pipe sizing shall not fall below either 25% of the largest pipe diameter in the system, or 2 inches in diameter.

4) It is very important that all control valves are open and that cleaning solution is in contact with all internal surfaces of the system. The cleaning solution should be circulated using the system recirculating pumps or temporary pumps depending on the design characteristics and construction scheduling.
5) Once the cleaning solution has been circulated for the desired time the system should be drained and flushed using the automatic makeup water system for supply. The temporary strainers should be removed and replaced with permanent strainers.
6) The water should be analyzed with the following targets:

Test	Target
pH	Same as the makeup water
Specific Conductance	Same as the makeup water
Fe	< 1.0 ppm

7) Once the water quality is equal to the target limitations the system can be considered clean and ready to accept the initial charge of chemical inhibitors. It is important that inhibitors and passivating agents are added to the system within 24 hours to prevent the corrosion and flash rusting. Untreated water shall not be allowed to remain in the system for more than 24 hours.

1) All water used for cleaning and flushing shall be drained to sewer.

b. Procedures, Open Systems:

1) All cooling towers shall be isolated, and all shutoff valves shall be arranged to bypass configuration in order to avoid chemical treatment entering the galvanized steel devices. Do not open the cooling tower to the cleaned piping until the system has been completely flushed with clean water.
2) All other Closed System cleaning procedures shall be applied.

c. Procedures, Steam Boilers:

1) Be sure the boiler is isolated at the steam header and that temporary site glasses have been installed. Add softened water to the boiler together with the proper amount of Trident 8002 pre-operational cleaner. The cleaning solution will be alkaline between 10.0- 11.0. The boiler should be fired to raise the temperature of the solution to 170 degrees and maintained for 24 hours. The boiler should be drained and flushed and refilled with clean softened water. The water should have < 1.0 ppm Fe and conductivity equal to that of the makeup water. The system should then be initially charged with chemicals to prevent corrosion.
2) The steam system should be cleaned using steam to scour the piping surfaces using a condensing assembly to evacuate dirty condensate from the system. Condensate and steam should be bypassed around all appliances and steam traps. Dirty condensate should not be allowed to return to the feedwater system but rather discharged to drain. The system is considered clean when the condensate conductivity is < 100 and the Fe test is < 1.0 mg/ltr. Untreated water shall not be allowed to remain in the system for more than 24 hours.

2. Visual inspection of heat exchangers:

a. HVAC contractor shall open condenser and evaporator heat exchangers (both ends) for inspection. Each exchanger shall be brushed and have eddy current testing performed prior to acceptance by District.

END OF SECTION

SECTION 23 31 13
METAL DUCTS

PART 1 - GENERAL

1.01 REQUIREMENTS

A. Design considerations specific to components in this section:

1. Required:

a. Air shall be ducted throughout the building, including within building chases, shafts, tunnels and mechanical rooms.
b. The use of ceiling return air plenums is allowed. No other non-metal plenums are allowed.
c. Ductwork shall be sized, selected and configured to limit the pressure drop to 1.5” or lower from fan discharge to exit of the diffuser in conditioned space, including all sound traps and other system losses.
d. Size ductwork based on the following maximum air velocity and air ressure drop requirements:

Location	**Maximum Air Velocity**	**Air Pressure Drop**	**Comments**
Duct main loops (high pressure)	Refer to 13 48 00 for acoustic velocity requirements	0.08” per 100’-0”	Air pressure drop to include fittings, transitions and the like. Maximum velocity shall be revisited in cases where no ceiling systems exist or distribution is exposed, or otherwise special acoustical considerations are required. Use whichever criteria provides the largest ductwork to comply with 1.5” overall system pressure drops.
Secondary branch (low pressure)	Refer to acoustic velocity requirements	0.08” per 100’-0”	Air pressure drop to include fittings, transitions and the like. Use whichever criteria provides the largest ductwork to comply with 1.5” overall system pressure drop.
Transfer	Refer to acoustic velocity requirements	-	
Grease exhaust	Refer to acoustic velocity requirements	-	Size per current mechanical code
Laboratory exhaust	Refer to for acoustic velocity requirements	-	Size per current mechanical code.

e. Follow recommendations made by the acoustical engineer.
f. Oval duct is allowed for medium and low pressure ductwork and is only allowed for systems under positive pressure.
g. Minimize lining of fabricated metal air plenums and ductwork wherever possible.
h. Utilize a looped system when possible.
i. Use full ducted return system when possible.
j. Using Firewrap to establish a fire-rated enclosure is not allowed for grease duct or any other ductwork.

PART 2 - PRODUCTS

A. Metal Ducts:

1. Manufacturers:

a. As selected by Designer

2. Component Characteristics:

a. Construct ductwork for the following pressure classes (minimum):

Pressure Class (“ w.g.)	Location	Comments	Required Sealant class
1	1. Supply ductwork downstream of terminal boxes. 2. Low pressure supply and return ductwork at fan coil units that are direct driven.	If anticipated operating pressure exceeds 1”, use next pressure classification level.	B
2	1. Return ductwork 2. Exhaust ductwork	If anticipated operating pressure exceeds 1”, use next pressure classification level.	A
4	1. Supply ductwork and plenum downstream of supply fan to terminal box		A
6	2. Where anticipated operating pressure exceeds all noted above.		A

b. Ductwork shall be selected and constructed on the more stringent of the current SMACNA standards or the current California Mechanical Code with local amendments.
c. Construct specialty exhaust ductwork with the following materials:

Ductwork System	Material
Type I Hood Grease Exhaust	Type 304 Stainless Steel (18 gauge), Fully Welded
Type II Hood Dishwasher Exhaust (non-grease)	Type 304 Stainless Steel (18 gauge), Fully Welded

Ductwork System	Material
Laboratory Fume Exhaust	Type 316L Stainless Steel, Fully Welded and required in all shafts. Refer to Section 23 35 00 for additional requirements. Note: Type 316L (not Type 316) is required due to welding specification.
Wet/High Humidity Zones (i.e. showers)	Aluminum

d. Ducts shall have their ends kept sealed and be stored on pallets until the point at which the duct is installed in its final location. When the duct is installed in its final location, it shall have a temporary plastic seal put in place whenever active construction is not requiring access to the open end.
e. Duct systems shall be cleaned just prior to startup using vacuum cleaning with mechanical agitation without disturbing the seal class or integrity of the ductwork systems. Contractor shall plan for this cleaning and ensure that adequate access panels in the ductwork are provided to accomplish the task.
f. As part of best management practices during construction, where appropriate, temporary filtration shall be employed to limit debris entering duct systems, as part of overall measures towards assuring these systems remain clean prior to startup.

3. Preferred:

a. For laboratory exhaust in ceilings, round longitudinally welded stainless steel ductwork is preferred with welds at 9 o'clock and 3 o'clock positions.

PART 3 - INSTALLATION

A. Required:

1. Install branch takeoffs with conical fittings or 45 degree entry taps.
2. Provide manual balance dampers at each major branch takeoff and at run outs to diffusers and grilles of supply, return and exhaust ductwork..
3. Provide access doors for grease exhaust ductwork per current mechanical code.
4. Provide necessary support for plenums as per SMACNA, which may be above standard ductwork support requirements.
5. Install plenums so as to not impede access to adjacent equipment or portions of the ceilings/rooms in which they are installed.
6. Provide access doors into all plenums.
7. Duct systems shall use radius elbows without turning vanes. Where this is not possible due to space constraints, provide miter elbows with turning vanes.

PART 4 - EVALUATION

A. List of items or systems requiring testing, evaluation, verification, or commissioning: Required: Ductwork

B. Documentation required:

1. Test reports: Duct Leakage Test

C. Required testing protocols:

1. Duct Leakage:

   a. The following portions of systems are required to have leakage tests:

System	Location	Notes
Supply	In risers	With SFDs and access panels installed.
Supply	On floors, upstream of VAV boxes or zonal reheat coils	Blocked before VAV box, with access panels installed.
Return and Relief	Risers	With SFDs and access panels installed.
General Exhaust	Risers	With SFDs and access panels installed.
Pressurization-critical Exhausts	Entire system as a whole	With SFDs and access panels installed. Blocked at diffuser connections.

   b. Testing Protocol:

      1) Seal all openings in duct section to be tested.
      2) Connect test apparatus to test section of duct, using a flexible duct connection or hose.
      3) Close damper or blower suction side to prevent excessive build up of pressure.
      4) Start blower and gradually open damper on suction side of blower.
      5) Build up pressure in duct test section equivalent to the duct construction gage. Negatively pressurized ducts shall be tested under negative pressure.
      6) Record indicated pressure or instrument that is connection to section of duct under test.
      7) Maintain this pressure for ten minutes and check for audible leaks. Mark location of each leak.
      8) Reduce pressure to 0 inch wg and repair all visual and audible leaks.
      9) Upon completion of repairs, build up pressure to the test pressure and read leakage pressure on instrument connected across test apparatus orifice. Repeat this procedure until the test complies with the required minimum leakage.
      10) Leakage CFM to be read by consulting chart calibrated with orifice diameter. If no leakage exists, zero pressure differential shall be
      11) indicated. Leakage CFM shall not exceed the value derived from the calculation methodology listed in the schedule on the previous page of this section.
      12) Calculation methodology: follow SMACNA leakage testing calculation methodology, but apply leakage class below as associated with sealant classes as noted above: The maximum leakage allowed in cfm/sf is to be referenced against the seal class listed above and the definitions of seal class from Table 4-1 of the SMACNA HVAC Air Duct Leakage Test Manual.

Seal Class	Leakage Class Allowed
A	6
B	12
C	24
Round Duct, all classes	3

   c. Engage the testing agency to verify the leakage tests of all ducts and submit a certification attesting to the results obtained.

d. Tested sections of ductwork to be visually marked by agency with certification sticker and initials of field test inspector. Tests shall be made before duct sections are concealed.

END OF SECTION

SECTION 23 33 00
AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.01 REQUIREMENTS

A. Design considerations specific to components in this section:

1. Manual balance dampers shall be provided at each major branch takeoff and at run outs to diffusers and grilles of supply, return, and exhaust ductwork. For acoustical considerations, see Section 13 48 00.
2. Select duct silencers from manufacturer's published acoustical and aerodynamic rating tables based on actual test readings or interpolated values of such readings obtained from tests made by recognized independent laboratories.
3. Silencer filler material shall meet appropriate fire hazard classification values, when tested in accordance with recognized standards/testing agencies following ASTM E477, ASTM E84, and NFPA 255 Standards.
4. Select and provide silencers for air pressure drops not exceeding 0.5 inches.
5. Flexible duct is allowed only at connections to supply diffusers and grilles.
6. Maximum length of flexible duct shall be limited to 6 feet.
7. Assure all proposed fire-smoke dampers retain the appropriate jurisdictional (local and state) approvals and listings.
8. Provide sound attenuator or lining directly downstream of air handling unit discharge to prevent fan noise breakout from entering occupied spaces.
9. It is district's strong preference that building full area coverage smoke detection be used to trigger air handling unit shut down and the shutdown of fire smoke dampers. This is allowed through exception by the mechanical and building codes.

PART 2 - PRODUCT

2.01 PRODUCT REQUIREMENTS

A. Volume Damper:

1. Manufacturers:
   a. As selected by Designer
2. Component Characteristics:
   a. Including built in indication and locking mechanisms
   b. Avoid using ceiling diffusers/registers with opposed blade dampers (OBD).

B. Fire-Smoke Damper:

1. Manufacturers:
   a. Ruskin
   b. Pottorf
   c. Or Approved equal
2. Component Characteristics:
   a. Where a duct smoke detector is installed for local damper control, a remote alarm indicator shall be provided (as required by code).
   b. When a damper is controlled by the fire alarm system, reference section 28 3100.

c. Smoke detector shall be compatible with building fire alarm (FA) system, where FA exist, and can accommodate new devices.
d. On duct smoke detectors are preferred over in duct smoke detectors.
e. Design shall ensure that minimum airflow requirements are met.
f. Where FA exists and dampers are not acting as part of smoke control system, provide a single supplementary fire alarm control relay to allow for BMS to separately monitor damper closure has occurred.

C. Duct Silencer:

1. Manufacturers:

a. Industrial Acoustics Company
b. Vibro-Acoustics
c. Approved equal

2. Component Characteristics:

a. Provide factory fabricated duct silencers of tubular or rectangular type as appropriate to meet project's Noise Criteria.
b. Construct silencers of galvanized steel with casing seams sealed or welded to be airtight at a pressure differential of 8 " w.g. between inside and outside of unit, stiffened and braced as required to prevent structural failure or deformation at same condition and to prevent audible vibration during normal operation. Where duct system is constructed of stainless steel, construct silencer of stainless steel.
c. Provide silencers with an inert acoustical absorbing filler material consisting of inorganic mineral fiber or fibrous glass that is vermin, moisture-proof, and will impart no odor into air stream.

D. Flexible Duct:

1. Manufacturers:

a. As selected by Designer

2. Component Characteristics:

a. Provide flexible duct with inner rigid support system.

E. Grease Duct Access Door:

1. Manufacturers:

a. DuctMate
b. FlameGard
c. 3M

2. Component Characteristics:

a. Airtight and suitable for duct pressure class.
b. UL labeled meeting NFPA 96 standards.
c. 304 stainless steel double-wall sandwich type construction. Lap inner face of door over duct opening, a minimum of 1/4-inch (6mm) on all four edges of the free duct opening.
d. Provide chain to prevent inner piece from fall into duct.
e. Grease-tight, high-temperature ceramic fiber gasket, rated for minimum 2300 deg.
f. Provide compression type tightening latches.

F. Hinged Rectangular Duct Access Door:

1. Manufacturers:

a. Greenheck

b. Pottorff

2. Component Characteristics:

a. Airtight and suitable for duct pressure class.
b. Minimum 26 gauge steel double-wall construction with 1 inch fiberglass insulation and beveled lock edge. Lap inner face of door over duct opening, a minimum of 1/4-inch (6mm) on all four edges of the free duct opening.
c. Continuous piano type hinge.
d. Frame duct opening with continuous 1 inch x 1 inch sheet metal angle.
e. All parts to be Galvanized steel for galvanized ductwork.
f. All parts to be 304 stainless steel for stainless steel ductwork.
g. Foam gasket at door-to-frame and frame-to-duct.
h. Door latches: operable rustproof zinc/aluminum alloy latch accessible from inside and outside duct. Steel and sponge rubber washers to prevent leakage. Beveled flange to work against frame to achieve compression.
i. Sash locks: Up to 18” (25mm) square: Furnish two locks. Above 18” (25mm) square: Furnish three locks.

PART 3 - INSTALLATION

A. Required:

1. Install balancing dampers as far back from diffusers and grilles as possible to reduce damper generated noise. This includes conditions where low pressure distribution ductwork to accompanying diffuser and grilles is completely rigid.

2. Locate volume dampers on rigid portion of low-pressure ductwork distribution and provide with locking mechanisms.

3. Locate volume dampers to be readily accessible to TAB contractors and operation and maintenance personnel.

4. Contractor shall properly tag all volume dampers concealed within plenum space or other architectural system in which these items are concealed.

5. Provide airtight construction for final installed placement of duct silencer by applying a duct sealing compound at all seams.

6. Install and support the flexible ducting in a way not compromise the free open area.

7. Provide the appropriate radius and/or plenum accessories for proper top or side connections to air outlets or inlets to avoid pinching the flexible duct.

8. Provide access doors as noted below:

Equipment Requiring Access Doors	**Location**		**Preferred Access Door Size (inches)**	**Remarks**
	Upstream	**Downstream**		
Control Devices Requiring Inspection	Either		18x18	
Backdraft Damper	x	-	18x18	Ensure visibility of damper.
Fire Dampers	Either		8x8	Ensure visibility of damper.
Combination Fire & Smoke Dampers	Either		18x18	Ensure visibility of damper.
Duct Mounted Heating/Cooling Coil	x	-	18x18	

Humidifiers	x	x	12x12	Confirm access requirements with manufacturer
Duct Mounted Drain Pans & Seals	-	x	18x18	
Outdoor Intakes & Mixed Air Plenums	Either		18x18	One location per plenum.
Full Height Plenum	Either		24W x 60H	One location per plenum.
Grease Exhaust Duct-work	See other sections			
Notes: • Ductwork access doors shall be square/rectangular and be a minimum 4” smaller than ductwork size to allow for proper installation. • For ductwork/equipment located within T-Bar ceilings, no ceiling access panels are required. Provide colored dot requirement at ceiling panel. • For ductwork/equipment located within hard lid enclosures, provide 18x18 ceiling access door. Access doors for fire dampers and combination fire and smoke damp- ers shall not require the use of tools, keys, or special knowledge.				

9. It is preferred that on duct detectors shall be used in conjunction with Smoke Fire Dampers.
10. Volume dampers may not be placed on flexible ductwork.

PART 4 - EVALUATION

A. List of items or systems requiring testing, evaluation, verification, or commissioning: Required Items: Fire-Smoke Dampers

B. Documentation required:

1. Test reports: Fire-Smoke Damper testing report, Testing, Adjusting, and Balancing report
2. UL listing: Fire-Smoke Dampers
3. Factory test results: Duct silencer acoustical and aerodynamic performance values.

C. Required testing protocols beyond normal Commissioning and TAB protocols:

1. Fire Alarm/Fire Damper Testing
2. Review of duct silencer submittals and application by project acoustical engineer (as applicable).

END OF SECTION

SECTION 23 34 00
HVAC FANS

PART 1 - GENERAL

1.01 REQUIREMENTS

A. Design consideration: Maximum speed for fans shall be 1750 RPM.

1. PRODUCT REQUIREMENTS

B. HVAC fans and powered ventilators:

1. Manufacturers:

a. Loren Cook
b. Greenheck
c. Penn
d. Twin City

2. Component Characteristics:

a. For all fans and powered ventilators, provide accessories appropriate to type of fan to ensure workers safety, maintenance access and positive drainage in outdoor configurations (i.e. inlet/outlet screens, access doors and scroll drains among others)
b. For powered ventilators and fans located in a location where building- borne vibration would adversely affect research equipment, occupant comfort, or sound performance required for the space, provide vibration isolation. Refer to Section 13 48 00 for vibration isolation requirements.
c. All exhaust fans and powered ventilators on the roof of buildings require vibration isolation.
d. For rooftop exhaust fans, provide factory mounted backdraft dampers, hinged access doors, disconnect switches and roof curbs (if required).
e. Provide fans with direct drives and speed controllers, when available from the manufacturer.

PART 2 - INSTALLATION

A. Provide hinged access panels to all motors, fans and filters, if available from the manufacturer.

B. Install exhaust fans so that recommended clearances are maintained for access to motor, belts and drains.

C. Where general exhaust fans are located on the roof in mechanical wells, provide utility type fans with discharge extensions to extend at least to the height of the penthouse or parapet.

PART 3 - EVALUATION

A. List of items or systems requiring testing, evaluation, verification, or commissioning: Required Items: All fans.

B. Documentation required:

1. Testing, Adjusting and Balancing Reports.

2. Commissioning report.

3. UL listing.

END OF SECTION

SECTION 23 36 00
AIR TERMINAL UNITS

PART 1 - GENERAL

1.01 REQUIREMENTS

A. Design considerations specific to components in this section:

1. Size terminal units for required maximum flow to be no more than 80% of peak rated flow for the box for the necessary sound level. Size terminal units to ensure that required minimum flow (to meet energy code requirements) is above the manufacturer's recommended minimum flow for the chosen box type, controller type, and velocity sensor.
2. Minimum CAV/VAV box: Size 6
3. Maximum CAV/VAV box: Size 14
4. Discharge temperature of supply air in heating mode shall be 95°F for office applications.
5. Provide minimum 2-row reheat coils for all exterior and interior zones.
6. For exterior offices, thermostats associated with air terminal units shall not be located on exterior walls or walls where direct sunlight is present for extended amount of time. Locate thermostats on interior walls or on columns.
7. Where medium pressure ductwork from nearby main to inlet of terminal unit is greater than 10 feet in length, as designed, this ductwork shall be sized up to the next even size diameter (or equivalent rectangular dimension).
8. Heating hot water branch piping should connect to the top of hot water mains.
9. Do not size new air terminal units to maximum CFM capacity for units.

PART 2 - PRODUCT S

A. Constant-air volume unit:

1. Manufacturers:
   a. Price
   b. Titus
   c. Krueger
   d. Tuttle & Bailey
2. Component Characteristics:
   a. Terminal units shall be constructed of minimum 22 gage galvanized steel.
   b. Provide standard sound attenuating box on discharge of the terminal unit without direct duct connections.
   c. Provide fiber-free insulation.
   d. Provide an access door upstream of the coil and downstream of the damper. The minimum size shall be 12 x 12.
   e. Provide access door with means of easy removal and replacement, including an acceptable form of latching which does not require tools to open and close.
   f. Where factory fabricated, provide access doors designed / constructed to be air tight, including gaskets (or other acceptable solution) that allows for proper sealing when panels are removed and reset during normal service.
   g. Access doors larger than 12 x 12 shall be hinged.
   h. DDC controller and damper motor shall be mounted at the factory. Field mounted units are not permitted.
   i. It is preferred that the access door is factory fabricated.

j. Access door is hinged, no matter of the size
k. Attenuator sections shall be factory fabricated.
l. It is not allowed to use direct duct connections on the sound attenuating plenum. If this is pursued, then a minimum 5ft length of 1" thick lining for sound attenuation is required between box discharge and first duct branch with diffusers.

B. Variable-air volume unit:

1. Manufacturers:

a. Price
b. Titus
c. Krueger

2. Component Characteristics:

a. Terminal units shall be constructed of minimum 22 gage galvanized steel.
b. Provide standard sound attenuating box on discharge of the terminal unit without direct duct connections. Refer to Section 13 48 00.
c. Provide fiber-free insulation.
d. Provide an access door upstream of the coil and downstream of the damper. The minimum size shall be 12 x 12.
e. Provide access door with means of easy removal and replacement, including an acceptable form of latching which does not require tools to open and close.
f. Where factory fabricated, provide access doors designed / constructed to be air tight, including gaskets (or other acceptable solution) that allows for proper sealing when panels are removed and reset during normal service.
g. Access doors larger than 12 x 12 shall be hinged.
h. DDC controller and damper motor shall be mounted at the factory. Field mounted units are not permitted.
i. It is preferred that the access door is factory - fabricated.
j. Access door shall be hinged, no matter of the size.
k. Attenuator sections shall be factory fabricated.
l. It is not allowed to use direct duct connections on the sound attenuating plenum. If this is pursued, then a minimum 5ft length of 1" thick lining for sound attenuation is required between box discharge and first duct branch with diffusers.

PART 3 - INSTALLATION

A. Provide duct access panels adequately sized for inspection and cleaning of coil in ductwork upstream and downstream of coil. Where necessary, detail or specify multiple access panels for larger size reheat coils.

B. Where medium pressure ductwork from nearby main to inlet of terminal unit is greater than 10 feet in length, due to final trade coordination demands, this shall be brought to attention of design engineer for confirmation of appropriate re- sizing ductwork to terminal unit.

C. Where field fabricated, provide access doors designed / constructed to be air tight, including the necessary gaskets (or other acceptable solution) that allows for proper sealing when panels are removed and reset during normal service.

D. Permanent hanging supports shall not be attached to terminal unit at locations that hinder removal of items requiring regular access, such as coil access panels.

E. Heating hot water branch piping should connect to the top of hot water mains.

F. Install air terminal units in accessible areas (ceiling grid). If terminal unit needs to be located over hard gypsum ceiling, provide a minimum 24" x 24" access panel. Coordinate location of access panel with architect.

G. Minimum service clearance of 24” shall be maintained for terminal unit control enclosure, as well as piping accessories at coil connections separately.

H. Provide full scale mock-up of proposed re-heat piping connection strategy.

PART 4 - EVALUATION

A. List of items or systems requiring testing, evaluation, verification, or commissioning: Required Items: VAV and CAV boxes.

B. Documentation required:

1. Test reports: Testing, Adjusting and Balancing Report

END OF SECTION

SECTION 23 37 00
AIR TERMINAL UNITS

PART 1 - GENERAL

1.01 REQUIREMENTS

A. Design considerations specific to components in this section:

1. Provide painted galvanized steel diffusers for most normal applications.
2. Provide stainless steel or aluminum steel in wetted environments.

PART 2 - PRODUCT S

A. Diffusers, registers, and grilles:

1. Manufacturers:

a. Price
b. Titus
c. Krueger
d. Tuttle & Bailey
e. Approved equal.

2. Component Characteristics:

a. No opposed blade dampers allowed. Request to use such due to justified constraints shall be submitted to FMS for review.
b. Diffusers with built-in thermostats and integral modulating dampers.

B. HVAC Gravity Ventilators:

1. Manufacturers:

a. Loren Cook
b. Greenheck
c. Penn

2. Component Characteristics:

a. Unit shall be of bolted and welded construction utilizing corrosion resistant fasteners.
b. Aluminum hood shall be constructed of minimum 14 gage marine alloy aluminum, bolted to a minimum 8 gage aluminum support structure.
c. Aluminum base shall have continuously welded curb cap corners for maximum leak protection.
d. Provide unit with ½” mesh bird screen mounted across intake/relief opening.
e. Provide unit with anti-condensate coating.
f. Provide gravity type back-draft or relief dampers at relief or exhaust ventilators. Gravity relief dampers shall fully open at 0.05-0.1” w.g. static pressure. Hood shall be low silhouette type.
g. Provide all required accessories for proper operation of ventilators per code and in accordance with design intent and sequence of operation.

PART 3 - EVALUATION

A. List of items or systems requiring testing, evaluation, verification, or commissioning: Required Items: Diffuser flow balancing. Outside air measurement.

B. Documentation required:

1. Test reports: Testing, Adjusting, and Balancing reports.

END OF SECTION

SECTION 23 38 13
COMMERCIAL-KITCHEN HOODS

PART 1 - GENERAL

1.01 REQUIREMENTS

A. Design considerations specific to components in this section:

1. Kitchen ventilation systems shall comply with current CMC requirements and all applicable amendments.
2. Kitchen ventilation system shall be capable of maintaining kitchen temperature above 68°F during heating mode and below 76°F during cooling mode.
3. If wash-down is provided at pollution control units, coordinate water source and necessary backflow prevention with Plumbing.
4. If wash-down is provided at commercial kitchen hood, coordinate water source and necessary backflow prevention with Plumbing.
5. Pressure drop calculations and duct/discharge velocity conditions shall be performed by designer and shall account for both clean and dirty filter conditions.
6. Where electrostatic precipitators not included in centralized pollution control unit, provisions for protecting charcoal filters shall be included.
7. VAV type systems will only be considered under the appropriate circumstances and on a case by case basis.

B. Preferred:

1. Provide centralized pollution control units
2. Electrostatic precipitators are preferred over UV technology
3. If UV technology is utilized, provide automatic wash-down system at hood.
4. Considerations for odor control and measures for providing such shall be coordinated with the University.
5. Where basic start/stop kitchen hood control is required, this shall be provided adjacent to the hood for manual control by end user (as oppose to automatic control through the building automation system).
6. Monitoring of equipment status for dedicated kitchen hood fan systems, via the building automation systems (BAS) is acceptable for new installations, and where existing BAS infrastructure is available and readily expandable.
7. UV hoods and precipitators shall not be provided in combination.
8. Precipitators built into hood system or within exhaust duct are not allowed.

PART 2 - PRODUCTS

A. Commercial-kitchen hoods:

1. Manufacturers:
   a. Coordinate with the food services consultant
   b. Gaylord
   c. Halton
   d. Greenheck
2. Component Characteristics:

a. Provide U.L. listed stainless steel kitchen hood of the 100% exhaust type.
b. Provide a state fire marshal approved fire protection system inside kitchen hood.
c. Short circuit hood where make up air is introduced directly into the hood is not permitted.
d. If precipitators are provided they shall be centralized at the pollution control unit not at the hoods.

B. Pollution Control Units:

1. Manufacturers: Coordinate with the food services consultant

a. Gaylord
b. Halton
c. Greenheck

2. Component Characteristics:

a. Provide centralized electrostatic precipitator (as applicable) and charcoal/carbon filter.
b. Provide automatic wash-down at the pollution control units.

PART 3 - INSTALLATION

A. Locate and install control switches for HVAC equipment so to prevent unauthorized use.

B. Layout of grease ductwork shall be coordinated such that there is the minimum required number of access door locations to meet the requirements of the Mechanical code and so they are placed in accessible locations not blocked by kitchen equipment or in food service areas.

C. Fully enclose grease duct in gypsum board fire-rated enclosure.

PART 4 - EVALUATION

A. List of items or systems requiring testing, evaluation, verification, or commissioning: Required Items: Kitchen hoods.

B. Test reports: Testing, Adjusting, and Balancing reports. UL listing: Kitchen Hood.

END OF SECTION

SECTION 23 40 00
HVAC AIR CLEANING DEVICES

PART 1 - GENERAL

1.01 REQUIREMENTS

A. Design considerations specific to components in this section:

1. Within design documents, explicitly state anticipated pressure drop for velocity specified and MERV rating per ASHRAE 52.1 - Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
2. Comply with NFPA and Code requirements with necessary UL Class ratings.
3. Maximum velocity allowed across filter is 500fpm or required coil face velocity of the device, whichever is lower.

B. Preferred:

1. Specify standard size filters and it is preferred that these sizes be specified
   a. 12 x 24 inches: MERV 8
   b. 24 x 24 inches: MERV 14
   c. For air filters in decentralized equipment, stock sizes are:

12x24x1	20x24x1	12x24x2	12x24x4	20x20x4
14x20x1	20x25x1	16x20x2	16x20x4	20x24x4
14x24x1	20x30x1	16x24x2	16x25x4	20x25x4
14x25x1	24x24x1	16x25x2	18x24x4	24x24x4
16x20x1	25x25x1	18x24x2		
16x24x1		18x20x2		
16x25x1		20x20x2		
18x20x1		20x24x2		
18x22x1		20x25x2		
18x24x1		20x30x2		
18x25x1	24x24x2			
20x20x1	25x25x2			

2. Metal “cleanable” type filters are not allowed.

PART 2 - PRODUCTS

2.01 DISPOSABLE, EXTENDED AREA PANEL FILTERS

A. Manufacturers:

1. Flanders
2. Camfil Farr Filtration Group.
3. AAF International.
4. Environmental Filter Corporation (EFC).
5. Eco-Air.
6. American Air Filter.

B. Component Characteristics:

1. UL 900 Class 2 media
2. Cardboard frame.

3. ASHRAE 52.1 performance: MERV 8, Dust spot efficiency 25-30%, Initial resistance @ 500 fpm: 0.30 in W.G., Final resistance: 1.0 in W.G.
4. A 4” filter is preferred for extended loading characteristics, however, where these are used for fan coil units or split systems, a 2” filter may be used.

2.02 EXTENDED SURFACE HIGH EFFICIENCY MEDIA FILTERS

A. Manufacturers:
1. Flanders
2. Camfil Farr Filtration Group.
3. AAF International.
4. Environmental Filter Corporation (EFC).
5. Eco-Air.
6. American Air Filter.

B. Component Characteristics:
1. UL 900 Class 2 media, Mini-pleated, water-resistant glass fiber with separators; in rigid holding frame with corrosion resistant coating.
2. ASHRAE 52.1 performance: MERV 14, Dust spot efficiency 95%, Initial resistance @ 500 fpm: 0.38 in W.G., Final resistance: 1.5 in W.G.
3. A 12” filter is preferred for extended loading characteristics.

2.03 HIGH EFFICIENCY PARTICULATE AIR (HEPA) FILTERS

A. Manufacturers:
1. Flanders
2. Camfil Farr Filtration Group.
3. AAF International.
4. Environmental Filter Corporation (EFC).
5. Eco-Air.
6. American Air Filter.

B. Component Characteristics:
1. UL 586 media, pleated, water-resistant all-glass fiber paper with separators
2. Filter shall be factory constructed to encapsulate the top and bottom of the filter pack and frame joints in a completely leak-tight manner.
3. Filter Frames: Galvanized steel, aluminum, or stainless steel, assembled in a rigid manner. Face Gasket: Silicone.
4. MIL-STD-282 Test 0.3 Micron Dioctyl Phthalate Smoke (DOP) Efficiency: 99.97 percent. Initial resistance @ 250 fpm: 0.65 in W.G, Final resistance: 3.0 in W.G.
5. A 12” filter is preferred for extended loading characteristics.

2.04 ACTIVATED CARBON FILTERS

A. Manufacturers:
1. Flanders

2. Camfil Farr Filtration Group.

B. Component Characteristics:

1. Activated Carbon Density: 34 lb/cu ft , pellets or granular to 6 x 10 Tyler mesh screen. Carbon Tetrachloride Activity: Minimum 60 percent; in thin bed. Carbon: 1.42 cu ft per 1000 cfm nominal airflow capacity.
2. Filter Frames: Galvanized steel unit incorporating extruded aluminum tracks to accommodate filter servicing trays in deep V arrangement arranged for servicing with disposable panel pre-filter.
3. IES Designation: RP-8, efficiency of 99.9 percent. Initial resistance @ 500 fpm: 0.45 in W.G.
4. All carbon filters shall be provided with a disposable panel “dusting” filter downstream of the carbon filter.
5. Side servicing is preferred.

2.05 FILTER FRAMES

A. Manufacturers:

1. Flanders
2. Camfil Farr Filtration Group.
3. AAF International.
4. Environmental Filter Corporation (EFC).
5. Eco-Air.
6. American Air Filter.

B. Component Characteristics:

1. If incoming ductwork is stainless steel, use stainless steel, otherwise use 16 gage extruded aluminum T-section construction with necessary gaskets between frames and walls
2. Permanent gasket framing members to prevent the bypass of unfiltered air. Each horizontal row of filters shall have a positive spring loaded sealing device which will allow easy installation and removal of cartridges but shall secure seal between cartridges while bank is in operation.
3. Provide a separate gasketed track for pre-filters, which can be serviced from upstream without disturbing the final filters.

2.06 FILTER GAGES

A. Manufacturers:

1. Dwyer Photohelic Series for BAS-linked gage.

B. BAS-linked gage Component Characteristics:

1. Direct Reading Dial: 3-1/2 inch diameter diaphragm actuated dial in metal case. 2 percent of full scale accuracy.
2. Furnish vent valves, black figures on white background, front calibration adjustment
3. Range: 0-2.0 in W.G for 30-35% prefilters, 0-3.0 in W.G for final filters, 0-4.0 in W.G for HEPA filters
4. Provide transmitter contacts for interface to building control system to be 4-20mA signal.

5. Provide a separate gasketed track for pre-filters, which can be serviced from upstream without disturbing the final filters.
6. Provide gauge with standard air filter installation kit.

PART 3 - INSTALLATION

A. Furnish three sets of filters for every device: temporary construction filters; one to be used during the testing, adjusting and balancing period; and one to be used at handover. At the client's discretion, leave the TAB filters in place at handover and provide the other set in factory packaging to the client for extra stock.

B. Locate gages as near as possible to 5 feet above floor and in a level manner. Mount filter gages immediately outside of filter housing.

C. Install filter gages on filter banks with separate static pressure tips upstream and downstream of each filter bank - this means that if the pair of pre and final filters are mounted in the same rack, pressure measurement points must be provided for each.

D. Outdoor units shall have the gage enclosed in a protective sheet metal box with a hinged inspection door.

E. Install pre- and final filters with felt, rubber, or neoprene gaskets to prevent passage of unfiltered air around filters. Install HEPA filters with silicone gaskets.

F. Samples: Submit two samples of replacement filter media of each type and each filter frame.

G. Do not operate fan system until temporary filters are in place. Replace temporary filters used during construction and testing, with clean permanent set prior to testing, adjusting and balancing.

H. The contractor may not run air-conditioning equipment until startup, testing, adjusting and balancing is ready to begin. Temporary filters shall be used at startup, with a MERV rating of 8 or higher and the filters required by this section as "permanent" filters shall be used for testing, adjusting and balancing.

PART 4 - EVALUATION

A. List of items or systems requiring testing, evaluation, verification, or commissioning: Required items: Filters

B. Documentation required:

1. MERV rating documentation.
2. UL Class documentation.
3. Manufacturer's Installation Instructions: Submit assembly and change-out procedures.

END OF SECTION

SECTION 23 52 33
WATER-TUBE BOILERS

PART 1 - GENERAL

1.01 REQUIREMENTS

A. Design considerations specific to components in this section:

1. Hot water boilers shall be used where steam requirements are minimal or this utility is not available.
2. Design engineer shall specify the efficiency and the method of calculation. System design measures shall be taken to avoid thermal shock and condensation of combustion gases in non-condensing boilers.
3. Air separators and expansion tanks shall be provided on all hot water heating systems regardless of piping arrangement.
4. Provide reverse return design to at header connection to boiler.
5. Boilers shall control primary pumps in a primary/secondary configuration. BMS system shall control secondary pumps.
6. Size boilers so that when one unit is out, the remaining unit(s) shall provide 70% of the anticipated block load.
7. Measures shall be accounted for to protect boilers from low return water temperatures (as applicable).
8. Water storage shall be provided (as necessary) to supplement the piping system, so to assure minimum recommended volume requirements.
9. Measures shall be accounted for to allow for a hot water supply temperature reset strategy.

PART 2 - PRODUCTS

A. Water-tube boiler:

1. Manufacturers:
   a. Parker
   b. Cleaver-Brooks
   c. Lochinvar
2. Component Characteristics:
   a. Provide Low Nox hot water boilers that meet minimum state and local efficiency and emission standards.
   b. Provide “low fire hold aquastat” to keep burner at low fire position until the water in the boiler reaches 212°F (to prevent thermal shock to tube sheets). Once water reaches 212°F, burner modulating control shall be released to normal function.
   c. Provide a microprocessor-based boiler management control system with remote communications package and software package to interface with a 3rd party facility management system. Boiler management control system and remote communications package shall be capable of providing the 3rd party facility management system a 4-20 mA signal indicating the burner rate of (0-100%) updated once every 5 seconds (minimum).
   d. Where available, native boiler controller shall be specified to match the same manufacturer as the anticipated building management system standard, so to assure seamless connection and integration.

PART 3 - INSTALLATION

A. The Contractor shall install the boiler with adequate clearances to allow removal of the boiler bundle, without the need to remove the entire boiler.

B. Arrange gas and hot water piping to facilitate boiler bundle removal and future removal of the boiler.

PART 4 - EVALUATION

A. List of items or systems requiring testing, evaluation, verification, or commissioning: Required Items: Boilers, manifolded flue configurations.

B. Documentation required:

1. Test reports: Testing, Adjusting, and Balancing reports. Commissioning report.
2. Factory testing: Combustion efficiency report.
3. On-site testing: Combustion efficiency report for boilers with manifolded flues.
4. South Coast Air Quality Management certificate: Boilers.
5. UL listing.
6. Provide onsite Combustion Efficiency testing of all boilers working under simultaneous use and using a common manifolded flue.

END OF SECTION

SECTION 23 57 00
HEAT EXCHANGERS FOR HVAC

PART 1 - GENERAL

1.01 REQUIREMENTS

A. Design considerations specific to components in this section:

1. ASME stamp per Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Calculate required size of unit to produce the output shown after deducting for scale formation of tube surfaces using a fouling factor of 0.0005.
3. Temperature range for operation will be a maximum of 180°F. Applications that allow for a sliding temperature scale shall be 180°F at 32°F outside air temperature and 120°F at 65°F outside air. These systems shall also shut off at about 65°F outside air. The circulation pumps on these systems will run for a minimum of 10 minutes after the steam has been shut down to eliminate the possibility of the temperature of the exchanger exceeding the 180°F.
4. Steam relief valves shall be at 125 psi, at size of heat exchanger, with vents piped to the outside of the building above the roof line away from overhangs and air intakes.
5. Hot water relief shall be at 75 psi, at size of heat exchanger, and piped to a sanitary drain.
6. Provide reverse return piping design at header of heat exchanger.
7. When selecting heat exchanger, consideration shall be given to available steam supply pressure at specific building site or region of campus as well as estimated upstream pressure drop associated with piping accessories and control devices.
8. Any space housing steam generating or consuming systems, (Mechanical or Plumbing steam rooms) shall be properly naturally ventilated, in order to maintain room temperatures not to exceed 85°F.
9. Do not air condition where ventilation will suffice in tempering steam rooms.
10. Do not select unit from manufacturer's catalog rating. See above.

PART 2 - PRODUCTS

A. Steam-to-water heat exchanger:

1. Manufacturers:
   a. Bell and Gossett
   b. Armstrong
2. Component Characteristics:
   a. Heat exchanger: Multi-pass, U-tube; steel shell, 125 psi W.P.; ASME Stamp label steam in shell, water in tubes.
   b. Copper tube 5/8 inch outer diameter or larger, 125 psi W.P.; removable tube bundle; cast iron divided head with matching flange and with non-asbestos gaskets.
   c. Steel tube sheets and baffles
   d. Attached metal name plate stating pressure rating and size of exchanger.
   e. Shell of heat exchanger shall have ¾ in NPT vacuum breaker installed in the designated connection.
   f. Equipment schedule shall designate number of tubes per pass, number of passes and total exchange surface.
   g. Support frame and saddles shall be steel that is galvanized or painted to protect it from

corrosion.

PART 3 - INSTALLATION REQUIREMENTS

A. Gages shall be 3” minimum and placed in a manner that are easily visible from the service area.

B. Frame for support of heat exchanger and associated equipment shall be installed so as to not interfere with the service of the equipment and be structurally sound.

C. Steam traps shall be piped with unions to allow removal and installed in such a manner as to allow ease of removal

D. Ensure that full tube clearance is available without significant disturbance to adjacent piping or equipment, including valves and instrumentation at these HX connection points.

E. Safety pressure relief valves shall be provided and installed on the leaving water side of these systems.

PART 4 - EVALUATION

A. List of items or systems requiring testing, evaluation, verification, or commissioning: Required Items: Heat Exchangers.

B. Documentation required:

1. Test reports: Testing, Adjusting, and Balancing.
2. Commissioning report.
3. ASME stamp: Steam-containing Heat Exchangers

END OF SECTION

SECTION 23 64 00
PACKAGED WATER CHILLERS

PART 1 - GENERAL

1.01 REQUIREMENTS

A. Design considerations specific to components in this section:

1. Required:

2. The following chiller types shall be used based on size of chiller:

Size	Chiller Type	Comments
<300 tons	Water-cooled screw/scroll	These types of chillers are not acceptable if intent is to connect onto and supplement the campus central chilled water loop/utility.
≥300 tons	Water-cooled centrifugal	
* Note that capacities listed are nominal tonnage. These may vary based on chiller type and manufacturer.		

a. The designer shall analyze the chiller and make a recommendation prior to committing to any chiller manufacturer.
b. Chiller efficiency and scheduled selection shall be based on chiller load profile according to its intended use, lead, lag, or standby and the overall chiller plant application part load values (APLV).. Fixed and variable speed drives shall be considered.
c. Size chillers so that when one unit is out, the remaining units shall provide 70% of the anticipated block load. Consideration for load profile will be given when proposing to deviate from this requirement.
d. Chiller selection and design shall allow for a primary variable operation and an 18-20°F temperature drop across the evaporator for chillers that are intended to be connected onto and become part of systems that make-up and supplement the campus central loop/utility.
e. Provide an expansion tank and air separator on all chilled water systems. Air separator to be located in the piping on suction side of pump. If building chillers to be connected onto and supplement the campus, expansion tank shall be piped and means shall be provided so it can be divorced from system when chiller is not in stand-alone mode, in which case system expansion is addressed centrally.
f. On primary/secondary piping arrangements, locate the de-coupler loop upstream of the takeoff to the first set of secondary pumps. De-coupler loop length is to be minimized, but no less than 6 equivalent piping diameters. Locate a temperature sensor in the middle of the de-coupler pipe The maximum pressure drop through the de-coupler pipe at maximum flow is not to exceed 1.5 ft head (total).
g. Appropriate structural and architectural building systems shall be accounted for and installed to allow for future removal and potential replacement of packaged water chiller equipment's. At minimum, means for disassembly of the largest equipment components shall be accounted for, along with consideration for rigging of such equipment's.
h. Design of refrigeration room shall adhere to local code and ASHRAE or other appropriate industry guideline to provide means and systems for proper ventilation and space pressurization control during normal and purge operating modes.
i. Water storage (often in the form of storage/buffer tank) shall be provided as to supplement the piping system, so to assure manufacturer recommended minimum

chiller volume requirements to maintain minimum loop time, This loop time shall not be below 5 minutes.

j. Provisions for connection of temporary chilled water systems, sized to match full design requirements, shall be accounted for.
k. Perform electrical short circuit analysis to properly validate rating and type of starter, as appropriate and applicable.
l. Primary/secondary pumping or variable speed pumping shall be considered where there are three or more chillers.

PART 2 - PRODUCT

2.01 PRODUCT REQUIREMENTS

A. Water chillers:

1. Manufacturers:

a. Trane or approved equal acceptable to District.

2. Component Characteristics:

a. Provide interactive control interface adjacent to machine. Interface shall have capability of monitoring and maintain full local control/operation of machine operation, along with diagnostic capabilities.
b. Provide appropriate control modules so specific control and monitoring points can be hardwired directly from equipment to Building Automation System including start/stop, stats, and alarm. Coordinate with USC FMS for identification of specific points required.
c. The entire system shall be capable of being monitored by the campus BMS interface and all data shall be provided in an open protocol with all necessary BacNet or Modbus gateways provided free of charge.
d. Provide factory-applied insulation over all cold surfaces.
e. Hinged water boxes on the condenser side.
f. Condenser tube sheet and head coating with approved product
g. Where applicable, chiller starters (including where VFDs specified) shall be unit mounted on chiller by manufacturer.
h. Consider using chillers with variable frequency drives for increased operating efficiency.
i. Hinged water boxes on the evaporator side.

B. Refrigeration detection system:

1. Manufacturers:

a. Honeywell - Vulcain
b. Genesis International - Sherlock

2. Component Characteristics:

a. Refrigerant detection system shall be specified for the anticipated refrigerant to be utilized in the refrigerant machinery room.
b. System shall be integrated and tied into fire alarm system, as dictated by appropriate code sections.
c. Provide UPS backup power and emergency power to refrigerant detection system. Coordinate with electrical engineer for provisions.

PART 3 - INSTALLATION

A. Provide low point piping, valves, and appropriate drains directly off chiller equipment or in piping directly adjacent to tube points of connection to allow for drainage.

B. Final piping connections to chiller barrels shall be done with braided stainless steel piping connections. Any other means shall be submitted for approval.

C. Flanges or mechanical grooved couplings are required within connecting pipes to individual evaporator and condenser bundles to accommodate swing-away or break-away applications for maintenance access of evaporator and condenser tubes. Note that breakaway piping at tube-pull application is the only application in which mechanical grooved couplings are allowed.

D. Refrigerant relief piping shall be hard piped (rigid) out to atmosphere and terminated at code appropriate location. At the point of connection to the rupture disk, provide flexible metal type connections.

E. Maintain manufacturer's guidelines for minimum clearances.

F. Account for adequate space above and adjacent to large equipment components (compressors, drives, etc.) to allow for clearances needed to erect and utilize rigging equipment and the means for removing these components for future service or replacement.

G. Provide enough clearance (on at least one end of machine) so that access to tube sheets and ability to achieve full tube pull, on both condenser and evaporator sides, may be accomplished.

H. Install electrical conduits and wiring so as to not hinder and interfere with serviceability of the machine by infringing on regions around machine requiring access clearances.

I. Install refrigerant detection control panels and system related accessories in accordance with local code and appropriate ASHRAE guideline through a coordinated effort with a combination of the project Electrical (Division 26), Controls/Low Voltage, and Fire Alarm designer's.

J. Provide independent sensors for BMS system for redundancy to verify chiller sensor readings to measure the following:

   1. CHW supply and return temperature in/out

   2. Differential pressure across evaporator and condenser

   3. Separate measuring devices to measure flow and other parameters needed to calculate kw/ton

K. Include provisions to serve building design loads, or full plant capacity (where serves multiple buildings) with temporary systems. This shall include additional piping and valving, allowing for quick connection of temporary chilled water systems. Where full building line size, or where CHW plant supply line size exceeds 8", headers with multiple connections (in any combination of 4", 6", and 8") shall be included. Individual connections shall include line size isolation valves and flanged 12" spool pieces as the point of connection for temporary systems. Locate and design these provisions, so to allow for the utilization of base building / plant pump systems, along with temporary chillers.

L. Rubberized products for final piping connections to chiller barrels and for connections from rupture disk to refrigerant relief piping are not allowed.

M. Control or monitoring accessories and related instrumentation shall not be allowed in sections of pipe downstream of local system isolation valves.

PART 4 - EVALUATION

A. List of items or systems requiring testing, evaluation, verification, or commissioning: Required Items: Chiller, Refrigerant Detection System.

B. Documentation required:

   1. Test reports: Testing Adjusting and Balancing.

   2. Commissioning report.

3. In-person witnessing for Field test results:
   a. Initial state Eddy Current analysis of tubes.
4. Factory test results: Factory test for performance and sound.
   a. Extent of performance scenarios to be coordinated with USC.
5. UL listing: Chiller.

END OF SECTION

SECTION 23 65 00
COOLING TOWERS

PART 1 - GENERAL

1.01 REQUIREMENTS

A. Design considerations specific to components in this section:

1. Based on trend data gather locally by weather station, design wet bulbs in the vicinity of the district's campuses with industry guidelines or Title 24 appendix information, this value shall prevail as the basis for selection of these systems.
2. Piping arrangement for cooling towers shall be designed such that flow to and from the tower is hydraulically balanced to ensure equal flow distribution to and from each tower cell.
3. Provide a condenser water pump dedicated to each chiller within the chilled water plant. Provide manual cross-over valves and headering to allow each pump to serve as a backup to other system pumps and support any chiller in overall system.
4. Coordination of cooling tower basin sweeper/filter system and the proposed pipe distribution/placement of nozzles within the cooling tower basin shall be done along with the manufacturer representatives of both systems.
5. Tower manufacturer shall provide sound level data for analysis by an acoustical engineer.

PART 2 - PRODUCTS

A. Cooling towers:

1. Manufacturers:
   a. Baltimore Air Coil
   b. Evapco
   c. Marley
2. Component Characteristics:
   a. Wetted section of tower shall be (Type 316) stainless steel.
   b. Non-wetted section of tower shall be (Type 304) stainless steel.
   c. Provide each fan section that makes up a modular cooling tower system with a variable frequency drive when motor is 7.5 Hp or greater.
   d. Provide adequately sized equalizer line with valves to permit each lower basin to be isolated for cleaning.
   e. Manufacturer shall engineer and furnish a sweeper system including pumps, filtration, piping, and nozzles for the specific application. Provide available gateway interface for interconnection with District's BMS.
   f. Provide electronic basin level control and capability for monitoring and mechanical level control. BMS shall monitor basin level status.
   g. Provide flow meter connected to central BMS to measure make-up water usage. Meter shall be specified with a dual output relay and shall connect to both the central BMS and the chemical treatment controller.
   h. Provide flow meter connected to central BMS to measure blow-down from condenser water system. Meter shall be specified with a dual output relay and shall connect to both the central BMS and the chemical treatment controller.
   i. Provide tower with a field-adjustable, acceleration-sensitivity set point in a range of 0 to 1 g and frequency range of 0 to 3000 cycles per minute. Cooling tower manufacturer shall recommend switch set point for proper operation and protection. The vibration cut out switch shall be tied into local fan control equipment. Provisions shall be

provided so this point is monitored by BMS.

j. Where towers made up of multiple cells, provisions shall be included to allow for the isolation and maintenance of each cell independently, without requiring a shutdown of the entire system.
k. Manufacturer provided equipment davit to facilitate removal and rigging of equipment (fan motors, etc.). If not provided by manufacturer, a suitable davit system shall be designed and specified.
l. Entire body of tower to be (Type 316) stainless steel.
m. Where systems deemed critical to the campus or part of a building deemed critical, provide redundant means (both a mechanical and an electronic means) of tower level control.

PART 3 - INSTALLATION

A. Provide internal or external ladders, walkways, service platforms, and guardrails as factory-mounted accessories for proper maintenance access.

B. Provide additional equipment davit(s) on cooling tower service platform (as applicable) to facilitate removal and rigging of equipment (fan motors, etc.) up and down from grade or roof level.

C. Provide isolation for each cooling tower cell by means of BMS and two-way control valves to allow for quick shutdown and maintenance on an individual tower while maintaining operation of the remaining towers. Isolation required for supply, return, and equalizer.

D. Provide blow out flanges at each end of equalizer line to allow for the removal of the piping for sand cleaning and flushing trapped in line.

E. In addition to the tower basin, and in order to avoid the build-up of sedimentation due to stagnation of water, provide connections to the sweeper/filter system at the following locations (including isolation valves at each point).

1. At each main connection leaving the tower from the respective basin(s).

2. At minimum, two equally spaced connections to the equalizer line

F. Instrumentation necessary to monitor vibration and direct tie in to fan controller for shutdown when exceeding acceptable thresholds.

PART 4 - EVALUATION

A. List of items or systems requiring testing, evaluation, verification, or commissioning: Required Items: Cooling Tower

B. Documentation required:

1. Test reports: Testing, Adjusting, and Balancing.

2. Commissioning report.

3. Factory test results: CTI ATC-105 test results.

4. Onsite test results: Dynamic balancing test reports. Automatic fill operation report UL listing: Cooling Tower.

C. Required testing protocols beyond normal Commissioning and TAB protocols:

1. Operate cooling tower and field adjust vibration switch sensitivity. Operate variable-speed fans through entire operating range and check for harmonic vibration imbalance. Set motor controller to skip speeds resulting in abnormal vibration.

2. Verify that automatic fill valve responds properly to low and high water levels, and adjust limits as necessary.

END OF SECTION

SECTION 23 73 23
CUSTOM CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The scope below shall cover both indoor and outdoor air handling units. Any units installed outdoors shall be specifically designed for outdoor use and shall have standing seam construction, a pitched roof to ensure rain runoff and all panels caulked to be watertight. Outdoor units shall have a hinged weather hood over the filter gauge and NEMA 3R enclosures for VFDs.

B. The following shall be considered minimum standards, yet designers shall apply these standards appropriately and expand upon them when specifying this equipment for critical or specialty environments, in which case stricter standards may be applied.

1.02 REQUIREMENTS

A. Design considerations specific to components in this section:

1. All air handling units shall be custom units.
2. Perform electrical short circuit analysis to properly validate rating and type of starter, as appropriate and applicable.
3. The following standards on subcomponents shall prevail:
    a. Exterior finish paint to have passed Salt Spray Resistance Test ASTM B-117-90 minimum 1000 hours, Impact Test ASTM D-2794-90 up to 160 lbs and Humidity Resistance Test ASTM D2247-87 minimum 1000 hours test with maximum blister 1/16 in/1 mm.
    b. Fabrication: Conform to AMCA 99 and ARI 430.
    c. Fan Performance Ratings: Conform to AMCA 210 and label with AMCA Certified Rating Seal.
    d. Fan Sound Ratings: AMCA 301; tested to AMCA 300 and label with AMCA Certified Sound Rating Seal.
    e. Motors shall be tested to IEEE Standard 112 test method B and NEMA MG 12.58.2 and 12.59 table 12-10.
    f. Air Coils: Certify capacities, pressure drops and selection procedures in accordance with ARI 410.
    g. Louvers: shall bear an AMCA Certified Ratings Seal in accordance with AMCA 500.
    h. Humidifiers: Capacities and selection in accordance with ARI 610.
4. Provide structure to brace casings to achieve a maximum deflection of 1 in 200 for the greater of anticipated system pressures or the following criteria:
    a. Suction pressure of at least 2.5 inch wg
    b. Supply discharge pressure of at least 6 inch wg.
5. Floor and base of unit shall have a maximum 1/8 inch deflection.
6. For duct connections through the floor, provide steel or aluminum walking grate on structural supports.
7. Motors shall be 1750 rpm.
8. When belt drive equipment is used, variable and adjustable pitch sheaves for motors 10 Hp and under shall be selected so required rpm is obtained with sheaves set at mid-position; fixed sheave for greater than 10 Hp, matched belts and drive rated as recommended by manufacturer or minimum 1.5 times nameplate rating of the motor.

9. Factory mount motor on slide rails. Mount fan and motor on independent welded structural steel base. Mount independent base on vibration isolators for connection to Air Handling Unit's structural steel frame.
10. Provide access to both sides of coils.
11. Slide coils into coil casing through removable end panel with blank off sheets and sealing collars at connection penetrations.
12. Damper Leakage: Maximum 2 percent at 4 inch W.G. differential pressure when sized for 2000 fpm face velocity.
13. Fans shall be supplied with a flow measurement system that provides pressure measurements to pressure transmitter provided by BMS contractor. The manufacturer must select the fan to compensate for any effect that this measurement system has on flow, static pressure or sound power.
14. All unit controls conduit distribution and device infrastructure shall be factory mounted and shall interface with the university standard Energy Management System (see independent controls guideline). At minimum this distribution shall include continuous 1" conduit throughout entire length of air handler, with junction boxes provided at each section of these units.
15. All unit fire / life safety conduit distribution and device infrastructure shall be factory mounted and coordinated to interface with the existing or proposed building fire alarm system. At minimum this distribution shall include continuous ¾" conduit throughout entire length of air handler, with junction boxes provided at each fan section.
16. Provide factory mounted entry pathways for controls and fire/life safety conduit distribution, so to avoid field penetrations into air handling unit.
17. Design of air handler base shall take into account the future anchorage requirements. A strategy shall be developed to avoid field welding of anchorage plates (where possible) or otherwise provide a plan to not compromise the factory coating when anchorage activities are taking place.
18. All systems shall be laid out to allow for unobstructed full coil pull along one side of the air handler. Engineer shall present explicit plan and procedure by which coils are pulled in future retrofit applications and identify details in air handler construction and piping arrangements to allow this to happen in a way that minimizes interference with piping and piping supports and does not require a complete hydronic system shut-down.
19. Designers shall coordinate the selection of related fire/life safety devices to be compatible with the existing fire alarm system type and capability.
20. Where smoke detectors are factory furnished and mounted, they shall be powered from a source independent to the air handling unit and other unit appurtenances.
21. Smoke detectors installed for the purpose of shutting down fan systems (not part of smoke control systems), shall be specified with an auxiliary means of being monitored by the BMS. This shall not impact the primary monitoring or control of this device when connected to building fire alarm.
22. Provisions for fan section door switches / contacts, to be interlocked with local motor controller for shut down of fan system when opened.
    a. To accomplish requirement, overall wiring diagram shall be coordinated, accounting for the pre-wiring of the air handling unit and the proper means for terminating onto the local motor controller.

B. Preferred:

1. Coil pull clearance shall be on the opposite side of coil connections to avoid significant re-piping.
2. Air handling unit smoke detectors to be factory furbished and mounted, with the appropriate enclosures and a dedicated conduit pathway throughout.
3. Modular air handling units not permitted

PART 2 - PRODUCT S

A. Air Handling Unit:

1. Manufacturers:

a. Air handler:

1) Energy Labs
2) Huntair
3) Thermal
4) Climate Craft
5) Temtrol
6) Haakon

b. Pre-filters: Flanders FAP-300 Series: Flat 2 inches deep, 30% efficiency per ASHRAE standard 52.1.
c. Primary filters: Aerostar FP Series 12" deep, 95% efficiency per ASHRAE standard 52.1.
d. Filter holding frame: Burke Environmental Astr-Frame Model ASF(304 SS)
e. Filter frame sealant: DOW 732 silicone sealant
f. Filter Gage: Dwyer Model 2002 AF
g. Louver: Ruskin.
h. Dampers: Ruskin

2. Component Characteristics:

a. Provide either bolted panel construction or unit with integral tubular frame. Fabricate on welded tubular steel or structural steel channel
b. Assemble sections with gaskets and bolts or fasteners.
c. Panels are to be removable.
d. The floor shall be either attached to the structural members below with cad-plated neoprene washered drive screws or shall be continuously welded.
e. Air handling unit structural frame shall be elevated a minimum of 12” above finished floor or roof or at an elevation to allow proper trapping of condensate, whichever is greater.
f. OSA Intakes: Provide (2) dampers on outside air intake, one sized for minimum outside airflow plus 10%, one sized for the remainder of flow to achieve economizer flow. Provide outside air extensions on outdoor units to allow for proper installation of outside air monitoring sensors. Provide a factory mounted cover over outside air intakes to protect from rain intrusion.
g. Unit Construction materials shall be as follows:

Unit Construction		
Location	**Material**	**Comments**
Outside Casing	16 ga. G90 Galvanized	Finish to be Polyceram 3200, powder coated finish-baked at 375 degree F or air dried Carboline Polyurethane.
Inside Casing except fan section	20 ga. G90 galvanized, solid	

Unit Construction		
Location	**Material**	**Comments**
Inside Casing for fan section	22 ga. G90 galvanized, perforated	
Insulation	Neoprene coated, glass fiber, Minimum 2 inch thick, 3 lbs/cu ft. "K" value (at 75°F)≥ 0.26 Btuh/(inch.sq ft.°F)	Attach with adhesive and weld pins with exposed edges of insulation coated with adhesive
Floor	16 ga. G90 galvanized steel with 20 ga. Galvanized steel underliner	Provide a minimum of 4" thick insulation, “K” value as noted above.
Base structure, fan bases, springs and structural steel supports	As noted elsewhere.	Shall be painted with an industrial DTM finish with built-in rust inhibitors
Walk-in Access Doors	Minimum 24 inch wide, flush-mounted, galvanized steel insulated sandwich construction. Door frame shall be extruded aluminum and incorporate a built-in thermal break barrier.	Provide 12 X 12 inch inspection window of 1/4 inch thick plexiglass or dual thermal pane. Hinges, gasket, latch and handles shall operable from both sides. Access doors into fan compartments shall have a tool operated safety latch, complying with Title 8 CAL- OSHA, ETL and the mechanical protection requirements of UL 1995.
Drain pans under cooling coil section and humidifier section	16 gage stainless steel type 304 inner liner, 20 gage G-90 galvanized under liner with insulation between.	Provide double sloped IAQ drain pan, pitched to single drain connection. Provide welded corners. Provide for length of 24 inch downstream of coil. Provide copper down spouts and intermediate drain pan for cooling coil banks more than one coil high
Lights for all accessible sections	Suitable for damp locations with wire guards.	Factory wire to exterior mounted 0-6 hr twist timer, adjacent to supply fan door.
Receptacles at all light switches	One GFI 120V duplex outlet mounted on casing exterior next to lighting twist timer.	Lights and duplex outlet must be on a separate 120V/single phase power circuit than power to the unit.
Louvers	Stationary, drainable, galvanized steel, 4 inch deep.	Provide bird screen in aluminum frame consisting of 1/2 inch mesh, 0.04 inch thick galvanized wire.

h. Unit Components shall be as follows:

Unit Components		
Location	**Material**	**Comments**
Filter Gage	3½ inch diameter diaphragm actuated dial in metal case with static pressure tips.	Gage to be mounted flush- faced to exterior of unit.
Filter frames (Refer to 23 40 00 for filters)	Upstream Face-loading "built up bank type". All welded 16 gage 304 stainless steel construction.	Filter section shall consist of individual holding frames that are factory assembled into a multi frame filter bank. Assembling of frames shall be accomplished with use of stainless steel screws and nuts. Welds shall be continuous on all matching joints and miters. All raw edges shall be deburred. Gasketing shall be applied to the perimeter of each holding frame. Filters shall compress gasket under positive pressure under normal flow. Also provide clamping assembly to hold filters in place.
Prefilters	Disposable extended area panel filters.	UL 900 listed, Class I or Class II, approved by local authorities.
Final filters	Low-resistance mini-pleat, V-bank rigid filter	UL 900 listed, Class I or Class II, approved by local authorities.
Fan	Air foil,Backward inclined single width, single inlet, centrifugal plug type fan. Refer to Section 23 34 00 for more requirements.	Provide AMCA arrangement 1 with unobstructed inlet. Provide plug fan inlet screen and protective enclosure around fan wheel, with access into unit for motor, drive and bearings. Provide flexible duct connection between fan and inlet wall opening. See design criteria for mounting configuration requirements.
Fan Bearings	Self-aligning, grease lubricated, ball or roller bearings	Extend lubrication to exterior of casing with plastic tube and attach grease fitting rigidly to casing.
Motors	Premium efficiency TEFC, NEMA Design B T-Frame motors, cast iron frame, inverter duty rated if provided with VFD (see section 23 05 13	Motors shall be wired to an external junction box. Motors shall have shaft bearing grounding kits installed to prevent excessive bearing wear due to VFD operation. See design criteria for mounting configuration requirements.

Unit Components		
Location	**Material**	**Comments**
	and 23 05 14 for more for requirements).	
Motor Bearings	Heavy duty pillow block type, self-aligning, grease-lubricated ball bearings	Provide bearings with ABMA 9 L-10 life of 200,000 at design operating conditions.
Shafts	Solid, hot rolled steel, ground and polished, with key-way and protectively coated with lubricating oil.	
V-Belt Drive (if belt driven)	Cast iron or steel sheaves, dynamically balanced, bored to fit shafts and keyed.	See design requirements for belt drives above.
Belt Guard (if belt driven)	0.106 inch thick, 3/4 inch diamond mesh wire screen welded to steel angle frame or equivalent, prime coated.	Fabricate to SMACNA HVAC Duct Construction Standards - Metal and Flexible. Secure to fan or fan supports without short circuiting vibration isolation, with provision for adjustment of belt tension, lubrication and use of tachometer with guard in place.
Hydronic Preheat and Cooling Coils	Serpentine type. Die formed channel frame 16 gage 304 stainless steel casing. Seamless copper tube drainable header. Tubes: 5/8 inch OD seamless copper, 0.020 thickness, expanded into fins, brazed joints.Fins: Copper, 0.008 thickness, or an aluminum fin with approved means of coating. Refer to 23 82 16.	Headers and return bends are to be fully contained within casing. Pipe 1/8 inch header vent and header drain connections to outside of unit. Return bends shall be a minimum of one tube thickness greater than the main tubes.

Unit Components		
Location	**Material**	**Comments**
Humidifier Dispersion Grid (as required)	Stainless steel distribution tube with evenly spaced orifices extended full width of unit	Factory- mount in plenum for draw-through units or diffuser section of blow-through units.
All Dampers	Factory-mounted Airfoil, extruded aluminum blades and santoprene rubber edge seals, 16 gage galvanized frame, stainless steel side jamb seals with stainless steel or zinc plate tubular square shafts, self-lubricating nylon non corrosive bearings	Provide dampers in parallel blade arrangement.

i. Formed metal bases are not acceptable.
j. Riveted or spot welded panels are not acceptable.
k. Welding or riveting of filter frames is not acceptable.

PART 3 - INSTALLATION

A. A separate 120V/single phase power circuit shall be provided to connect to the light/receptacle circuit of the air handling unit. Lighting shall be controlled via a 0-6 hour twist timer housed in a weatherproof enclosure.

B. Install unit in accordance with ARI Guideline D and in accordance with manufacturer's instructions.

C. Bolt sections together with gaskets.

D. Do not operate units until ductwork is clean, filters are in place, bearings are lubricated, commissioning pre-functional test procedures are complete, fan has been test run under observation by manufacturer start-up technician and all start- up and pre-functional documentation has been reviewed and approved by USC's commissioning agent.

E. Provide one set of additional filters for each unit.

F. Supply one set for each unit of fan belts.

G. Install isolated fans with resilient mountings and flexible electrical leads. Install restraining snubbers as required. Adjust snubbers to prevent tension in flexible connectors when fan is operating.

H. Provide fixed sheaves required for final air balance.

I. Make connections to coils with unions or flanges. Connect water supply to leaving air side of coil (counter flow arrangement). Provide manual air vents at high points complete with stop valve. Ensure water coils are drainable and provide drain connection at low points.

J. Insulate coil headers located outside air flow as specified for piping.

K. Connect humidifiers to water supply. Provide gate valve on water supply line. Provide 3/4 inch hose Bibb accessible from interior. Pipe drain and overflow to nearest floor drain.

L. Install flexible duct connections between fan inlet and discharge ductwork and air handling unit sections. Ensure that metal bands of connectors are parallel with minimum one inch flex between ductwork and fan while running.

M. Where unit requires field assembly of major sections by contractor, factory witnessed or manufacturer certified inspection shall be completed to assure proper assembly.

N. Coordinate mounting and final anchorage strategy of equipment and its base, to associated support structure, in order to avoid compromising integrity of factory exterior finish due to welding or other field modifications when anchoring this equipment. Any welding of stiffeners, anchor plates, etc.; shall be done prior to unit arriving on site, and done so to avoid damaging base rail of cabinet of AHU.

O. Coordinate required air handler equipment pad edge distance to minimize unnecessary pad surface area, where ponding of water may occur.

P. Temporary filtration for units, through construction and startup, shall be accounted for and provided for both new and retrofit installations.

PART 4 - EVALUATION

A. List of items or systems requiring testing, evaluation, verification, or commissioning: Required Items: Air Handling Unit. Start-up required by factory representative or factory certified representative.

B. Documentation required:

1. Test reports: Testing Adjusting and Balancing.
2. Commissioning report.
3. Factory test results: Cabinet leakage test, Laboratory sound test.
4. UL or listing: Entire unit shall be UL or E.T.L. listed.
5. Factory Technician Start-up report

C. Required testing protocols:

1. Unit manufacturer shall provide a factory leak test on one unit at design operating static pressure. Cabinet leakage shall not exceed 1% of design flow rate at 12" WG. Manufacturer shall furnish a written report to the engineer.
2. The unit manufacturer shall test one unit at an AMCA accredited laboratory. Sound testing using a sound intensity meter is not acceptable. The unit shall be tested per AMCA 300-85 Unit Discharge and Return Sound Power Tests and Cabinet radiated Sound Power Test. A written report shall be provided showing the test results and the test methods used. The octave band sound power levels shall be determined via the reverberant room method in accordance with the latest version of ARI 260 or AMCA 300 standard in an AMCA certified laboratory. An alternate procedure approved by and details agreed to by the project acoustical consultant is also acceptable when based according and traceable to national or international standards. When submitting an alternate procedure, the alternate procedure shall be submitted with the first air handler submittal to allow for extra time in review by the project acoustical consultant. In addition, the manufacturer who is proposing the alternate procedure shall simultaneously submit a letter that agrees to pay for the project acoustical consultant's time and material fee up to a maximum of two man weeks of time to cover that amount of time related to the evaluation of the alternate procedure.

Evaluation of the alternate procedure is no guarantee that it will be accepted. The decision resides solely with the project acoustical engineer as to whether the alternate procedure will be allowed. If the alternate procedure is rejected, then the AMCA certified laboratory testing specified above must be done.

END OF SECTION

SECTION 23 81 26
SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.01 REQUIREMENTS

A. Design considerations specific to components in this section:

1. The use of these types of equipment shall be limited to areas requiring 24 hour cooling operation.
2. If the heat-generating equipment within the room is served by emergency standby power, then the DX system shall be on emergency power.
3. The split systems shall consist of controllers, in room thermostats, piping accessories, thermostatic expansion valve, and compatible condensers and in room fan coil units with total system performance guaranteed by the manufacturer.
4. A dedicated split system shall be provided for each space which requires 24-hour cooling operation.
5. "Multi-Split" type units which serve multiple spaces with a single outdoor condensing unit, is not permitted.
6. Condensate drains should be designed to be gravity fed if possible to eliminate need for condensate pumps.

PART 2 - PRODUCT

2.01 PRODUCT REQUIREMENTS

A. Split-System Air-Conditioners:

1. Manufacturers:
   a. Carrier
   b. Trane
2. Component Characteristics:
   a. Provide head pressure controls to allow for stable unit operation at low ambient conditions.
   b. Provide hot gas bypass option in single compressor equipment for low load conditions.
   c. Provide hot gas reheat option in equipment requiring humidity control.
   d. Provide a primary stainless drain pan and a secondary galvanized steel drain pan.
   e. Provide independent thermostat and controller.
   f. Refer to Section 23 2300 for refrigerant piping requirements.

PART 3 - INSTALLATION

A. Required:

1. BMS shall provide an independent temperature sensor for monitoring located next to the split-system thermostat.
2. Hard-wired, wall mounted, thermostat shall be provided.

B. Installation of fan coil units above sensitive electric/electronic equipment.

PART 4 - EVALUATION

A. List of items or systems requiring testing, evaluation, verification, or commissioning: Required Items: Split Systems

B. Documentation required:

1. Test reports: Testing, Adjusting, and Balancing.
2. Commissioning report.
3. UL listing: Split Systems.

END OF SECTION

SECTION 23 81 45
PACKAGED VARIABLE REFRIGERANT FLOW SYSTEMS

PART 1 - GENERAL

1.01 REQUIREMENTS

A. Design considerations specific to components in this section:

1. VRF/VRV systems will be considered on replacement projects where the job site conditions are such that replacement with “like kind” or approved systems would require significant structural changes, or other major re- work, resulting in substantial occupant displacement, or if the project’s budget would be highly impacted. The A/E design team shall provide, during the assessment phase, an overall Life Cycle Cost breakdown of the VRF system as compared to other viable options. USC FMS will review the engineer’s assessment and provide a recommendation for the final design. Typical installations; retrofit of housing or 24-hour technical spaces.
2. The A/E design team shall evaluate the proposed VRF system and discuss with District.
3. The Mechanical Engineer will assume full design responsibility for VRF system selection, layout, details and coordination. The VRF manufacturer shall provide support/supervision during the following stages: design development, shop drawing development, field installation/verification, start-up and commissioning. The Engineer shall not rely solely on the design direction provided by the VRF manufacturers’ representative.
4. The condenser will be sized to meet the maximum block cooling load.
5. Refrigerant:
   a. The Mechanical Engineer shall include, within plans, a hazard assessment which considers a potential refrigerant leak anywhere along the proposed refrigerant pipe route. The assessment shall identify the maximum allowed refrigerant quantity, the proposed refrigerant quantity and the volume of the room(s) that may be exposed to the refrigerant leak.
   b. Calculations shall be performed to ensure the maximum allowed refrigerant charge is per ASHRAE Standards 15 & 34. A refrigerant chart, identifying maximum allowable refrigerant per code vs actual design quantities are to be provided on the design documents.
6. If the heat-generating equipment within the room is served by emergency standby power, the VRF/VRV system shall be on emergency power.
7. The systems shall consist of controllers, in room thermostats, piping accessories, thermostatic expansion valve and compatible condensers and in room fan coil units with total system performance guaranteed by the manufacturer taking into account the likely range of loadings between the multiple fan coil units
8. Designer shall confirm sufficient clearances are provided for the air-cooled condensers. These clearance requirements shall be clearly indicated on the construction documents.
9. Indoor air-cooled condensing units shall be avoided unless ducting of inlets and outlets is provided.

PART 2 - PRODUCT

2.01 PRODUCT REQUIREMENTS

A. Variable Refrigerant Flow Systems:

1. Manufacturers:

a. Mitsubishi
b. Daikin
c. LG

B. Component Characteristics:

1. Project specifications shall require start-up and training by the VRF manufacturer be provided.

2. The proprietary central VRF/VRV controller shall interface with the central BMS. The system shall be furnished with the necessary BACnet Broadcast Management Device (BBMD) or appropriate devices/equipment which will allow full monitoring and control to aid in system troubleshooting.

3. All control points shall be accessible from the central BMS. At a minimum, the following control points shall be implemented into the central BMS:

Control Point	**BMS Interface**
System Enable/Disable	Full Adjustment
Supply Air Temperature (SA temp)	View
Return Air Temperature (RA temp)	View
Space Temperature	View
Space Temperature Setpoint	Full Adjustment
Filter Status	View
Fan Status	View
Compressor(s) Status	View
Economizer Damper Position (as applicable)	View
Alarm(s)	View
Any other Diagnostic points required by CEC Title 24 (automated fault detection & diagnos- tics, etc.)	View
Note: These control points shall be coordinated with the VRF/VRV manufacturer. The engineer is responsible for providing all associ- ated control diagrams, control points lists and interface require- ments on the construction documents.	

4. The system shall consist of multiple evaporators, branch selector devices, piping joints and headers, all refrigerant piping accessories, a refrigeration distribution system using PID control and an outdoor unit.

5. The outdoor unit shall be a direct expansion (DX), air-cooled heat pump, multi-zone air-conditioning system with variable speed driven compressors. The outdoor unit may connect an indoor evaporator capacity up to 150% of the outdoor condensing unit capacity.

6. All zones are each capable of operating separately with individual temperature control.

7. The indoor units shall be connected to the outdoor unit(s) utilizing the manufacturer specified piping joints and headers.

8. Operation of the system shall permit simultaneous cooling and heating of all of the fan coil units.

PART 3 - INSTALLATION REQUIREMENTS

A. Only contractors who has experience shall be eligible for installation and implementation of VRF/VRV systems:

1. Installing contractor shall be certified for installation and servicing by the specified manufacturers.

B. The system shall be designed and installed with refrigerant isolation valves that would allow servicing of individual fan coils and condensing units without the complete loss of refrigerant.

C. Shut-down of a single fan coil unit (for service and/or repair needs) are to not affect the cooling capacity and operation of other fan coil units served by the same condensing unit.

D. Shut-down of a single condensing unit shall not impact operation of any other associated VRF/VRV system.

E. For 24 hour technical spaces, BMS shall provide an independent temperature sensor for monitoring located next to the in room fan coil units' VRV system thermostats.

F. Provide condensate pump if the fan coil unit cannot drain by gravity and the unit itself does not contain an onboard condensate pump.

G. Manufacturer's representative shall confirm in writing that the contractor's proposed installation paths for refrigerant piping and controls wiring are compatible with the stated performance of the system based on the design.

PART 4 - EVALUATION

A. List of items or systems requiring testing, evaluation, verification, or commissioning: Required Items: Condensers and Fan coil units within the Systems.

B. Documentation required:

1. Test reports: Testing, Adjusting and Balancing.
2. Commissioning report.
3. UL listing: Condensers and Fan coil units within the Systems.
4. Manufacturer's start-up technician's report verifying performance and explicitly reiterating the total performance guarantee.

END OF SECTION

SECTION 23 82 16
AIR COILS

PART 1 - GENERAL

1.01 REQUIREMENTS

A. Design considerations specific to components in this section:

1. Centralized cooling and heating (pre-heat) coils are required to have an approved coil coating as identified within.
2. Where air coils are be replaced as part of existing HVAC system retrofit, all accessories associated with isolation, measuring, and control of circuit (See standard de-centralized and centralized coil installation details, found in related section) shall be replaced with new and selected to match updated operating characteristics of the new air coil.
3. Stacked cooling coils shall be provided with intermediate condensate drain pans, and consistent with the requirements for these items, identified elsewhere in the overall Division 23 standards.
4. For new coils, coatings shall be one of the following:
   a. PVC
   b. Heresite
   c. Electrofin

PART 2 - PRODUCTS

A. Coils:

1. Manufacturers: As Selected by Designer
2. Component Characteristics:
   a. Use the following sizing criteria for cooling coils for buildings connected onto campus central chilled water utility:

Criteria for Centralized Air Handling Cooling Coils	**System**			
	Re-circulating		**Greater than 50% OSA**	
	VAV	**CAV**	**VAV**	**CAV**
Minimum Cooling Coil Depth (Rows)	8	8	10	10
Max Finned Area Coil Face Velocity	400 FPM	350 FPM	350 FPM	350 FPM
Minimum Fins Per Inch	10 FPI	10 FPI	10 FPI	10 FPI
Max Fins Per Inch	10 FPI	10 FPI	10 FPI	10 FPI
Max Air Pressure Drop	0.75”	0.75”	0.75”	0.75”
Design Inlet Water Temperature (ºF)	45	45	45	45
Design Leaving Water Temperature (ºF)	65	65	65	65
Max Supply Air DB Temperature Leaving Air Handler (ºF) 1. * Adjust leaving coil temperature based upon blow-	55*	55*	55*	55*

thru vs. draw-thru coil configuration. 2. * Refer to Section 23 0000 for appropriate tempera- ture based upon project requirements.				
Minimum Water Pressure Drop at 20ºF Temperature Differential	7’	7’	7’	7’
Max Water Pressure Drop at 20ºF Temperature Differential	10’	10’	10’	10’
Fin Material and Coating	See 23 732 3	See 23 732 3	See 23 732 3	See 23 732 3

b. For sizing criteria related to de-centralized equipment, refer to the equipment section’s stated criteria.
c. Use the following sizing criteria for heating coils:

Criteria for Heating Coils	Decentralized	Centralized
Minimum Heating Coil Depth (Rows)	2	2
Max Finned Area Coil Face Velocity	700 FPM	700 FPM
Minimum Fins Per Inch	8 FPI	8 FPI
Max Fins Per Inch	12 FPI	12 FPI
Fin Material	Aluminum fins, copper tubes, stainless steel casings.	See 23 7223

3. Preferred:
   a. Coil circuiting will typically provide the desired conditions for coil performance.
4. Disallowed: None

PART 3 - INSTALLATION

A. Shall be installed and piped in such a manner so local air vent is the primary (and only) high point in the branch piping circuit, between upstream main and coil.

B. Isolation valves, strainers (or approved valve kits containing any one of these items), to be installed in horizontal segment of branch piping associated with individual air coil.

C. Braided flexible connections at final connection to air coil. Associated piping and coil shall be installed and supported as to not impart load on flexible connections. Flexible connection length shall not exceed 12 inches.

D. Braided flexible connections other than at final connection to air coil is not permitted.

END OF SECTION

SECTION 23 82 19
FAN COIL UNITS

PART 1 - GENERAL

1.01 REQUIREMENTS

A. Design considerations specific to components in this section:

1. Refer to the following table for fan coil unit design criteria:

Fan Coil Unit Size	Design Criteria	Comments
≤ 2000 cfm	1. 45°F inlet water temperature 2. Maximum airside face velocity of 500 fpm at high speed.	Maximize water delta T with a minimum of 12°F temperature difference.
> 2000 cfm / < 5000 cfm	Refer to Section 23 82 16 for starting criteria *Note: Appropriate exceptions will be considered for this application, including semi-custom solutions.*	Use air handling unit cooling coil design criteria from 23 73 23 for starting criteria *Note: Appropriate exceptions will be considered for this application, including semi-custom solutions.*
≥ 5000 cfm	Refer to Section 23 82 16 for criteria.	Use air handling unit cooling coil design criteria from 23 73 23.

a. Design cooling leaving air temperature shall be 55°F from unit.
b. The fan coil shall meet all cooling and heating loads at the design criteria operating at medium fan speed setting as maximum. If there is only low and high fan speed options, select coils based on low fan speed.

PART 2 - PRODUCTS

A. Fan Coil Units:

1. Manufacturers:

a. Airtherm
b. USA Coil & air
c. IEC
d. International

2. Component Characteristics:

a. Blow-thru type with coil located downstream of the fan to trap fan heat.
b. Direct drive if offered as a standard product size.
c. Refer to Section 23 82 16 and table on previous page for cooling coil requirements.
d. Hardwired controller (thermostat) by fan coil unit manufacturer shall be provided unless otherwise noted.
e. Coordinate with USC FMS to determine if a secondary temperature sensor connected to the Honeywell EBI is required for monitoring purposes.
f. Provide MERV 8 throwaway filters upstream of cooling and heating coils per CAL-

Green requirements.

g. Provide stainless steel primary drain pans and galvanized steel secondary drain pans. Secondary drain pans shall extend beneath the unit as well as the coil connections.
h. Use direct drive for nominal CFM selections up to 1200 CFM (3 tons). Provide direct drive fan coil units whenever project manufacturer has direct drive fan coils in larger selections.

PART 3 - INSTALLATION

A. Install fan coil units in accessible areas (such as T-bar ceiling grid). If a fan coil is to be located over hard gypsum ceiling, provide a minimum 24" x 24" access panel. Access panel shall not require special tools unless otherwise noted. Coordinate location of access panel with architect.

B. Provide access panels positioned to allow access to and removal of all motors, fans, filters, and controls.

C. Primary condensate drain piping located within building (plenum, conditioned space) shall be insulated.

D. Where bottom access required for maintenance, secondary drain pan and associated piping shall be installed so to be easily demountable for service.

E. Temporary filtration for units, through construction and startup, shall be accounted for and provided for both new and retrofit installations.

F. Extend secondary condensate drain pans beneath hydronic control valves and associated trim, when the fan coil unit is located within a room housing electrical or electronic equipment.

PART 4 - EVALUATION

A. List of items or systems requiring testing, evaluation, verification, or commissioning: Required Items: Fan Coil Units.

B. Documentation required:

1. Test reports: Testing, Adjusting, and Balancing.
2. Commissioning report.
3. UL listing: Fan Coil Units.

C. List of items or systems requiring testing, evaluation, verification, or commissioning: Required Items: Coils.

D. Documentation required:

1. Test reports: Testing, Adjusting and Balancing.
2. Commissioning report.

END OF SECTION

SECTION 23 84 13
HUMIDIFIERS

PART 1 - GENERAL

1.01 REQUIREMENTS

A. Design considerations specific to components in this section:

1. Do not use humidifiers except where specifically required to meet narrow relative humidity space conditions as dictated by proposed space function.
2. Coordinate water quality or source requirements with Plumbing scope.
3. Provide humidity sensor in return duct if serving multiple spaces, otherwise provide for multiple space sensors that can be polled for overall control.
4. Provide humidification in the main supply duct or within air handling units.
5. Where application allows, specify humidifiers that do not require special water requirements, including, but not limited to, the use of soft or deionized water.
6. Individual space humidifiers are not allowed unless it is not practical to provide central humidification systems.

PART 2 - PRODUCT

2.01 PRODUCT REQUIREMENTS

A. Humidifiers:

1. Manufacturers:

a. Armstrong
b. DriSteem
c. Approved equal

B. Component Characteristics:

1. Provide a controlling high limit humidity sensor in supply duct to override the signal to the humidifier valve and limit supply air humidity at its duct location to a maximum of 80% RH. Locate a high humidity switch in the event the supply air humidity exceeds 90% RH.

a. Preferred: No preferences
b. Disallowed: None

PART 3 - INSTALLATION

A. Follow manufacturer’s recommendation regarding minimum upstream and downstream installation dimensions (from dispersion tubes) and measures to be taken, in order to assure wetting will not occur.

B. Provide access doors upstream and downstream of humidifier dispersion tubes. Refer to Section 23 33 00 for requirements.

C. Steam and condensate piping:

1. Tap/soft water applications: Steam piping & condensate piping shall be Rigid Copper (Type K) tubing.
2. R.O./D.I. water “Clean Steam” applications: Steam piping & condensate piping shall be ASTM A312 TP 304 Schedule 40 seamless stainless-steel tubing.

D. Provide plexiglass viewports in AHU/ductwork at humidifier dispersion tubes to allow observation of operation.

E. Provide stainless steel pan underneath humidifier equipment, where found above ceiling. Pan dimensions to extend to the capture to total upstream and downstream length of stainless-steel ductwork.

F. As applicable, provide a minimum of 3 feet of stainless-steel ductwork downstream, and a minimum of 2 feet of stainless-steel ductwork upstream of dispersion tubes.

PART 4 - EVALUATION

A. List of items or systems requiring testing, evaluation, verification, or commissioning: Required Items: Humidifiers

B. Documentation required:

1. Test reports: Testing, Adjusting, and Balancing.
2. Commissioning report.
3. UL listing: any electric equipment associated with the humidifier

END OF SECTION

SECTION 23 90 00
LEAK DETECTION

PART 1 - GENERAL

1.01 REQUIREMENTS

A. Coordinate with Honeywell Controls

PART 2 - PRODUCT REQUIREMENTS

A. Water Leak Detector:

1. Manufacturers:

a. Building Automation Products, Inc (BAPI) or approved equal.

2. Component Characteristics (Required):

a. Water Leak Detector E24
b. Water leak detector transmitter with contacts and rope sensor as determined by project requirements.
c. Part Number: LDTx-RRxx-BB-LTF (where sensor and rope length determined by project requirements)

PART 3 - INSTALLATION

A. Confirm Honeywell controller is installed in location. If none existing, provide a new controller with data interface. See controls standards.

B. Provide control wires from water detection system to Honeywell controller.

PART 4 - EVALUATION

A. Confirm communication between water detection system and Honeywell controller.

B. Confirm communication between water detection system and BMS.

END OF SECTION

SECTION 26 00 00
ELECTRICAL DESIGN REQUIREMENTS

PART 1 - GENERAL

1.01 Basic Operating System Voltages.

A. Primary Voltages: As determined & provided by Utility per Designer's requirements.

B. Secondary Voltages:

Normal	480Y/277V, 3 Phase, 4 Wire 208Y/120V, 3 Phase, 4 Wire
Emergency/Standby	480Y/277V, 3 Phase, 4 Wire 208Y/120V, 3 Phase, 4 Wire

C. Branch Circuits:

General Use Receptacles	120V
Special Purpose Receptacles	208V, 1 phase and 208V, 3 phases
Fluorescent Lighting (if applicable & used for specific application only)	277V
Special Purpose Incandescent (if applicable & used for specific application only)	120V
LED Lighting	120V/277V Multi volt
Motors 1/3 HP and smaller	120V
Motors 1/2 HP and larger	480V, 3 phases

D. Existing Voltages: Designer to verify

E. Secondary – Normal (if applicable) 240/120, 1 Phase or 120/208 volt 3 phase 4 wire

PART 2 - REQUIREMENTS

2.01 Standards and Code Requirements

A. UL Listing and Code Compliance

1. All equipment shall be UL listed, shall be provided with proper identification related to the UL listing, as well as appropriate listing documentation.

2. All equipment and electrical spaces shall meet the minimum code requirements including all California codes and amendments adopted by Division of State Architect (DSA).

B. Code References:

1. All drawing sets shall include code references to the specific code being applied including the California Electrical Code (CEC), National Electrical Code (NEC) and DSA. All drawing sets shall include code references to the specific Title 24 Energy Code being applied to project.

2. General code references to the "current edition of the code" on design documents are not acceptable.

C. Calculations: Short circuit calculations shall be provided for the project.

2.02 Design Criteria

A. Single Line (One-Line) Diagram Requirements:

1. Single line diagrams shall be of the most accurate and descriptive nature allowed by the available information. Site surveys and earlier drawings shall be used as references to ensure that the single line being depicted is as up to date as possible (existing facilities or school sites).

B. All Single Line Diagram sheets shall include the following information:

1. All connected building equipment, including panels, generators, switchboards, utility equipment, mechanical gear, etc.

2. Names, locations and ratings of all gear

3. Feeder schedule for equipment included in scope of work. Feeder schedules that do not fit on the single line, due to the amount of equipment being shown, shall be located on an adjacent sheet. The single line sheet shall make reference to the adjacent sheet with the feeder schedule.

4. Load Summary: The load summary shall be in a table format. The load summary shall include all equipment loads being fed into the main switchgear.

5. Sheet notes shall be provided as necessary.

6. Available fault current and AIC ratings at each bus

C. Provide, design, dimension, coordinate and install the following items:

1. Support and anchorage of all equipment and conduit.

2. Fittings for seismic expansion and deflection.

3. “Raceway & Boxes for Electrical Systems”.

4. Vibration isolation and seismic anchorage.

2.03 Floor Plan Requirements:

A. Panel Schedules

1. All electrical drawing sets shall include panel schedules. These sheets shall include any and all panels affected by the project scope, regardless of whether the gear is directly or indirectly affected.

2. Any panel being referenced by a home run in the floor plans shall have an individual panel schedule and a load summary.

3. Panel schedules shall indicate where the panel is located, especially in the cases of large projects with several Electrical Rooms.

4. Reference boxes should be included on each sheet in the drawing set that includes panel schedules. The reference box should indicate where on the page each panel schedule is located for quick reference.

B. Light Fixture Schedule: A light fixture schedule shall be provided for the projects and shall be included in the electrical drawing set. The light fixture schedule shall be in table form including all of the pertinent information necessary for the contractor. Information should include length, ballast/driver type, wattage, manufacturer and location.

2.04 Circuiting and Identification Requirements

A. Each home run shall indicate the corresponding panel name and the circuit number(s).

B. Lighting plans and/or reflected ceiling plans shall show the respective lighting panel in its proper location in each electrical room to provide clear indication of home run destination.

C. Identification: The identification of all equipment shall follow the standard specifications for Identification of Electrical Systems. This includes all the text to be written on the nameplate, as well as the color and location.

D. Equipment Naming:

1. Naming Categories

a. Emergency

*Only used in cases where emergency power is provided. Category omitted for Normal power.

EL-	Emergency-Life Safety (as defined by NEC Article 700)
ER-	Legally Required Stand by (as defined by NEC Article 701)
E-	Optional Stand by (as defined by NEC Article 702)

b. Type

*Panels are the default type. No specific Type is provided for panels.

U	Unit Substation
DB	Distribution Board
G	Generator
ATS	Automatic Transfer Switch
T	Transformer
Voltage	
H	480 or 480/277
L	208/120V

c. Area

*Only used for larger buildings. Category omitted in cases of smaller buildings.

N	North
S	South
E	East
W	West

*Segments A, B, C, D are also acceptable.

d. Floor

B	Basement
R	Roof

M Mezzanine

e. Alpha
A Panel
AA Sub panel to A
*Alpha category is sequential. The second panel follows with B and so on.

2. Conventions: See Naming Categories above for the selection options in each category.

a. Switchboards/Distribution Boards/Panels Naming Convention

Panels shall be named based on the following criteria
(Emergency-) Type Voltage (Area) Floor Alpha

Example 1: a standard 120/208V, panel located on the south side of the first floor
LS1A

Example 2: a 480V emergency standby distribution board located on the north side of the basement
E-DBHNB

b. ATS Naming Convention

ATS shall be named based on the following criteria
(Emergency-) A Voltage (Area) Floor (Alpha)

Example 1: an emergency stand by 480V ATS in the basement
E-AHB

c. Transformer Naming Convention

Transformers shall be named based on the following criteria–
(Emergency-) T (Area) Floor (Alpha)

Example 1: a life safety transformer in the south area of the basement
EL-TSB

Example 2: the first of two normal transformers on the first floor
T1A

d. Miscellaneous equipment: Other equipment, including but not limited to UPS, PDUs and RDCs, shall follow similar to the Panel Naming Convention and will use the first letter to identify the equipment.

3. New or Renovated Buildings: For new buildings and completely renovated buildings, panels shall be named in relation to the floor the panel is located on and the type of power the panel is providing. See Conventions section above for additional information.

4. Existing Buildings: For existing buildings, panels shall be named in coordination with existing panels. If no pattern is evident in the existing building for panel naming. See Conventions section above for additional information. Verify there is no existing panel with the same name as the new panel in existing buildings.

E. Lighting Floor Plan Fixture Labeling

1. On the electrical lighting floor plans and/or reflected ceiling plans, each light fixture shall have the following information:

2. Fixture type – in capital letters

3. Circuit Number – including panel and circuit.

F. Coordination:

1. Light fixtures shall be coordinated with location of equipment, especially in back of house spaces. Coordination of light locations shall not be left to the contractor or “with field conditions”.

G. Field Verifications:

1. Expectations: All contractors are expected to visit the project site once initiated to confirm the existing conditions, including but not limited to project space, electrical rooms, existing panels, etc. Drawings shall accurately reflect current existing conditions.

H. Calculation Requirements

1. Overcurrent protective device coordination study shall be performed for the project.

PART 3 - PRODUCTS

3.01 Normal Power Distribution Equipment (Medium Voltage systems only)

A. Load Interrupter Switch

1. A load interrupter switch shall be provided at service entrance in lieu of a load side breaker on the primary transformer.

2. The use of automatic (power) or manually operated switches will depend on the application by designer.

3. Interrupter switch shall be rated at 15kV (for medium voltage applications).

B. Utility Transformer

1. The utility transformer shall be provided by Utility. Transformers shall step down from primary voltage (depending on the site utility requirements) to 480V/277V.

2. The preferred location of the utility transformer is outside the building, in the Main Electrical Room. Transformers may be located outside of the building.

3. Minimum 4” concrete pads and spill containment shall be provided to meet code requirements. Refer to Division 3 for concrete pad.

4. Acoustical Noise Control considerations shall be considered with respect to Transformer adjacency and required sound isolations.

5. Leak detection shall be provided in the main electrical room with connection to the building BMS.

C. Primary Feeders: All primary feeders shall consist of conduit with copper wire.

D. Secondary Distribution Transformers: Secondary distribution transformers and all downstream transformers shall be of fire- resistant, air insulated, dry type construction, cooled by the natural circulation of air through the windings. Only copper windings shall be specified.

E. Distribution and Branch Circuit Panelboards:

1. Panelboards that are not located in the same room as their distribution breaker shall have a main breaker provided in the panel.

2. Ground fault protection is to be provided at the building main breaker(s) as well as on any breakers larger than 1000A, 480V only.

F. Secondary Feeders

1. All secondary feeders shall consist of conduit and copper wire.

G. Branch Circuits

1. Ratings and Size: Branch circuits shall be at minimum #12AWG.

2. Acceptable Conduit Types

a. Conduit shall be specified as Electrical Metallic Tubing (EMT) or Intermediate Metal Conduit (IMC).
b. Flexible metal conduit (FMC) is acceptable for up to 6-foot max for final terminations to motor loads and light fixtures.

3. Conduit Size and Fill

a. A minimum of ¾" conduit shall be specified.
b. No more than 9 conductors (3-hot, 3 neutral and 3 ground) shall be installed in a common conduit.
c. In cases where a panel is located in the same room as the corresponding circuits exception may be made to the above requirements (typically labs) unless otherwise approved by Engineer.

4. Usage

a. Branch circuits shall be comprised of like usage. Branch circuits with computer equipment shall have only computers on the circuit. Printers and computers shall not be placed on the same circuit. In general, motors and computers shall not be placed on the same circuit. Branch circuits with computers on them should be limited to maximum (4) computers per circuit.
b. Other branch circuits shall have a maximum of 6 receptacles per circuit.
c. Receptacles (and light fixtures) shall be circuited such that the room or area has a diversity of circuits. For example, all outlets in one office shall not be on the same circuit. The failure of one circuit should not take down an entire area.
d. Corridor outlets shall be on a separate circuit with only other corridor outlets.

5. J-boxes for Branch Circuits

    a. At least one j-box shall be provided for the receptacle branch circuits feeding each room. Branch circuits shall enter the room, connect to the j-box and then continue to the appropriate receptacles. If the circuit continues to an adjacent room, the connection shall be j-box to j-box.

H. Wiring Devices

1. Plate Colors and Labeling

    a. The preferred device plate is plastic. Plate colors typically are specified by the Architect. White shall be the default color. For receptacles with special power requirements, plate colors shall match receptacle colors.
    b. All device plates shall be labeled with originating panel and circuit numbers. The preferred labeling method is black lettering on clear ½" labeling tape.
    c. Projects that include pre-wired workstations are also required to have each receptacle labeled with panel and circuit number. A note shall indicate as such on both the electrical drawings as well as the furniture plans.

2. Receptacle Colors

    a. For non-switched normal power outlets, the default receptacle color shall be white.
    b. For switched normal power outlets, receptacle shall be green. Plate color can be standard white or green.
    c. For emergency receptacles, receptacle and plate shall be red.
    d. For UPS receptacles, receptacle and plate shall be orange.
    e. For receptacles with isolated ground, receptacle shall be white with an orange triangle. No preference on plate color.

3. Receptacle Orientation

    a. All receptacles shall be orientated with the ground up.
    b. For receptacles located in wiremold, receptacle orientation shall be specified by the engineer on the documents. All receptacles included in the wiremold shall face the same direction.

4. Receptacle Switching

    a. For switched normal power outlets, entire receptacle shall be switched. Half switched outlets are not acceptable.

5. GFCI

    a. Along with code required locations, all Janitors Closets shall be provided with GFCI outlets.

I. Housekeeping Pads

1. Concrete pads shall be provided for all equipment that sits on the ground located in the basement and all areas with the potential for water accumulation.

2. Concrete pads shall be a minimum of 4".

a. Secondary Unit Substations consisting of coordinated incoming line, transformer and low voltage sections, are not preferred. Secondary Unit Substations may be provided and located either outside the building or inside the Main Electrical Room. Location of the equipment is based upon the location of the building and surroundings. Equipment located outside of the building must be approved by the architect and district.
b. Bus duct is not acceptable for any applications.
c. Aluminum wire is not acceptable for any applications.
d. Aluminum bus bar is not acceptable.
e. Aluminum transformer windings are not acceptable.
f. Feed through panels are not acceptable for new construction. For existing conditions that have feed through panels, load may be added but additional feed through panels should not be included.
g. Aluminum conduit is not acceptable under any circumstances.
h. The use of non-metallic sheathed cable (NM or NMC), armored cable (AC) or metal clad cable (MC) is not permitted.
i. Wires shall not change colors between the breaker and the final termination.
j. Engraved device plates are not preferred.

J. Emergency and Standby Power and Lighting Systems Criteria

1. Terminology

a. The term “emergency system” refers to the entire system supported by a generator.
b. The Emergency System, as defined by Article 700, is more commonly referred to as the Life Safety System.
c. The Legally Required Standby Systems (Article 701) and the Optional Standby Systems (Article 702) are more commonly referred to as the Standby System.
d. Regardless of terminology, all code requirements for the generator systems are to be met.

2. Acceptable Power Sources

a. Order of Preference for Sources

1) The preferred method of providing emergency (life safety) power to a building is via generator.
2) In cases where it is not physically feasible to include a generator, a central inverter type battery system is acceptable.
3) In cases where a central inverter type battery system is not feasible, individual local batteries will be permitted.
4) For projects in existing school buildings, the method being employed in the building shall be followed unless otherwise directed.

b. Generators

1) For existing buildings, where a life safety generator is available, all code required life safety devices shall be dual fed by the generator.
2) Generator Distribution Board: In the cases where one generator feeds multiple transfer switches, a distribution board with circuit breakers shall be provided.
3) Generator Fuel Storage Requirements

i) Fuel for all generators shall be diesel fuel located either in a belly tank or local tank. Fuel tanks shall be able to sustain full load for a minimum of 24-hour fuel capacity at full load.
ii) Where fuel storage devices are specified with annunciator panels, annunciator panel shall interface with the BMS System for status and alarms.

4) Generator Communication: All generators, regardless of the usage, shall communicate with the BMS EBI System.

3. Automatic Transfer Switches

a. Automatic transfer switches shall be provided for the connection of generators. At least two ATS shall be provided to support both emergency (life safety) and standby loads.
b. One ATS may be provided if only emergency (life safety) load is to be supported.
c. ATS Communication: All ATS', regardless of the usage, shall communicate with the District BMS EBI System.

4. Battery Backup

a. Battery backup for life safety lights and exit signs may be acceptable in instances where a generator is not available or not feasible.
b. Central inverter systems with battery backup shall be provided when a generator system is not feasible. Batteries shall provide a minimum of 90 minutes per code. An automatic battery charging means shall be provided per code.
c. Individual battery systems shall be a last preference.
d. Acceptable UPS Configurations: UPS systems shall include a UPS module comprised of solid-state electronics consisting of a rectifier, an inverter and associated controls. UPS systems may be either the non-redundant or parallel redundant configurations depending on the application.
e. UPS Batteries

1) Batteries for the UPS system are typically valve regulated lead acid (VRLA) batteries due to space constraints. Batteries shall provide a minimum of 30 minutes at full UPS load for all Data system requirements like MDF rooms.
2) Each UPS module shall be provided with the necessary battery strings for that module. If more than one module is provided, each shall have its own battery strings to maintain for a minimum of 30 minutes, regardless of the other module(s).

f. Maintenance By-pass Provisions: Each module shall be specified with individual maintenance by-pass provisions to allow for maximum maintainability of the system.
g. Distribution: Distribution for large scale UPS systems are typically provided via power distribution units (PDU).
h. Typical Manufacturers: UPS system manufacturers include Emerson Liebert or APC.
i. UPS Communications: UPS shall communicate with the BMS EBI System.

5. Systems on Generator Power

a. Required Systems: All required systems shall be provided emergency power (whether life safety, legally required standby or optional standby power) to meet code requirements.
b. Other Systems: The following systems shall be provided generator power on the proper code branch where available.

1) All access control and/or security devices shall be provided with emergency power.

2) All building management system (BMS) devices shall be provided with emergency power.
3) Elevator(s) shall be provided with generator power as per code requirements.
4) At least (1) emergency outlet shall be provided in each electrical room, mechanical room, elevator machine room and other machine rooms.
5) At least (1) emergency light fixture shall be provided in each electrical room, mechanical room, elevator machine room and other machine rooms.

6. Roll Up Generators

a. General Provisions

1) Where the building conditions require roll up generator provisions, as required, the following shall be met.
2) An adequately sized breaker, meant to accommodate the critical loads in a building, shall be provided within the main switchgear. A separate section with key interlocks can be provided, or a remote disconnect can be provided to allow for the safe and efficient connections of a temporary generator. Options on where the breaker is located and how connections are made shall be determined on a project by project basis by designer.

b. Building Conditions

1) For New Buildings - Without a Generator
For a new building, where a permanent generator has not been specified, roll up generator provisions shall be provided.
2) For New Buildings - With a Life Safety Generator
For a new building, where a permanent life safety emergency generator has been specified, roll up generator provisions shall be provided.
3) For New Buildings - With a Life Safety & Standby Generator
For a new building, where a permanent generator has been provided for both life safety power and standby power which meets the needs of the building's Emergency Response Plan, roll up generator provisions are not required.
4) For a new building, where a permanent generator has been provided for both life safety power and standby power which either does not meet the needs of the building's Emergency Response Plan or as required.
5) For Existing Buildings - Adding a Standby Generator
For an existing building, where a project involves the addition of a standby generator in addition to a life safety generator or to replace an existing generator, roll up provisions are not required.

7. Fire Systems

a. Fire Pump

1) Concrete encased cable or MI cable is acceptable for feeding the fire pump.
2) When the fire pump is provided with generator power, a separate ATS shall be specified as per code.

b. Fire Alarm

1) All fire alarm devices shall be provided with copper stranded wire, maximum size #12AWG. All wiring for fire alarm devices shall be in conduit.

2) Power supplies for strobes shall be located in maintenance spaces, preferably in the electrical rooms.

c. Fire Plans

1) Devices powered with 120V (or greater) shall be shown on electrical power floor plans with circuit designations for coordination.
2) Fire alarm devices shall be shown on dedicated Fire Alarm plan and shall not be mixed with power plans.

d. Preferred:

1) The preferred method of providing emergency (life safety) power to new building is via generator.
2) The preferred location of generator fuel storage is in a skid-based tank.

K. Lighting System Criteria

1. Lighting System Overview

a. New buildings shall have lighting provided at 277V. Light fixtures specified for new buildings shall consider cost, accessibility, ease of maintenance and availability of replacement parts. Specialty fixtures should be kept to a minimum.
b. New buildings shall be designed using LED fixtures. Existing buildings shall have fixtures to match existing where applicable with LED Retrofit kits.
c. Existing buildings may have lighting provided at either 120V or 277V depending on the age of the facility. Light fixtures specified for existing buildings shall match the existing look and feel of the building. New fixtures being specified should also take into account cost, accessibility, ease of maintenance and availability of replacement parts.

2. Normal Lighting Distribution Equipment

a. Branch Circuits

1) Branch circuits shall be at minimum #12AWG.
2) Acceptable Conduit Types

i) Conduit shall be specified as Electrical Metallic Tubing (EMT) or Intermediate Metal Conduit (IMC).
ii) Flexible metal conduit (FMC) is acceptable for up to 6-foot max for final terminations to light fixtures.

3) Conduit Size and Fill

i) A minimum of ¾" conduit shall be specified.
ii) No more than 7 conductors (3-phase, 3 neutral and 1 ground) shall be installed in a common conduit.
iii) 20% spare capacity shall be left on each circuit for future lights.

4) Usage: Light fixtures should be circuited such that the room or area has a diversity of circuits where feasible. It is preferred that all lights in one office not be on the same circuit where multiple circuits exist in the area in order to minimize the failure of one circuit taking down an entire area.

b. J-boxes for Branch Circuits: At least one j-box shall be provided for the lighting branch circuits feeding each room. Branch circuits shall enter the room, connect to the j-box and then continue to the appropriate light fixtures. If the circuit continues to an adjacent room, the connection shall be j-box to j-box
c. Fixture Specifics – new LED fixtures

    1) LED fixtures shall meet the requirements Lighting specifications.
    2) Preferred general use fixture is Lithonia VTL series

d. Fixture Specifics – To match existing fluorescent fixtures

    1) In existing buildings, fluorescent fixtures may be provided with LED retrofit kits used where there is a need to match existing fixtures.
    2) Color Temperature and CRI: Color temperature of the bulb shall be 4100 Kelvin with a CRI of 85 and higher.
    3) Ballasts: Ballasts shall be electronic with less than 10% THD and a power factor of no less than .85.

e. Exit Signs: Exit signs shall be white thermal plastic LED fixtures with green lettering. In existing buildings, exit signs may be specified to match existing. Coordinate with Facilities Management Services.
f. Lighting Control System

    1) Network lighting control system and Local lighting control systems shall be the nLight system by Acuity Brands.

g. Lighting for Pits

    1) Lighting shall be provided for all elevator pits that are included in a project.
    2) Provide on emergency power where applicable
    3) Specify wet location fixtures only

h. Wires shall not change colors between the breaker and the final termination.
i. Lightolier Dimming is not acceptable.

3.02 Electrical Room Design

A. Main Electrical Room

1. Main Service Equipment located inside a building shall be within a space designated as the Main Electrical Room. The Main Electrical Room will have at least two points of exit, with a double door on a minimum of one opening. The Main Electrical Room shall have direct access to the corridor(s). All doors shall swing in the path of egress. The acoustical considerations including the partition walls sound insulation ratings.

2. Within the design of the Main Electrical Room, consideration shall be taken to maintain proper clearances of all equipment for maintenance. The minimum clearance for most equipment shall be 4’ in front. Equipment containing heavy maintenance parts shall be provided with additional clearance.

3. Electrical rooms shall be sized to include 20% usable space to allow addition of future electrical equipment. Exception – Low voltage panels and equipment usage.

4. Along with the design of the Main Electrical Room, the engineer shall provide the path for which to remove and replace large equipment. All equipment, regardless of size and lifespan, shall be assumed to require replacement at least once in the life of the building.

5. The engineer shall ensure that the Main Electrical Room is provided with ventilation as required to ensure proper operation of the most heat sensitive piece of equipment.

6. The Main Electrical Room shall be located in an area with no Kitchen, Café or any type of cooking/warming establishments, no restrooms or water closets, no waste or waste disposal rooms located above.

7. The Main Electrical Room shall have no water or waste pipes running through it, regardless of the height at which such pipes are located.

8. Leak detection shall be provided in the main electrical room where located at grade.

B. Secondary Distribution Electrical Rooms

1. Each building shall be provided with a minimum of one secondary distribution electrical rooms containing 480/277V and 120/208V equipment.

2. Electrical rooms shall be located a maximum of 150 feet from the furthest point of distribution.

3. All secondary distribution electrical rooms shall be provided as enclosed spaces. All doors shall swing in the path of egress regardless of the size or location of the room. Lockable closets or lockable fences may be acceptable in certain applications. Panels may be located outside of the electrical room, including corridors.

4. Electrical rooms shall be designed to provide the minimum code required clearance for all equipment. Electrical rooms shall be sized to include 20% usable space to allow addition of future electrical equipment. Room partition walls and floor/ceiling assembly shall provide sound insulation as required.

5. Electrical rooms shall not be located with Kitchen or cooking areas, restrooms or waste rooms of any kind above them.

6. Electrical rooms shall not have waste or water piping of any kind running through it, regardless of the height at which such pipes are located.

C. All Electrical Rooms

1. Each electrical room shall be provided with a minimum of (2) duplex receptacles on emergency power (where available). One outlet shall be located at the door. The other shall be located at the far end of the room. Location of outlets shall be coordinated with equipment layout so as not to be covered by equipment.

2. Lighting shall include at least (1) emergency fixture. Larger rooms shall include a minimum of (2) emergency fixtures.

3. Lighting for all electrical rooms shall be coordinated with the location of equipment in the room. Adequate work lighting shall be provided to the face of all equipment.

4. Electrical rooms shall be sized to include 20% usable space to allow addition of future electrical equipment.

5. Piping other than fire sprinkler and electrical room FCU are not permitted through electrical room.

D. Mechanical Rooms and Other Spaces

1. Each mechanical room and other equipment type spaces such as elevator machine rooms, shall also be provided with a minimum of (1) emergency duplex receptacle located at the door.

2. Lighting shall include at least (1) emergency fixture. Larger rooms shall include a minimum of (2) emergency fixtures.

3. Electrical equipment shall not be located in non-designated spaces such as janitor's closets and storage rooms.

4. Electrical equipment shall not be located directly adjacent to or above of interior spaces with NC35 or lower acoustics requirement,

5. No equipment or piping foreign to the electrical room shall pass through the electrical room.

6. Neither the Main Electrical Room nor any electrical room shall be located in an area with a kitchen, café or any type of cooking/warming establishment, a restroom or water closet, a waste or waste disposal room located above.

7. Neither the Main Electrical Room nor any electrical room shall have water or waste pipes running through it, regardless of the height at which such pipes are located.

PART 4 - INSTALLATION DESIGN REQUIREMENTS

A. Ensure maintenance and accessibility provisions for servicing and replacement of equipment.

B. Provide adequate working area around equipment for service.

C. There must be permanent access to the roof if any equipment needing service is mounted on the roof.

D. Where electrical equipment is located at grade level and/or in an open public accessible area, a fence/gate/etc. shall be provided for security and/or visibility purposes.

PART 5 - EVALUATION

A. List of items or systems requiring testing, evaluation, verification, or commissioning: Required Items.

B. Documentation required:

1. See individual product specification sections for specific documentation.

2. Commissioning report: The entire emergency systems, UPS systems and lighting control systems shall fall under the scope of the Commissioning process and be subject to the

protocols listed in the independent Commissioning guidelines.

3. Operations and Maintenance Manuals: shall be provided as required by the independent Close-out Guidelines.

END OF SECTION

SECTION 26 0513
MEDIUM VOLTAGE CABLES

(Applicable when medium voltage systems are specified & designed)

PART 1 - PRODUCTS

1.01 Cables:

A. Manufacturers:

1. Okonite - “Okoguard-Okoseal”, cable type “Uniblend” or equal by South Wire

B. Characteristics:

a. Cable Type: MV105, 15kV (as applicable).
b. Comply with UL 1072, AEIC CS8, ICEA S-93-639, & ICEA S-97-682.
c. Conductor: Single shielded, Stranded copper conductors.
d. Conductor Stranding: Concentric lay, Class B, compact stranded.
e. Strand Filling: Conductor interstices are filled with impermeable compound.
f. Conductor Insulation: 220 mils, ethylene-propylene polymer (EPR) insulation with 133% insulation level
g. Shielding: Copper tape, helically applied over semiconducting insulation shield.
h. Circuit Identification: Color-coded tape (black, red, blue) under the metallic shielding
i. Cable Jacket: Sunlight-resistant PVC.

2. Aluminum conductors are not permitted.

1.02 Raceway Tags:

A. Manufacturers:

1. Tech Products Inc.- Fast Tag Miniature Markers

B. Characteristics:

a. Provide tags with highly raised characters, hot stamped with UV stable foil, non-conductive and non-corroding.
b. Tags shall be black lettering on yellow background
c. Attach tags to raceways with noncorrosive stainless-steel wire.
d. Tags shall be provided at minimum where the cable enters and leaves the manhole.

1.03 Cable Splicing and Terminating Products and Accessories:

A. Manufacturers:

1. Thomas & Betts Corporation/Elastimold

2. Raychem

3. G&W Electric Company

4. RTE Components; Cooper Power Systems, Inc.

5. Scott Fetzer Co. (The); Adalet.

6. 3M; Electrical Products Division

B. Characteristics:

1. Solid Terminations for Shielded-Cables: Comply with the following classes of IEEE 48. Insulation class is equivalent to that of cable. Include shield ground strap for shielded cable terminations.

   a. Class 1 Terminations: Modular type, furnished as a kit, with stress- relief tube; multiple, molded-silicone rubber, insulator modules; shield ground strap; and compression-type connector.
   b. Class 1 Terminations: Heat-shrink type with heat-shrink inner stress control and outer non-tracking tubes; multiple, molded, non-tracking skirt modules; and compression-type connector.
   c. Class 1 Terminations: Modular type, furnished as a kit, with stress- relief shield terminator; multiple-wet-process, porcelain, insulator modules; shield ground strap; and compression-type connector.
   d. Class 1 Terminations, Indoors: Kit with stress-relief tube, non-tracking insulator tube, shield ground strap, compression-type connector, and end seal.
   e. Class 2 Terminations, Indoors: Kit with stress-relief tube, non-tracking insulator tube, shield ground strap, and compression-type connector. Include silicone-rubber tape, cold shrink- rubber sleeve, or heat-shrink plastic-sleeve moisture seal for end of insulation whether or not supplied with kits.
   f. Class 3 Terminations: Kit with stress cone and compression-type connector.

2. Separable Insulated Connectors:

   a. Description: Modular system, complying with IEEE 386, with disconnecting, single-pole, cable terminators and with matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture.
   b. Terminations at Distribution Points: Modular type, consisting of terminators installed on cables and modular, dead-front, terminal junctions for interconnecting cables.
   c. Tool Set: Shotgun hot stick with energized terminal indicator, fault- indicator test tool, and carrying case.
   d. Dead-Break Cable Terminators: Elbow-type unit with 600-A continuous-current rating; designed for de-energized disconnecting and connecting; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.
   e. Dead-Front Terminal Junctions: Modular bracket-mounted groups of dead-front stationary terminals that mate and match with above cable terminators. Two-, three-, or four-terminal units as indicated, with fully rated, insulated, watertight conductor connection between terminals and complete with grounding lug, manufacturer's standard accessory stands, stainless-steel mounting brackets, and attaching hardware.
   f. Protective Cap: Insulating, electrostatic-shielding, water-sealing cap with drain wire.
   g. Portable Feed-Through Accessory: Two-terminal, dead-front junction arranged for removable mounting on accessory stand of stationary terminal junction.
   h. Grounding Kit: Jumpered elbows, portable feed-through accessory units, protective caps, test rods suitable for concurrently grounding three phases of feeders and

carrying case.

i. Standoff Insulator: Portable, single dead-front terminal for removable mounting on accessory stand of stationary terminal junction. Insulators suitable for fully insulated isolation of energized cable- elbow terminator.

3. Arc Proofing Materials:

a. Tape for First Course on Metal Objects: 10-mil thick, corrosion- protective, moisture-resistant, PVC pipe-wrapping tape.
b. Arc-Proofing Tape: Fireproof tape, flexible, conformable, in lumescent to 0.3-inch-thick, compatible with cable jacket.
c. Glass-Cloth Tape: Pressure-sensitive adhesive type, 1/2 inch wide.

PART 2 - INSTALLATION REQUIREMENTS

A. Install cables according to IEEE 576.

B. Pull Conductors: Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values

1. Where necessary, use manufacturer-approved pulling compound or lubricant that will not deteriorate conductor or insulation.

2. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips that will not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.

C. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

D. Install "buried-cable" warning tape 12 inches above cables.

E. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls, one loop minimum, by the longest route from entry to exit and support cables at intervals adequate to prevent sag.

F. Install cable splices at pull points and elsewhere as indicated; use standard kits.

G. Install terminations at ends of conductors and seal multi-conductor cable ends with standard kits.

H. Install separable insulated-connector components as follows:

1. Protective Cap: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected.

2. Portable Feed-Through Accessory: Three.

3. Standoff Insulator: Three.

I. Arc Proofing: Unless otherwise indicated, arc proof medium-voltage cable at locations not protected by conduit, cable tray, direct burial, or termination materials. In addition to arc proofing tape manufacturer's written instructions, apply arc proofing as follows:

1. Clean cable sheath.

2. Wrap metallic cable components with 10-mil pipe-wrapping tape.

3. Smooth surface contours with electrical insulation putty.

4. Apply arc-proofing tape in one half-lapped layer with coated side toward cable.

5. Band arc-proofing tape with 1-inch- wide bands of half-lapped, adhesive, glass-cloth tape 2 inches o.c.

J. Terminations:

1. All terminations shall be accomplished via pre-molded EPDM type connection system. The 600-amp separable insulated connector system shall be rated for continuous operation at 15kV for single conductor shielded power cables and shall be non-load / dead break type.

2. The system shall be made up of specific kits (600 amp) designed for, tapping (adding-on) dead-ending and connecting equipment. Dead-break cable terminators shall be elbow type with 600A continuous current rating.

3. The system shall accommodate a 5/15kV cable size of 250 MCM, copper conductors. The system shall be capable of making dead-end, 2-way and multiple tap splices and shall be suitable for continuous immersion under water.

4. Conductor terminations may be cold, or heat shrink type termination kits rated 5/15kV, 60/95kV BIL with current rating same as the cable. Splice kits are not acceptable

K. Seal around cables passing through fire-rated elements according to UL.

L. Install fault indicators on each phase where indicated.

M. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware.

PART 3 - EVALUATION

3.01 List of items or systems requiring testing, evaluation, verification, or commissioning: Medium Voltage Cables.

3.02 Documentation:

A. Test reports: Engage a qualified Independent testing and inspecting agency to perform field tests/inspections and provide reports for all MV Cable installations, including splices and terminations.

B. Source quality report (Factory test results):

1. Test and inspect cables according to ICEA S-93-639 before shipping.

C. Test strand-filled cables for water-penetration resistance according to ICEA T-31- 610, using a test pressure of 5 psig.

D. The independent testing agency shall perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Sections 7.3. Certify compliance with test parameters.

2. After installing medium-voltage cables and before electrical circuitry has been energized, test for compliance with requirements.

E. Corrective measures:

1. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION

SECTION 26 05 19
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - REQUIREMENTS

1. Furnish products listed and classified by UL, CEC, UL and nationally recognized/approved agency as suitable for purpose specified.

2. Wire and cable boxes and reels shall bear the date of manufacture. The date of manufacture shall not precede contract date by more than one year.

3. Conductor sizes indicated are based on copper conductors. Do not provide conductors smaller than those indicated.

4. Wires shall not change colors between the breaker and final termination.

PART 2 - PRODUCTS

2.01 Conductors and Cables:

A. Manufacturers:

1. American Insulated Wire Corp: a Leviton Company

2. General Cable Corporation

3. Southwire Company

4. Senator Wire & Cable Company

B. Characteristics:

1. Single Conductors 600V and below:

a. Provide copper conductors.
b. Provide stranded or solid conductors as specified.
c. Provide conductors with Type THHN/THWN, 90°C insulation for indoor applications.
d. Provide conductors with Type THWN-2 or XHHW-2, 90°C insulation for exterior, wet or damp locations.
e. Provide conductors with Type RHW-2, 90°C insulation for areas subjected to temperatures exceeding 60°C (140°F).
f. Comply with NEMA WC 70.
g. Aluminum and MC cables/conductors are not permitted.

2.02 Connectors, Splices and Terminations:

A. Manufacturers:

1. AFC Cable Systems, Inc.

2. Hubbell Power Systems, Inc.

3. O-Z/Gedney; EGS Electrical Group LLC.

4. 3M; Electrical Products Division

5. Tyco Electronics Corp

B. Characteristics:

1. Provide factory-fabricated connectors, splices and terminals of size, ampacity rating, material, type and class for application and service indicated.

2. Connections to Fixtures: Make circuit wiring connections to fixture wire with insulated electrical spring connectors. Threaded-type wire nuts, porcelain or Bakelite are not acceptable.

3. Wire Joints:

a. No. 6 AWG and larger: Burndy Type QPR, Penn Union, or equal.
b. No. 8 AWG and smaller: Pigtail splices or made with insulated electrical spring connectors.

C. Terminations:

1. Provide compression set, bolted, or screw type lug, or direct to bolted or screw type terminal.

2. Connections to Circuit Breakers and Switches:

a. No. 12 AWG wire: formed around binding post or screw.
b. No. 10 AWG and No. 8 wire AWG: 3M or Burndy or Thomas & Betts or equal locking tongue lug.
c. No. 6 AWG wire and larger: Burndy Type QDA, Penn Union, or equal, round flange solderless lug.

D. Sleeves for Cables:

1. Steel Pipe Sleeves: standard, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

2. Cast-Iron Pipe Sleeves: Cast or fabricated “wall pipe”, equivalent to ductile- iron pressure pipe, with plain ends and integral water-stop.

3. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.

4. Coordinate sleeve selection and application with selection and application of firestopping per UL.

E. Plastic Cable Ties:

1. Required: Nylon or approved, locking type.

2.03 Sleeve Seals:

A. Manufacturers:

1. Advance Products & Systems, Inc.

2. Calpico, Inc

3. Metraflex Co

4. Pipeline Seal and Insulator, Inc.

B. Component Characteristics:

1. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.

a. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
b. Pressure Plates: Stainless steel. Include two for each sealing element.
c. Connection bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

PART 3 - INSTALLATION

3.01 General:

A. Do not exceed cable manufacturer's recommendations for maximum pulling tension and minimum bending radius. Where pulling compound is used, use on UL listed compound compatible with the cable outer jacket and with the raceway involved.

B. Tighten all screws and terminal bolts using torque type wrenches and/or drivers to tighten to the inch-pound requirements of the NEC and UL.

C. Where single conductors and cables in manholes, handholes, vaults, cable trays and other indicated locations are not wrapped together by some means such as arc and fireproofing tapes, bundle throughout their exposed length all conductors entering from each conduit with nylon self-locking releasable cable ties placed at intervals not exceeding 18 inches on center.

3.02 Conductors 600V and Below:

A. Provide conductor sizes as required.

B. All wiring shall be installed in conduit.

C. Install conductors only after:

1. Building interior is enclosed and weather tight

2. Mechanical work likely to damage conductors has been completed

3. Raceway installation is complete and supported

D. Arrange wiring in cabinets, switchgear and electrical equipment neatly cut to proper length, remove surplus wire and bridle and secure in an acceptable manner.

E. Conceal cables in finished walls, ceilings and floors, unless noted otherwise.

F. Pull conductors into raceway at same time. Use pulling means; including fish tape, cable, rope and basket-weave wire/cable grips that will not damage cables or raceway.

G. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible. Protect exposed cables from damage.

H. Support cables above accessible ceiling using plastic cable ties to support cables from structure. Do not rest cable on ceiling panels.

I. Identify and color-code conductors and cables.

J. Wiring at outlets: Install conductor at each outlet, with at least 12 inches of slack.

K. Limit conduit fill to a maximum of 6 current-carrying conductors. No more than three branch circuits plus associated neutral and ground conductor will be allowed.

L. Install stranded conductors where conductors terminate in crimp type lugs. Do not place bare stranded conductors directly under screws.

M. Cap spare conductors and conductors not terminated with UL listed end caps.

N. For conductors that will be connected by others, provide at least 6 feet spare conductors in freestanding panels and at least 2 feet spare in other assemblies. Provide more spare conductors in any particular assembly where it is obvious that more conductors will be needed to reach the termination point.

3.03 Conductor Material Applications:

A. Branch Circuits: Copper conductors, solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.

B. Minimum conductor sizes shall be as follows:

1. No. 12 AWG – branch circuits of any kind.

2. No. 14 AWG – Remote control and signal systems, fire alarm systems, except for initiating or data.

C. Branch wiring length limitations.

1. 208Y/120V circuits over 100ft in length: Increase wire size on one size for each 60 ft of length. Increase conduit size as required.

2. 480Y/277V circuits over 150 ft in length: Increase wire size one size for each 150 ft of length. Increase conduit size as required.

3.04 Conductor Insulations and Wiring Methods:

A. Service Entrance: Type THW-2 or XHHW-2, single conductors in raceway.

B. Feeders:

1. Less than 100A: Type THHN-THWN, single conductors in raceway.

2. 100A and Larger: Type THW or XHHW-2, single conductors in raceway.

3. Exposed, concealed in concrete, below slabs-on-grade and underground Feeders:

a. Type THW or XHHW-2, single conductors in raceway.

C. Branch Circuits:

1. Exposed: Type THHN-THWN, single conductors in raceway.

2. Indoors: Type THHN-THWN, single conductors in raceway:

3. Concealed in Concrete, below Slabs-on-Grade and Underground:

a. Type THWN-2, single conductors in raceway

D. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh and strain relief device at terminations to suit application.

E. Class 1 Control Circuits: Type THHN-THWN, in raceway.

F. Class 2 Control Circuits: Type THHN-THWN, in raceway

3.05 Conductor Color Code:

A. Smaller than No. 6 AWG: Provide all single conductors with integral insulation pigmentation of the designated colors.

B. No. 6 AWG and larger: Conductors may be provided with color coding by wrapping the conductor at each end and all accessible locations with vinyl tape. Wrap at least six (6) full overlapping turns of tape around the conductor covering an area of 1 ½ to 2 inches wide at a visible location.

C. Use the following colors as described:

System		**Conductor Color**
All Systems	Equipment Grounding	Green
240/120 Volts	Grounded Neutral	White
1-Phase, 3-Wire	One Hot Leg	Black
	Other Hot Leg	Red
208Y/120 Volts	Grounded Neutral	White
3-Phase, 4-Wire	Phase A	Black
	Phase B	Red
	Phase C	Blue

480Y/277 Volts	Grounded Neutral	Gray
3-Phase, 4-Wire	Phase A	Brown
	Phase B	Orange
	Phase C	Yellow

D. Phase Rotation: Phase A, B and C implies the direction of positive phase rotation.

3.06 Connectors, Splices and Terminals:

A. Connectors:

1. Except where equipment is furnished with bolted or screw type lug, use compression set pressure connectors with insulating covers. Use compression tools and die compatible with the connectors being installed.

2. Use bolt or compression-set type with application of insulating tape, pre-stretched or heat-shrinkable insulating tubing for splices and taps of No. 8 AWG conductors and larger. Install with hydraulic compression tool.

3. Use pre-insulated “twist-on” connectors with integral spring for splices and taps of No. 10 AWG conductors or smaller.

4. Tighten electrical connectors according to manufacturer’s published torque-tightening values. If manufacturer’s torque values are not indicated, use those specified in UL 466A-486B.

B. Splices:

1. Splice wires and cable only in one accessible location, such as within junction boxes.

2. Make splices to carry full capacity of conductors with no perceptible temperature rise.

3. Make below-grade splices in manholes and handholes watertight with pre-stretched or heat-shrinkable insulating tubing, or resin-filled insulator.

4. Use electrical tape to build up insulation level equivalent to cable insulation and cover with not less than two half-lapped layers of plastic electrical tape, for joints, taps and splices of No. 1 AWG conductors and larger.

5. Plastic Snap-On splice insulators are not allowed.

6. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than un-spliced conductors.

7. No WAGO type splice connectors permitted.

C. Terminals:

1. Insulate ends of spare conductors with electrical tape and identify spare circuit number where appropriate.

2. Eye type crimped terminal for removable screw type terminal. Forked torque terminal when screw terminal cannot be removed.

3. Train wires to eliminate fanning of strands, crimp with proper tool and die.

4. Torque screw termination per manufacturer's recommended values. If manufacturer's torque values are not indicated, use those specified in UL 466A-486B.

3.07 Cable Ties:

A. Neatly bundle conductors and cables together for support. Size cable ties sufficiently to accommodate the multiple cables being supported.

3.08 Fireproofing:

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07.

B. Wrap together as a single cable all conductors entering from each conduit.

C. Follow tape manufacturer's installation instructions. Secure the arc and fireproofing tape at frequent intervals with bands of the specified glass cloth electrical tape

PART 4 - EVALUATION

4.01 List of items or systems requiring testing, evaluation, verification, or commissioning: Low Voltage Cables.

A. Test reports: The contractor perform testing and inspecting to perform field tests/inspections and provide reports for service entrance and feeder conductors for compliance with requirements.

B. Test procedures used.

1. Test results that comply with requirements.

2. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

a. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements
b. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Sections 7.3. Certify compliance with test parameters.
c. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.
d. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.

3. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

4. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action

taken and observations after remedial action.

5. Perform insulation resistance testing of all power and control circuits below 600 volts with a 500-volt megger, applied for 1 minute.

C. Corrective measures:

1. Remove and replace malfunctioning circuits/feeders and retest as specified above.

END OF SECTION

SECTION 26 05 23
CONTROL-VOLTAGE ELECTRICAL POWER CABLES

PART 1 - PRODUCTS

1.01 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.

1. Flame Travel Distance: 60 inches or less.

2. Peak Optical Smoke Density: 0.5 or less.

3. Average Optical Smoke Density: 0.15 or less.

C. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.

D. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

E. RoHS compliant.

1.02 BACKBOARDS

A. Description: Plywood, **fire-retardant treated,** 3/4 by 48 by 96 inches. Comply with requirements for plywood backing panels in Section 061000 "Rough Carpentry."

B. Painting: Paint plywood on all sides and edges with **flat** or **eggshell** white **latex** or **alkyd** paint. Painting shall not be started until IOR has properly identified and noted correct fire- resistant plywood has been installed and labels are visible. (do not paint fire resistant labels)

1.03 CATEGORY 6 (CMR/CMX) CABLE

A. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 6 cable at frequencies up to 550 MHz. Support for Gigabit Ethernet / 1000BASE-T / ATM up to 155 Mbps, IEEE 802.3af Power Over Ethernet for VoIP / 100BASE-T / IEEE 802.3, ANSI.X3.263 FDDI TP-PMD, Ethernet / 10BASE-T / IEEE 802.5, 4 & 16 Mbps Token Ring / 550 MHz Broadband Video and standards under development such as ATM at 622 Mbps, 1.2 and 2.4 Gbps

B. Manufacturers:

1. AMP NETCONNECT; a TE Connectivity Ltd. company.

2. Belden Inc.

3. Berk-Tek Leviton; a Nexans/Leviton alliance.

4. CommScope, Inc.

5. Mohawk; a division of Belden Networking, Inc.

6. SYSTIMAX Solutions; a CommScope Inc. brand.

C. Standard: All electrical characteristics shall meet ANSI / TIA-568-C.2 and ISO / IEC 11801 Category 6 requirements; including NEXT and ELFEXT (Pair-to-pair and Power Sum), Insertion Loss, Return Loss, and Delay Skew Conductors, 24 AWG solid copper.

D. Shielding/Screening: Unshielded twisted pairs (UTP), Shielded twisted pairs (FTP) Screened twisted pairs (F/UTP), Screened and shielded twisted pairs (F/FTP) as required for the application.

E. Cable Rating: **Riser** or **Plenum** as applicable.

F. Jacket: **White**, **Gray** or selected by district at the time of installation thermoplastic.

1.04 BALANCED TWISTED PAIR CABLE HARDWARE

A. Description: Hardware designed to connect, splice, and terminate balanced twisted pair copper communications cable.

B. General Requirements for Balanced Twisted Pair Cable Hardware:

1. Comply with the performance requirements of **Category 6**

2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.

3. Cables shall be terminated with connecting hardware of same category or higher.

C. Source Limitations: Obtain balanced twisted pair cable hardware from same manufacturer as balanced twisted pair cable, from single source.

D. Connecting Blocks: **110-style IDC for Category 6**. Provide blocks for the number of cables terminated on the block, plus **25** percent spare, integral with connector bodies, including plugs and jacks where indicated.

E. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

1. Number of Terminals per Field: **One** for each conductor in assigned cables.

F. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.

1. Features:

a. Universal T568A and T568B wiring labels.
b. Labeling areas adjacent to conductors.

c. Replaceable connectors.

d. 24 or 48 ports.

2. Construction: 16-gauge steel and mountable on 19-inch equipment racks.

3. Number of Jacks per Field: One for each four-pair conductor group of indicated cables, plus spares and blank positions adequate to suit specified expansion criteria.

G. Patch Cords: Factory-made, four-pair cables in **48-inch** lengths; terminated with an eight-position modular plug at each end.

1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords shall have latch guards to protect against snagging.

2. Patch cords shall have color-coded boots for circuit identification.

H. Plugs and Plug Assemblies:

1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair 100-ohm unshielded or shielded balanced twisted pair cable.

2. Comply with IEC 60603-7-1, IEC 60603-7-2, IEC 60603-7-3, IEC 60603-7-4, and IEC 60603-7.5.

3. Marked to indicate transmission performance.

I. Jacks and Jack Assemblies:

1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair 100-ohm unshielded or shielded balanced twisted pair cable.

2. Designed to snap-in to a patch panel or faceplate.

3. Standards.

a. Category 6, unshielded balanced twisted pair cable shall comply with IEC 60603-7-4.
b. Category 6 shielded balanced twisted pair cable shall comply with IEC 60603-7.5.

4. Marked to indicate transmission performance.

J. Faceplate:

1. **Four** or **Six** port, vertical single gang faceplates designed to mount to single gang wall boxes.

2. Plastic Faceplate: High-impact plastic. Coordinate color with Section "Wiring Devices."

3. Metal Faceplate: **Stainless steel**, complying with requirements in Section "Wiring Devices."

4. For use with snap-in jacks accommodating any combination of balanced twisted pair, optical fiber, and coaxial work area cords.

    a. Flush mounting jacks, positioning the cord at a 45-degree angle.

K. Legend:

1. Machine printed, in the field, using adhesive-tape label.

2. Snap-in, clear-label covers and machine-printed paper inserts.

1.05 TWIN-AXIAL DATA HIGHWAY CABLE

A. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, **No. 24** AWG, stranded tinned-copper conductors.

2. Plastic insulation.

3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.

4. Plastic jacket.

5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned-copper drain wire.

6. Flame Resistance: Comply with NFPA 262.

1.06 RS-232 CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Allied Wire & Cable Inc.

2. Belden Inc.

3. General Cable Technologies Corporation.

4. West Penn

B. PVC-Jacketed, TIA 232-F:

1. **Three** or **Nine** No. 22 AWG stranded (7x30) tinned copper conductors.

2. Polypropylene insulation.

3. Aluminum foil-polyester tape shield with 100 percent shield coverage.

4. PVC jacket.

5. Conductors are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.

6. NFPA 70 Type: Type CM.

7. Flame Resistance: Comply with UL 1581.

C. Plenum-Type, TIA 232-F:

1. **Three** or **Nine**, No. 22 AWG, stranded (7x30) tinned copper conductors.

2. PE insulation.

3. Aluminum foil-polyester tape shield with 100 percent shield coverage.

4. Fluorinated ethylene propylene jacket.

5. Conductors are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.

6. Flame Resistance: Comply with NFPA 262.

1.07 RS-485 CABLE

A. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, **two pairs**, No. 22 AWG, stranded (7x30) tinned-copper conductors.

2. Fluorinated ethylene propylene insulation.

3. Unshielded.

4. Fluorinated ethylene propylene jacket.

5. Flame Resistance: NFPA 262.

1.08 LOW-VOLTAGE CONTROL CABLE

A. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1. Multi-pair, twisted, No. 16 AWG, stranded (19x29) or No. 18 AWG, stranded (19x30) tinned-copper conductors.

2. PVC insulation.

3. Unshielded.

4. PVC jacket.

5. Flame Resistance: Comply with NFPA 262.

1.09 CONTROL-CIRCUIT CONDUCTORS

A. Manufacturers:

1. Encore Wire Corporation.

2. General Cable; General Cable Corporation.

3. Service Wire Co.

B. Class 1 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.

C. Class 2 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.

D. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.

E. Class 2 Control Circuits and Class 3 Remote-Control and Signal Circuits That Supply Critical Circuits: Circuit Integrity (CI) cable.

1. Smoke control signaling and control circuits.

1.10 FIRE-ALARM WIRE AND CABLE

A. Manufacturers:

1. Allied Wire & Cable Inc.

2. CommScope, Inc.

3. Draka Cableteq USA; a Prysmian Group company.

4. Radix Wire.

5. Superior Essex Inc.

6. South wire

B. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.

C. Signaling Line Circuits: Twisted, shielded pair, not less than No. 18 AWG or size as recommended by system manufacturer.

1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire-alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a two-hour rating.

D. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196 for a two-hour rating.

1. Low-Voltage Circuits: No. 16 AWG, minimum, in pathway.

2. Line-Voltage Circuits: No. 12 AWG, minimum, in pathway.

3. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor **with outer jacket** with red identifier

stripe, NTRL listed for fire-alarm and cable tray installation, plenum rated.

END OF SECTION

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - REQUIREMENTS

A. For purpose of this guideline, this section pertains to grounding and bonding equipment, including but not limited to:

1. Ground Rods
2. Ground bars
3. Active electrodes
4. Mechanical connectors
5. Compression connectors
6. Exothermic connections
7. Ground wells

B. All grounding products/materials shall be UL labeled and conform to the requirements of CEC and IEEE standards.

C. The entire electrical installation consisting of non-current carrying metal parts (I.e. raceways, cable trays, boards, boxes, cabinets, fixtures, switches, transformers, equipment and etc.) shall be completely and effectively grounded in accordance with all applicable codes and standards, whether or not such connections are specifically shown or specified.

D. Grounding electrodes: The grounding electrodes provided shall be as stated in CEC, except minimum conductor size used shall be #4/0 AWG and the minimum length of cables buried for grounding purposes shall be doubled.

E. The resistance values for the electrical system shall be as follows:

1. Resistance from the main switchboard ground bus through the ground electrode to earth shall not exceed 5 OHMS unless otherwise noted.
2. Resistance from the farthest panelboard, switchboard and etc. ground bus through the ground electrode to earth shall not exceed 20 OHMS unless otherwise noted.

PART 2 - PRODUCTS

2.01 Ground Rods:

A. Manufacturers:

1. Eritech / Erico
2. Blackburn / Thomas & Betts

3. Galvan Industries

B. Characteristics:

1. All ground rods shall be copper clad steel with heavy uniform copper coating

2. Dimensions: 10’ long and minimum of 3/4" in diameter.

2.02 Ground Bars:

A. Manufacturers:

1. Eritech / Erico NVENT

2. Copperweld

3. Hubbell Premises Wiring

4. Panduit

B. Characteristics:

1. Provide rectangular annealed copper ground bars with pre-punched holes. The spacing and size of ground bar holes shall match the connection holes required for terminal lugs being furnished.

2. Provide mounting kit complete with fasteners, insulators and brackets as required.

3. Dimensions: Min. 1/4" Thick x 4" Wide x 24”Long or longer as required.

2.03 Active Electrodes:

A. Manufacturers:

1. Lyncole

2. Eritech / Erico

B. Characteristics:

1. Active electrodes shall be provided as required for specific/stringent grounding requirements.

2. Material: Hallow metallic, salt-filled, copper-tube electrode.

3. Dimensions: 10’ long, straight.

2.04 Mechanical Connectors:

A. Manufacturers:

1. Burndy / FCI

2. Blackburn / Thomas & Betts

B. Characteristics:

1. Provide copper alloy connectors, suitable for grounding and bonding applications, in configurations required for particular installation.

2. Ground Rod Clamps: Where required, grounding conductors shall be connected to ground rods or posts using U-bolt clamps. The cable connectors shall be “GAR” (for single cable) and “GD” (for two cable) series by Burndy.

3. Water Pipe Clamps: Where required, grounding conductors shall be connected to water pipe using type “GAR-BU” series by Burndy.

2.05 Compression Connectors:

A. Manufacturers:

1. Burndy / FCI

2. Blackburn / Thomas & Betts

B. Characteristics:

1. Provide irreversible compression copper connectors with high mechanical strength and electrical integrity.

2. Terminal Lugs: Provide heavy-duty terminal lugs with inspection probe hole, extended barrel and two-hole tang for cable to ground bar terminations. The lugs shall be pre-filled with oxide inhibitor and individually sealed to prevent from moisture and contaminates prior to connection to bus bars. The lugs shall be “Hyground” series, type “YGHA” manufactured by Burndy.

3. Cable to Cable connectors: Provide high strength connectors for cable to cable and cable to ground grid connections. The connectors shall be “Hyground” series products manufactured by Burndy.

2.06 Exothermic Connectors:

A. Manufacturers:

1. Cadweld / Erico

2. Fuseweld / Thomas & Betts

B. Characteristics:

1. Provide all exothermic materials, accessories and tools for preparing and making permanent field connections between grounding system components as required.

2.07 Grounding Wells:

A. Manufacturers:

1. Jensen, catalog #N9
2. Quickset, catalog # EC-17
3. Associated

B. Component Characteristics:

1. Ground wells shall be precast concrete boxes equipped with cast iron covers with a cast iron frame cast into the box. The covers shall be checkered and bolt-on type.
2. Exterior Dimensions: 14" Wide x19" Long x 12"deep, or larger, if necessary, to obtain the required clearances for accessing the connectors.

PART 3 - INSTALLATION

3.01 General:

A. The grounding and bonding systems installation shall be in accordance with CEC, IEEE 142 and 1100.

B. Provide wall mounted ground bars in all electrical rooms with insulated standoffs.

C. Provide ground rods at locations indicated on Drawings and as required. Provide additional rods as required to achieve specified resistance to ground. Provide grounding well at each rod location

D. Grounding wells installed outdoors shall be located in the nearest usable planting area, where not otherwise indicated on the Drawings. The wells in planting areas shall be installed 2" above soil. Wells installed in non-planter areas shall be flush with the finished grade.

E. Apply corrosion-resistant finish to all grounding and bonding products installed outdoors, damp locations and below ground, where factory applied protective coating has been damaged.

F. Conduit terminating in concentric, eccentric or oversized knockouts at panelboards, cabinets, gutters, etc. shall have grounding bushings and bonding jumpers installed interconnecting all such conduits.

G. All conduit stub-ups shall be grounded and where multiple stub-ups are made within an equipment enclosure, such as a switchboard, they shall be equipped with grounding bushings and bonded together and to the enclosure and the enclosure ground bus.

H. The System grounding conductors shall be insulated and a minimum of #4/0 AWG unless otherwise indicated and shall be continuous without joints or splices.

I. Equipment Grounding Conductor:

1. The grounding electrode/equipment conductors' sizes shall meet or exceed CEC Tables.
2. A separate insulated conductor (green) shall be provided within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.
3. A grounding conductor shall be extended from grounding bus of serving switchboard or

panel to ground bus of downstream panel, grounding screw of receptacles, lighting fixture housing, light switch outlet boxes or metal enclosures of service equipment/devices.

4. A grounding conductor shall be provided in each flexible conduit and connected at each end via grounding bushing.

5. Bare conductors shall be used where encased in concrete, in plenums, in direct contact with earth for ground rod rings.

J. Isolated Grounding Conductor:

1. A dedicated and isolated grounding conductor shall be provided for circuits supplying equipment (I.e. MRI, electronic equipment, computers and etc.) that are sDistricteptible to Radio Frequency Interference (RFI) and Electromagnetic Interference (EMI).

2. A dedicated and isolated ground bus shall be provided for all distribution equipment serving equipment/devices with isolated ground requirements.

3. All isolated ground conductors for 120/208V distribution system shall be originating from upstream transformer grounding point (bus/lug).

4. All branch circuits serving isolated ground receptacles shall include an isolated grounding conductor independent of equipment grounding conductor, which is extended from IG bus of serving panel to IG terminals of receptacle.

5. Isolated ground conductors shall be insulated, green with yellow strip.

K. All non-electrical systems shall be bonded to grounding system, including but not limited to the following:

1. Bond all metal siding not attached to grounded structure.

2. Bond all reinforcing steel and metal accessories in any water feature (I.e. pool, fountain and etc.) structures, where applicable.

3. Bond metal HVAC air ducts to equipment grounding conductors of associated fans, motors & heaters. Provide tinned bonding jumper across flexible duct connections to maintain ground continuity.

4. Bond gas piping system for the above ground portion of the run and downstream from equipment shutoff valve.

5. Provide bonding jumpers across expansion and deflection couplings in conduit runs, piping, pipe connections to water meters and dielectric couplings in metallic cold water piping system.

6. Bond to lightning protection system, where applicable.

7. Bonding pigtails shall be insulated copper conductor, identified green, sized per code and provided with termination screw or lug.

L. Grounding Connectors and Connections:

1. Provide mechanical connections for all connections to ground rods, posts, cable trays, conduits, data and networking racks/cabinets and water pipes.

2. Provide compression connectors for cable-to-bar and cable-to-cable connections unless otherwise noted. All connections shall be torqued per manufacturer's specification. Attach lugs to bus with appropriate size cadmium bronze bolt, flat washer and Belleville washer.

3. Provide exothermic welds for buried or concealed joints, cable-to- cable and cable to structural steel surfaces. Connections made outdoors shall be suitable for exposure to the elements. Connections made indoors shall use low smoke, low emissions process. All materials involved shall be from the same source to insure compatibility. Connections made with this process shall meet requirements of IEEE Standard 837 and other applicable specifications.

4. All Buried or concealed joints shall be inspected and approved by the inspector and the District's Representative before concealment.

M. Power system grounding:

1. Provide, unless otherwise indicated, a main building reference ground bus at location in main electrical room that consists of the main building neutral bus bonded to the main building ground bus. Connect the following items using CEC sized copper grounding conductors to lugs on the main building neutral bus:

   a. Grounding electrode conductor from driven ground rods, concrete encased electrode and supplementary grounding electrodes.
   b. Bonding conductor to metallic cold water piping system.
   c. Bonding conductor to building structural steel.

2. Provide a dedicated ground bus in each electrical room connected to main building reference ground bus via 1"C with 1#4/0 AWG or as indicated on grounding riser diagram.

N. Separately derived electrical system grounding:

1. Ground each separately derived system per requirements in CEC as a minimum, unless greater requirements are stated elsewhere in the contract documents.

2. Transformers: Provide a dual rated four or six-barrel grounding lug with a 5/8", 11 threaded holes. Drill enclosure with 11/16" bit and attach lug to enclosure utilizing a torque bolt and a dragon tooth transition washer or equal. Connect the following when present:

   a. Grounding electrode conductor.
   b. Primary feeder ground.
   c. Secondary feeder ground.
   d. Main bond jumper.
   e. Isolated ground conductor (where applicable).

O. Telecommunication system grounding:

1. Provide telecommunication ground bus, sized as required, wall mounted at main and each satellite telecommunication room with insulated standoffs.

2. Provide one #4/0 AWG in 1" conduit from the Main Telecommunication ground bus to the

main building reference ground bus, unless otherwise shown.

3. Provide one #2 AWG in 3/4" conduit, unless otherwise shown from each Satellite Telecommunication ground bus or backboard to main telecommunication ground bus in the Main Telecommunication room.

PART 4 - EVALUATION

A. List of items or systems requiring testing, evaluation, verification, or commissioning: Grounding and bonding systems.

B. Documentation required:

1. Test reports: The contractor shall engage a qualified Independent testing and inspecting agency to perform field tests/inspections and provide reports for all connections/terminations and protective devices.

2. General Testing:

a. Visual and mechanical inspection:

1) The testing agency shall inspect the grounding electrode and connections prior to concrete encasement, burial, or concealment.
2) Check tightness and welds of all ground conductor terminations.
3) Verify installation complies with the intent of the contract documents

b. Electrical Tests: The resistance to ground for all systems shall be measured by the "direct" method or "fall-of-potential" method.

1) Perform "fall-of-potential" test per Institute of Electrical and Electronic Engineers (IEEE) Standard No. 81, Section 9.04 on the main grounding electrode or system.
2) Perform the 2 point method test per IEEE No. 81, Section 9.03 to determine the ground resistance between the main grounding system and all major electrical equipment frames, system neutral and derived neutral points.
3) The earth electrode under test must be far enough away from the water pipe system to be outside its sphere of influence. Rule of thumb: Distance from the earth electrode system to the water pipe system should be about 10 times the radius of the electrode or grid to obtain a measurement within an accuracy of plus or minus 10%.

c. Obtain and record ground resistance measurements both from electrical equipment ground bus to the ground electrode and from the ground electrode to earth.
d. Device Testing: When improper grounding is found on receptacles, check receptacles in entire project and correct. Perform retest.

3. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Sections 7.13 as appropriate. Certify compliance with test parameters.

4. Perform ground resistance and continuity testing in accordance with IEEE 142.

5. Adjustments: Furnish and install additional bonding and add grounding electrodes as required complying with resistance limits specified under this Section of the Specification.

END OF SECTION

SECTION 26 05 29
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - PRODUCTS

1.01 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Hangers and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7 and latest California Building Codes.

1. The term "withstand" means "the supported equipment and systems will remain in place without separation of any parts when subjected to the seismic forces specified and the supported equipment and systems will be fully operational after the seismic event."

2. Component Importance Factor: 1.5

B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame Rating: Class 1.

2. Self-extinguishing according to ASTM D635.

1.02 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch- diameter holes at a maximum of 8 inches o.c. in at least one surface.

1. Manufacturers::

a. Allied Tube & Conduit; a part of Atkore International.

a. B-line, an Eaton business.
b. CADDY; a brand of nVent.
c. Thomas & Betts Corporation; A Member of the ABB Group.
d. Unistrut; Part of Atkore International.

2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.

3. Material for Channel, Fittings, and Accessories: Galvanized steel.

4. Channel Width: Selected for applicable load criteria.

5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.

6. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.

7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.

D. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M steel plates, shapes, and bars; black and galvanized.

E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

a. Manufacturers::

1) Hilti, Inc.
2) ITW Ramset/Red Head; Illinois Tool Works, Inc.
3) Simpson Strong-Tie Co., Inc.

2. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened Portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

a. Manufacturers::

1) Hilti, Inc.
2) ITW Ramset/Red Head; Illinois Tool Works, Inc.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.

4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.

5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F3125/F3125M, Grade A325.

6. Toggle Bolts: Stainless-steel springhead type.

7. Hanger Rods: Threaded steel.

1.03 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

1.04 APPLICATION

A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:

1. NECA 1.

2. NECA 101

3. NECA 102.

4. NECA 105.

5. NECA 111.

B. Comply with requirements in Section” Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

C. Comply with requirements for raceways and boxes specified in Section” Raceways and Boxes for Electrical Systems."

D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and RMC as scheduled in NECA 1, where its Table 1 lists maximum spacings that are less than those stated in NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with single-bolt conduit clamps using spring friction action for retention in support channel.

F. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings, and for fastening raceways to trapeze supports.

1.05 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT/IMC and RMC may be supported by openings through structure members, according to NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lbs .

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.

2. To New Concrete: Bolt to concrete inserts.

3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.

4. To Existing Concrete: Expansion anchor fasteners.

5. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick. Anchorage and methods shall be approved by DSA and acceptable AOR/Project Structural Engineer.

6. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69 Spring-tension clamps.

7. To Light Steel: Sheet metal screws.

8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that comply with seismic-restraint strength and anchorage requirements.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

1.06 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

B. Field Welding: Comply with AWS D1.1/D1.1M.

END OF SECTION

SECTION 26 05 33
RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - REQUIREMENTS

1.01 Design considerations specific to components in this section:

A. The size of the raceways shall be as specified by the designer and not less than required by California Electrical Code (Chapter 9, Annex, Table C1, based on "THW" insulation type) for the size and number of conductors to be pulled therein. CEC requirements shall prevail or as specified by the designer.

1. Minimum Raceway Size: 3/4 inch unless otherwise specified.
2. Minimum Raceway Size: 1 inch for underground installation.
3. Minimum Raceway Size: 5 inch for medium voltage cables.
4. Raceway size shall be increased to the next larger size where it shall be installed underground.

B. A separate raceway shall be installed for each homerun.

PART 2 - PRODUCT S

2.01 RIGID STEEL CONDUIT (RSC):

A. Manufacturers:

1. Allied Tube and Conduit
2. Western

B. Characteristics:

1. Provide high quality prime steel, standard weight raceway, hot- dipped galvanized inside and out. Treads shall be hot-dipped galvanized after cutting.
2. The wall thickness shall be uniform for the entire length with smooth and defect free interior.
3. Fitting shall be zinc coated, ferrous metal and threaded type. Split or bolt-on type is not acceptable.
4. Electro-galvanizing is not permitted.

2.02 ELECTRICAL METALLIC TUBING (EMT):

A. Manufacturers:

1. Allied Tube and Conduit
2. Western Tube and Conduit
3. Republic Conduit

B. Characteristics:

1. Provide tubing of high-grade steel electrically welded with exterior protective coating of hot galvanized zinc, applied by the electro galvanized process.
2. Tubing shall be dipped in a chromic acid bath to chemically form a corrosion-resistant protective coating of zinc chromate over galvanized surface.
3. Interior surface shall be coated with aluminum lacquer or enamel.
4. Fitting shall be steel, watertight, gland ring compression type, wrench tightened connectors and couplings as Manufactured by Appleton, O-Z Gedney, Cooper/Crouse-Hinds.
5. Provide compression fittings
6. Die Cast and indenter type fittings and Set screw fittings are not permitted.

2.03 PVC COATED METAL CONDUIT:

A. Manufacturers:

1. Robroy Industries “PLASTI-Bond Red” or Ocal or Thomas & Betts

B. Component Characteristics:

1. Provide PVC coated rigid steel conduits and fittings with a half lap, 40 mil extruded PVC jacket. The jacket shall have high tensile strength, shall be highly resistant to corrosion and shall not oxidize or deteriorate or shrink when exposed to sunlight and weather. The jacket shall be flame retardant and shall not support combustion.
2. The interior of conduit and fittings shall be coated with urethane coating (two mil thickness) for protection against corrosion.
3. Fittings and accessories shall be provided by the same manufacturer and installed in accordance with the manufacturer's specifications.

2.04 FLEXIBLE METAL CONDUIT:

A. Manufacturers:

1. AFC
2. Alflex
3. Electri-Flex
4. Thomas & Betts

B. Characteristics:

1. Provide conduit manufactured from single strip, standard weight steel hot-dipped galvanized on all four sides prior to conduit fabrication.
2. Provide die cast fittings of the type that screw into the inside of the conduit with threaded edges at 90 degrees to the fitting body to insure a force fit. Fittings shall be manufactured by AFC, O-Z Gedney, T&B and Steel City.
3. General: flexible conduit and fittings shall provide positive ground continuity. Include a separate green grounding conductor in each run.
4. Aluminum and light-weight steel conduits and Binding screw type fittings are not permitted

2.05 LIQUIDTIGHT FLEXIBLE METAL CONDUIT:

A. Manufacturers:

1. AFC
2. Alflex
3. Electri-Flex
4. Thomas & Betts

B. Characteristics:

1. Provide conduit manufactured from single strip standard weight steel, hot dipped galvanized on all four sides prior to conduit fabrication and shall be provided with an extruded polyvinyl chloride cover.
2. Provide malleable iron, zinc plated fittings with locknut and O-ring seal and slim diameter with small turning radius. Manufactured by O- Z Gedney-4Q series, T&B- 5200 series or Appleton Flexible Fittings- ST series.
3. General: Liquid tight conduit and fittings shall provide positive ground continuity. Include a separate green grounding conductor in each run.

2.06 RIGID NONMETALIC CONDUIT (PVC):

A. Manufacturers:

1. Carlon
2. PW Pipe
3. Cantex
4. Thomas & Betts

B. Characteristics:

1. Provide heavy wall virgin polyvinyl chloride Schedule 40 conduit rated for use with 90°C conductors when installed in concrete encasement.
2. Provide Schedule 80 conduit rated for use with 90°C conductors when installed direct buried.
3. The PVC shall conform to (UL) requirements and listed for exposed and direct burial application.
4. Fittings and cement shall be provided by the same manufacturer. All joints shall be solvent welded in accordance with the manufacturer's recommendations.

2.07 WIREWAYS:

A. Manufacturers:

1. Wiremold
2. B-line
3. Hubbell

B. Characteristics:

1. Provide non - metallic wireway as required.
2. The size shall be minimum wiremold 5500/ 5400 series unless otherwise noted. The finish shall be selected by architect.
3. Outdoor units shall be raintight with screw covers and furnished with full gaskets.
4. Provide with divider for power and data where required.

2.08 CONDUIT HANGERS:

A. Manufacturers:

1. Cooper B-Line
2. Cush-A-Clamp
3. Caddy
4. Thomas & Betts

B. Characteristics:

1. Conduit shall be strapped using either conduit strap, conduit clips or conduit hangers as outlined below.
2. Two- hole stainless steel conduit strap mounted on strut is preferred.
3. Conduit clip mounted on strut may also be accepted.
4. Conduit hangers, stainless steel, may also be accepted.
5. Cable ties, twist ties, wire ties and any other tying devices are not permitted.
6. One-hole conduit straps are not permitted.

2.09 OUTLET BOXES - Standard:

A. Manufacturers:

1. Appleton

2. Crouse-Hinds
3. Steel City
4. T & B
5. Raco

B. Characteristics:

1. Outlet boxes and covers shall be galvanized pressed steel and plugged holes and shall be hot dipped galvanized or sherardized.
2. The minimum box size shall be 4” square by 2-1/8” deep.
3. Telephone and data outlets shall be a minimum of 4-11/16” square by 2-1/8” deep.
4. Fire Alarm boxes shall be 4” square with plaster rings to suit type of device. Special boxes shall be as specified in Division 28.
5. For boxes concealed in walls or ceiling, provide the solid gang, galvanized steel knockout type. Sectional boxes shall not be used.
6. Light fixture outlet boxes shall be equipped with fixture-supporting device, as required by the unit to be installed.
7. Switch Outlets: Use solid gang boxes for three or more switches for mounting behind a common single plate.

2.10 OUTLET BOXES – In Concrete:

A. Manufacturers:

1. Appleton
2. Crouse-Hinds

B. Characteristics:

1. Flush Mounted: Provide galvanized steel, 4” octagon rings with mounting lugs, back plate and adapter ring as required.
2. Surface Mounted: Provide galvanized cast iron alloy; flat flanged box with threaded hubs and mounting lugs as required. Provide cast cover plate of same material as the box with ground flange, neoprene gasketed and stainless-steel screws.

2.11 PULL AND JUNCTION BOXES:

A. Manufacturers:

1. O.Z. Gedney
2. Wiegmann.
3. Hoffman

B. Component Characteristics:

1. Sheet Metal Pull and Junction Box: Provide standard outlet or concrete ring boxes wherever possible; otherwise use minimum 16-gauge galvanized sheet metal, NEMA 1 boxes, sized to Code requirements with covers secured by cadmium plated machine screws located 6 inches on centers.
2. Cast Metal Pull and Junction Box: Provide standard cast malleable iron outlet or device boxes wherever possible; otherwise use cadmium plated, cast malleable iron boxes with bolt-on, interchangeable conduit hub plates with neoprene gaskets.
3. Flush mounted pull boxes and junction boxes: Provide overlapping covers with flush head cover retaining screws, prime coated.

2.12 PRECAST CONCRETE BOXES:

A. Manufacturers:

1. Jensen
2. Associated
3. Quickset
4. Oldcastle

B. Component Characteristics:

1. Provide high density reinforced concrete pull box with end and side knockouts and non-settling shoulders. Use cast iron lid with hold down bolts or use traffic rated covers in areas subject to vehicular traffic.

2.13 POKE-THROUGH:

A. Manufacturers:

1. For new construction: Legrand/Wiremold, Evolution 6AT series (6" diameter) or equal by Hubbell.
2. For existing buildings: Legrand/Wiremold, 4" diameter

B. Characteristics:

1. Provide recessed style multi-service, fire rated, poke-thru devices with fully recessed device outlets that allow all plug-in devices and jacks to be fully contained within the compartment with cover closed and only cables visible.
2. Provide poke thru devices complete with assembly, insert, activation cover, receptacles, communication modules mounting accessories, etc. and any additional accessories to facilitate the installation shown on drawings.
3. Integral gasket shall be provided as part of the cover assembly to maintain scrub water tightness by preventing water, dirt and debris from entering the power and communication compartments.
4. Provide Die-cast aluminum cover assembly in black finish or as directed by District.
5. Furniture Feeds: Cat. # 6ATCFF-xx series with surface style cover.
6. Misc. Devices: Cat. # 6STCP series with associated surface style cover Cat. # 6CTC-xx.

2.14 FLOOR BOXES:

A. Manufacturers:

1. Legrand/Wiremold Evolution Series
2. FSR 500/600 series

B. Characteristics:

1. Recessed Floor Boxes: Provide recessed gang able floor box with quantity and configuration of gangs as indicated on contract documents. Provide Die-cast aluminum flip lid cover assembly for use in tile or carpet installation in black finish or as directed by Architect.
2. Flush Floor Boxes: Provide flush multi-gang floor box for power, communication and other signaling systems as indicated on contract documents. Provide Brushed aluminum cover assembly for use in tile/carpet installation or as directed by Architect.
3. Boxes shall be complete with device plates, covers, devices, receptacles, etc. and any other accessories as required.
4. All boxes shall have handle or means to easily open the box.

2.15 CONDUIT OUTLET BODY:

A. Manufacturers:

1. Appleton, type "LBD" or "LBDN" series

2. Crouse-Hinds

B. Characteristics:

1. Provide Cadmium plated cast iron alloy, oblong conduit outlet bodies with threaded conduit hubs and neoprene gasket, cast iron covers where required. Condulets shall be cast iron with threaded hubs and gasket.

2.16 CONDUIT SEALS:

A. Manufacturers:

1. Appleton, type “ESUF” or “ESUM” series
2. Crouse-Hinds, type “EYS” or “EZS” series

B. t Characteristics:

1. Provide cast iron alloy for both body and closure. The seals shall have large openings with threaded closures to provide easy access to conduit hubs.

2.17 WALL PENETRATION SEALS:

A. Manufacturers:

1. Link-Seal
2. STI Firestop
3. Metraflex

B. Characteristics:

1. Provide modular watertight seals for all conduits penetrating exterior walls to prevent entrance of water inside the building.

2.18 EXPANSION COUPLINGS:

A. Manufacturers:

1. Emerson - O-Z/Gedney, Type "AX" or "DX series
2. Eaton -Crouse Hinds Type "XD" or "XJD" series

B. Component Characteristics:

1. Provide expansion couplings in areas that two sections of conduit are subject to longitudinal movement due to thermal expansion, buckling and where crossing the structural joints.

PART 3 - INSTALLATION

A. Install Work in accordance with CBC & CEC standards and codes.

B. Arrange raceway and boxes to maintain headroom and present neat appearance.

C. Identify raceway and boxes.

D. Ground and bond raceway and boxes.

E. Fasten raceway and box supports to structure and finishes.

3.02 Installation – Raceway:

A. Provide the type of raceway permitted in these Specifications or required for each location or condition per applicable codes and jurisdictions whichever is more stringent.

B. Avoid moisture traps; install junction box with drain fitting at low points in conduit system.

C. Installation of raceways shall be coordinated with building structure and other trades and shall be complete with bends, fittings, junction and pull boxes to meet all codes and make complete operating system.

D. Upon completing the installation of any run of conduit, the runs shall be tested to see that they are free from all obstructions and have a smooth interior. Each end of each conduit run shall be plugged with "pennies" and bushings and left plugged until ready to pull circuit wires.

E. Raceways shall not be run in foundation, column, concrete slab, or in the plane of the concrete shear wall without written approval of the structural engineer and District for each individual run.

F. Raceways shall be concealed above ceiling, below floors and in walls, unless otherwise noted.

G. Where steel conduits enter a concrete floor below a surface mounted panelboard, they shall be encased in a concrete curb of enough height to match the height of the finished base tile.

H. Holes for conduits through existing concrete walls, manhole, or floors shall be made by the "core-drill" method. The size and location shall be approved by the District.

I. Routing:

1. Raceway routing is shown in approximate locations unless dimensioned.
2. Route raceways parallel and perpendicular to walls and ceilings for all exposed and concealed locations, no jogging or zigzagging allowed.
3. Route raceways in furred spaces to clear access openings.
4. Route conduit in (where allowed by architect/structural engineer) under slab from point-to-point. Do not cross conduits in slab.
5. Maintain minimum of 6 inch or larger clearance as required between raceway and piping for maintenance purposes.
6. Maintain 12-inch clearance between raceway and surfaces with temperatures exceeding 104°F such as hot water and steam pipes, flues, heating appliances etc.

J. Supports:

1. Raceway supports shall be dedicated to support the raceways only and shall not support any other item.
2. Support raceways from structure above suspended ceilings; maintain minimum 8 inch or larger clearance above drop ceiling to allow removal of ceiling tiles. Maintain minimum 3 inch or larger clearance above recessed light fixtures.
3. Do not attach raceway to ceiling support wires or other piping systems.
4. Provide plated or galvanized hangers, rods, channels and metallic support and fastening material. Do not use perforated metal strap or wood as support material.
5. Hangers and racks shall be attached to concrete with insets, set at the time the concrete is poured and to steel members with beam clamps or machine bolts.
6. Conduit clamps and hanger rods attached to concrete structures shall be secured by machine bolts or rods screwed into anchors. Anchors not cast into the concrete shall be of the expansion shield type.

7. Where single conduits 3/4 inch and larger are suspended from ceiling, use pipe hangers suspended from rods.
8. Where two or more conduits 1-1/2 inch and larger are suspended from ceiling, use trapeze type hanger suspended from rods.
9. Install fittings to accommodate expansion and deflection where raceway crosses seismic and expansion joints. Where Raceways cross the joints, provide approved expansion or deflection fittings, or combinations of fittings and liquid tight flex conduits to allow deflection in all directions as required.
10. Raceways shall be continuous from outlet to outlet, from outlet to cabinet, junction box, pull box and shall enter and be secured to all boxes, etc., in such a manner that each system will be mechanically and electrically continuous from service to all outlets.
11. Supports shall be installed for 3/4 to 1-1/4 inch conduits; within 18 inch of each junction box inclusive and on either side of couplings and fittings and at a spacing not to exceed 8 feet.
12. Supports shall be installed for 1-1/2 inch and larger conduits; within 36 inch of each junction or pull box and terminal cabinet and at a spacing not to exceed 8 feet.
13. When conduits are supported from trapezes, the supports shall be spaced not more than 8 feet apart.
14. Secure exposed conduit runs on concrete, plaster or other construction in place with cast conduit clamps affixed with metallic expansion anchors or toggle bolts and cadmium plated machine or lag screws.
15. Surface Raceway: Install flat-head screws, clips and straps to fasten raceway channel to surfaces; mount plumb and level. Install insulating bushings and inserts at connections to outlets and corner fittings.
16. Support raceways adjacent to walls with preformed channels.
17. Do not strap or fasten rigid conduit to mechanical equipment, or to equipment subject to vibration or mounted on shock absorbing bases.

K. Conduit Hangers:

1. Conduit straps, clips or hangers shall be used to mount conduit.
2. Where conduit clips are used, preference is to mount on strut, rather than on wall.

L. Seismic Bracing:

1. Provide seismic bracing for raceways consisting of (3) ¾", or (2) 1", or (1) 1-1/4" and larger or multi size combinations, wherever raceways are suspended more than 10 inch to the bottom of the raceway from its anchoring point on the structure. All such bracing as described herein or below shall be run from the raceway to the structure and anchored to the latter in an approved manner.
2. Provide diagonal bracing every 16 feet to the structure from hangers and changes in direction.
3. Seismic bracing as described above shall be provided immediately upon completion of each conduit run, to prevent obstruction of conduits by other utilities or construction work.

M. Bends:

1. Keep bends and offsets in raceway runs to an absolute minimum. There are no zigzagging or small jogging permitted.
2. Install no more than equivalent of four 90-degree bends between boxes. Install conduit bodies to make sharp changes in direction, as around beams.
3. Conduit bends will not be permitted around the corners of beams, walls or equipment. Provide condulets as required with accessible covers.
4. For bends and offsets in conduit 1 inch and larger, use larger radius factory fittings or a hydraulic bender. Replace flattened, deformed or kinked conduit.
5. For the serving utilities the bending radius of raceways shall meet their requirements.

N. Cuts and Joints:

1. Cut conduit square using saw or pipe cutter; de-burr cut ends.
2. Cut conduit squarely and ream ends to remove burrs. Close open ends of conduits, unless in a closed box or cabinet, with approved conduit caps or closures as soon as installed and keep closed until ready to pull in conductors.
3. Ream the ends of all conduits and clean conduits before pulling conductors.
4. Where conduit is underground, under slabs or grade, exposed to the weather, or in wet locations, make joints liquid tight and gas tight.
5. For rigid steel conduit use conduit unions to connect two rigidly held conduits. Running thread will not be accepted.
6. Cut threads on rigid conduit to standard taper and to length such that bare metal exposed by the threading operation will be completely covered by the couplings or fittings used.
7. Use pipe joint compound (pipe dope) and oil applied to the male threads only and tighten joints securely.
8. For underground or under slab conduits, apply a heavy coat of Pabco P & B No. 2 paint after installation to surfaces within 6" on both sides of fittings and to areas where wrenches or other tools have been applied.
9. For exposed conduits, repair scratches and other defects with galvanizing repair stick, Enterprise Galvanizing "Galvabar", or equal.
10. Right- and left-hand couplings shall not be used.
11. Make all fittings in plastic conduit watertight with approved solvent- weld cement specifically manufactured for the purpose and approved by PVC conduit manufacturer.

O. Terminations:

1. Secure conduits to panels, pull boxes, wireways and enclosures with locknuts, inside and out and provide high impact plastic or insulated throat steel bushings at terminations in pull boxes, wireways, signal cabinets, boxes and enclosures.
2. For rigid steel conduit, provide steel insulating bushings with plastic liner.
3. For EMT provide insulated throat connectors secured with locknut on interior of box or enclosure.
4. For flex conduit, provide insulated throat steel twist-in connectors secured with locknut on interior of the box or enclosure, or steel twist- in connectors with plastic bushing and locknut.
5. At panelboards, switchboards and gear specified with ground bus terminate conduits with ground bushing bonded to ground bus with code size conductor.
6. Conduit connections to panel cabinets and pull boxes shall have grounding wedge lugs between the bushing and the box or locknuts designed to bite into the metal.
7. Use approved couplings or unions; running thread, thread less coupling, or split coupling connections are not permitted.
8. Use insulated bushings and locknuts on all conduits where entering pull boxes, junction boxes, outlet boxes, cabinets and similar enclosures and for all signal and telephone conduit terminated in cabinets or backboards. For 1-inch or larger bushings, shall be with grounding lugs, O-Z/Gedney Type BLG or equal. Bushings shall be installed before any wire is pulled.
9. For all PVC jacketed steel conduits wrap all joints with two layers of 10 mil PVC tape.
10. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for minimum 20 minutes.

P. Sleeves:

1. Coordinate sleeve selection and application with selection and application of firestopping.
2. Wherever conduits pass through concrete walls, suspended slabs or metal deck floors furnish and install sleeves of ample size to permit installation of conduit. Sleeves shall be

installed prior to pouring of concrete and shall have ends flush with the wall or extend 2 inches above floor surfaces. Verify locations with the Architect.
3. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
4. Use rectangular sleeve (minimum of 0.052-inch thick steel) for openings that the perimeter is less than 50 inches and all sides are less than 16 inches.
5. Use rectangular sleeve (minimum of 0.138-inch thick steel) for openings that the perimeter is equal or greater than 50 inches and one or more sides are equal or greater than 16 inches.
6. Cut sleeves to length for mounting flush with both wall surfaces.
7. Extend sleeves installed in floors 2 inches above finished floor level.
8. Finish around Sleeves: Rough edges shall be finished smooth.
9. Space between conduit and sleeves where conduit passes through exterior walls shall be sealed to permit movement of conduit but prevent entrance of water.
10. Space between conduit and sleeves where conduit passes through fire rated interior walls and slabs shall be sealed with approved materials to provide a fire barrier conforming to the requirement of Codes as listed in General Requirements.
11. Sleeve shall be 1 inch to 2 inch bigger than conduit size.

Q. Empty Raceways:

1. Install suitable pull string or cord in each empty raceway except sleeves and nipples.
2. Provide nylon or polypropylene pull ropes in all conduits more than 60 inch in length that are left empty for future use. Minimum of 60 inch of rope shall be provided at each end of the conduit.
3. For 1-1/2 inch and smaller conduits, provide 1/8 inch outside diameter rope.
4. For 2 inch and larger conduits, provide 3/8 inch outside diameter rope.
5. Tag all empty conduits at each accessible end with a permanent tag identifying the purpose of the conduit and the location of the other end.
6. In wet, corrosive outdoor or underground locations, use brass, bronze, or copper 16-gauge tags or lead tags secured to conduit ends with #16 or larger galvanized wire.
7. Inscribe on the tags, with steel punch dies, clear and complete identifying information.
8. Install suitable caps, recommended by manufacturer, to protect installed conduit against entrance of dirt and moisture until ready to pull in conductors.
9. All open ends of conduits for communications cabling shall be furnished with plastic bushing.

R. Seals:

1. Conduits terminating where termination is subject to moisture or where conduit penetrates exterior wall shall be sealed.
2. Seal all conduits from exterior outlets at first interior junction to prevent moisture from entering the building through the conduit. Slope exterior conduits away from the building.
3. Provide conduit seal for all conduits that pass through Classified (hazardous) areas, sump pump and sewage ejector pits, refrigerated areas, temperature-controlled rooms such as cold room or warm rooms.
4. Seal all fire rated wall or ceiling penetrations. Sealant material and method shall be UL listed.

3.03 Raceway Application:

A. Rigid steel conduit shall be used for the following:

1. Where required by Code.
2. Where exposed to weather, damp and wet locations
3. Where exposed to physical damage
4. In Cold Rooms and refrigerated area (65°F or less).
5. Generator enclosure

B. EMT conduit shall be used for the following:

1. EMT conduit shall be used for all sizes up to 4” in dry locations as in stud partitions and furred ceiling space.
2. EMT conduit may be used up to 4” for Telecommunication and Voice/Data System.
3. EMT conduit may be used up to 4” for Fire Alarm System wiring where conduit is concealed and where it is not main run and riser.
4. EMT conduit shall not be used for underground, exterior, where it is prohibited and where rigid steel conduit is required.

C. Flexible steel conduit shall be used for the following:

1. Where required by Code.
2. In dry locations.
3. Where structural condition prevents the use of other type of conduit and for a maximum length of 24".
4. For final connection to motors, transformers and vibrating equipment. Lengths shall be limited to within maximum of 6’.
5. For final connection from junction box to light fixture. Lengths shall be limited to within maximum of 6’.

D. Liquid tight Flexible conduit shall be used for the following:

1. Where required by Code.
2. In plenum areas.
3. Where exposed to weather, in damp or wet locations.
4. In refrigerated areas (65°F or less).
5. Between the seismic joints.
6. For connections to equipment containing water (i.e. water heaters)
7. Any connections made below sinks.
8. Provide polyvinyl covers listed for the application of area of use.
9. Minimum length of flexible liquid tight conduit shall be 3’ for connection to motors and vibrating equipment. The lengths shall be limited to a maximum of 6’ unless otherwise noted.

E. Rigid nonmetallic conduits, PVC Schedule 40 shall be used for the following:

1. For 2" and larger size conduit encased in concrete at a minimum depth of 36" below grade and installed 36” beyond building envelope.
2. For 480V and below, 1-1/2" and smaller size surrounded with 3" slurry all around the conduit at minimum 24" below grade for outside of building envelope.

F. PVC coated steel conduits shall be used in lieu of rigid nonmetallic conduit for the following conditions or locations:

1. In corrosive and/or moist areas
2. Use for all cooling tower areas
3. Use for all conduit stub-ups through the floor slab, including the elbows.
4. Use for all conduit penetrations through the exterior walls, including 36” on either side of the penetration.
5. For all bends in conduits 2” and larger, use large radius factory made bends or field fabricate with a power bender.
6. All conduits and fittings that have a damaged PVC coating shall be replaced promptly.

3.04 Installation – Boxes:

A. Provide the type of boxes permitted in these Specifications or required for each location or condition per applicable codes and jurisdictions whichever is more stringent.

B. Install boxes in accordance with manufacturer's written instructions, as shown on drawings and as specified herein.

C. Provide pull boxes inside the building to facilitate pulling of conductors and cables for long and excessive runs of raceways. The spacing of pull boxes shall not exceed 200 feet of raceway runs for electrical system and 100 feet for telecommunications system. These pull boxes are not necessarily indicated on drawings. (Coordinate telecommunication requirements)

D. All boxes shall be of CEC size for the number of wires or conduits passing through or terminating therein, but in no case shall any box be less than 4” square by 2-1/8” deep.

E. Locate electrical boxes as required for splices, taps, wire pulling, equipment connections, Code compliance and other building elements.

F. Prior to coring slab for poke-thru devices, coordinate with structural engineer and Architect for approval.

G. Install outlet boxes at the locations specified. Adjust locations as required by structural conditions and to suit coordination requirements of other trades.

H. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only such as electrical rooms, mechanical rooms and utility areas.

I. In Accessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.

J. Do not install flush mounting boxes back-to-back in walls; install with minimum 6 inches separation. Install with minimum 24 inches separation in acoustic and fire rated walls.

K. For boxes not specified or indicated, use boxes and mounting height as required by equipment and recommended by equipment manufacturer.

L. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.

M. Install flush mounting box without damaging wall insulation or reducing its effectiveness.

N. For boxes mounted in exterior walls, make sure that there is insulation behind outlet boxes to prevent condensation in boxes.

O. Use extension rings with blank covers for making exposed conduit connections to flush wall or ceiling boxes.

P. Locate outlet boxes to allow light fixtures positioned as indicated on Drawings.

Q. Locate switch outlet boxes on the latch side of doorways unless otherwise indicated.

R. Install gang box where more than one device is to be mounted together. Do not use sectional box.

S. Install gang box with plaster ring for single device outlets.

T. Supports:

1. Support boxes independently of conduit system:
2. Install stamped steel bridges/brackets to fasten flush mounting outlet box between studs.
3. Install adjustable steel channel fasteners for hung ceiling outlet box.
4. Do not fasten boxes to ceiling support wires or other piping systems.
5. Support boxes, installed in suspended ceilings supporting acoustical tiles or panels, directly from the structure above wherever pendant mounted lighting fixtures are to be installed from the box.
6. Mount boxes, installed in suspended ceilings of gypsum board or lath and plaster construction, to 16-gauge metal channel bars attached to main ceiling runners.

U. Boxes for different systems:

1. Where both emergency and normal circuits feed a single light fixture, provide an outlet box for each system.
2. Provide separate pull boxes and J-Box for different voltage conductors. Also provide separate boxes for general loads, communications, fire alarm, lighting, signal and miscellaneous systems.
3. Multiple gang boxes containing 277volt switches shall have a barrier between each switch.
4. Paint the outside and inside of all boxes containing fire alarm devices with red paint.

V. Covers:

1. Covers for flush outlets shall finish flush with plaster or another finished surface.
2. Install raised covers (plaster rings) on all outlet boxes in stud walls or in furred, suspended or exposed concrete ceilings. Covers shall be of a depth to suit the wall or ceiling finish.
3. For outlets flush in exterior walls, use weatherproof joints and connections all around. Outlets shall have cast covers and be fitted with gaskets.
4. Label the cover of each accessible junction box with panel and circuit designation and function.
5. Install galvanized steel cover plates on boxes in unfinished areas, above accessible ceilings and on surface mounted outlets.
6. Provide cast metal boxes with gasketed cast metal cover plates where boxes are exposed in damp or wet locations.

W. Use conduit outlet bodies to facilitate pulling of conductors or to make changes in conduit direction only. Do not make splices in conduit outlet bodies.

X. Leave no unused openings in any box. Install close-up plugs as required to seal openings.

Y. J-Boxes shall not be installed on any vibrating equipment (I.e. pumps, fans, etc.) unless used for power or control of the same equipment. No J-Box shall be installed on air ducts or pipes.

Z. J-Boxes shall not be installed in visible finished areas. Place boxes that might be exposed to public view in a location approved by the District's Representative. Provide covers or plates to match adjacent surfaces as approved by the District's Representative.

AA. aa) For exterior underground conduit runs provide precast concrete boxes in exterior planting areas, walkways and etc. Provide 6" deep gravel base under each box.

BB. bb) Prior to coring existing floor slab for floor devices, coordinate with structural engineer and the District for approval.

3.05 Miscellaneous Items:

A. Install conduit to preserve fire resistance rating of partitions and other elements, using materials and methods per UL.

B. Provide fire-proofing pad add additional sheet rock as necessary to maintain original fire rating of walls where boxes are installed on rated walls.

C. Provide acoustic pad or membrane around all outlet boxes and switches located in party walls of offices, meeting rooms and all quiet areas.

D. Route conduit through roof openings for piping and ductwork or through suitable roof jack with pitch pocket. Coordinate location with roofing installation.

E. Wherever conduit extends through roof, furnish and install galvanized sheet metal flashing. Flashing shall extend six inches above roof.

3.06 Adjustments:

A. Align adjacent wall mounted outlet boxes for switches, thermostats and similar devices.

B. Adjust flush-mounting outlets to make front flush with finished wall material.

C. For outlets mounted above counters, benches or backsplashes, coordinate location and mounting heights with built-in units. Adjust mounting height to agree with required location for equipment served.

D. In concrete or drywall construction, set recessed boxes so that the front of the plaster ring or front of the box for those without plaster rings is not more than 1/4” behind the final finished surface.

E. Set all recessed boxes in other types of construction so that the fronts are flush with the finished surface. Where these settings are not achieved, provide a 24-gauge or heavier galvanized steel liner flush with finished surface.

F. Adjust position of outlet boxes in finished masonry walls to suit masonry course lines. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate cutting of masonry walls to achieve neat openings for boxes.

END OF SECTION

SECTION 26 05 36
CABLE TRAYS FOR ELECTRICAL SYSTEMS

PART 1 - PRODUCTS

1.01 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Cable trays and supports shall withstand the effects of earthquake motions determined according to **ASCE/SEI 7 and Latest California Building Codes**.

1. The term "withstand" means "cable trays will remain in place without separation of any parts when subjected to the seismic forces specified."

2. Component Importance Factor: **1.5**

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes in cable tray installed outdoors.

1. Temperature Change: **120 deg F** ambient; material surfaces.

1.02 GENERAL REQUIREMENTS FOR CABLE TRAY

A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.

B. Sizes and Configurations: See the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.

C. Structural Performance: See articles on individual cable tray types for specific values for the following parameters:

1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.

2. Concentrated Load: A load applied at midpoint of span and centerline of tray.

3. Load and Safety Factors: Applicable to both side rails and rung capacities.

1.03 LADDER CABLE TRAY

A. Description: Two longitudinal side rails with transverse rungs swaged or welded to side rails, complying with NEMA VE 1.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. B-line, an Eaton business.

2. Cope Cable Tray; A Part of Atkore International.

3. Mono Systems, Inc.

4. Thomas & Betts Corporation; A Member of the ABB Group.

C. Capacities and Characteristics:

1. Width: **12 inches or 18 inches or size as required** unless otherwise indicated on Drawings.

2. Minimum Usable Load Depth: **6 inches** unless otherwise indicated on Drawings.

3. Straight Section Lengths: **10 feet** except where shorter lengths are required to facilitate tray assembly.

4. Rung Spacing: **6 inches** o.c.

5. Radius-Fitting Rung Spacing: 9 inches at center of tray's width.

6. Minimum Cable-Bearing Surface for Rungs: 7/8-inch width with radius edges.

7. No portion of the rungs shall protrude below the bottom plane of side rails.

8. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb concentrated load, when tested according to NEMA VE 1.

9. Fitting Minimum Radius: **12 inches or 24 inches or 36 inches or 48 inches as required**.

10. Class Designation: Comply with NEMA VE 1 class 20C ladder type tray, Aluminum material.

11. Splicing Assemblies: Bolted type using serrated flange locknuts.

12. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

13. Covers: ventilated bottom and open top type made of same materials and with same finishes as cable tray.

14. Furnish manufacturer's standard clamps, hangers, brackets, splice plates, reducer plates, blind ends, barrier strips, connectors, and grounding straps.

1.04 WIRE-MESH CABLE TRAY

A. Description: **Galvanized** steel wire mesh, complying with NEMA VE 1.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. B-line, an Eaton business.
2. Cooper Industries; Cooper B-Line; GS Metals Corp.
3. Legrand US.

4. Mono Systems, Inc.

C. Capacities and Characteristics:

1. Width: **12 inches or 18 inches or size as required** unless otherwise other sizes are required.

2. Minimum Usable Load Depth **6 inches**.

3. Straight Section Lengths: **10 feet**, except where shorter lengths are required to facilitate tray assembly.

4. Structural Performance: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb concentrated load, when tested according to NEMA VE 1.

5. Class Designation: Comply with NEMA VE 1

6. Splicing Assemblies: Bolted type using serrated flange locknuts.

7. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

D. Materials and Finishes:

1. Steel:

a. Straight Sections and Fittings: Steel complies with the minimum mechanical properties of **ASTM A1008/A1008M, Grade 33, Type 2**.

b. Steel Tray Splice Plates: ASTM A1011/A1011M, HSLAS, Grade 50, Class 1.

c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A510/A510M, Grade 1008.

d. Finish: Hot-dipped galvanized after fabrication, complying with ASTM A123/A123M, Class B2.

1) Hardware: Galvanized, ASTM B633 or Stainless steel, Type 316.

e. Finish: Hot-dipped galvanized after fabrication, complying with ASTM A653/A653M, G90.

1) Hardware: Galvanized, ASTM B633.

f. Standard manufacturers finish.

1.05 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.

B. Barrier Strips: Same materials and finishes as for cable tray.

C. Cable tray supports and connectors, including bonding jumpers, as recommended by cable

tray manufacturer.

1.06 WARNING SIGNS

A. Lettering: **1-1/2-inch-** high, black letters on yellow background, with legend "WARNING! NOT TO BE USED AS WALKWAY, LADDER, OR SUPPORT FOR LADDERS OR PERSONNEL."

B. Comply with Section ”Identification for Electrical Systems."

1.07 CABLE TRAY INSTALLATION

A. Install cable tray and support systems according to **NEMA FG 1** or **NEMA VE 2**.

B. Install cable tray as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.

C. Install cable tray, so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.

D. Remove burrs and sharp edges from cable trays.

E. Fasten cable tray supports to building structure **and install seismic restraints**.

F. Design fasteners and supports to carry cable tray, cables, and a concentrated load of 200 lbs. Comply with requirements in Section "Hangers and Supports for Electrical Systems."**Comply with seismic-restraint details according to Section "Seismic Controls for Electrical Systems."**

G. Place supports, so that spans do not exceed maximum spans on schedules, and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of tray rungs.

H. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.

I. Do not install more than one cable tray splice between supports.

J. Make changes in direction and elevation using manufacturer's recommended fittings.

K. Make cable tray connections using manufacturer's recommended fittings.

L. Seal penetrations through fire and smoke barriers. Comply with requirements in Section "Penetration Firestopping."

M. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.

N. Install cable trays with enough workspace to permit access for installing cables.

O. Install barriers to separate cables of different systems, such as power, communications, and data processing, or of different insulation levels, such as 600, 5000, and 15 000 V.

P. Install warning signs in visible locations on or near cable trays after cable tray installation.

1.08 CABLE TRAY GROUNDING

A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section" Grounding and Bonding for Electrical Systems."

B. Cable trays with electrical power conductors shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

C. Cable trays with single-conductor power conductors shall be bonded together with a grounding conductor run in the tray along with the power conductors and bonded to the tray at 72-inch intervals. The grounding conductor shall be sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors," and Article 392, "Cable Trays."

D. When using epoxy- or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding-bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.

E. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

F. In existing construction, remove inactive or dead cables from cable trays.

1.09 CONNECTIONS

A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.

B. Connect raceways to cable trays according to requirements in NEMA VE 2 and NEMA FG 1.

1.10 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.

2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.

3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.

4. Verify that there are no intruding items, such as pipes, hangers, or other equipment, in the cable tray.

5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.

6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.

7. Check for improperly sized or installed bonding jumpers.

8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.

9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

B. Prepare test and inspection reports.

1.11 PROTECTION

A. Protect installed cable trays and cables.

1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.

2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.

3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION

SECTION 26 05 44
SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - PRODUCTS

1.01 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.

2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral water stop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. Sleeves for Rectangular Openings:

1. Material: Galvanized sheet steel.

2. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

1.02 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

A. Manufacturers:

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. Pipeline Seal and Insulator, Inc.

1. Sealing Elements: EPDM or Nitrile (Buna N) rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

2. Pressure Plates: Carbon steel or Stainless steel.

3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating or Stainless steel of length required to secure pressure plates to sealing elements.

1.03 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, water stop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber water stop collar with center opening to match piping OD.

B. Manufacturers:

1. HOLDRITE.

1.04 GROUT

A. Description: Non shrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

1.05 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam.

1.06 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint.
b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall, so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.

4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.

5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.

2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel or cast-iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

1.07 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

1.08 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position water stop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION

SECTION 26 05 48.16
SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

A. Comply with seismic-restraint requirements in the latest California Building Codes (CBC) unless requirements in this Section are more stringent.

B. Seismic-restraint devices shall have horizontal and vertical load testing and analysis. They shall bear anchorage preapproval from OSHPD in addition to preapproval, showing maximum seismic-restraint ratings, by ICC-ES or another agency acceptable to authorities having jurisdiction (DSA). Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) that support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

C. Comply with NFPA 70.

1.02 PERFORMANCE REQUIREMENTS

A. Wind-Restraint Loading:

1. Basic Wind Speed: As Applicable.

2. Building Classification Category: As Applicable.

3. Minimum 10 lb/sq. ft. multiplied by maximum area of component projected on vertical plane normal to wind direction and 45 degrees either side of normal.

B. Seismic-Restraint Loading:

1. Site Class as Defined in the CBC: As Applicable.

2. Assigned Seismic Use Group or Building Category as Defined in the CBC: As Applicable.

1.03 RESTRAINT CHANNEL BRACINGS

A. Manufacturers:

1. B-line, an Eaton business.
2. Hilti, Inc.
3. Mason Industries, Inc.
4. Unistrut; Part of Atkore International.

A. Description: MFMA-4, shop- or field-fabricated bracing assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end, with other matching components, and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

1.04 RESTRAINT CABLES

B. Manufacturers:

1. CADDY; a brand of nVent.
2. Gripple Inc.
3. Kinetics Noise Control, Inc.
4. Vibration Mountings & Controls, Inc.

A. Restraint Cables: ASTM A603 galvanized or ASTM A492 stainless - steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with a minimum of two clamping bolts for cable engagement.

1.05 SEISMIC-RESTRAINT ACCESSORIES

C. Manufacturers:

1. B-line, an Eaton business.
2. Kinetics Noise Control, Inc.
3. Mason Industries, Inc.

A. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.

B. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.

C. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchor bolts and studs.

D. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices used.

E. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

1.06 MECHANICAL ANCHOR BOLTS

D. Manufacturers:

1. B-line, an Eaton business.
2. Hilti, Inc.
3. Kinetics Noise Control, Inc.
4. Mason Industries, Inc.

A. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488.

1.07 APPLICATIONS

A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by OSHPD or an agency acceptable to Division of State Architect.

B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods caused by seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

1.08 SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork with Architect.

B. Equipment and Hanger Restraints:

1. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.

2. Install seismic-restraint devices using methods approved by OSHPD or an agency acceptable to Division of State Architect. Providing required submittals for component.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

E. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

F. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.

2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.

3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.

4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.

5. Set anchors to manufacturer's recommended torque using a torque wrench.

6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

1.09 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where connection is terminated to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

1.10 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.

2. Test at least four of each type and size of installed anchors and fasteners selected by Architect.

3. Test to 90 percent of rated proof load of device.

B. Seismic controls will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION

SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - REQUIREMENTS

1.01 Design considerations specific to components in this section:

A. All electrical equipment, devices, raceways, conduits, boxes, cables and conductors shall be labeled for identification as stated and per following codes and standards:

1. Comply with CEC
2. Comply with 29 CFR 1910.144 and 29 CFR 1910.145
3. Comply with ANSI Z535.4 for safety signs and labels.
4. Adhesive-attached labeling materials shall comply with UL969.
5. Furnish products listed and classified by Underwriters Laboratories, Inc. or by a testing agency acceptable to Authorities Having Jurisdiction as suitable for purpose specified and indicated.

PART 2 - PRODUCT REQUIREMENTS

2.01 Markers:

A. Manufacturers:

1. Thomas & Betts
2. Brady

B. Component Characteristics:

1. identification devices in accordance with manufacturer's written instructions and requirements of the CEC.

2.02 Tapes:

A. Manufacturers:

1. Kroy
2. Merlin

B. Characteristics:

1. Provide identification devices in accordance with manufacturer's written instructions and requirements of the CEC.

PART 3 - INSTALLATION

3.01 Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification work with corresponding designations specified. Provide numbering, lettering, and colors as approved in submittals and as required by Code.

3.02 Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.

3.03 Nameplates:

A. Provide laminated, engraved plastic nameplates with ⅜ inch high letters for all switchgear, switchboards, motor control centers, transfer switches, panelboards, signal system equipment cabinets, and terminal cabinets. Provide similar nameplates with ⅜ inch high letters for transformers, time switches, individually mounted breakers, switches and controls, switchboards, and motor center branch devices. Attach nameplates to gear with sheet metal screws. Adhesive mounted nameplates are not acceptable. Refer to single line diagrams and schedules for actual designations and circuit numbers that apply to this project.

B. Include nameplate schedule on shop drawing submittals.

C. Indicate on Gear Nameplates:

1. Line 1: Equipment designation
2. Line 2: Primary voltage, phase, number of wires. (In addition, include kVA rating of transformers, kW rating generators, Amperes for switchgear, Automatic Transfer Switches, and panelboards).
3. Line 3: Source equipment “Fed From” (For Automatic Transfer Switch, indicate normal and emergency source equipment and for equipment fed from a transformer, indicate source with transformer in parenthesis).
4. Line 4: (where applicable, For Automatic Transfer Switch, indicate priority number.)
5. Indicate equipment and/or equipment controlled and designation on component nameplates.
6. Install panelboard nameplates behind panel door in public areas and on panel face in equipment rooms.

D. Nameplate Color Schedule:

1. Over 600V: Brown letters on white label.
2. 277 through 600V: Orange letters on white label.
3. 120 through 240V: Black letters on white label.
4. Emergency System: White letters on red label.
5. Devices Connected ahead of Service Mains and Substation Secondary Mains: Letter color as per switchboard voltage on Yellow label.
6. Fire Alarm System: Black letters on red label.
7. Communication or Signal Systems: White letters on black label. Identify system and voltage.
8. Building Control System: White letters on green label.

E. Stenciled Designations: Provide readily visible block letter stenciled designations for the following with ⅜ inch high minimum letters on background of contrasting colors as outlined under Nameplate Color Schedule (above). Fabricate stencils of brass and deliver to Owner on

completion of work. Obtain receipt and include in maintenance manual.

1. Junction and pull boxes of signal and communication systems identifying system and voltage.
2. Lighting Outlet and Junction Boxes: Identify voltage and circuits contained within box.
3. 480V Outlet and Junction Boxes: 480V. Identify circuit(s).
4. Each 10-foot length of medium voltage conduit, exposed or in accessible ceiling space and associated junction and pull boxes: DANGER HIGH VOLTAGE
5. Feeder conduit runs on 25 foot centers and on both sides of wall and floor penetrations where visible from floor and above demountable ceilings.
6. Indicate circuit designation and number on all feeders. Indicate system on all signal and communications system conduit sized 1½ inch and larger.

F. Labels:

1. Provide label, in addition to UL label, for each switchgear, switchboard, panelboard, transfer switch, and motor control center indicating the short circuit rating of the gear as constructed and the minimum rating of devices allowable. Submit with shop drawings.
2. At all 120V outlet locations, provide labels with panel and circuit information using a P-touch or similar label maker with minimum ½" tape. For normal power, label shall be black letters on white tape. For emergency power, label shall be white letters on red tape.
3. At all dedicated outlet locations, in addition to label above, provide the name of the device to be connected at the dedicated outlet on the label.
4. At all fusible devices, either individually mounted or part of gear, provide a label or nameplate inside each switch cover, indicating specific type of fuse required for replacement.

G. Emergency System:

1. Identify all enclosures per Article 700 of the CEC
2. Paint junction box covers and covers of multi-outlet assemblies' red.
3. Use visibly red receptacles and devices. Alternately, engrave plates "EMERGENCY SYSTEM" and fill in with red enamel.

H. Conduit and Conductors:

1. Tag feeders at panels, switchboards, pull boxes, and other accessible enclosures, indicating source, voltage, circuit number, and conductor ampere rating. Tags to be readily readable after installation.
2. Identify medium voltage conductors with phase and circuit number.
3. In exterior or wet locations, and for medium voltage conductors in all locations, provide tag Fast tag Miniature Markers or equal type system, single line, with 3/16 inch minimum high letters, yellow background, and tied with No. 16 AWG galvanized wire.
4. In interior dry locations, provide metal or laminated plastic discs as above, attached with nylon cord.
5. Tag exposed ends of conduit stubs indicating system, name of panel, switchboard, etc., of origin and conduit size.
6. Identify all branch circuit system conductors with pre-marked self-adhesive, wrap around cloth wire markers, indicating circuit number and name of panel, cabinet, etc., or origin, at panelboards, motor control centers, switchboards, isolated power panels, terminal cabinets, wireways, junction boxes and at all outlet boxes containing more than one neutral wire.
7. Underground Electrical Line Identification: Install line marker for underground wiring, both

direct-burial and in raceway. During trench backfilling, for underground power, signal, and communication lines, install continuous underground plastic line marker, located directly above line 6 to 8 inches below finished grade. Where multiple lines installed in a common trench or concrete envelope do not exceed an overall width of 16 inches, install a single line marker.

8. Provide, above underground conduits stubbed for future use, engraved flush bronze marker anchored in 4-inch square by 12-inch-deep concrete block, flush with grade, indicating system, conduit size and point of origin.
9. Paint Fire Alarm System J-boxes and pull boxes red and provide label: “Fire Alarm System”.

I. Identify Raceways of Certain Systems with Color Banding: Band exposed or accessible raceways of the following systems for identification. Bands shall be painted with colors indicated below. Make each color band 2-inch-wide, completely encircling conduit, and place adjacent bands of two-color markings in contact, side by side. Install bands at changes in direction, at penetrations of walls and floors, and at 10-foot maximum intervals in straight runs. Apply the following colors:

1. Fire Alarm Systems: Red.
2. Fire Suppression Supervisory and control System: Red and Yellow
3. Mechanical and Electrical Supervisory System: Green and White
4. Communication System: Green and Yellow

J. Conductor Color Coding: provide color coding for secondary service, feeder, and branch circuit conductors throughout the project secondary electrical system as follows:

208/120 Volts	Phase	480/277 Volts
Black	A	Brown
Red	B	Orange
Blue	C	Yellow
White	Neutral	Gray
Green	Ground	Green

K. Use conductors with color factory-applied the entire length of the conductors except as follows:

1. The following field-applied color-coding methods may be used in lieu of factory-coded wire for sizes larger than No. 10 AWG:

   a. Apply colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or tape are made. Apply the last two laps of tape with no tension to prevent possible unwinding. Use 1 inch wide tape in colors. Do not obliterate cable identification markings by taping. Tape locations may be adjusted slightly to prevent such obliteration.
   b. In lieu of pressure-sensitive tape, colored cable ties may be used for color identification. Apply three ties of specified color to each wire at each terminal or splice point starting 3 inches from the terminal and spaced 3 inches apart. Apply with a special tool or pliers, tighten for snug fit, and cut off excess length.
   c. Color coded conductors of cables used in communication and signal systems and control conductors in line and low voltage control panels, motor control centers, and supervisory panels. Use white for grounded conductors and green for equipment ground, exclusively.

L. Devices: Engrave on each device plate with 3/16-inch-high block letters with black enamel as

follows:

1. Lock switch and switch with pilot light – device controlled.
2. Switch for fan, motor unit heater – equipment controlled.
3. Switch where lights or equipment are out of sight – identify area or equipment controlled.
4. Switches in gangs of three or more – identify areas or equipment switched.
5. Receptacles over 150V to ground and/or 30A and higher rating – voltage and ampere rating.
6. Isolated Ground Receptacles – Isolated Ground.
7. Where wording is not indicated, allow for ten letters per device and use wording as directed.
8. For switch cabinets engrave each device or provide engraved nameplate.

M. Warning Signs: Conform with the latest edition of the CEC. Provide No. 18 AWG steel, white porcelain enameled signs with 1-inch high letters to read “DANGER! – HIGH VOLTAGE, AUTHORIZED PERSONNEL ONLY!”. Post on doors or entries to all rooms or areas containing equipment rated over 600V and on front of such equipment enclosures. Provide similar signs with 1-inch high black letters in all electrical and signal rooms and closets reading “ELECTRICAL (or SIGNAL) ROOM – NO STORAGE PERMITTED”. Submit shop drawings.

N. Panel Schedules:

1. Provide typewritten panel schedules on inside of panel doors behind clear plastic. Indicate as-built quantity and type of outlets served as well as general location of outlets or fixtures and/or item of equipment served.

O. Diagrams and Posted Signs:

1. For switchboards with bus rating 1000A or greater, and for substations, provide a bus diagram framed and mounted behind clear plastic indicating rating, devices, ground fault detectors, standby generator connection, and switchboard components.
2. For signal and communication systems, provide block wiring and location diagram mounted behind clear plastic and posted at system control location.
3. For medium voltage switchgear, provide a single line bus diagram air brush painted in contrasting color across the front face of the switchgear indicating all components within cubicles including lightning arresters, metering, etc.
4. For all main electrical rooms provide a single line diagram framed and mounted behind clear plastic indicating as-built system configuration and distribution.

END OF SECTION

SECTION 26 05 73
OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 - REQUIREMENTS

A. For purpose of this guideline, this section includes services necessary to complete the system analysis studies required for the Overcurrent Protective Device Coordination Study which includes short circuit coordination study, protective device evaluation study, and protective device coordination study.

B. The studies shall include all portions of the electrical distribution system from the normal to emergency power source or sources down to and including the smallest circuit breaker in the distribution system.

C. An independent consulting or testing company not involved on the project shall perform the study and prepare a complete and detailed report and shall be evaluated and accepted by the Designer for compliance and meet project needs. The independent consulting or testing company shall be engaged by contractor with the approval of Architect/Engineer.

D. The firm performing the study should be currently involved in medium and low- voltage power system evaluation. The study shall be performed, stamped and signed by a CA registered professional electrical engineer. Credentials of the individual(s) performing the study and background of the firm shall be submitted to the District for approval prior to start of the work.

E. A minimum of ten (10) years' experience in power system analysis is required for the individual in charge of the study.

F. The firm performing the study should demonstrate capability and experience to provide assistance during start up as required

PART 2 - PRODUCTS

2.01 Firms:

A. KSG Consulting Engineers, Inc.

B. Applied Engineering Concepts

C. Electrical Reliability Services

D. Or Equal as required by Project Designer.

2.02 Studies:

A. Provide short-circuit and protective device evaluation study as prepared by the independent consultant.

B. The studies shall be performed with the aid of a computer program and shall be in accordance with the latest applicable IEEE and ANSI standards. For computer software, use the most recent version of SKM power tools for windows or approved equal.

C. A protective device evaluation study shall be performed to determine the adequacy of circuit

breakers, switches, automatic transfer switches and fuses by tabulating and comparing the short circuit ratings of these devices with the calculated fault currents. Appropriate multiplying factors based on system X/R ratios and protective device rating standards shall be applied. Any problem areas or inadequacies in the equipment due to short circuit currents shall be promptly brought to the District's attention.

D. A protective device coordination study shall be performed for the entire electrical distribution system to provide the necessary calculations and logic decisions required to select or to check the selection of power fuse ratings, protective relay characteristics and settings, ratios and characteristics of associated current transformers, ground fault relays and low voltage breaker trip characteristics and settings. The studies shall be in accordance with the latest applicable IEEE and ANSI standards.

2.03 Report:

A. The report shall be neatly bound in an 8-1/2" x 11" folder or binder with a table of contents and separate tabs for each section of report.

B. The report shall include a detailed description, purpose, basis and scope of the study.

C. The report shall include several sections of the electrical distribution system with single line diagram, description and listing of devices and equipment that are representative of every individual situation or connection. Protective device time verses current coordination curves, circuit breaker and fuse selection with commentary regarding any component shall be provided for each section.

D. Provide tabulations of all circuit breakers, fuses and other protective device ratings time verses current short circuit duties. Provide comment for each device that do not meet the acceptable values calculated by the study and make recommendations for any modifications as required.

E. Fault current calculations including a definition of terms and guide for interpretation of computer printout shall be provided.

F. Recommended size for power fuses and recommended settings for ground fault relays and for all adjustable trip relays shall be provided.

PART 3 - INSTALLATION

A. The equipment manufacturer shall provide the services of a qualified field engineer and necessary tools and equipment to test and calibrate the protective relays, ground fault relays and circuit breaker trip devices as recommended by the coordination Study

B. Upgrade and modification to equipment characteristics and ratings to be finalized by the results of the Short Circuit and Protective Device Coordination Studies.

C. Field settings of devices, adjustments, upgrading and modifications to the new equipment to accomplish conformance with the accepted Short Circuit, Protective Device Coordination and Arc Flash Studies, shall be carried out by the Contractor at no additional cost to the District. The Contractor shall not be responsible for upgrading the existing equipment unless otherwise directed.

D. Notify District's Representative in writing of any required major equipment modifications.

E. Provide arc flash labels for all buses as required.

F. Labels shall be machine printed, with no field markings.

G. Equipment shall not be energized until the breakers have been set and tested to the pickup levels determined by the approved final power system study.

END OF SECTION

SECTION 26 05 73.13
SHORT-CIRCUIT STUDIES

PART 1 - GENERAL

1.01 Product Data:

1. For computer software program to be used for studies.

2. Submit the following after the approval of system protective devices submittals. Submittals **shall** be in digital form.

   a. Short-circuit study input data, including completed computer program input data sheets.

   b. Short-circuit study and equipment evaluation report; signed, dated, and sealed by a qualified professional engineer.

      1) Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.

      2) Revised one-line diagram, reflecting field investigation results and results of short-circuit study.

1.02 QUALITY ASSURANCE

A. Study shall be performed using commercially developed and distributed software designed specifically for power system analysis.

B. Software algorithms shall comply with requirements of standards and guides specified in this Section.

C. Manual calculations are unacceptable.

1. Power System Analysis Software Qualifications: Computer program shall be designed to perform short-circuit studies or have a function, component, or add-on module designed to perform short-circuit studies.

2. Computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

D. Power Systems Analysis Specialist Qualifications: Professional engineer licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

E. Short-Circuit Study Certification: Short-Circuit Study Report shall be signed and sealed by Power Systems Analysis Specialist.

F. Field Adjusting Agency Qualifications:

1. Employer of a NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification responsible for all field adjusting of the Work.

2. A member company of NETA.

3. Acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.01 Manufacturers and products listed in SpecAgent and MasterWorks Paragraph Builder are neither recommended nor endorsed by the AIA or AVITRU. Before inserting names, verify that manufacturers and products listed there comply with requirements retained or revised in descriptions and are both available and suitable for the intended applications. For definitions of terms and requirements for Contractor's product selection, see Section 016000 "Product Requirements."

2.02 POWER SYSTEM ANALYSIS SOFTWARE DEVELOPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. EDSA Micro Corporation.
2. SKM Systems Analysis, Inc.

A. Comply with IEEE 399 and IEEE 551.

1. Analytical features of power systems analysis software program shall have capability to calculate "mandatory" features as listed in IEEE 399.

B. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output.

2.03 SHORT-CIRCUIT STUDY REPORT CONTENTS

A. Executive summary of study findings.

B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

C. One-line diagram of modeled power system, showing the following:

1. Protective device designations and ampere ratings.

2. Conductor types, sizes, and lengths.

3. Transformer kilovolt ampere (kVA) and voltage ratings.

4. Motor and generator designations and kVA ratings.

5. Switchgear, switchboard, motor-control center, and panelboard designations and ratings.

6. Derating factors and environmental conditions.

7. Any revisions to electrical equipment required by the study.

D. Comments and recommendations for system improvements or revisions in a written document, separate from one-line diagram.

E. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to available short-circuit currents. Verify that equipment withstands ratings exceed available short-circuit current at equipment installation locations.

2. Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.

3. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

4. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in standards to 1/2-cycle symmetrical fault current.

F. Short-Circuit Study Input Data:

1. One-line diagram of system being studied.

2. Power sources available.

3. Manufacturer, model, and interrupting rating of protective devices.

4. Conductors.

5. Transformer data.

G. Short-Circuit Study Output Reports:

1. Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

a. Voltage.
b. Calculated fault-current magnitude and angle.
c. Fault-point X/R ratio.
d. Equivalent impedance.

2. Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

a. Voltage.
b. Calculated symmetrical fault-current magnitude and angle.
c. Fault-point X/R ratio.
d. Calculated asymmetrical fault currents:

1) Based on fault-point X/R ratio.
2) Based on calculated symmetrical value multiplied by 1.6.
3) Based on calculated symmetrical value multiplied by 2.7.

3. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

a. Voltage.
b. Calculated symmetrical fault-current magnitude and angle.
c. Fault-point X/R ratio.
d. No AC Decrement (NACD) ratio.
e. Equivalent impedance.
f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

END OF SECTION

SECTION 26 05 73.16
COORDINATION STUDIES

PART 1 - PRODUCTS

1.01 POWER SYSTEM ANALYSIS SOFTWARE DEVELOPERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. CGI CYME.
2. EDSA Micro Corporation.
3. SKM Systems Analysis, Inc.

A. Comply with IEEE 242 and IEEE 399.

B. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory" features as listed in IEEE 399.

C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

1.02 COORDINATION STUDY REPORT CONTENTS

A. Executive summary of study findings.

B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

C. One-line diagram of modeled power system, showing the following:

1. Protective device designations and ampere ratings.

2. Conductor types, sizes, and lengths.

3. Transformer kilovolt ampere (kVA) and voltage ratings.

4. Motor and generator designations and kVA ratings.

5. Switchgear, switchboard, motor-control center, and panelboard designations.

6. Any revisions to electrical equipment required by the study.

7. Study Input Data: As described in "Power System Data" Article.

a. Short-Circuit Study Output: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section "Short-Circuit Studies."

D. Protective Device Coordination Study:

1. Report recommended settings of protective devices, ready to be applied in the field. Use manufacturer's data sheets for recording the recommended setting of overcurrent protective devices when available.

    a. Phase and Ground Relays:

        1) Device tag.
        2) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
        3) Recommendations on improved relaying systems, if applicable.

    b. Circuit Breakers:

        1) Adjustable pickups and time delays (long time, short time, and ground).
        2) Adjustable time-current characteristic.
        3) Adjustable instantaneous pickup.
        4) Recommendations on improved trip systems, if applicable.

    c. Fuses: Show current rating, voltage, and class.

E. Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:

1. Device tag and title, one-line diagram with legend identifying the portion of the system covered.

2. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.

3. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

4. Plot the following listed characteristic curves, as applicable:

    a. Power utility's overcurrent protective device.
    b. Low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
    c. Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
    d. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
    e. Ground-fault protective devices.
    f. The largest feeder circuit breaker in each motor-control center and panelboard.

5. Maintain selectivity for tripping currents caused by overloads.

6. Provide adequate time margins between device characteristics such that selective operation is achieved.

7. Comments and recommendations for system improvements.

1.03 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance of the Work. Devices to be coordinated are indicated on Drawings.

1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

1.04 POWER SYSTEM DATA

A. Obtain all data necessary for conduct of the overcurrent protective device study.

1. Verify completeness of data supplied in one-line diagram on Drawings. Call any discrepancies to Architect's attention.

2. For equipment included as Work of this Project, use characteristics submitted under provisions of action submittals and information submittals for this Project.

B. Gather and tabulate all required input data to support the coordination study. List below is a guide. Comply with recommendations in IEEE 551 for the amount of detail required to be acquired in the field. Field data gathering shall be under direct supervision and control of the engineer in charge of performing the study and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification.

1.05 COORDINATION STUDY

A. Comply with IEEE 242 for calculating short-circuit currents and determining coordination time intervals.

B. Comply with IEEE 399 for general study procedures.

C. Base study on device characteristics supplied by device manufacturer.

D. Extent of electrical power system to be studied is indicated on Drawings.

E. Begin analysis at the service, extending down to system overcurrent protective devices as follows:

1. To normal system low-voltage load buses where fault current is 10 kA or less.

F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

G. Transformer Primary Overcurrent Protective Devices:

1. Device shall not operate in response to the following:

a. Inrush current when first energized.
b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

H. Motor Protection:

1. Select protection for low-voltage motors according to IEEE 242 and NFPA 70.

2. Select protection for motors served at voltages more than 600 V according to IEEE 620.

I. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and protection recommendations in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

J. Generator Protection: Select protection according to manufacturer's written instructions and to IEEE 242.

K. Include the ac fault-current decay from induction motors and apply to low- and medium-voltage, three-phase ac systems. Also account for fault-current dc decrement, to address asymmetrical requirements of interrupting equipment.

L. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and a single line-to-ground fault at each equipment indicated on one-line diagram.

1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.

M. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short-circuit ratings.

2. Adequacy of switchgear, motor-control centers, and panelboard bus bars to withstand short-circuit stresses.

3. Include in the report identification of any protective device applied outside its capacity.

1.06 LOAD-FLOW AND VOLTAGE-DROP STUDY

A. Perform a load-flow and voltage-drop study to determine the steady-state loading profile of the system. Analyze power system performance two times as follows:

1. Determine load flow and voltage drop based on full-load currents obtained in "Power System Data" Article.

2. Determine load flow and voltage drop based on 80 percent of the design capacity of load buses.

3. Prepare load-flow and voltage-drop analysis and report to show power system components that are overloaded or might become overloaded; show bus voltages that are less than as prescribed by NFPA 70.

1.07 MOTOR-STARTING STUDY

A. Prepare the motor-starting study report, noting light flicker for limits proposed by IEEE 141, and applicable standards, and voltage sags so as not to affect operation of other utilization equipment on system supplying the motor.

1.08 FIELD ADJUSTING

A. Adjust relay and protective device settings according to recommended settings provided by the coordination study. Field adjustments shall be completed by the engineering service division of equipment manufacturer under the "Startup and Acceptance Testing" contract portion.

B. Make minor modifications to equipment as required to accomplish compliance with short-circuit and protective device coordination studies.

C. Testing and adjusting shall be by a full-time employee of the Field Adjusting Agency, who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification.

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters. Perform NETA tests and inspections for all adjustable overcurrent protective devices.

1.09 DEMONSTRATION

A. Engage Power Systems Analysis Specialist to train District's maintenance personnel in the following:

1. Acquaint personnel in fundamentals of operating the power system in normal and emergency modes.

2. Hand-out and explain the coordination study objectives, study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpreting time-current coordination curves.

3. For Owner's maintenance staff certified as NETA ETT-Certified Technicians Level III or NICET Electrical Power Testing Level III Technicians, teach how to adjust, operate, and maintain overcurrent protective device settings.

END OF SECTION

SECTION 26 05 73.19
ARC-FLASH HAZARD ANALYSIS

PART 1 - PRODUCTS

1.01 COMPUTER SOFTWARE DEVELOPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. CGI CYME.
2. ESA Inc.
3. SKM Systems Analysis, Inc.

A. Comply with IEEE 1584 and NFPA 70E.

B. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory" features as listed in IEEE 399.

1.02 ARC-FLASH STUDY REPORT CONTENT

A. Executive summary of study findings.

B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

C. One-line diagram, showing the following:

1. Protective device designations and ampere ratings.

2. Conductor types, sizes, and lengths.

3. Transformer kilovolt ampere (kVA) and voltage ratings, including derating factors and environmental conditions.

4. Motor and generator designations and kVA ratings.

5. Switchgear, switchboard, motor-control center, panelboard designations, and ratings.

D. Study Input Data: As described in "Power System Data" Article.

E. Short-Circuit Study Output Data: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."

F. Protective Device Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in Section 260573.16 "Coordination Studies."

G. Arc-Flash Study Output Reports:

1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the

following for each equipment location included in the report:

a. Voltage.
b. Calculated symmetrical fault-current magnitude and angle.
c. Fault-point X/R ratio.
d. No AC Decrement (NACD) ratio.
e. Equivalent impedance.
f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

H. Incident Energy and Flash Protection Boundary Calculations:

1. Arcing fault magnitude.

2. Protective device clearing time.

3. Duration of arc.

4. Arc-flash boundary.

5. Restricted approach boundary.

6. Limited approach boundary.

7. Working distance.

8. Incident energy.

9. Hazard risk category.

10. Recommendations for arc-flash energy reduction.

I. Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of computer printout.

1.03 ARC-FLASH WARNING LABELS

A. Comply with requirements in Section "Identification for Electrical Systems" for self-adhesive equipment labels. Produce a 3.5-by-5-inch self-adhesive equipment label for each work location included in the analysis.

B. Label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:

1. Location designation.

2. Nominal voltage.

3. Protection boundaries.

a. Arc-flash boundary.
b. Restricted approach boundary.

c. Limited approach boundary.

4. Arc flash PPE category.

5. Required minimum arc rating of PPE in Cal/cm squared.

6. Available incident energy.

7. Working distance.

8. Engineering report number, revision number, and issue date.

C. Labels shall be machine printed, with no field-applied markings.

1.04 EXAMINATION

A. Examine Project overcurrent protective device submittals. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

1.05 ARC-FLASH HAZARD ANALYSIS

A. Comply with NFPA 70E and its Annex D for hazard analysis study.

B. Preparatory Studies: Perform the Short-Circuit and Protective Device Coordination studies prior to starting the Arc-Flash Hazard Analysis or obtain results from another source.

1. Short-Circuit Study Output: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section "Short-Circuit Studies."

C. Calculate maximum and minimum contributions of fault-current size.

1. Maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.

2. Calculate arc-flash energy at 85 percent of maximum short-circuit current according to IEEE 1584 recommendations.

3. Calculate arc-flash energy at 38 percent of maximum short-circuit current according to NFPA 70E recommendations.

4. Calculate arc-flash energy with the utility contribution at a minimum and assume no motor contribution.

D. Calculate the arc-flash protection boundary and incident energy at locations in electrical distribution system where personnel could perform work on energized parts.

E. Calculate the limited, restricted, and prohibited approach boundaries for each location.

F. Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented

as follows:

1. Fault contribution from induction motors shall not be considered beyond three to five cycles.

G. Arc-flash energy shall generally be reported for the maximum of line or load side of a circuit breaker. However, arc-flash computation shall be performed and reported for both line and load side of a circuit breaker as follows:

1. When the circuit breaker is in a separate enclosure.

2. When the line terminals of the circuit breaker are separate from the work location.

H. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

1.06 POWER SYSTEM DATA

A. Obtain all data necessary for conduct of the arc-flash hazard analysis.

1. Verify completeness of data supplied on one-line diagram on Drawings and under "Preparatory Studies" Paragraph in "Arc-Flash Hazard Analysis" Article. Call discrepancies to Architect's attention.

2. For new equipment, use characteristics from approved submittals under provisions of action submittals and information submittals for this Project.

1.07 LABELING

A. Apply one arc-flash label on the front cover of each section of the equipment and on side or rear covers with accessible live parts and hinged doors or removable plates for each equipment included in the study. Base arc-flash label data on highest values calculated at each location.

B. Each piece of equipment listed below shall have an arc-flash label applied to it:

1. Motor-control center.

2. Low-voltage switchboard.

3. Switchgear.

4. Medium-voltage switch.

5. Medium voltage transformers

6. Low voltage transformers. Exclude transformers with high voltage side 240 V or less and less than 125 kVA.

7. Panelboard and safety switches.

8. Motor Control Center/panel.

C. Note on record Drawings the location of equipment where the personnel could be exposed to

arc-flash hazard during their work.

1. Indicate arc-flash energy.

2. Indicate protection level required.

1.08 APPLICATION OF WARNING LABELS

A. Install arc-flash warning labels under the direct supervision and control of Power System Analysis Specialist.

1.09 DEMONSTRATION

A. Engage Power Systems Analysis Specialist to train District's maintenance personnel in potential arc-flash hazards associated with working on energized equipment and the significance of arc-flash warning labels.

END OF SECTION

SECTION 26 08 10
TESTING OF ELECTRICAL SYSTEMS

(Designer to modify requirements per Project Requirements)

PART 1 - REQUIREMENTS

1.01 Design considerations specific to components in this section:

A. For purpose of this guideline, this section pertains to testing of electrical systems.

1. The following testing shall be performed by an independent testing company:

a. Service Grounding Test
b. Ground Fault Protection Systems Test & Calibration
c. Transformers, Dry Type
d. Transformers (oil filled) (if applicable)
e. Motor Controllers
f. Circuit Breaker Tests
g. Switchboards
h. Panelboards
i. Generator (if applicable)
j. Automatic Transfer Switches (if applicable)
k. UPS (if applicable)
l. Metering Test and Calibration (if applicable)
m. Medium Voltage cables and equipment including terminations. (if applicable)
n. The following testing shall be performed by the contractor:
o. Fire Alarm Systems
p. Receptacle and Device Tests
q. 600-volt wiring
r. Power System Tests
s. Variable Frequency Drives
t. Fan Shutdown Systems
u. Smoke Damper Control

2. Test and provide written certification that the entire electrical installation complies with contract documents, code and proper system operation. Perform acceptance tests in accordance with manufacturer's recommendations, NFPA 70b and InterNational Electrical Testing Association (NETA) testing specifications NETA ATS-2009.

3. Qualifications of testing agency

a. The testing firm shall be an independent testing organization that can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers and installers of equipment or systems evaluated by the testing firm.
b. The testing firm shall meet the criteria for Full Membership or be a Full Member company of the InterNational Electrical Testing Association (NETA).
c. A minimum of ten (10) years' experience in testing electrical equipment is required for the individual in charge of the project.
d. The firm performing the study should demonstrate capability and experience to provide assistance during start up as required.
e. The testing firm shall only utilize full-time engineers who are regularly employed by the firm for testing services.

f. All on-site personnel shall have a minimum of 5 years of experience in electrical equipment startup and testing.
g. The firm shall provide a competent project engineer to oversee and coordinate all site work and shall be on site whenever 3 or more of the firm's engineers are on site.

4. Test instrument

a. Utilize a calibration program that assures that all applicable test instruments are maintained within rated accuracy.
b. Accuracy directly traceable to the National Institute of Standards and Technology
c. Calibrate Field Instruments: Analog – every 6 months maximum; Digital – every 12 months maximum.
d. Calibrate Laboratory Instruments every 12 months.
e. Calibrate Leased Specialty Equipment every 12 months (Where accuracy is guaranteed by leaser).
f. Maintain dated calibration labels visible on all test equipment.
g. Keep records that show date and results of instruments calibrated or tested up-to-date.
h. Maintain up-to-date instrument calibration instructions and procedures.

PART 2 - PRODUCTS

2.01 Requirements:

A. Testing Company: Retain the services of an independent testing company that is qualified to test electrical equipment and is an approved testing company by the State of California. The testing company shall not be associated with the manufacturer of equipment or systems under test. Testing company shall prepare typewritten reports on all the systems they test.

1. Electro-Test Inc. (ETI)

2. Applied Engineering Concepts (AEC)

B. Test Equipment:

1. The contractor shall provide all apparatus and material required for testing. The contractor shall use installation tools and test equipment that are designed for the specific task and shall use this equipment per the manufacturer's instructions.

2. All test equipment shall have current calibration certification by a third-party calibration laboratory and shall have a signed and dated calibration sticker affixed to the device. Calibration shall be traceable to the national bureau of standards and shall not be less than 6 months since last calibration. Defective test equipment and installation tools shall not be used. Installation tools such as torque wrenches shall be calibration certified.

C. Project Documents:

1. The contractor shall send or deliver the following project documents to testing company two weeks prior to testing:

a. Division 26 Specifications.
b. Electrical Floor Plans showing equipment to be tested.
c. Electrical One-Line Diagrams.
d. Submittals of Manufacturer's Data and Shop Drawings including engineers review

letter of all systems to be tested.
e. Over current protective device and Coordination Study.
f. Arc Flash Hazard Analysis Study

PART 3 - EVALUATION

3.01 List of items or systems requiring testing, evaluation, verification, or commissioning: Tests.

A. Test reports: Testing company shall prepare typewritten reports on all the systems they test.

3.02 Labels: Upon completion of testing agency tests a NETA label shall be attached to all serviced devices. These labels shall indicate date serviced and the testing company.

A. Tests to be performed by testing company:

1. Service Grounding Tests:

a. Perform fall-of-potential tests on main grounding electrode system provided by this contract per IEEE Standard No. 81. Maximum resistance to ground shall be less than 5 ohms. If this resistance cannot be obtained with the ground system shown, notify the District's Representative immediately for further instructions.
b. Confirm that the neutral is grounded only at the service equipment by removing the service neutral grounding conductor and meggering the neutral bus.
c. Additional testing requirements as required by Designer.

2. Ground Fault Protection Systems Tests:

a. Scope: Prior to Test: Inspect neutral main bonding connection to assure:

1) Zero sequence system is grounded upstream of sensor
2) Ground connection is made ahead of neutral disconnect link
3) Ground strap systems are grounded through sensing device
4) Verify ground electrode conductor(s) for proper size and connection

b. Inspect control power transformer to insure adequate capacity for system.
c. Monitor panels (if present) shall be manually operated for:

1) Trip test
2) No trip test
3) Non-automatic reset

d. Proper operation and test sequence shall be recorded.
e. Zero sequence systems shall be inspected for symmetrical alignment of core balance transformers about all current carrying conductors.
f. Ground fault system integral to the circuit breaker will have its current sensors and neutral sensor inspected for proper polarity.
g. Ground fault device circuit nameplate identification shall be verified by device operation.
h. Pickup and time delay settings shall be set in accordance with engineer's instructions or as shown.

3. Electrical Tests:

a. System neutral insulation resistance shall be measured to insure no shunt ground paths exist, neutral ground disconnect link shall be removed, neutral insulation resistance measured and link replaced.
b. The relay pickup current shall be determined by current injection at the sensor and the circuit interrupting device operated.
c. The relay timing shall be tested by injecting 150% and 300% of pickup current into sensor. Total trip time shall be electrically monitored.
d. System operation shall be tested at 57% rated voltage value.
e. Zone interlock system shall be tested by simultaneous sensor current injection and monitoring zone blocking function.

4. Test Parameters:

   a. System neutral insulation resistance shall be two (2) mega-ohm or greater.
   b. Relay pickup current shall be within 10% of device dial of fixed setting.
   c. Relay timing shall be in accordance with manufacturer's published time-current characteristic curves.

5. Transformers, dry type.

6. Motor Controllers

7. Switchboards: Perform thermographic survey (Infrared scanning) of all feeder (destination) breakers in accordance with NETA Section 9.

8. Panelboards

9. Generator:

   a. Inspect generator, all major components and report installation or shipping damage, loose material, shipping blocks, contamination or unfavorable environmental conditions that must be corrected. Check equipment for operation of doors, security of mounting. Report any deficiencies.

10. Automatic Transfer Switches:

    a. Scope: Test all transfer switches
    b. Inspect transfer switches and report installation or shipping damage, loose material, shipping blocks, contamination or unfavorable environmental conditions that must be corrected. Check equipment for operation of doors, security of mounting. Report any deficiencies.

11. UPS:

    a. Scope: Test all UPSs and associated breakers.
    b. Inspect all UPSs, all major components, terminations and report installation or shipping damage, loose material, shipping blocks, contamination or unfavorable environmental conditions that must be corrected. Check equipment for operation of doors, security of mounting. Report any deficiencies.

12. Metering Test & Calibration:

    a. Scope: Test all new meters specified.

b. Instrument Transformers:

1) Test transformer polarity electrically.
2) Verify connection at secondary CT leads by driving a low current through the leads and checking for this amount at applicable devices.
3) Confirm transformer ratio by primary current injection.
4) Measure insulation resistance primary-to-ground, secondary-to- ground and primary-to-secondary
5) Overpotential test primary insulation.
6) Measure potential transformer ratio.

c. Metering and instrumentation

1) aa Calibrate all meters at mid-scale.
2) Calibrate watt hour meter to one-half percent.
3) Verify all instrument multipliers.

B. Test to be performed by contractor:

1. Receptacle and device tests

a. Receptacle Polarity Test: Test every receptacle installed or reconnected under this contract with a receptacle circuit tester. Tester shall test for open ground, reverse polarity, open hot, open neutral, hot and ground reversed, hot or neutral and hot open. Rewire receptacles with faults and re-test. Submit test report signed by the electrician that performed the test.
b. Ground-Fault Receptacle Circuit Interrupter Tests: Test each receptacle or branch circuit breaker having ground-fault circuit protection to assure that the ground-fault circuit interrupter will not operate when subjected to a ground-fault current of less than 4 milliamperes and will operate when subjected to a ground-fault current exceeding 6 milliamperes. Perform testing using an instrument specifically designed and manufactured for testing ground-fault circuit interrupters. Apply the test to the receptacle. A TEST@ button operation will not be acceptable as a substitute for this test. Replace receptacles that do not shut-off power with 5/1000 of an ampere with 1/40th of a second and re-test.
c. Operational Tests: Demonstrate the operation of each switch, circuit breaker and other item of electrical control with the systems fully energized and operating. Each shall be demonstrated three (3) times.

2. 600-volt wiring

a. Scope: Test all electrical feeders and conductors for motors over 15 hp whose operating voltage is 600 volts or less that are installed or re-connected under this contract.
b. Test for continuity of each circuit.
c. Test for grounds in each circuit which shall consist of the physical examination of the installation to ensure that all required ground jumpers, devices and appurtenances do exist and are mechanically firm.
d. Perform insulation-resistance test on each conductor with respect to ground and adjacent conductors. Applied potential shall be 500 volts dc for 300 volt rated cable and 1000 volts dc for 600 volt rated cable. Test duration shall be one (1) minute. If conductor fails test replace wiring or correct defect and re-test.
e. Perform torque test for each conductor tested and terminated in an overcurrent device

or bolted type connection; torque all connections per manufacturer's recommendations and tabulate the results on a tabular form.

f. All feeders shall be Megger tested prior to energizing any equipment.

3. Power system tests

   a. Scope: Inspect and test entire electrical systems provided by this contract to verify equipment and controls are correctly operating.
   b. Load Balance Tests: Check all panelboards for proper load balance between phase conductors and make adjustments as necessary to bring unbalanced phases to within 15% of average load.
   c. Motor Tests: Prior to energizing any motors check all motors for proper rotation, phase balance and measure actual load current. Report immediately to the District's Representative if phase balance exceeds 1% from mean value. Submit tabulation of motor currents for all motors 1 HP or more after the HVAC system has been balanced.
   d. Phase Relationship Tests: Check connections to all new and existing equipment for proper phase relationship. During such check, disconnect all devices that could be damaged by the application of voltage or reversed phase sequence.
   e. Transformer Taps: Connect all transformers at A Normal tap. After facility is fully occupied for a period of not less than two weeks, measure secondary voltages at all new and existing transformers.

4. Variable frequency drives

   a. Physical Mechanical Inspection (Electrical Contractor)

      1) Drive and motor environment clean.
      2) Adequate drive and motor access for ventilation and maintenance
      3) No unusual noise or vibration.
      4) No disconnects installed between VFD and motor w/o shutdown interlock to VFD.
      5) Shut-down interlocks between VFD and motor verified to be operational.
      6) Separate conduit for incoming power and outgoing motor leads.
      7) No power factor correction capacitors connected to motor.
      8) Shaft rotation correct, normal operation
      9) If equipped with bypass, note bypass starter overload size for correct operation.
      10) Shaft rotation correct for bypass operation.
      11) Verify bypass switch starts and operates equipment.
      12) Compare motor nameplate with VFD for compatibility.
      13) Inspect structure frames, supports, barriers, doors, etc. for alignment and proper fit.
      14) Inspect control wiring terminations, fuses, shielding, pull apart connectors and board engagement.

5. Electrical Checks (Electrical Contractor)

   a. Verify wiring conforms to factory schematics.
   b. Verify instrument transformer ratios match meter scales.

6. Electrical Checks (Manufacturer's Representative)

   a. Insure proper operation of:

      1) Pilot devices (switches, pushbuttons, lights)

2) Contactors and line voltage starters.
3) Control and timing relays.
4) Protective devices.
5) Auxiliary electrical contacts.
6) Circuit breakers and disconnect switches.

b. Perform other tests and startup procedures as recommended by manufacturer.

END OF SECTION

SECTION 26 09 13
ELECTRICAL POWER MONITORING AND CONTROL

PART 1 - PRODUCTS

1.01 SYSTEM DESCRIPTION

A. Microprocessor-based monitoring and control of electrical power distribution system(s) that includes the following:

1. Electrical meters that monitor, control, and connect to the data transmission network.

2. LAN: High-speed, multi-access, open, nonproprietary, industry-standard communication protocols.

3. Include PC-based workstation with web access, with its operating system and application software, connected to data transmission network.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. UL Compliance: Listed and labeled as complying with UL 61010-1.

1.02 PERFORMANCE REQUIREMENTS

A. Surge Protection: For external wiring of each conductor entry connection to components to protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads.

1. Minimum Protection for Power Lines 120 V and More: SPDs complying with UL 1449, listed and labeled for intended use by an NRTL acceptable to authorities having jurisdiction. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines: Comply with requirements as recommended by manufacturer for type of line being protected.

B. Addressable Devices: All transmitters and receivers shall communicate unique device identification and status reports to monitoring and control clients.

C. Interface with DDC System for HVAC: Provide factory-installed hardware and software to enable the DDC system for HVAC to monitor, display, and record data for use in processing reports.

1. Hardwired Monitoring Points: Electrical power demand (kilowatts), electrical power consumption (kilowatt-hours, power factor etc.,).

2. ASHRAE 135 BACnet or LonTalk or Modbus or Industry-accepted, open-protocol as directed by District for communication interface with the DDC system for HVAC shall enable the DDC system for HVAC operator to remotely monitor meter information from a DDC system for HVAC operator workstation. Control features and monitoring points displayed locally at metering panel shall be available through the DDC system for HVAC.

D. Backup Power Source:

1. Electrical power distribution equipment served by a backup power source for controls shall have associated power monitoring and control system products that monitor and control such systems and equipment also served from a backup power source.

1.03 MULTIFUNCTION ENERGY METERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton.
2. General Electric Company.
3. Schneider Electric USA, Inc.

A. Multifunction Energy Meter: Separately mounted, modular, permanently installed, solid-state, digital I/O instrument for power and energy metering and monitoring; complying with UL 61010-1.

1. Capable of metering 4-wire Y, 3-wire Y, 3-wire delta, and single-phase power systems.

2. Equipped with security lock to protect revenue related metering from unauthorized and accidental changes.

B. Environment: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Indoor installation in non-air-conditioned or non-temperature-controlled spaces that have environmental controls to maintain ambient conditions of minus 4 deg to 158 deg F dry bulb and 5 to 95 percent relative humidity, noncondensing.

2. Comply with IEC 60529 degree of protection code of IP65 for the front of the meter, and code of IP30 for the body.

C. Overvoltage: Comply with UL 61010-1 overvoltage withstand rating for CAT III.

D. Accuracy:

1. Comply with ANSI C12.20, Class 0.5.

2. Neutral Current Measurement: Not more than 0.65 percent.

3. Power Factor: 1.0 percent.

4. Frequency: 0.1 percent.

5. THD: 1.0 percent.

6. Waveform Sampling: 64 per cycle.

E. Data Link: 135 BACnet or LonTalk or Modbus or Industry-accepted, open-protocol as directed by District for communication interface.

F. Meter Physical Characteristics:

1. Display: Backlit LCD with antiglare and scratch-resistant lens.

2. Display of Metered Values:

    a. One screen to show at least three user-selected values displayed at the same time. Selections available to display shall include the following:

        1) All meters.
        2) Measurements.
        3) THD.
        4) Energy.
        5) Demand.
        6) Minimum and maximum values.
        7) Power demand.

G. Sampling Rate: Continuously sample and record voltage and current at a rate not less than 64 samples per cycle, simultaneously on all voltage and current channels of the meter.

H. Meters:

1. Instantaneous, rms:

    a. Current: Each phase, neutral and three-phase average.
    b. Voltage: L-L each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
    c. Active Power (kW): Each phase and three-phase total.
    d. Reactive Power (kVAR): Each phase and three-phase total.
    e. Apparent Power (kVA): Each phase and three-phase total.
    f. Power Factor: Each phase and three-phase total.

2. Energy:

    a. Active Energy (kWh): Three-phase total.

3. Demand, Derived from Instantaneous rms Meters:

    a. Current: Present and maximum.
    b. Active: Present and maximum.
    c. Reactive: Present and maximum.
    d. Apparent: Present and maximum.

4. Power Quality Measurements:

    a. THD: Current and voltage from measurements simultaneously from the same cycle, as can be calculated from the specified sampling rate.

I. I/O: Two optically isolated digital outputs for KY pulsing or control. Output signal characteristics shall be 150 mA at 200 V.

1. KY Pulse: Generate standard KY pulses for a user-defined increment of metered active energy as follows:

    a. User-defined pulse output associated with kWh.

b. User-defined pulse output associated with kVARh.

2. <Insert control function>.

J. Capacities and Characteristics:

1. Power Supply: [120-V ac, 60 Hz] <Insert text>.

2. Circuit Connections:

a. Voltage: Measurement auto ranging, 60- to 400-V ac L-N. Connect directly to low-voltage (600 V and less) without using voltage transformers

b. Current: Connect to instrument grade current transformer with a metering range of 5 mA to 6 A. Overcurrent tolerance of the instrument shall be 10 A continuous, 50 A for 10 seconds once per hour, and 120 A for one second per hour.
c. Frequency: 45 to 65 Hz.
d. Time: Input from a GPS receiver to synchronize the internal clock of the instrument and to time-synchronize this instrument with the network to a deviation of not greater than 1 ms.

1.04 POWER METERS

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton.
2. General Electric Company.
3. Schneider Electric USA, Inc.

A. Description: Separately mounted, modular, permanently installed, solid-state, digital I/O instrument for power monitoring and control; complying with UL 61010-1.

1. Capable of metering 4-wire Y, 3-wire Y, 3-wire delta, and single-phase power systems.

2. Equipped with security lock to protect revenue related metering from unauthorized and accidental changes.

B. Environment: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Indoor installation in non-air-conditioned or non-temperature-controlled spaces that have environmental controls to maintain ambient conditions of minus 13 to 158 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing.

2. Comply with IEC 60529 degree of protection code of IP51 for the front of the meter, and code of IP30 for the body.

C. Overvoltage: Comply with UL 61010-1 overvoltage withstand rating for CAT III.

D. Accuracy:

1. Comply with ANSI C12.20, Class 0.5.
2. Neutral Current Measurement: Not more than 0.65 percent.
3. Power: 0.6 percent.
4. Power Factor: 0.5 percent.
5. Active Energy: 0.6 percent.
6. Reactive Energy: 2.5 percent.
7. Frequency: 0.05 percent.
8. THD: 1.0 percent.
9. Waveform Sampling: 32 per cycle.

E. Data Link:

1. Provide for firmware and software updates through the communications port.
2. 135 BACnet or LonTalk or Modbus or Industry-accepted, open-protocol as directed by District for communication interface.

F. Meter Physical Characteristics:

1. Display: Backlit LCD with antiglare and scratch-resistant lens.
2. Display of Metered Values: One screen to show at least four lines of user-selected values on one screen at the same time. Provide graphical representation of user-selected values. The screen selections available at the display shall include the following:

    a. All meters, including those listed under the following:

        1) Measurements.
        2) THD.
        3) Energy.
        4) Demand.
        5) Minimum and maximum values.
        6) Power demand.

G. Sampling Rate: Continuously sample and record voltage and current at a rate not less than 32 samples per cycle, simultaneously on all voltage and current channels of the meter.

H. Meters:

1. Measurements: Instantaneous, in real time, rms to the 15th harmonic.

    a. Voltage: L-L each phase, L-N each phase, and three-phase average.
    b. Current: Each phase, three-phase average, and neutral.
    c. Unbalanced current, L-L V ac and L-N V ac.
    d. Active Power (+/- kW): Each phase and three-phase total.

e. Reactive Power (+/- kVAR): Each phase and three-phase total.
f. Apparent Power (+/- kVA): Each phase and three-phase total.
g. Displacement Power Factor: Each phase and three-phase total.
h. Distortion Power Factor: Each phase and three-phase total.
i. Frequency.

2. THD from measurements simultaneously from the same cycle, through 15th harmonic.

a. Voltage THD: L-L each phase, L-N each phase, and three-phase average.
b. Current THD: Each phase and three-phase average.
c. Total demand distortion.

3. Energy: Accumulated, indicate whether in-flow or out-flow, net and absolute values. Store the values in instrument's nonvolatile memory.

a. Active kWh.
b. Reactive kVARh.
c. Apparent kVAh.

4. Demand: Present, last, predicted, peak.

a. Three-phase average current.
b. Three-phase total active power (kW).
c. Reactive power (kVAR).
d. Apparent power (kVA).

5. Minimum and Maximum Values:

a. L-L and L-N voltages.
b. Current in each phase.
c. Power factor.
d. Active power total.
e. Reactive power total.
f. Apparent power total.
g. THD L-L and L-N voltages.
h. THD current in each phase.
i. Frequency.

I. Power Demand, User Selectable:

1. Thermal Demand: Sliding window updated every second for the present demand and at end of the interval for the last interval. Adjustable window that can be set in 1-minute intervals, from 1 to 60 minutes.

2. Block Interval with Optional Subintervals: Adjustable for 1-minute intervals, from 1 to 60 minutes. User-defined parameters for the following block intervals:

a. Sliding block that calculates demand every second, with intervals less than 15 minutes, and every 15 seconds with an interval between 15 and 60 minutes.
b. Fixed block that calculates demand at end of the interval.
c. Rolling block subinterval that calculates demand at end of each subinterval and displays it at end of the interval.

3. Demand Calculation Initiated by a Synchronization Signal:

    a. Signal is a pulse from an external source. Demand period begins with every pulse. Calculation shall be configurable as either a block or rolling block calculation.

    b. Signal is a communication signal. Calculation shall be configurable as either a block or rolling block calculation.

    c. Provide for synchronizing the demand with the internal of this instrument.

J. Data Recording: Store the listed values in instrument's nonvolatile memory, indicate which of the three phases relates to the value. Attach a date and time stamp to the peak values and the alarms.

1. Minimum and maximum of real-time rms measurement.

2. Energy.

3. Demand values.

4. Alarms, store the last 40 events.

K. Alarms: Transmit a digital output and show on display when alarmed. Provide for no fewer than 15 metered items. Each alarm shall be user configured, by using the following options:

1. Date and time stamp.

2. Enable-disable (default) or enable.

3. Pickup magnitude.

4. Pickup time delay.

5. Dropout magnitude.

6. Dropout time delay.

7. Alarm type.

8. Alarm label.

L. Output Signals: Provide two mechanical relays, rated not less than 250-V ac, 2-A resistive, and rated for 200-k cycles or more. The relays shall be user configurable in one of the following listed modes:

1. Normal contact closure where the contacts change state for as long as the signal exists.

2. Latched mode when the contacts change state when a pickup signal is received and are held until a dropout signal is received.

3. Timed mode when the contacts change state when a pickup signal is received and are held for a preprogrammed duration.

M. Meter Face:

1. Display: Backlit LCD display, six lines, with antiglare and scratch-resistant lens.

2. Display of Metered Values: One screen to show at least four user-selected values on one screen at the same time.

3. Provide for the reset of metered peak values.

N. Capacities and Characteristics:

1. Power Supply: 120-V ac, 60 Hz or as required..

2. Circuit Connections:

a. Voltage: Measurements autoranging, 60- to 400-V ac L-N.Connect directly to low-voltage (600 V and less) without using voltage transformers.

b. Current: Connect to instrument grade current transformer with a metering range of 5 mA to 6 A. Overcurrent tolerance of the instrument shall be 10 A continuous, 50 A for 10 seconds once per hour, and 120 A for one second per hour.
c. Frequency: 45 to 65 Hz.
d. Time: Input from a GPS receiver to synchronize the internal clock of the instrument and to time-synchronize this instrument with the network to a deviation of not greater than 1 ms.

1.05 CIRCUIT METERS AND MONITORS

C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton.
2. General Electric Company.
3. Schneider Electric USA, Inc.

A. Description: Separately mounted, modular, permanently installed, solid-state, digital I/O instrument for power monitoring and control; complying with UL 61010-1. Capable of metering 4-wire Y, 3-wire Y, 3-wire delta, and single-phase power systems.

1. Equipped with security lock to protect revenue related metering from unauthorized and accidental changes.

B. Environmental Conditions: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Indoor installation in non-air-conditioned or non-temperature-controlled spaces that have environmental controls to maintain ambient conditions of 14 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing.

2. Comply with IEC 60529 degree of protection code of IP52 for the front of the meter, and code of IP30 for the back.

C. Overvoltage: Comply with UL 61010-1 overvoltage withstand rating for CAT III.

D. Accuracy:

1. Comply with ANSI C12.20, Class 0.5.

2. For Voltage and Current: 0.5 percent of reading.

3. For Active Power: 0.2 percent.

4. For Active and Reactive Energy: ANSI 12.20, Class 0.2.

5. For Frequency: 0.01 Hz in the range of 45 to 65 Hz.

6. For Power Factor: 0.2 percent from 0.5 leading to 0.5 lagging.

E. Data Link:

1. Modbus TCP:

a. 10/100BaseTX balanced twisted-pair cabling. RJ-45 connector, 100-m link.
b. Optical fiber 100BaseFX, LC duplex connector, 1300-m link. Multimode 62.5/125-microsecond, 2000-m link.
c. Provide for firmware and software updates through the communications port.
d. Ethernet 10/100BaseTX balanced twisted-pair cabling port.
e. Ethernet 10/100BaseTX balanced twisted-pair cabling port, Ethernet to serial line gateway, and embedded web server.
f. 135 BACnet or LonTalk or Modbus or Industry-accepted, open-protocol as directed by District for communication interface.

F. Meter Physical Characteristics:

1. Display: Backlit LCD screen with antiglare and scratch-resistant lens.

2. Display of Metered Values: One screen to show at least four lines of user-selected values on one screen at the same time. Provide graphical representation of user-selected values.

3. Allow user to select a date/time format and the ability to create additional screens for user-specified views and custom quantities without overwriting existing standard screens.

G. Sampling Rate:

1. Continuously sample and record voltage and current at a rate not less than 128 samples per cycle, simultaneously on all voltage and current channels of the meter.

H. Meters shall measure, record with time stamp, calculate, and on request display the following:

1. Measurements: Instantaneous, in real time, rms to the 63rd harmonic:

a. Voltage: L-L each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
b. Current: Each phase, three-phase average, and neutral.
c. Active Power (kW): Each phase and three-phase total.
d. Reactive Power (kVAR): Each phase and three-phase total.

e. Apparent Power (kVA): Each phase and three-phase total.
f. Displacement Power Factor: Each phase and three-phase total.
g. Distortion Power Factor: Each phase and three-phase total.
h. Frequency.

2. THD from measurements simultaneously from the same cycle, through 63rd harmonic:

a. Voltage: L-L each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
b. Current: Each phase, three-phase average, and neutral.

3. Energy: Accumulated, indicate in-flow or out-flow, net and absolute values. Store the values in instrument's nonvolatile memory. Provide for storing accumulated energy at user-defined intervals, up to three intervals per day.

a. Active kWh.
b. Reactive kVARh.
c. Apparent kVAh.

4. Demand: Three-phase totals, present, predicted, peak.

a. Average current.
b. Active power (kW).
c. Reactive power (kVAR).
d. Apparent power (kVA).

5. Average, Minimum and Maximum Values:

a. Record, date and time stamp, and save the minimum and maximum values of all rms metered values since the last reset.

I. Power Demand, User Selectable:

1. Thermal Demand: Sliding window updated every second for the present demand and at end of the interval for the last interval. Adjustable window that can be set in 1-minute intervals, from 1 to 60 minutes.

2. Block Interval with Optional Subintervals: Adjustable for 1-minute intervals, from 1 to 60 minutes. User-defined parameters for the following block intervals:

a. Sliding block that calculates demand every second, with intervals less than 15 minutes, and every 15 seconds with an interval between 15 and 60 minutes.
b. Fixed block that calculates demand at end of the interval.
c. Rolling block subinterval that calculates demand at end of each subinterval and displays it at end of the interval.

3. Demand Calculation Initiated by a Synchronization Signal:

a. Synchronize demand with receipt of a signal pulse from an external source. Demand period begins with every pulse. Calculation shall be configurable as either a block or rolling block calculation.

b. Synchronize demand with receipt of a communication signal. Calculation shall be configurable as either a block or rolling block calculation.

c. Provide for synchronization to the clock in the instrument.

J. Trend Curves: Provide for recording four trend curves at intervals of one minute, one hour, one day, or one month; and forecast values for the trended parameters.

1. Record minimum, maximum, and average values of eight user-selected parameters as follows:

a. Every second for one minute for the one-minute curve.
b. Every minute for one hour for the one-hour curve.
c. Every hour for one day for the one-day curve.
d. Every day for one month for the one-month curve.

2. Forecast the trended parameters for the following:

a. The next four hours.
b. The next four days.

K. Waveform Capture:

1. Steady State Waveform Capture: Manually initiated.

a. Capture, record with time stamp, and store voltage and current waveforms for two cycles.

b. Capture, record with time stamp, and store 128 digitally sampled data points for each cycle of each phase voltage. The number of waveform captures stored onboard shall be user configurable.

c. Harmonic analysis performed on the captured waveforms shall resolve harmonics through the 63rd.
d. Captured waveforms shall be recorded from actual circuit performance.

2. Disturbance Waveform Capture:

a. Capture, record with time stamp, and store 128 digitally sampled data points for each cycle of each phase voltage. Disturbance waveform capture may be initiated manually, by an external contact closure, or by an alarm. The waveform captures shall be user configurable from 185 cycles on 1 channel at 16 points per cycle, to 3 cycles on 6 channels at 128 points per cycle.

L. Disturbance Detection and Alarm:

1. Detect and initiate alarm when detecting voltage or current sag and swell.

a. Detect disturbance events of less than half-cycle in length, by monitoring and calculating rms magnitude of each half-cycle.
b. Event detection shall be with user-defined parameters of threshold and delay. The threshold shall be user defined as a fixed or relative set point. With relative set point, the instrument will alarm based on the nominal current or voltage equal to its present average value. The instrument shall automatically adjust the nominal current and voltage values to avoid nuisance alarms caused by gradual daily variations of currents and voltages.
c. When detecting an alarm condition:

1) Initiate disturbance waveform capture.
2) Record the disturbance parameters into an onboard alarm log with a date and time stamp to the millisecond.
3) Alarm on shall be visible on the display and be transmitted over the data link.
4) Display the voltage sag/swell events on ITIC or SEMI graphs to quantify the event for accepted industry standards.

M. Harmonics Information:

1. Calculate the harmonic magnitudes and angles for each phase voltage and current through the 63rd harmonic. Provide harmonic power flows up to the 41st harmonic for active, reactive, and apparent power.

2. The current and voltage information for all phases shall be obtained simultaneously from the same cycle.

3. Report harmonic information as a percentage of the fundamental or as a percentage of the rms values, as selected by the user.

N. Alarms: Alarm events shall be user definable. Provide a minimum of 40 user-defined alarm conditions.

1. User Configuration Options:

a. Date and time stamp.
b. Enable-disable (default) or enable.
c. Pickup magnitude.
d. Pickup time delay.
e. Dropout magnitude.
f. Dropout time delay.
g. Alarm type.
h. Alarm label.

2. The following classes of events shall be available to be programmed as alarm events:

a. Over/under current.
b. Over/undervoltage.
c. Current imbalance.
d. Phase loss, current.
e. Phase loss, voltage.
f. Voltage imbalance.
g. Over kVA.
h. Over kW or kVAR into/out of load.
i. Over/under frequency.
j. Under power factor, true or displacement.
k. Over THD.
l. Over demand, current or power.
m. Reverse power.
n. Phase reversal.
o. Status input change.
p. End of incremental energy interval.
q. End of demand interval.
r. Over/under analog inputs.

s. Current sag/swell.
t. Voltage sag/swell.

3. For each over/under metered alarm value, provide for the user to define a pickup, dropout, and delay.

4. The circuit meter and monitor alarms response time shall be not less than one second.

5. Provide for up to four alarms to be combined to give a single result using Boolean algebra operations.

O. EN 50160 Evaluation: Report EN 50160 evaluation data in the following formats: summary of active evaluations, summary of evaluation status, detailed information for each evaluated parameter, and detailed information for each abnormal event.

P. I/O Module: Modular, with multiple I/O options to accomplish specified performance and one or more spare positions for future.

1. KY Pulse: Generate a standard KY pulses for a user-defined increment of metered active energy as follows:

a. User-defined pulse output, associated with kWh.
b. Alarm pulse output, which turns on the pulsing at user-defined point.

2. Digital Inputs: As follows:

a. One input connection rated 24- to 125-V ac or -V dc, +/- 10 percent, less than 5-mA burden, 1350-V rms isolation.

b. Six input connections rated 19- to 30-V dc, 5 mA maximum at 24-V dc. Provide an onboard 24-V dc power supply.

c. Two input connections rated 20- to 150-V dc or -V ac, 2 mA maximum.

3. Analog inputs, no fewer than two, adjustable from 0- to 5-V dc or 4 to 20 mA.

4. Outputs to operate field-installed relays, no fewer than two, providing 6- to 240-V ac or 6- to 30-V dc, 2 A rms. 5 A maximum for 10 seconds per hour.

5. Analog outputs, no fewer than two, 4- to 20-mA dc into 600 ohms maximum.

Q. Data Recording: Store the listed values in instrument's nonvolatile memory, indicate which of the three phases relates to the value. Attach a date and time stamp to the peak values and the alarms.

1. Data Logs, General: User configurable. Automatically stamp each entry to the millisecond with date and time.

a. Each log entry shall hold data of up to 96 parameters each.
b. Each log shall be user configurable to log data at a different user-defined schedule interval.
c. Provide each log with user-defined event or a minimum/maximum condition that will trigger log file entries.
d. Configure log entries to be recorded as Fill & Hold or Circular (First in, First out, or

FIFO), as defined by the user.

2. Minimum/Maximum Logs:

   a. Minimum/Maximum/Average interval log also logs minimum/maximum/average of selected parameters on a selected interval from a user-selected interval length from 1 to 1440 seconds.
   b. Minimum/Maximum log shall include the time, date, and value for the minimum and maximum of each of the real-time metered values.

3. Alarm Log: Record time, date, event information, and coincident information for each user-defined and automatically initiated alarm or event. Record selected parameters at 100-ms intervals during events and alarms. Automatically stamp each entry to the millisecond with date and time.

4. Waveform Logs: Capture and store waveforms, from 185 cycles on one channel at 16 samples per cycle, up to 3 cycles on six channels at 128 samples per cycle as defined by the user. Waveform log entries shall be externally triggered or forced in response to a user-defined event. Configure log entries to be recorded as Fill & Hold or Circular (FIFO), as defined by the user.

R. Capacities and Characteristics:

1. Power Supply: 120-V ac, 60 Hz] <Insert text>.

2. Circuit Connections:

   a. Voltage: Measurement autoranging, 0- to 600-V ac L-L, 0- to 347-V ac L-N.
   b. Current: Connect to instrument grade current transformer with a metering range of 5 mA to 6 A. Overcurrent tolerance of the instrument shall be 10 A continuous, 50 A for 10 seconds once per hour, and 120 A for one second per hour.
   c. Frequency: 45 to 65 Hz.
   d. Time: Input from a GPS receiver to synchronize the internal clock of the instrument and to time-synchronize this instrument with the network to a deviation of not greater than 1 ms.

1.06 PC OPERATING SYSTEM SOFTWARE

A. Description: System software shall monitor, analyze, display, control, and save all the parameters and features available at the connected meter.

B. Software: Configured to run on a portable laptop computer, a single PC, or a tablet computer, with capability for accessing a single meter at a time, at the location of the meter. System is not connected to LAN.

C. Minimum Requirements:

1. Real-time multitasking and multiuser 32 or 64 bit operating system that allows execution of multiple real-time programs and custom program development.

2. Operating system shall be capable of operating Microsoft Windows applications.

3. Scheduling software shall schedule centrally based time and event, temporary, and

exception day programs.

1.07 NETWORK CONFIGURATION SOFTWARE

A. Network Management Graphical Interface Features:

1. Add and remove devices in the power monitoring and control network.

2. Application for naming devices based on a user-defined naming scheme.

3. Add and remove I/O servers in the power monitoring and control network.

4. Edit communication properties for devices including timeouts and delays.

5. Display mandatory fields when adding a new device.

6. Allow to manually connect and disconnect serial, Ethernet, modem, and Ethernet gateway sites.

7. Enable and disable devices and sites in the power monitoring and control network without interruption to other devices or sites.

8. Pool modem resources so that the software uses any available modem.

9. Monitor the following diagnostics:

a. Communication request/response and error rates, and timeouts.
b. Log acquisition services.

B. Web Reporter: Allow viewing historical data in preformatted report templates via a web browser.

1. Features:

a. User-configurable report generator to trigger on event, based on a schedule, or manual initiation.
b. Format reports in HTML, PDF, TIF, Excel, XML, or user-selected printer, or network folder.
c. Distribution of reports via email.

2. Report on power and demand profiles.

3. Power quality report with CBEMA evaluation.

4. EN 50160 compliance report.

5. 100-ms PQ report.

6. Energy over Period Report:

a. User-defined rollup interval by day, week, month, or year.
b. Compare daily energy to the following:

1) Previous day.
2) Same day, previous week.
3) Same day, previous month.
4) User-defined specific day.

c. Compare weekly energy to the following:

1) Previous week.
2) Same week from previous month.
3) Same week from previous year.
4) User-defined specific week.

d. Compare monthly energy to the following:

1) Previous month.
2) Same month from previous year.
3) User-defined specific month.

e. Compare annual energy to the following:

1) Previous year.
2) User-defined specific year.

7. Energy by daily period report for the user-defined periods. Aggregate consumption of the periods by the day, week, and year.

8. Tabular Report: Show values for multiple measurements and measurements from multiple devices in tabular format.

9. System Configuration Report:

a. Device name.
b. Device type.
c. Device address.
d. Connection status.
e. Device protocol.
f. Device description.

10. Each default report shall include the following:

a. Summary aggregation of data from the selected devices.
b. Individual device information.
c. Raw data.

11. The reporting tool shall provide a graphical interface to create and manage multiple Time of Use schedules:

a. Tariffs including energy cost rates per kWh, kVARh, and kVAh, and demand charges per kW, kVAR, and kVA.
b. Off-peak and on-peak times.

1.08 MONITORING AND CONTROL OF POWER DISTRIBUTION EQUIPMENT

A. Power Distribution Equipment: Web-enabled, direct connected to the LAN or intranet.

B. Instrument Transformers: Comply with IEEE C57.13.

1. Potential Transformers: Secondary voltage rating of 120 V and NEMA C12.11 accuracy class of 0.3 with burdens of W, X, and Y.

2. Current Transformers: Burden and accuracy class suitable for connected relays, meters, and instruments.

C. Ethernet Connectivity:

1. Serial communications network shall be wired to an Ethernet server in the incoming section of the equipment. Hardware and cabling required for the connection to the network shall be included within the power distribution equipment.

2. Serial communications devices within the equipment shall be factory addressed and tested to verify reliable communications to the equipment's Ethernet Server.

D. Ethernet Gateways:

1. User configurable; complying with UL 60950-1, and IEEE 802.3, Class 3 PoE.

2. Include provisions to set initial Ethernet parameters via a local operator interface, or standard (RJ-45) Ethernet port, that is accessible from the front of the equipment. Initial setup shall be limited to basic Ethernet addressing parameters, as assigned by Owner.

3. Common Gateway Features:

a. User configurable, with secure password-protected login process.
b. Include communications diagnostic information for serial and Ethernet ports as well as internal health status and memory management information through embedded HTML web pages for viewing using a standard web browser.
c. Allow firmware upgrades through the communications port.

4. Include a "Quick-Start" guide with the equipment to describe the commissioning process for setting the equipment's Ethernet network address and for ensuring trouble-free data access from any PC on the network, using a standard web browser.

5. Implement a common user interface ("look and feel") across all styles of power equipment.

E. Distribution Equipment Monitoring:

1. Main menu and summary pages, factory configured, to display data for each communicating device within the power equipment lineup.

2. Display Data:

a. Circuit summary page to display circuit name, three-phase average rms current, real power (kW), power factor, and breaker status (if applicable).
b. Load current summary page to display circuit name, and phase a, b, and c rms current

values.

c. Demand current summary page to display circuit name, and phase a, b, and c average demand current values.
d. Power summary page to display circuit name, present demand power (kW), peak demand power (kW), and recorded time and date.
e. Energy summary page to display circuit name, real energy (kWh), reactive energy (kVARh), and time/date of last reset.
f. For unit substations equipped with dry-type transformer(s) and microbased temperature controller(s), the circuit summary web page listed above shall be augmented with transformer coil temperatures, phase a, b and c current values, and cooling fan status (on/off).
g. For motor-control centers, the circuit summary web page shall be tailored specifically for this application, to display circuit name, three-phase average rms current, thermal capacity (percentage), drive output frequency (in Hertz, where applicable), and contactor status.

1.09 SYSTEM OPERATOR INTERFACES

A. Operator means of system access shall be through the following:

1. Desktop workstation with hardwired connection through LAN port.

2. Remote connection using outside of system PC, tablet, or phone using an internet portal.

1.10 RACEWAYS AND BOXES

A. Comply with requirements in Section” Raceways and Boxes for Electrical Systems" for electrical power wiring and NFPA 70 Class 1 remote-control and signaling circuits.

B. Comply with requirements in Section” Pathways for Communications Systems" for control wiring, and NFPA 70 Class 2 remote-control and signaling circuits.

1.11 WIRES AND CABLES

A. Electrical Power Wiring: Comply with requirements in Section ”Low-Voltage Electrical Power Conductors and Cables."

1. Copper conductors are Type THHN/THWN-2.

B. Control Wiring:

1. Copper: Comply with requirements in Section” Control-Voltage Electrical Power Cables."

2. Optical Fiber: Comply with requirements in Section "Communications Optical Fiber Backbone Cabling" and “Communications Optical Fiber Horizontal Cabling."

C. Optical-Fiber Cable: Multimode, 50/125-micrometer OM3/OM4, six-fiber, nonconductive, tight-buffer, optical-fiber cable, with aqua jacket.

D. Balanced Twisted-Pair Cable: 100-ohm, four-pair balanced twisted-pair cable, Category 6.

E. Low-Voltage Control Cable: Multiple conductor, color-coded, No. 20 AWG copper, minimum.

1. Sheath: PVC; except in plenum-type spaces, use sheath listed for plenums.

2. Ordinary Switching Circuits: Three conductors unless otherwise indicated.

3. Switching Circuits with Pilot Lights or Locator Feature: Five conductors unless otherwise indicated.

1.12 SURGE PROTECTION DEVICES

D. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton.
2. Leviton Manufacturing Co., Inc.
3. PowerLlogics, Inc./PQ Protection.
4. Schneider Electric USA, Inc.

A. SPDs: Comply with UL 1449

1. Include LED indicator lights for power and protection status.

2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.

3. Include Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status

4. Generally, available surge current ratings are 300, 250, 200, 150, and 100 kA.

B. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 100 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual metal-oxide varistors in a given mode.

C. Comply with UL 1283.

D. Protection modes and UL 1449 SPD for grounded wye circuits with 480Y/277 V or 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:

1. L-N: 1200 V for 480Y/277 V; 700 V for 208Y/120 V.

2. L-G: 1200 V for 480Y/277 V; 700 V for 208Y/120 V.

3. N-G: 1200 V for 480Y/277 V; 700 V for 208Y/120 V.

4. L-L: 2000 V for 480Y/277 V; 1200 V for 208Y/120 V.

E. Protection modes and UL 1449 SPD for 240/120-V, single-phase, three-wire circuits shall not exceed the following:

1. L-N: 700 V.

2. L-G: 700 V.

3. N-G: 700 V.

4. L-L: 1200 V.

F. SCCR: Equal or exceed 100 kA.

G. Nominal Rating: 20 or 10 kA.

H. Indoor Enclosures: NEMA 250, Type 1.

I. Outdoor Enclosures: NEMA 250, Type 3R or Type 4X.

1.13 POWER MONITORING AND CONTROL SYSTEM INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

D. Identification Installation:

1. Comply with Section ”Low-Voltage Electrical Power Conductors and Cables" for electrical power wiring.

2. Comply with Section 271513 "Communications Copper Horizontal Cabling" for identification products and cable management system requirements for UTP and low-voltage control cable.

3. Comply with Section 271523 "Communications Optical Fiber Horizontal Cabling" for identification products and cable management system requirements for optical-fiber cable.

1.14 NETWORK NAMING AND NUMBERING

A. Coordinate with District and provide unique naming and addressing for networks and devices.

1.15 GROUNDING

A. For data communication wiring, comply with NECA/BICSI 568.

B. For low-voltage control wiring and cabling, comply with requirements in Section "Grounding and Bonding for Electrical Systems."

1.16 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

2. Visually inspect balanced twisted-pair cabling and optical-fiber cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments and inspect cabling connections to confirm compliance with TIA-568-C.1.

3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

4. Test balanced twisted-pair cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination, but not after cross-connection.

   a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in its "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in its "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
   b. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

5. Optical-Fiber Cable Tests:

   a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.0. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
   b. Link End-to-End Attenuation Tests:

      1) Multimode Link Measurements: Test at 850 or 1300 nm in one direction according to IEC 61280-4-1.
      2) Attenuation test results for links shall be less than that calculated according to equation in TIA-568-C.0.

   c. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide or transfer the data from the instrument to the computer, save as text files, print, and submit.

6. Power Monitoring and Control System Tests.

   a. Test Analog Signals:

      1) Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
      2) Check analog current signals using a precision current meter at zero, 50, and 100 percent.
      3) Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.

b. Test Digital Signals:

1) Check digital signals using a jumper wire.
2) Check digital signals using an ohmmeter to test for contact making or breaking.

c. I/O Control Loop Tests:

1) Test every I/O point to verify that safety and operating control set points are as indicated and as required to operate controlled system safely and at optimum performance.
2) Test every I/O point throughout its full operating range.
3) Test every control loop to verify that operation is stable and accurate.
4) Adjust control loop proportional, integral, and derivative settings to achieve optimum performance while complying with performance requirements indicated. Document testing of each control loop's precision and stability via trend logs.
5) Test and adjust every control loop for proper operation according to sequence of operation.
6) Test software and hardware interlocks for proper operation.
7) Operate each analog point at the following:

i) Upper quarter of range.
ii) Lower quarter of range.
iii) At midpoint of range.

8) Exercise each binary point.
9) For every I/O point in the system, read and record each value at operator workstation, at controller, and at field instrument simultaneously. Value displayed at operator workstation and at field instrument shall match.
10) Prepare and submit a report documenting results for each I/O point in the system, and include in each I/O point a description of corrective measures and adjustments made to achieve desire results.

C. Wiring and cabling will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

1.17 FINAL REVIEW

A. Submit written request to Architect and Construction Manager when the power monitoring and control system is ready for final review. Written request shall state the following:

1. The system has been thoroughly inspected for compliance with Contract Documents and found to be in full compliance.

2. The system has been calibrated, adjusted, and tested and found to comply with requirements of operational stability, accuracy, speed, and other performance requirements indicated.

3. The system monitoring and control of electrical distribution systems results in operation according to sequences of operation indicated.

4. The system is complete and ready for final review.

B. Review by Architect and Construction Manager will be made after receipt of written request. A field report shall be issued to document observations and deficiencies.

C. Take prompt action to remedy deficiencies indicated in field report and submit a second written request when all deficiencies have been corrected. Repeat process until no deficiencies are reported.

D. Final review shall include a demonstration to parties participating in final review.

E. Beginning at Substantial Completion, maintenance service shall include six- and 12-months' full maintenance by manufacturer's authorized service representative. Include.

1.18 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for three (3) years.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within three (3) years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

1.19 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the power monitoring and control system. Prior to training a written curriculum shall be provided for approval by district/AOR/Engineer. The training shall be provided in a classroom environment followed by the field in service hands on demonstration.

B. Extent of Training:

1. Base extent of training on scope and complexity of power monitoring and control system indicated and training requirements indicated. Provide extent of training required to satisfy requirements indicated even if more than minimum training requirements are indicated.

2. Inform Owner of anticipated training requirements if more than minimum training requirements are indicated.

3. Minimum Training Requirements:

a. Provide no fewer than ½ day or 4 hours of training total.

b. Stagger training over multiple training classes to accommodate Owner's requirements. All training shall occur before end of warranty period.

c. Total days of training shall be broken into not more than two separate training classes.

C. Training Outline: Submit training outline for Owner review at least 10 business days before scheduling training. Outline shall include a detailed agenda for each training day that is broken down into each training session that day, training objectives for each training session, and synopses for each lesson planned.

D. On-Site Training:

1. Owner will provide conditioned classroom or workspace with ample desks or tables, chairs, power, and data connectivity for instructor and each attendee.

2. Instructor shall provide training materials, projector, and other audiovisual equipment used in training.

3. Provide as much of training located on-site as deemed feasible and practical by Owner.

4. On-site training shall include regular walk-through tours, as required, to observe each unique product type installed with hands-on review of operation, calibration, and service requirements.

5. The operator workstation provided with the system shall be used in training. If operator workstation is not indicated, provide a temporary workstation to convey training content.

E. Off-Site Training: Provide a minimum, of (1) day training as required at a location determined by the Vendor and acceptable to District. All training expenses shall be included in project scope.

1. Provide conditioned training rooms and workspace with ample tables, chairs, power, and data connectivity for each attendee.

2. Provide capability to remotely access to Project monitoring and control system for use in training.

3. Provide a workstation for use by each attendee.

END OF SECTION

SECTION 26 09 23
LIGHTING CONTROL DEVICES

(To be used when Network Lighting Controls and Modular Dimming Systems are not used on the project design)

PART 1 - PRODUCTS

1.01 TIME SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Industries, Inc.
2. Intermatic, Inc.
3. Leviton Manufacturing Co., Inc.
4. Tork.

A. Electronic Time Switches: Solid state, programmable, with alphanumeric display; complying with UL 917 and CA T24 requirements for Astronomical Time Clocks.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Contact Configuration: DPDT.

3. Contact Rating: 20-A ballast load, 120/277-V ac.

4. Programs: Eight on-off set points on a 24-hour schedule and an annual holiday schedule that overrides the weekly operation on holidays.

5. Programs: Two on-off set points on a 24-hour schedule, allowing different set points for each day of the week and an annual holiday schedule that overrides the weekly operation on holidays.

6. Programs: All channels; each channel is individually programmable with 40 on-off operations per week, plus four seasonal schedules that modify the basic program and an annual holiday schedule that overrides the weekly operation on holidays.

7. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program on selected channels.

8. Astronomic Time: All channels.

9. Automatic daylight savings time changeover.

10. Battery Backup: Not less than seven days reserve, to maintain schedules and time clock.

B. Electromechanical-Dial Time Switches: Comply with UL 917.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Contact Configuration: DPDT.

3. Contact Rating: 20-A ballast load, 120/277 V ac.

4. Circuitry: Allows connection of a photoelectric relay as a substitute for the on-off function of a program.

5. Astronomic time dial.

6. Eight-Day Program: Uniquely programmable for each weekday and holidays.

7. Skip-a-day mode.

8. Wound-spring reserve carryover mechanism to keep time during power failures, minimum of 16 hours.

1.02 OUTDOOR PHOTOELECTRIC SWITCHES

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Industries, Inc.
2. Intermatic, Inc.
3. Leviton Manufacturing Co., Inc.

A. Description: Solid state, with DPST dry contacts rated to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A, and compatible with LED lamps.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Light-Level Monitoring Range: 1.5 to 10 fc with an adjustment for turn-on and turn-off levels within that range and a directional lens in front of the photocell to prevent fixed light sources from causing turn-off.

3. Time Delay: Fifteen-second minimum, to prevent false operation.

4. Surge Protection: Metal-oxide varistor.

5. Mounting: Twist lock complies with NEMA C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

6. Failure Mode: Luminaire stays ON.

B. Description: Solid state; one set of NO dry contacts rated for 24 V dc at 1 A or 24 V ac at 1 A, to operate connected load, complying with UL 773, and compatible with power pack.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Light-Level Monitoring Range: 1.5 to 10 fc with an adjustment for turn-on and turn-off levels within that range.

3. Time Delay: Thirty-second minimum, to prevent false operation.

4. Mounting: 1/2-inch threaded male conduit.

5. Failure Mode: Luminaire stays ON.

6. Power Pack: Dry contacts rated for 20-A LED load at 120- and 277-V ac and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.

   a. LED status lights to indicate load status.
   b. Plenum rated.

7. Power Pack: Digital controller capable of accepting three or four RJ45 inputs with two outputs rated for 20-A LED] load at 120- and 277-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, Class 2 power source, as defined by NFPA 70.

   a. With integral current monitoring.
   b. Compatible with digital addressable lighting interface.
   c. Plenum rated.

1.03 INDOOR OCCUPANCY AND VACANCY SENSORS

C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Industries, Inc.
2. Hubbell Building Automation, Inc.
3. Intermatic, Inc.
4. Leviton Manufacturing Co., Inc.
5. Lithonia Lighting; Acuity Brands Lighting, Inc.
6. Philips Lighting Controls.
7. Sensor Switch, Inc.

A. General Requirements for Sensors:

1. Wall and Ceiling mounted, solid-state indoor occupancy and vacancy sensors.

2. Dual technology.

3. Integrated or Separate power pack.

4. Hardwired connection to switch and BAS and BAS and lighting control system.

5. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

6. Operation:

   a. Occupancy Sensor: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time, delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.

   b. Vacancy Sensor: Unless otherwise indicated, lights are manually turned on and sensor

turns lights off when the room is unoccupied; with a time, delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.

c. Combination Sensor: Unless otherwise indicated, sensor shall be programmed to turn lights on when coverage area is occupied and turn them off when unoccupied, or to turn off lights that have been manually turned on; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.

7. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A.

8. Power: Line voltage.

9. Power Pack: Dry contacts rated for 20-A LED load at 120- and 277-V ac and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.

10. Mounting:

a. Sensor: Suitable for mounting in any position on a standard outlet box.
b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

11. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.

12. Bypass Switch: Override the "on" function in case of sensor failure.

13. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; turn lights off when selected lighting level is present.

B. Dual-Technology Type: Wall and Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.

2. Detector Sensitivity: Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches.

3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.

4. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of 1000 square feet when mounted 48 inches above finished floor.

1.04 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

D. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Industries, Inc.
2. Hubbell Building Automation, Inc.
3. Leviton Manufacturing Co., Inc.
4. Lithonia Lighting; Acuity Brands Lighting, Inc.
5. Sensor Switch, Inc.

A. General Requirements for Sensors: Automatic-wall-switch occupancy sensor with manual on-off switch, suitable for mounting in a single gang switchbox, with provisions for connection to BAS using hardwired connection.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application[, and shall comply with California Title 24.

2. Occupancy Sensor Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn lights off when unoccupied; with a time, delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.

3. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.

4. Switch Rating: Not less than 800-VA LED] load at 120 V, 1200-VA LED load at 277 V.

B. Wall-Switch Sensor Tag WS1:

1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 900 sq. ft.

2. Sensing Technology: Dual technology - PIR and ultrasonic.

3. Switch Type: SP, field-selectable automatic "on," or manual "on," automatic "off."

4. Capable of controlling load in three-way application.

5. Voltage: Dual voltage - 120 and 277 V.

6. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.

7. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.

8. Concealed, "off" time-delay selector at 30 seconds and 5, 10, and 20 minutes.

9. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

10. Color: As selected by Architect.

11. Faceplate: Color matched to switch.

1.05 DIGITAL TIMER LIGHT SWITCH

E. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Industries, Inc.
2. Intermatic, Inc.
3. Leviton Manufacturing Co., Inc.

A. Description: Combination digital timer and conventional switch lighting control unit. Switchbox-mounted, backlit LCD display, with selectable time interval in 10-minute increments.

1. Rated 960 W at 120-V ac for tungsten lighting, 10 A at 120-V ac or 10 amps at 277-V ac for LED and 1/4 horsepower at 120-V ac.

2. Integral relay for connection to BAS.

3. Voltage: Dual voltage - 120 and 277 V.

4. Color: As selected by Architect.

5. Faceplate: Color matched to switch.

1.06 OUTDOOR MOTION SENSORS

F. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Industries, Inc.
2. Hubbell Building Automation, Inc.
3. Leviton Manufacturing Co., Inc.
4. Lithonia Lighting; Acuity Brands Lighting, Inc.
5. Sensor Switch, Inc.
6. Watt Stopper; a Legrand® Group brand.

A. Description: Solid-state outdoor motion sensors.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application and shall comply with California Title 24.

2. Dual-technology (PIR and ultrasonic) type, weatherproof. Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. Comply with UL 773A.

3. Switch Rating:

a. Luminaire-Mounted Sensor: 500-VA LED.
b. Separately Mounted Sensor: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.

4. Switch Type: SP, field-selectable automatic "on," or manual "on," automatic "off." With bypass switch to override the "on" function in case of sensor failure.

5. Voltage: Dual voltage, 120- and 277-V type.

6. Detector Coverage:

a. Standard Range: 210-degree field of view, with a minimum coverage area of 900 sq. ft. .
b. Long Range: 180-degree field of view and 110-foot detection range.

7. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.

8. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.

9. Concealed, "off" time-delay selector at 30 seconds and 5, 10, and 20 minutes.

10. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and help eliminate false "off" switching.

11. Operating Ambient Conditions: Suitable for operation in ambient temperatures ranging from minus 40 to plus 130 deg F, rated as "raintight" according to UL 773A.

1.07 LIGHTING CONTACTORS

G. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ASCO: a brand of Vertiv.
2. Eaton.
3. General Electric Company.
4. Square D.

A. Description: Electrically operated and mechanically held, combination-type lighting contactors complying with NEMA ICS 2 and UL 508.

1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less THD of normal load current).

2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.

3. Enclosure: Comply with NEMA 250.

4. Provide with control and pilot devices as matching the NEMA type specified for the enclosure.

1.08 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Section "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Section "Low-Voltage Electrical Power Conductors and Cable

1.09 INSTALLATION

A. Comply with NECA 1.

B. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.

C. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.

D. Install and aim sensors in locations to achieve not less than 90-percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

E. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration unless contactors are installed in an enclosure with factory-installed vibration isolators.

1.10 WIRING INSTALLATION

A. Refer to low voltage cabling specifications and Wiring Methods: Comply with Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 3/4 inch.

B. All low voltage trades shall coordinate with each other with the assistance of general contractor to maintain consistency of installation methods including data networking cabling contractor.

C. Wiring within Enclosures: Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

D. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.

E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

1.11 IDENTIFICATION

A. Identify components and power and control wiring according to Section "Identification for Electrical Systems."

B. Label time switches and contactors with a unique designation.

1.12 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After installing time switches and sensors, and after electrical circuitry

has been energized, start units to confirm proper unit operation.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Lighting control devices will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

1.13 ADJUSTING

A. Occupancy Adjustments: When requested within six months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.

2. For daylighting controls, adjust set points and dead band controls to suit Owner's operations.

3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

1.14 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least 15 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

1.15 DEMONSTRATION

A. Train District’s maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION

SECTION 26 09 36
MODULAR DIMMING CONTROLS

PART 1 - REQUIREMENTS

1.01 Design considerations specific to components in this section:

A. For purposes of this guideline, this section pertains to n e w Modular Dimming Controls system for local dimming of classrooms, lecture halls and auditoriums.

1. New systems for lecture halls and auditoriums shall be controlled by a Modular Dimming Control system

a. Acuity Controls "Fresco" or equal.

2. New systems for classrooms shall be controlled by a local dimming controller:

a. Acuity Controls “nLIGHT” or equal.

B. Systems shall consist of factory assembled dimming controls, low voltage wall stations, control interfaces and modules, occupancy (motion) sensors, and LED lighting fixtures. Additional components may also be required and are described herein and/or shown on the drawings.

C. The system must be designed and installed to comply with all code requirements required by Title 24 of the State of California, based on the design date.

1.02 The Modular Dimming Control systems shall be listed and comply as required with all federal, state and local energy codes to include, but not be limited to California Title 24, ASHRAE 90.1-2004 and the City of Los Angeles.

1.03 Provide equipment complying with FCC emissions' standards, part 15, subpart J for Class A applications.

PART 2 - PRODUCTS

2.01 Modular Dimming Systems:

A. Acuity Controls, “Fresco, nLIGHT”

2.02 Component Characteristics:

A. Dimming Performance Requirements:

1. Electrolytic capacitors operate at least 36 degrees F (20 degrees C) below the capacitor’s maximum temperature rating when the device is under full load

2. Inrush tolerance: Use MOSFET that has a maximum rating of six times the operating current of the dimmer/relay

3. Surge tolerance: Panels are designed and tested to withstand surges of 6,000V, 3,000amps according to IEEE C62.41.2 and IEC 61000-4-5 without impairment to

performance

4. Power failure recovery: When power is interrupted and subsequently restored, within 3 seconds lighting to automatically return to same levels prior to power failure

5. Utilize half cycle to half cycle zero cross movement to allow for voltage compensation in order to overcome line noise and lamp flickering

6. Incorporate electronic soft start default at initial turn-on that smoothly ramps lights to appropriate levels within 0.5 seconds

7. Utilize air gap off to disconnect the load line from the line supply

8. Control all light sources in smooth and continuous manner.

9. Dimmers with visible steps are not acceptable

10. Assign load type to each dimmer that will provide proper dimming curve for the specific light source to be controlled

11. Minimum and maximum light levels are user adjustable on a circuit by circuit basis

B. Power Interfaces:

1. Small rooms: Power pack(s) shall beprovided depending on the load types to becontrolled.

2. Larger rooms: Provide dimming panels as required due to number of circuits to be dimmed.

C. Multi-zone wall station (Acuity Controls Fresco or equal):

1. The number of zones shall be determined per plans.

2. Intensity for each zone indicated by means of one graphically represented slider.

3. Fade time selectable for eachscene.

4. v) For temporary local overrides, individual raise/lower buttons to allow zones to be adjusted without altering scene values stored in memory.

D. Low voltage wall station (Acuity Controls, nLight Series or equal)

1. Electronic switch with preset buttons and LEDs.

2. The switch shall be capable ofeasy reprogramming without replacingunit.

3. Engrave wall stations with appropriate button, zone and scene engraving descriptions furnished prior to fabrication.

4. Provide faceplates with concealed mounting hardware.

E. Low voltage Control Interfaces:

1. Provide Contact Closure Interfaces as required to integrate the lighting controls with other

systems (i.e. A/V, shades, etc.).

2. Provide interfaces to communicate directly with dimming control station via user-supplied PC or digital audiovisual equipment.

3. Provide programmable interface to Astronomical time clock.

4. Provide ability to communicate via Ethernet to dimming control station via user-supplied PC.

F. Sensors:

1. Interior Daylight Sensors: Closed-loop basis for daylight sensor control scheme.

2. Partition Sensor: Provide contact closure based on status of sensor.

3. Occupancy Sensor: Provide dual technology PIR and Microphonics

4. Acuity Brands nLight

G. Local Lighting Controllers:

1. Manufacturers: Acuity Controls, “nLight” series

a. Power pack will incorporate one or more Class 1 relays and contribute low voltage power to the rest of the system
Secondary power packs incorporate the relay(s), 0-10VDC dimming output, or line voltage dimming output
b. Accept 120/277VAC and plenum rated
c. All devices have two RJ-45 ports
d. Parameters available and configurable remotely from software and locally via device push-button
e. Power pack to be securely mounted to junction box with ½ inch threaded chase nipple or mounted within luminaire ballast channel
f. Power (secondary) packs that provide up to 16A switching of all load types
g. Power (secondary) packs that provide up to 5A switching of all load types as well as 0-10VDC dimming LED drivers
h. Specific secondary packs provide up to 5A of switching and can dim 120VAC LED or 120/277VAC line voltage dimmable LED (2-wire and 3-wire versions)
i. Specific secondary packs provide up to 5A of switching and can dim 120/277VAC magnetic low voltage transformers
j. Specific secondary packs provide up to 5A of switching and can dim 120VAC electronic low voltage
k. Specific power/secondary are UL924 listed for switching of emergency power circuits

PART 3 - INSTALLATION

3.01 DIMMING CONTROL SYSTEM

1. The Dimming Control system equipment shall be installed in accordance with manufacturer's recommendations and as required on contract documents.

2. The Dimming Control system shall be installed utilizing manufacturer's approved shop drawings and in accordance with these specifications.

3. The entire system shall be installed per applicable requirements of the CEC, California Energy Commission.

4. Coordinate all conduit terminations for line voltage and low voltage conductors.

5. Low voltage and line voltage wiring shall not be run together in the same conduit.

6. The contractor shall be required to provide input feed wiring, load wiring and control wiring which terminates to a set of clearly marked low voltage terminals.

7. Provide equipment at locations and in quantities indicated on Drawings. Provide any additional equipment required to provide control intent.

8. Define each dimmer's load type, assign each load to a zone and set control functions

9. Ensure that daylight sensor placement minimizes sensors view of electric light sources; ceiling mounted, and fixture-mounted daylight sensors shall not have direct view of luminaries.

10. Contractor shall assign the system transmitters for each room to the appropriate controller to configure the room.

11. Install wall mounted devices with the vertical centerline plumb and flush against adjacent wall surfaces.

3.02 List of items or systems requiring testing, evaluation, verification, or commissioning: Central Dimming Controls system.

3.03 Documentation:

A. Test reports: The contractor shall hire factory trained technicians to functionally test each system component after installation to verify proper operation of the entire system, including all dimmers, dimming stations, switches, sensors and etc. and provide reports for all connections/terminations, controls and settings.

3.04 Testing protocols:

A. Upon completion of the installation contractor shall completely test all line voltage power and low voltage control wiring for continuity and accuracy of connections.

B. Set and operate controls to demonstrate their functions and capabilities in a methodical sequence that cues and reproduces actual operating functions.

1. Include testing of modular dimming control equipment under conditions that simulate actual operational conditions. Record control settings, operations, cues, and functional observations.

C. System Start-up Training:

1. The manufacturer shall be notified 14 days in advance prior to substantial completion of the project to run a final diagnostic and confirm system programming.

2. A factory technician shall be provided for a one-day on-site training of the District's

representatives and maintenance personnel.

D. Replace at no additional costs to the District all devices or components, which are found defective or do not operate within factory specified tolerances.

E. Submit the testing final report for review prior to project closeout and final acceptance by the District's Representative. Test report shall indicate test dates, devices tested, results, observation, deficiencies and remedies. Test report shall be included in the operation and maintenance manuals.

F. The lighting control system shall be listed, approved and comply as required with all national, state and local energy codes to include but not limited to California Title 24 and ASHRAE 90.1-2004.

G. All materials, equipment and parts comprising the units specified herein shall be manufactured recently and of current manufacturer.

H. All materials, equipment, accessories and devices covered by these specifications shall be complete and best suited for the intended use and shall conform to applicable codes and standards for their use.

I. Provide equipment complying with FCC emissions' standards in part 15 subpart J for Class A application.

J. Warranty: Five (5) year 100% parts & labor replacement

Provide a spreadsheet of all	Label	Labeling Sequence	Labeling As
Power Relay Packs			
nPP16	PP	Rm#/Switchleg/PP/Serial#	
nPP16ER	PPER	Rm#/Switchleg/PPER/Serial#	
nPP16D	PPD	Rm#/Switchleg/PP/ Serial#	
nPP16DER	PPDER	Rm#/Switchleg/PPDER/Serial#	
nPANEL4	NP4	Rm#/Switchleg/NP4/Serial#	
Daylight Harvesting: Daylight Zone 1 (DZ1)/ Daylight Zone 2 (DZ2)			
Secondary Relay Packs			
nSP5 PCD 2W	2W	Rm#/Switchleg/2W/Serial#	
nSP5 PCD MLV	MLV	Rm#/Switchleg/MLV/Serial#	
nSP5 PCD ELV 120	ELV	Rm#/Switchleg/ELV/Serial#	
nSP5 PCD 3W	3W	Rm#/Switchleg/3W/Serial#	
Daylight Harvesting: Daylight Zone 1 (DZ1)/ Daylight Zone 2 (DZ2)			
nLight Enabled Fixtures			
NEF 2x2 & 2x4 Fixtures	NEF	Rm#/Switchleg/NEF/Serial#	
NEF Can Lights (nPS80EZ)	NEFEZ	Rm#/Switchleg/NEFEZ/Serial#	

Daylight Harvesting: Daylight Zone 1 (DZ1)/ Daylight Zone 2 (DZ2)	

Wall Switches (Wall Pods)			
nPODM DX	WS1P	Rm#/WS1P/Serial#	
nPODM 2P DX	WS2P	Rm#/WS2P/Serial#	
nPODM 4P DX	WS4P	Rm#/WS4P/Serial#	
nPODM GFX	WSGFX	Rm#/WSGFX/Serial#	
nWSX (PDT)LV DX	WSOS	Rm#/WSOS/Serial#	
nPODM 1S	WS1S	Rm#/WS1S/Serial#	
nPODM 2S	WS2S	Rm#/WS2S/Serial#	
nPODM 4S	WS4S	Rm#/WS4S/Serial#	

Occupancy and Daylight Harvesting Sensors			
nCM/RM 9 RJB	OS	Rm#/OS/Serial#	
nCM/RM 10 RJB	OS	Rm#/OS/Serial#	
nCM/RM PDT9 RJB	OS	Rm#/OS/Serial#	
nCM/RM PDT10 RJB	OS	Rm#/OS/Serial#	
nCM/RM ADCX RJB	PC	Rm#/PC/Serial#	
nCM/RM PDT 9 ADCX RJB	OSPC	Rm#/OSPC/Serial#	
nCM/RM PDT 10 ADCX RJB	OSPC	Rm#/OSPC/Serial#	
nCM/RM 6 RJB	OS6	Rm#/OS6/Serial#	
nWV (PDT) 16	WV16	Rm#/WV16/Serial#	

Backbone Device			
nBRG 8	BRG	BRG#/123456	

END OF SECTION

SECTION 26 09 43.23
NETWORK LIGHTING CONTROLS

PART 1 - REQUIREMENTS

1.01 Design considerations specific to components in this section:

A. Required:

1. For purpose of this guideline, this section pertains to Network Lighting Controls system that has capability to communicate seamlessly with the School Central Lighting Control system so it can be remotely controlled via the internet or building wide Ethernet LAN by District.

    a. integration of the lighting control software (Sensorview) with the building services must be coordinated with District BMS system
    b. Manufacturers start up technicians must provide the following services prior to conclusion of the project through collaboration with Engineer:

        1) Program all controls according to Engineer specified standard specifications
        2) Oversee the connection of the BMS connection to BACNET points.
        3) Assist in the setup of software plug-ins including Green Screen and Virtual Wall Pods as required.
        4) Set up group scheduling
        5) Provide task tuning.

2. Provide network lighting control system consisting of components manufactured by single source. The lighting control system shall consist of but not limited to:

    a. Digital network lighting control system shall be computer-based software that provides control, configuration, monitoring, alerting and reports.
    b. The lighting control system shall provide time-based, sensor-based (both occupancy and daylight), and manual lighting control.
    c. The system shall be capable of turning lighting loads on/off as well as dimming lights.
    d. All system devices shall be networked together enabling digital communication and shall be individually addressable.
    e. The system architecture shall can enable stand-alone groups
    f. (rooms) of devices to function in some default capacity even if network connectivity to the greater system is lost.
    g. The system architecture shall facilitate remote operation via computer connections.
    h. The system shall not require any centrally hardwired switching equipment.
    i. The system shall be capable of wireless, wired, or hybrid wireless/wired architectures.
    j. The system shall be capable of warning of an impending off sweep by flashing lights Off/On once or twice (programmable) by relay or by zone prior to the lights being turned off. Building occupants shall be able to override any scheduled “Off” sweep using dedicated wall switches within the occupied space for a short period of time (programmable) that does not exceed 2-hours, prescribed by California Energy Commission.
    k. The system shall be capable of implementing On commands, Off commands, Raise (dimming) commands, Lower (dimming) commands for any relay, group or zone by means of digital wall switches, contact closure switches, time clock schedules including offsets from dusk and dawn by up to 10 hours, photocell, pc software or other devices

connected to programmable inputs in a lighting control panel.

l. The Network Lighting Control system installed shall have minimum of 20% spare capacity to accommodate future growth or revisions.
m. System design and BOM shall include additional 1% of all devices for stock in hand. To be provided by the installing contactor to District.
n. The system must be designed and installed to comply with all code requirements required by title 24 for the state of California based on the design date.

3. Acuity Brands: nLight

a. The lighting control system shall be listed, approved and comply as required with all national, state and local energy codes to include but not limited to California Title 24 and ASHRAE 90.1-2004.
b. All materials, equipment and parts comprising the units specified herein shall be manufactured recently and of current manufacturer.
c. All materials, equipment, accessories and devices covered by these specifications shall be complete and best suited for the intended use and shall conform to applicable codes and standards for their use.
d. Provide equipment complying with FCC emissions' standards in part 15 subpart J for Class A application.
e. Warranty: Five (5) year 100% parts replacement
f. Provide a complete spreadsheet of all components and associated distributor(s)

B. System Characteristics:

1. System shall have an architecture that is based upon three main concepts; 1) intelligent lighting control devices 2) standalone lighting control zones 3) network backbone for remote or time-based operation.
2. Intelligent lighting control devices shall consist of one or more basic lighting control components; occupancy sensors, photocell sensors, relays, dimming outputs, manual switch stations, and manual dimming stations. Combining one or more of these components into a single device enclosure should be permissible so as to minimize overall device count of system.
3. System must interface directly with intelligent LED luminaires such that only CAT- 5e/Cat 6 cabling is required to interconnect luminaires with control components such as sensors and switches.
4. Intelligent lighting control devices shall communicate digitally, require <7 mA of current to function (Graphic wall stations excluded), and possess RJ-45 style connectors.
5. Lighting control zones shall consist of one or more intelligent lighting control components, be capable of stand-alone operation, and be capable of being connected to a higher-level network backbone.
6. Devices within a lighting control zone shall be connected with CAT-5e low voltage cabling in any order.
7. Lighting control zone shall be capable of automatically configuring itself for default operation without any start-up labor required.
8. Individual lighting zones must continue to provide a user defined default level of lighting control in the event of a system communication failure with the backbone network or the management software becoming unavailable.
9. Power for devices within a lighting control zone shall come from either resident device already present for switching (relay device) or dimming purposes, controls enabled luminaires, or from the network backbone. Standalone “bus power supplies” shall not be required in all cases.
10. All switching and dimming for a specific lighting zone shall take place within the devices

located in the zone itself (i.e. not in remotely located devices such as panels) to facilitate system robustness and minimize wiring requirements. Specific applications that require centralized or remote switching shall be capable of being accommodated.

11. System shall have one or more primary wall mounted network control “controller” devices that are capable of accessing and controlling connected system devices and linking into an Ethernet LAN.
12. System shall use “bridge” devices that route communication and distribute power for up to 8 directly connected lighting zones together for purposes of decreasing system wiring requirements. Bridging devices, relays, power packs and associated components/devices when installed above T -bar/accessible ceiling shall be placed in a common location within each room that they are installed and identified with labelling below ceiling grid.
13. System shall be capable of wirelessly connecting a lighting zone to a wireless data network for purposes of eliminating the “bridge” devices and all cabling that connects zones to bridge devices.
14. System shall have a web-based software management program that enables remote system control, status monitoring, and creation of lighting control schedules and profiles.
15. Individual lighting zones shall be capable of being segmented into several “local” channels of occupancy, photocell, and switch functionality for more advanced configurations and sequences of operation.
16. Devices located in different lighting zones shall be able to communicate occupancy, photocell (non-dimming), and switch information via either the wired or wireless backbone.
17. System shall be capable of operating a lighting control zone according to several sequences of operation. System shall be able to change a spaces sequence of operation according to a time schedule so as to enable customized time-of-day, day- of-week, utilization of a space. Note: Operating modes should be utilized only in manners consistent with local energy codes.

C. Switching Schemes:

1. Auto-On I Auto-Off (via occupancy sensors)

    a. Zones with occupancy sensors automatically turn lights on when occupant is detected.
    b. Zones with occupancy and/or photocell sensors turn lights off when vacancy or sufficient daylight is detected.
    c. Pressing a switch will turn lights off. The lights will remain off regardless of occupancy until switch is pressed again, restoring the sensor to Automatic On functionality.

2. Manual-On I Auto-Off (also called Semi-Automatic)

    a. Pushing a switch will turn lights on.
    b. Zones with occupancy and/or photocell sensors turn lights off when vacancy or sufficient daylight is detected.

3. Manual-On to Auto-On/Auto-Off

    a. Pushing a switch will turn lights on.
    b. After initial lights on, zones with occupancy and/or photocell sensors turn lights on/off according to occupancy/vacancy and/or daylight conditions.
    c. Sequence can be reset via scheduled (ex. daily each morning) events

4. Auto·-to-Override On

a. Zones with occupancy sensors automatically turn lights on when occupant is detected.
b. Zone lighting then goes into an override on state for a set amount of time or until the next time event returns the lighting to an auto-off style of control.
c. Sequence can be reset via scheduled {ex. daily each morning) events

5. Manual-to-Override On

a. Pushing a switch will turn lights on.
b. Zone lighting then goes into an override on state for a set amount of time or until the next time event returns the lighting to an auto-off style of control.
c. Sequence can be reset via scheduled (ex. daily each morning) events

6. Auto On /Predictive Off

a. Zones with occupancy sensors automatically turn lights on when occupant is detected.
b. Zones with occupancy and/or photocell sensors turn lights off when vacancy or sufficient daylight is detected.
c. If switch is pressed, lights turn off and a short "exit timer" begins. After timer expires, sensor scans the room to detect whether occupant is still present. If no occupancy is detected, zone returns to auto-on. If occupancy is detected, lights must be turned on via the switch.

7. Multi-Level Operation (multiple lighting levels per manual button press)

a. Operating mode designed specifically for bi-level applications
b. Enables the user to cycle through the up to four potentials on/off lighting states using only a single button.
c. Eliminates user confusion as to which of two buttons controls which load

8. Three different transition sequences are available in order to comply with energy codes or user preference)

a. Mode available as a setting on all nLight devices that have single manual on/off switch (ex. nWSX, nPODM, nPODM-DX).
b. Depending on the sequence selected, every button push steps through relays states according to below table
c. In addition to achieving bi-level lighting control by switching loads with relays, the ability to command dimming outputs to "step" in a sequence that achieves bi-level operation is present.

PART 2 - PRODUCTS

2.01 Manufacturer:

A. Required for New Buildings and complete renovations:

1. Acuity Brands nLight

2.02 CONTROL MODULE (ECLYPSE CONTROLLER)

A. Control module shall be a device that facilitates communication and time- based control of downstream network devices and linking into an Ethernet network.

B. Devices shall have a user interface that is capable of wall mounting, powered by low voltage, and have a touch screen.

C. Control device shall have three RJ-45 ports for connection to the graphic touch screen, other backbone devices bridges) or directly to lighting control devices (up to 128 per port).

D. Device shall automatically detect all devices downstream of it.

E. Device shall have a standard and astronomical internal time clock.

F. Device shall have one RJ-45 10/100 BaseT Ethernet connection.

G. Device shall have a USB port

H. Each control gateway device shall be capable of linking 1500 devices to the management software.

I. Device shall be capable of using a dedicated static or DHCP assigned IP address.

J. BACnet Testing Laboratories (BTL) listed as a BACnet Building Controller (B-BC)

K. Network Control device shall be the following nLight model Series: **nECY 120 BAC**

2.03 NETWORKED SYSTEM OCCUPANCY SENSORS

A. Occupancy sensors system shall sense the presence of human activity within the desired space and fully control the on/off function of the lights.

B. Sensors shall utilize passive infrared {PIR) technology, which detects occupant motion, to initially turn lights on from an off state; thus, preventing false on conditions. Ultrasonic or Microwave based sensing technologies shall not be accepted.

C. For applications where a second method of sensing is necessary to adequately detect maintained occupancy (such as in rooms with obstructions), a sensor with an additional "dual" technology shall be used.

D. Dual technology sensors shall have one of its two technologies not require motion to detect occupancy. Acceptable dual technology includes PIR/Microphonics (also known as Passive Dual Technology or PDT) which both looks for occupant motion and listens for sounds indicating occupants. Sensors where both technologies detect motion {PIR/Ultrasonic) shall not be acceptable.

E. All sensing technologies shall be acoustically passive meaning they do not transmit sounds waves of any frequency (for example in the Ultrasonic range), as these technologies have the potential for interference with other electronic devices within the space (such as electronic white board readers). Acceptable detection technologies include Passive Infrared (PIR), and/or Microphonics technology. Ultrasonic or Microwave based sensing technologies shall not be accepted.

F. Sensors shall be available with zero, one, or two integrated Class 1 switching relays, and up to one 0-10 VDC dimming output. Sensors shall be capable of switching 120 I 277 I 347 VAC. Load ratings shall be 800 W@ 120 VAC, 1200 W@ 277 VAC, 1500 W@ 347 VAC, and

X HP motor. Relays shall be dry contacts.

G. Sensors shall be available with one or two occupancy "poles", each of which provides a programmable time delay.

H. Sensors shall be available in multiple lens options which are customized for specific applications.

I. Communication and Class 2 low voltage power shall be delivered to each device via standard CAT-S low voltage cabling with RJ-45 connectors.

J. All sensors shall have two RJ-45 ports or capable of utilizing a splitter.

K. All sensors shall have the ability to detect when it is not receiving valid communication (via CAT-S connections) and blink its LED in a pattern to visually indicate of a potential wiring issue

L. Every sensor parameter shall be available and configurable remotely from the software and locally via the device push-button.

M. Sensors shall be able to function together with other sensors in order to provide expanded coverage areas by simply daisy-chain wiring together the units with CAT-5e/6 cabling.

N. Sensors shall be equipped with an automatic override for 100-hour burn-in of lamps. This feature must be available at any time for lamp replacements.

O. Sensors shall comply with Title 24 requirements by automatically turning on lighting at 70%.

2.04 WALL SWITCH SENSOR:

A. Wall switch sensors shall recess into single-gang switch box and fit a standard GFI opening.

B. Wall switch sensors must meet NEC grounding requirements by providing a dedicated ground connection and grounding to mounting strap. Line and load wire connections shall be interchangeable. Sensor shall not allow current to pass to the load when sensor is in the unoccupied (Off) condition.

C. Wall switch sensors shall have optional features for photocell/daylight override, vandal resistant lens, and low temperature/high humidity operation.

D. Wall switch sensors shalt be White or as directed by Architect.

E. Wall switch sensors shall be available with optional raise/lower dimming adjustment controls.

F. Sensors shall comply with Title 24 requirements by automatically turning on lighting at 70%.

G. Wall switch sensors shall be the following Sensor Switch model numbers, with device color and optional features as specified:

1. nWSX LV (PIR, No Relay, Raise/Lower Dim Ctrl)
2. nWSX PDT LV (Dual Tech w/ Night light, No Relay, Raise/Lower Dim Ctrl)

2.05 EMBEDDED SENSORS:

A. Network system shall have sensors that can be embedded into luminaire such that only the lens shows on luminaire face.

B. Embedded sensors shall be capable of both PIR and Dual Technology occupancy detection

C. Embedded sensors shall have an optional photocell

D. Embedded sensors shall be the following Sensor Switch model number:

1. nES 7 (PIR, No Relay)
2. nES 7 ADCX (PIR w/ Photocell,No Relay)
3. nES PDT 7 {Dual Technology, No Relay)
4. nES PDT 7 ADCX (Dual Technology w/ Photocell, No Relay)

E. Network system shall also have ceiling, fixture, recessed, & corner mounted sensors available.

F. Fixture mount sensors shall be capable of powering themselves via a line power feed.

G. Sensors shall have optional features for photocell/daylight override, dimming control, and low temperature/high humidity operation.

H. Sensors with dimming can control 0 to 10 VDC dimmable ballasts by sinking up to 20 mA of Class 2 current {typically 40 or more ballasts).

I. System shall have wireless enabled fixture mountable sensors available

J. Wireless enable sensors shall be one of the Sensor Switch model numbers:

1. RES7N (networked)
2. RES7Z (stand-alone zone).

2.06 NETWORKED SYSTEM DAYLIGHTSENSORS

A. Photocell shall provide for an on/off set-point, and a dead band to prevent the artificial light from cycling. Delay shall be incorporated into the photocell to prevent rapid response to passing clouds.

B. Photocell and dimming sensor's set-point and dead band shall be automatically calibrated through the sensor's microprocessor by initiating an "Automatic Set- point Programming" procedure. Min and max dim settings as well as set-point may be manually entered.

C. Dead band setting shall be verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., furniture layouts, lamp depreciation, or lamp outages).

D. Dimming sensors shall control 0 to 10 VDC dimmable ballasts by sinking up to 20mA of class 2 current (typically 40 or more ballasts).

E. Photocell and dimming sensors shall be equipped with an automatic override for 100-hour burn-

in of lamps. This feature must be available at any time for lamp replacements. (Note: This function should be performed prior to any dimming of the lamps including the "auto set-point" setting.)

F. Combination units that have all features of on/off photocell and dimming sensors shall also be available.

G. A dual zone option shall be available for on/Off Photocell, Automatic Dimming Control Photocell, or Combination units. The second zone shall be capable of being controlled as an "offset" from the primary zone.

H. Line voltage versions of the above described photocell and combination photocell/dimming sensors shall be capable of switching both 120 VAC, 277 VAC, and 347 VAC. Load ratings shall be 800 W@ 120 VAC, 1200 W@ 277 VAC, 1500 W@ 347 VAC, and Y.4 HP motor load. Relays shall be dry contacts.

I. Sensor shall be the following Sensor Switch model numbers, with device options as specified:

1. nCM ADC (dimming)
2. nCM PC ADC (on/off, 0-10 VDC dimming)

J. Network system shall have dimming photocells that can be embedded into luminaire such that only the lens shows on luminaire face.

K. Embedded sensors shall be the following Sensor Switch model number: nES ADCX (Dimming Photocell)

2.07 NETWORKED SYSTEM POWER (RELAY) PACKS

A. Power Pack shall incorporate one or more Class 1 relays and contribute low voltage power to the rest of the system. Secondary Packs shall incorporate the relay(s), shall have an optional 2nd relay, 0-10 VDC dimming output, or line voltage dimming output, but shall not be required to contribute system power. Power Supplies shall provide system power only but are not required to switch line voltage circuit. Auxiliary Relay Packs shall switch low voltage circuits only.

1. Power Packs shall accept 120 or 277 VAC (or optionally 347 VAC), be plenum rated, and provide Class 2 power to the system.
2. All devices shall have two RJ-45 ports.
3. Every Power Pack parameter shall be available and configurable remotely from the software and locally via the device push-button.
4. Power Pack shall securely mount to junction location through a threaded ½ inch chase nipple or be capable of being secured within a luminaire ballast channel. Plastic clips into junction box shall not be accepted. All Class 1 wiring shall pass through chase nipple into adjacent junction box without any exposure of wire leads. Note: UL Listing under Energy Management or Industrial Control Equipment automatically meets this requirement, whereas Appliance Control Listing does not meet this safety requirement.
5. When required by local code, Power Pack must install inside standard electrical enclosure and provide UL recognized support to junction box. All Class 1 wiring is to pass through chase nipple into adjacent junction box without any exposure of wire leads.
6. Power Packs and Power Supplies shall be available that are wireless enabled.
7. Power (Secondary) Packs shall be available that provide up to 16 Amp switching of all

lighting load types.

8. Power (Secondary) Packs shall be available that provide up to 5 Amps switching of all lighting load types as well as 0-10 VDC dimming or fluorescent ballasts/LED drivers.
9. Specific Secondary Packs shall be available that provide up to 5 Amps of switching as well as 0-10 VDC dimming of fluorescent ballasts/LED drivers.
10. Specific Secondary Packs shall be available that provide up to 5 Amps of switching and can dim 120 VAC incandescent lighting loads or 120/277 VAC line voltage dimmable fluorescent ballasts (2-vvil e and 3-wire versions).
11. Specific Secondary Packs shall be available that provide up to 5 Amps of switching and can dim 120/277 VAC magnetic low voltage transformers.
12. Specific Secondary Packs shall be available that provide up to 4 Amps of switching and can dim 120 VAC electronic low voltage transformers.
13. Specific Secondary Packs shall be available that provide up to 5 Amps of switching of dual phase (208/240/480 VAC) lighting loads.
14. Specific Secondary Packs shall be available that require a manual switch signal (via a networked Wall Station) in order to close its relay.
15. Specific Power/Secondary Packs shall be available that are UL9241isted for switching of Emergency Power circuits.
16. Specific Secondary Packs shall be available that control louver/dampermotors for skylights.
17. Specific Secondary Packs shall be available that provide a pulse on/pulse off signal for purposes of controlling shade systems via relay inputs.

B. Power (Relay) Packs and Supplies shall be the following Sensor Switch model Series:

1. nPP16 (Power Pack w/ 16A relay)
2. nPP16 D (Power Pack w/ 16A relay and 0-10VDC dimming output)
3. nSP16 (Secondary Pack w/ 16A relay)
4. nPP16 ER (UL924 Listed Secondary Pack w/16A relay for switching emergency power circuits)
5. nPP16 D ER (Ul924 Listed Secondary Pack w/ 16 A relay and 0-10VDC dimming output for switching emergency power circuits)
6. nSPS PCD 2W (Secondary Pack w/ SA relay and incandescent dimming or 2- wire line voltage fluorescent dimming output)
7. nSPS PCD 3W (Secondary Pack w/ SA relay and 3-wire line voltage fluorescent dimming output)
8. nSPS PCD MLV {Secondary Pack w/ SA relay and magnetic low voltage dimming output)
9. nSPS PCD ELV 120 (Secondary Pack w/ 4A relay and electronic low voltage dimming output)
10. nSHADE (Pulse On/Off Control Pack
11. nPS 80 (Auxiliary Bus Power Supply)
12. nAR 40 (Low voltage auxiliary relay pack)

2.08 NETWORKED SYSTEM RELAY AND DIMMING PANELS

A. Panel shall incorporate up to 4 normally closed latching relays capable of switching 120/277 VAC or up to 2 Dual Phase relays capable of switching 208/240/480 VAC loads.

1. Relays shall be rated to switch up to a 30A ballast load at 277 VAC.
2. Panel shall provide one 0-IOVDC dimming output paired with each relay.
3. Panel shall power itself from an integrated 120/277 VAC supply.
4. Panel shall be capable of operating as either two networked devices or as one.

5. Panel shall supply current limited low voltage power to other networked devices connected via CAT-S.
6. Panel shall provide auxiliary low voltage device power connected wired directly to a dedicated terminal connection

B. Power (Relay) Packs and Supplies shall be the following Sensor Switch model numbers:

1. nPANEL 4 (Panel w/ four 120/277 VAC relays and four 0-10 VDC dimming outputs)
2. nPANEL 2 480 (Panel w/ two dual phase relays (208/240/480 VAC) and two 0-10 VDC dimming outputs)

2.09 NETWORKED AUXILAY INPUT/ OUTPUT (I/0) DEVICES

A. Devices:

1. Devices shall be plenum rated and be inline wired, screw mountable, or have an extended chase nipple for mounting to a W' knockout.
2. Devices shall have two RJ-45 ports
3. Communication and low voltage power shall be delivered to each device via standard CAT-S low voltage cabling with RJ-45 connectors.
4. Specific 1/0 devices shall have a dimming control output that can control 0- 10 VDC dimmable ballasts or LED drivers by sinking up to 20 mA of current (typically 40 or more ballasts).
5. Specific 1/0 devices shall have an input that read a 0-10 VDC signal from an external device.
6. Specific 1/0 devices shall have a switch input that can interface with either a maintained or momentary switch and run a switch event, run a local/remote control profile, or raise/lower a dimming output
7. Specific 1/0 devices shall sense state of low voltage outdoor photocells
8. Specific 1/0 devices shall enable RS-232 communication between lighting control system and Touch Screen based A/V control systems.
9. Specific 1/0 devices shall sense

B. Auxiliary Input/output Devices shall be the following Sensor Switch model numbers:

1. nIO D (I/0 device with 0-10 dimming output)
2. nIO 1S or nIO RLX (1/0 device with contact closure or 0-10VDC dimming input)
3. nIO NLI (Input device for detecting state of low voltage outdoor photocell; sold in nIO PC KIT only)
4. nIO X (Interface device for communicating with RS-232 enabled AV Touch Screens

2.10 NETWORKED LED LUMINAIRES

A. Networked LED luminaires:

1. Luminaires shall have a mechanically integrated control device
2. Luminaire shall have two RJ-45 ports
3. Luminaire shall be able to digitally network directly to other network control devices (sensors, photocells, switches, dimmers)
4. Luminaire shall provide low voltage power to other networked control devices

B. System:

1. System shall be able to turn on/off LED luminaire without using a relay
2. System shall be able to maintain constant lumen output over the specified life of the LED luminaire (also called lumen compensation) by varying the input control power (and thus saving up to 20% power usage).
3. System shall indicate (via a blink warning) when the LED luminaire has reached its expected life (in hours).

C. LED luminaires shall be the following Lithonia model families or equal by Acuity Brands:

1. Lithonia
2. Gotham
3. Peerless
4. Mark

2.11 NETWORKED SYSTEM WALL SWITCHES & DIMMERS

A. Devices shall recess into single-gang switch box and fit a standard GFI opening.

B. Communication and low voltage power shall be delivered to each device via standard CAT-5e low voltage cabling with RJ-45 connectors.

C. All devices shall have two RJ-45 ports.

D. All devices shall provide toggle switch control. Dimming control and low temperature/high humidity operation are available options.

E. Devices shall be available in four colors (Ivory, White, Light Almond, Gray).

F. Devices with mechanical pushbuttons shall provide tactile and LED user feedback.

G. Devices with mechanical pushbuttons shall be made available with custom button labeling

H. Devices with a single “on” button shall be capable of selecting all possible lighting combinations for a bi-level lighting zone such that the user confusion as to which of two buttons (as is present in multi-button scenarios) controls which load is eliminated.

I. Wall switches & dimmers shall be the following nLight model numbers, with device options as specified:

1. **nPODM** (single on/off, pushbuttons, LED user feedback)
2. **nPODM DX** (single on/off, single dimming raise/lower, pushbuttons, LED user feedback)
3. **nPODM 2P** (dual on/off, pushbuttons, LED user feedback)
4. **nPODM 2P DX** (dual on/off, dual dimming raise/lower, pushbuttons, LED user feedback)
5. **nPODM 4P** (quad on/off, pushbuttons, LED user feedback)
6. **nPODM 4P DX** (quad on/off, quad dimming raise-lower, pushbuttons, LED user feedback)

2.12 NETWORKED SYSTEM GRAPHIC WALL STATION

A. Product:

1. Device shall have a 3.5" full color touch screen for selecting up to 8 programmable lighting control presets or acting as up to 16 on/off/dim control switched.

2. Device shall enable configuration of lighting presets, switched, and dimmers via password protected setup screens.
3. Device shall enable user supplied .jpg screen saver image to be uploaded.
4. Device shall surface mount to single-gang switch box
5. Device shall have a micro-USB style connector for local computer connectivity.
6. Device shall have two RJ-45 ports for communication

B. Device shall be the following Sensor Switch model number: nPOD GFX

2.13 NETWORKED SYSTEM SCENE CONTROLLERS

A. Controllers:

1. Device shall have two to four buttons for selecting programmable lighting control profiles or acting as on/off switches.
2. Device shall recess into single-gang switch box and fit a standard GFI opening.
3. Devices shall provide LED user feedback.
4. Communication and Class 2 low voltage power shall be delivered to each device via standard CAT-S low voltage cabling with RJ-45 connectors.
5. All sensors shall have two RJ-45 ports.
6. Device shall be capable of reprogramming other devices in its zone so as to implement user selected lighting scene.
7. Device shall be capable of selecting a lighting profile be run by the system's upstream Gateway so as to implement selected lighting profile across multiple zones (and not just its local zone).
8. Device shall have LEOs indicating current selection.

B. Scene Selector device shall be the following Sensor Switch model number:

1. nPODM 2S (2 Scene, push-button)
2. nPODM 4S (4 Scene, push-button)
3. nPODM 4S DX (4 Scene, push-button, On/Off/Raise/Lower)
4. nPODM 4L DX (4 Adjustable Presets, push-button, On/Off/Raise/Lower)

2.14 COMMUNICATION BRIDGES

A. Product:

1. Device shall surface mount to a standard 4" x 4" square junction box.
2. Device shall have 8 RJ-45 ports.
3. Device shall be capable of aggregating communication from multiple lighting control zones for purposes of minimizing backbone wiring requirements back to Control Gateway.
4. Device shall be powered with Class 2 low voltage supplied locally via a directly wired power supply or delivered via a CAT-S cabled connection.
5. Device shall be careful of redistributing power from its local supply and connect lighting control zones with excess power to lighting control zones with insufficient local power. This architecture also enables loss of power to a particular area to be less impactful on network lighting control system.

B. Communication Bridge devices shall be the following Sensor Switch model numbers: nBRG 8 (8 Ports)

2.15 LIGHTING CONTROL PROFILES

A. Changes to the operation of the system shall be capable of being made in real- time or scheduled via lighting control profiles. These profiles are outlines of settings that direct how a collection of devices function for a defined time period.

B. Lighting control profiles shall be capable of being created and applied to a single device, zone of devices, or customized group of zones.

C. All relays and dimming outputs shall be capable of being scheduled to track or ignore information regarding occupancy, daylight, and local user switches via lighting control profile.

D. Every device parameter (e.g. sensor time delay and photocell set-point) shall be configurable via a lighting control profile.

E. All lighting control profiles shall be stored on the network control gateway device and on the software's host server.

F. Lighting control profiles shall be capable of being scheduled to run according to the following calendar options: start date/hour/minute, end date/hour/minute, and sunrise/sunset+/- timed offsets.

G. Sunrise/sunset times shall be automatically derived from location information using an astronomical clock.

H. Daylight savings time adjustments shall be capable of being performed automatically, if desired.

I. Lighting control profile schedules shall be capable of being given the following recurrence settings: daily, weekday, weekend, weekly, monthly, and yearly.

2.16 MANAGEMENT SOFTWARE

A. Every device parameter (e.g. sensor time delay and photocell set-point) shall be available and configurable remotely from the software

B. The following status monitoring information shall be made available from the software for all devices for which it is applicable: current occupancy status, current PIR Status, current Microphonics Status, remaining occupancy time delay(s}, current photocell reading, current photocell inhibiting state, photocell transitions time remaining, current dim level, device temperature, and device relay state(s).

C. The following device identification information shall be made available from the software: model number, model description, serial number, manufacturing date code, custom label(s), and parent network device.

D. A printable network inventory report shall be available via the software.

E. A printable report detailing all system profiles shall be available via the software.

F. Software shall require all users to login with a Username and Password.

G. Software shall provide at least three permission levels for users.

H. All sensitive stored information and privileged communication by the software shall be encrypted.

I. All device firmware and system software updates must be available for automatic download and installationvia the internet.

J. Software shall be capable of managing systems interconnected via a WAN (wide area network)

2.17 BMS COMPATIBILITY

A. BACnet Testing Laboratories (BTL) listed as a BACnet Building Controller (B-BC)

B. Native BACnet MS/TP and IP

2.18 SYSTEM ENERGY ANALYSIS & REPORTINGSOFTWARE

A. System shall be capable of reporting lighting system events and performance data back to the management software for display and analysis.

B. Intuitive graphical screens shall be displayed in order to facilitate simple viewing of system energy performance.

C. An "Energy Scorecard" shall be display that shows calculated energy savings in dollars, KWHr, or C02.

D. Software shall calculate the allocation of energy savings to different control measures (occupancy sensors, photocells, manual switching, etc.).

E. Energy savings data shall be calculated for the system as a whole or for individual zones.

F. A time scaled graph showing all relay transitions shall be presented.

G. A time scaled graph showing a zones occupancy time delay shall be presented

H. A time scaled graph showing the total light level shall be presented.

I. User shall be able to customize the baseline run-time hours for a space.

J. User shall be able to customize up to four time-of-day billing rates and schedules.

K. Data shall be made available via a .CSV file

PART 3 - INSTALLATION

3.01 EXAMINATION

A. Thoroughly examine site conditions for acceptance of lighting control system panels and components to verify conformance with manufacturer and specification tolerances. Do not commence with installation until all conditions are made satisfactory.

B. Do not install network power controls until space is enclosed, HVAC systems are operating and overhead and wet work in space is complete.

C. Provide complete installation of system in accordance with Contract Documents.

D. Install network power switching controls in accordance with manufacturer's instructions.

E. Provide equipment at locations and in quantities indicated on Drawings. Provide any additional equipment required to provide control intent.

F. Grounding: Provide electrical grounding in accordance with NFPA 70.

G. Mount exterior daylight sensors to point due north with constant view of daylight.

H. Ensure that interior daylight sensor placement minimizes sensors view of electric light sources; ceiling mounted, and fixture-mounted daylight sensors shall not have direct view of luminaires.

I. Ensure that occupancy sensor placement minimizes sensors view of areas beyond the control zone or outside the individual offices or rooms that are controlled by the sensor.

J. Provide all required components and programming to ensure the system is fully integrated with the equipment and systems specified in other Division 26 sections, A/V system, BAS system, shade controls and etc.

K. Provide panelboard schedule in pocket provided in panel doors.

L. System must comply with applicable Title 24 code requirements.

3.02 SOFTWARE

A. A. Install and program software to meet the Owner's requirements. Provide current licenses. And backup copies of the software for the Owner's records.

3.03 START-UP & SUPPORT FEATURES

A. Manufacturer's Field Service: Engage a factory-authorized service representative to assist in the start-up, including programming for the entire system.

1. To facilitate start-up, all devices daisy-chained together (using CAT-5e) shall automatically be grouped together into a functional lighting control zone.
2. All lighting control zones shall be able to function according to default settings once adequate power is applied and before any system software is installed.
3. Once software is installed, system shall be able to auto-discover all system devices without requiring any commissioning.
4. All system devices shall be capable of being given user defined names.
5. All devices within the network shall be able to have their firmware reprogrammed remotely and without being physically uninstalled for purposes of upgrading functionality at a later date.
6. All sensor devices shall have the ability to detect improper communication wiring and blink it's LED in a specific cadence as to alert installation/startup personnel.

3.04 TESTING

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections

and operation of the entire system.

B. Switch each load on and off with manual line test feature of the power switching module before installing processors.

C. Perform operational testing to verify compliance with Specifications. Adjust as required.

1. Test for circuit continuity.
2. Verify that the control module features are operational.
3. Check operation of local override controls.
4. Test system diagnostics by simulating improper operation of several components selected by Architect.
5. Prepare test and inspection reports.

D. Lighting controls will be considered defective if they do not pass tests and inspections.

3.05 SEQUENCE OF OPERATION

A. Building Wide as described or indicated on drawings.

B. Area Functionality as described or indicated on drawings.

3.06 FIELD QUALITY CONTROL

A. Aim and Focus Visit: Owner's Representative to coordinate on-site meeting with Lighting Control System Manufacturer and Lighting Design Consultant to make required lighting adjustments to the system for conformance with the lighting Design Consultant's original design intent.

3.07 ADJUSTING

A. Within 12 months of the date of Substantial Completion provide onsite service to adjust the system to account for actual occupied conditions.

3.08 TRAINING

A. Factory authorized service representative to instruct owner's staff to adjust, operate and maintain network power switching systems; and provide instruction using the system software.

3.09 CLEANING

A. Upon completion of project prior to final acceptance the contractor shall thoroughly clean the entire lighting control/management equipment. Remove paint splatters and other spots, dirt, and debris.

3.10 PARTS LIST

A. Provide a complete spare parts list, including recommended quantities.

3.11 CLOSEOUT ACTIVITIES

A. Demonstration: Schedule a final demonstration with the District's Representative.

B. Training: Train District's personnel to operate, maintain, and program network power switching systems. Allow for a minimum of trips to the jobsite to provide additional training as needed.

C. Furnish set of approved submittals and record drawings of actual installation for owner's personnel in attendance at training session.

PART 4 - EVALUATION

4.01 List of items or systems requiring testing, evaluation, verification, or commissioning: Network Lighting Controls system.

4.02 Documentation required:

A. Test reports: The contractor shall hire factory trained technicians to functionally test each system component after installation to verify proper operation of the entire system, including all relays, dimming units, switches, sensors and etc. and provide reports for all connections/terminations, controls and settings.

4.03 Required testing protocols:

A. Test relays, switches and sensors after installation to confirm proper operation and confirm correct loads are recorded on directory card in each panel.

B. At least three weeks prior to any testing, notify the District’s Representative so that arrangement can be made for witnessing test, if deemed necessary. All pre- testing shall have been tested satisfactorily prior to the District’s Representative witnessed test.

4.04 Pre-functional Testing:

A. Visual and Mechanical Inspection:

1. Inspect for physical damage, defects alignment and fit.
2. Perform mechanical operational tests in accordance with manufacturer's instructions.
3. Compare nameplate information and connections to Contract Documents.
4. Check tightness of all control and power connections.
5. Check that all covers, barriers and doors are secure.

B. Electrical Tests:

1. The system shall be completely tested in accordance with operational parameters and manufacturer's instructions. Any problem shall be documented and corrected.
2. Submit a complete report listing every device, the date it was tested, the results and the date retested (if failure occurred during the previous test). The test report shall indicate that every device tested successfully.

C. Start-up Testing and Training:

1. The manufacturer shall be notified 14 days in advance prior to substantial completion of the project to run a final diagnostic and confirm system programming on site or remotely.
2. A factory technician shall be provided for a one-day on-site training of the District’s representatives and maintenance personnel.

D. Replace at no additional costs to the District all devices, which are found defective or do not operate within factory specified tolerances.

E. Submit the testing final report for review prior to project closeout and final acceptance by the District's Representative. Test report shall indicate test dates, devices tested, results, observation, deficiencies and remedies. Test report shall be included in the operation and maintenance manuals.

Device	Label	Labeling Sequence	Labeling as required
Power Relay Packs			
nPP16	PP	Rm#/Switchleg/PP/Serial#	
nPP16ER	PPER	Rm#/Switchleg/PPER/Serial#	
nPP16D	PPD	Rm#/Switchleg/PP/ Serial#	
nPP16DER	PPDER	Rm#/Switchleg/PPDER/Serial#	
nPANEL4	NP4	Rm#/Switchleg/NP4/Serial#	
Daylight Harvesting: Daylight Zone 1 (DZ1)/ Daylight Zone 2 (DZ2)			
Secondary Relay Packs			
nSP5 PCD 2W	2W	Rm#/Switchleg/2W/Serial#	
nSP5 PCD MLV	MLV	Rm#/Switchleg/MLV/Serial#	
nSP5 PCD ELV 120	ELV	Rm#/Switchleg/ELV/Serial#	
nSP5 PCD 3W	3W	Rm#/Switchleg/3W/Serial#	
Daylight Harvesting: Daylight Zone 1 (DZ1)/ Daylight Zone 2 (DZ2)			
nLight Enabled Fixtures			
NEF 2x2 & 2x4 Fixtures	NEF	Rm#/Switchleg/NEF/Serial#	
NEF Can Lights (nPS80EZ)	NEFEZ	Rm#/Switchleg/NEFEZ/Serial#	
Daylight Harvesting: Daylight Zone 1 (DZ1)/ Daylight Zone 2 (DZ2)			
Wall Switches (Wall Pods)			
nPODM DX	WS1P	Rm#/WS1P/Serial#	
nPODM 2P DX	WS2P	Rm#/WS2P/Serial#	
nPODM 4P DX	WS4P	Rm#/WS4P/Serial#	
nPODM GFX	WSGFX	Rm#/WSGFX/Serial#	
nWSX (PDT)LV DX	WSOS	Rm#/WSOS/Serial#	
nPODM 1S	WS1S	Rm#/WS1S/Serial#	
nPODM 2S	WS2S	Rm#/WS2S/Serial#	
nPODM 4S	WS4S	Rm#/WS4S/Serial#	
Occupancy and Daylight Harvesting Sensors			
nCM/RM 9 RJB	OS	Rm#/OS/Serial#	
nCM/RM 10 RJB	OS	Rm#/OS/Serial#	

nCM/RM PDT9 RJB	OS	Rm#/OS/Serial#	
nCM/RM PDT10 RJB	OS	Rm#/OS/Serial#	
nCM/RM ADCX RJB	PC	Rm#/PC/Serial#	
nCM/RM PDT 9 ADCX RJB	OSPC	Rm#/OSPC/Serial#	
nCM/RM PDT 10 ADCX RJB	OSPC	Rm#/OSPC/Serial#	
nCM/RM 6 RJB	OS6	Rm#/OS6/Serial#	
nWV (PDT) 16	WV16	Rm#/WV16/Serial#	

Backbone Device			
nBRG 8	BRG	BRG#/123456	

END OF SECTION

SECTION 26 09 43.23
RELAY-BASED LIGHTING CONTROLS

(Modernization Projects Only)

PART 1 - PRODUCTS

1.01 LIGHTING CONTROL RELAY PANELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Leviton Manufacturing Co., Inc.
2. Lighting Controls & Design; Acuity Brands Lighting, Inc.
3. Watt Stopper; a Legrand® Group brand.

A. Description: Standalone lighting control panel using mechanically latched relays to control lighting and appliances.

B. Lighting Control Panel:

1. A single enclosure with incoming lighting branch circuits, control circuits, switching relays, and on-board timing and control unit.

2. A vertical barrier separating branch circuits from control wiring.

C. Control Unit: Contain the power supply and electronic control for operating and monitoring individual relays.

1. Timing Unit:

a. 365-day calendar, astronomical clock, and automatic adjustments for daylight savings and leap year.
b. Clock configurable for 12-hour (A.M./P.M.) or 24-hour format. With independent schedules, each having 365 day time periods.
c. Schedule periods settable to the minute.
d. Day-of-week, day-of-month, day-of-year with one-time or repeating capability.

2. Sequencing Control with Override:

a. Automatic sequenced on and off switching of selected relays at times set at the timing unit, allowing timed overrides from external switches.
b. Sequencing control shall operate relays one at a time, completing the operation of all connected relays in not more than 10 seconds.
c. Override control shall allow any relay connected to it to be switched on or off by a field-deployed manual switch or by an automatic switch, such as an occupancy sensor.
d. Override control "blink warning" shall warn occupants approximately thirty **minutes** before actuating the off sequence.

3. Nonvolatile memory shall retain all setup configurations. After a power failure, the controller shall automatically reboot and return to normal system operation, including accurate time

of day and date.

D. Relays: Electrically operated, mechanically held single-pole switch, rated at 20 A at 120-V tungsten, 30 A at 277-V ballast, 1.5 hp at 120 V, and 3 hp at 277 V. Short-circuit current rating shall be not less than 14 kA. Control shall be three-wire, 24-V ac.

E. Power Supply: NFPA 70, Class 2, sized for connected equipment, plus 20 percent spare capacity. Powered from a dedicated branch circuit of the panelboard that supplies power to the line side of the relays, sized to provide control power for the local panel-mounted relays, bus system, low-voltage inputs, field-installed occupancy sensors, and photo sensors.

F. Operator Interface:

1. Integral alphanumeric keypad and digital display, and intuitive drop-down menus to assist in programming.

2. Log and display relay on-time.

3. Connect relays to one or more time and sequencing schemes.

1.02 MANUAL SWITCHES AND PLATES

A. Push-Button Switches: Modular, momentary contact, three wire, for operating one or more relays and to override automatic controls.

1. Match color and style specified in Section ”Wiring Devices."

2. Integral green LED pilot light to indicate when circuit is on.

3. Internal white LED locator light to illuminate when circuit is off.

B. Wall Plates: Single and multi-gang plates as specified in Section 262726 "Wiring Devices."

C. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.

1.03 FIELD-MOUNTED SIGNAL SOURCES

A. Daylight Harvesting Switching Controls: Comply with Section "Lighting Control Devices." Control power may be taken from the lighting control panel, and signal shall be compatible with the relays.

B. Indoor Occupancy Sensors **and Extreme-Temperature Occupancy Sensors**: Comply with Section "Lighting Control Devices." Control power may be taken from the lighting control panel, and signal shall be compatible with the relays.

1.04 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG. Comply with requirements in Section "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cables: Multiconductor cable with copper conductors not smaller than **No. 18** AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than **No. 14** AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

D. Twisted-Pair Data Cable: **Category 6** Comply with requirements for twisted pair cabling.

1.05 INSTALLATION

A. Comply with NECA 1.

1.06 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section "Identification for Electrical Systems."

B. Create a directory to indicate loads served by each relay; incorporate Owner's final room designations. Obtain approval before installing. Use a PC or typewriter to create directory; handwritten directories are unacceptable.

C. Lighting Control Panel Nameplates: Label each panel with a nameplate complying with requirements for identification specified in Section "Identification for Electrical Systems."

1.07 Acceptance Testing Preparation:

1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers described below **and low-voltage surge arrestors**. Certify compliance with manufacturer's test parameters.

    a. Circuit-Breaker Tests:

        1) Compare nameplate with Drawings and Specifications.
        2) Inspect physical and mechanical conditions.
        3) Inspect anchorage and alignment.
        4) Verify that the units are clean.
        5) Operate the circuit breaker to ensure smooth operation.
        6) Inspect bolted electrical connections for high resistance using one or more of the following methods:

            i) A low-resistance ohmmeter.
            ii) Verify tightness of bolted electrical connections by calibrated torque wrench.
            iii) Thermographic survey.

        7) Inspect operating mechanism, contacts, and arc chutes in unsealed units.
        8) Perform adjustments for final protective device settings according to the overcurrent protective device coordination study. Comply with requirements in Section "Coordination Studies."
        9) Perform insulation resistance tests for one minute on each pole, phase-to-phase, and phase-to-ground with the circuit breaker closed and across each pole using

manufacturer's published data.
10) Perform a contact/pole-resistance test.
11) Perform insulation-resistance tests on control wiring with respect to ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be for one minute. Follow manufacturer's written instructions for solid-state units.
12) Determine long-time pickup and delay by primary current injection.
13) Determine short-time pickup and delay by primary current injection.
14) Determine ground-fault pickup and time delay by primary current injection.
15) Determine instantaneous pickup by primary current injection.
16) Test functions of the trip unit by means of secondary injection.
17) Perform minimum pickup voltage tests on shunt trip and close coils according to manufacturer's published data.
18) Verify correct operation of auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, anti-pump function, and trip unit battery condition. Reset trip logs and indicators.
19) Verify operation of charging mechanism.

b. Surge Arrestor Tests:

1) Compare nameplate with the Contract Documents.
2) Inspect physical and mechanical conditions.
3) Inspect anchorage, alignment, grounding, and clearances.
4) Verify that the units are clean.
5) Inspect bolted electrical connections for high resistance using one or more of the following methods:

i) Low-resistance ohmmeter.
ii) Verify tightness of bolted electrical connections by calibrated torque wrench.

6) Verify that the ground lead on each device is individually attached to a ground bus or ground electrode.
7) Perform an insulation-resistance test on each arrestor, phase terminal-to-ground using voltage according to manufacturer written instructions.
8) Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding tests.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

B. Lighting control panel will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports, including a certified report that identifies lighting control panels and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

1.08 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for **Three (3)** years.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within **two** years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least **30** days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

1.09 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain the control unit and operator interface.

END OF SECTION

SECTION 26 12 00
MEDIUM VOLTAGE TRANSFORMERS

(Applicable when medium voltage systems are specified & designed)

PART 1 - REQUIREMENTS

1. The primary voltage for projects at District shall be as designed by the project needs.
2. Primary Device and Transformer: Connections shall be cable or copper flexible braid.
3. Transformer and Secondary Device: Connections shall be copper flexible braid.

PART 2 - PRODUCTS

2.01 Pad-mounted, Liquid-filled Transformers:

A. Manufacturers:

a. ASEA Brown Boveri
b. Hammond Power Solutions
c. Square-D
d. Cooper Industries
e. General Electric
f. Eaton/Cutler-Hammer

B. Characteristics:

1. Provide Copper wound, 2-winding transformers.
2. Impedance rating shall be 5.75% ±6.5%.
3. Basic Impulse Level for Nominal Primary Voltage 5kV shall be 60 kV and for Nominal Primary Voltage 15kV shall be 95 kV.
4. Insulating Liquid shall be less-flammable oil, UL listed as complying with CEC requirements for fire point of not less than 300°C when tested according to ASTM D 92.
5. Both windings shall have epoxy insulation.
6. Cooling System: Class OA/FFA, self-cooled and with provisions for future forced-air cooled rating. Cooling systems shall include auxiliary cooling equipment, automatic controls and status indicating lights.
7. Full-Capacity Voltage Taps shall consist of (4) 2.5% taps, 2 above and 2 below rated high voltage; with externally operable tap changer for de- energized use and with position indicator and pad-lockable handle.
8. Insulation Temperature Rise shall be 55°C when operated at rated kVA output in a 40°C ambient temperature.
9. The insulation system shall allow an additional 12% kVA output at 65°C average winding temperature rise by resistance, on a continuous basis, without any decrease in normal transformer life.
10. Temperature Control: Transformer shall include fans and auxiliary equipment necessary for automatic temperature controlled forced air cooling to obtain an additional 15% capacity.
11. High-Voltage Terminations shall be dead front with universal-type bushing wells for dead-front bushing-well inserts, complying with IEEE 386 and including the following:

a. Bushing-Well Inserts: One for each high-voltage bushing well.
b. Surge Arresters: Dead-front, elbow-type, metal-oxide-varistor units.

c. Portable Insulated Bushings: Arranged for parking insulated, high- voltage, load-break cable terminators; one for each primary feeder conductor terminating at transformer.

12. Sound level may not exceed sound levels listed in NEMA TR1, without fans operating.
13. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws.
14. Insulating liquid shall be biodegradable and nontoxic.
15. Paint color shall be green or grey.
16. Aluminum wound transformers are not permitted.

C. Accessories:

1. Characteristics:

1) Combination Drain and Filer Valve: 1 inch, with sampling device
2) Dial-type top liquid thermometer
3) Magnetic liquid-level gage
4) Pressure-vacuum gage
5) Pressure Relief Device: Self-sealing with an indicator
6) Mounting provisions for low-voltage current transformers
7) Mounting provisions for low-voltage potential transformers
8) Busway terminal connection at low-voltage compartment
9) Cooling fans
10) Auxiliary control equipment
11) Alarm contacts for gages and thermometer listed above

2.02 DRY TYPE TRANSORMERS:

A. Manufacturers:

a. ASEA Brown Boveri
b. Hammond Power Solutions
c. Square-D
d. Cooper Industries
e. General Electric
f. Eaton/Cutler-Hammer

B. Enclosure: Totally enclosed, VPI dry type, ventilated, primary and secondary windings; with resin insulation system rated at 220 deg C with a 150 deg C average winding temperature rise above a maximum ambient temperature of 40 deg C.

C. The transformer(s) shall be the unit substation type with side-mounted primary and side-mounted secondary terminations.

D. Primary terminations shall be designed for close coupling to a metal enclosed air load break switch section, a switchgear section, an air terminal chamber, if required, to be provided with the transformer. Secondary terminations shall be designed for close coupling to a switchboard section, an air terminal chamber to be provided with the transformers, if required.

E. Orientation shall be primary on the left/right when facing the transformer front, see drawings for elevations.

F. The transformer(s) shall be rated as shown on the drawings, Primary voltage (per design

requirements) volt delta. Secondary voltage 480-volt wye, 4-wire, 60 Hz with two 2-1/2% full capacity above normal and two 2-1/2% full capacity below normal primary taps. Impedance shall be 5.75% or manufacturer's standard impedance, ±7-1/2%. All transformers shall have an average temperature rise of 150° C above a 40° C maximum.

G. The basic impulse levels (BIL) shall be a minimum of 60 kV for the 5-kV class/110KV for 15KV class.

H. The coils shall be wound with copper conductors.

I. All insulating materials are to be in accordance with IEEE Standard C57.12.01™ for 220° C UL insulation system.

J. All cores to be constructed of high grade, grain-oriented, non-aging silicon steel with high magnetic permeability, and low hysteresis and eddy current losses. Magnetic flux densities are to be kept well below the saturation point. Core laminations shall be step-lap miter cut at the core corners to reduce hot spots, core loss, excitation current, and sound level.

K. The coils and all clamping structure and bus work shall be assembled on the core, and then dried at atmospheric pressure in an oven through which hot air is continuously circulated. The totally assembled core and coil assembly shall be vacuum pressure impregnated in polyester varnish. The total VPI process shall apply a one (1) cycle polyester protective shield of varnish the coils and a protective shield to the bus, core and support structure. The varnish shall be cured on the core and coil assembly following an established temperature vs. time baking cycle in a hot air circulating oven. The VPI process shall effectively impregnate the entire core and coil assembly, which results in a unit, which is virtually impermeable to moisture, dust, salt air and other industrial contaminants.

L. The transformer enclosures shall be ventilated outdoor and fabricated of heavy gauge, sheet steel construction. Enclosures are to be provided with lifting provisions on the base structure and shall have jacking pads designed to be flush with the enclosure. The base is to be constructed of steel members to permit skidding or rolling in any direction. Rubber vibration isolation pads shall be installed by the manufacturer between the core and coil and the enclosure.

M. The paint color shall be ANSI 49.

N. Transformer sound levels shall be warranted by the manufacturer not to exceed the values specified in IEEE Std. C57.12.01™..

O. Metal-oxide, gapless-type distribution class lightning arresters shall be installed by the manufacturer on the high voltage side of the transformer to provide additional protection against high voltage lightning or switching surges.

P. Provide fan cooling equipment which shall include Square D Model 98 3-phase electronic winding temperature monitor controlled automatically by a Type K thermocouple placed in the low voltage air duct. The temperature monitor must contain yellow and red indicating lights. The yellow lamp indicates fan power, while the red lamp signal that alarm and trip contacts have been activated. A 0-1 milliampere output is required for remote indication. Alarm contacts shall be provided for fans, alarm, and trip function. An audible alarm must sound when the highest phase temperature exceeds a preset point. The fans must be able to operate in either manual or automatic mode. Fan controller must be POWERLOGIC ® system compatible with future forced air-cooling system and shall include:– control wiring, controller with test switch, current limiting fused in the power supply to the controller, indications lights, alarm silencing relay, auto/manual switch, and

necessary accessories to properly control the system.

Q. Testing - Tests shall be conducted in accordance with the provisions of IEEE C57.12.91™ and shall include, as a minimum, the following tests:

1. Ratio
2. Polarity
3. Phase Rotation
4. No-Load Loss
5. Excitation Current
6. Impedance Voltage
7. Load Loss
8. Applied Potential
9. Induced Potential
10. QC Impulse Test
11. Temperature Test (typical data from previous unit is acceptable)
12. Sound Test (typical data from previous unit is acceptable)

R. Automatic forced-air cooling system controls, including thermal sensors, control wiring, temperature controller with test switch, power panel with current-limiting fuses, indicating lights, alarm, and alarm silencing relay, SQUARE- D Model 98 controller or equal.

1. Include mounting provision for fans.

S. Insulation Materials: IEEE C57.12.01, rated 220 deg C.

T. Insulation Temperature Rise:150 deg C, maximum rise above 40 deg C.

U. Basic Impulse Level: Minimum 60 kV BIL.

V. Full-Capacity Voltage Taps: 4 nominal 2.5 percent taps, 2 above and 2 below rated primary voltage.

W. Sound level may not exceed 65 dBA levels, without fans operating.

X. Impedance: 5.75 percent.

Y. High-Temperature Alarm: Sensor at transformer with local audible and visual alarm and contacts for remote alarm Square- D model 98.

Z. Control power required for the transformer shall be self-contained.

AA. Transformer shall comply with DOE 2016 efficiency standards.

BB. Transformers shall be furnished with integrally mounted infrared viewing window.

PART 3 - INSTALLATION

3.01 Examine roughing-in of conduits and grounding systems to verify the following:

A. Wiring entries comply with layout requirements.

B. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.

3.02 Examine walls, floors, roofs and concrete bases for suitable mounting conditions where transformers will be installed.

3.03 Verify that ground connections are in place and that requirements of “Grounding and Bonding for Electrical Systems” have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

3.04 Proceed with installation only after unsatisfactory conditions have been corrected.

3.05 Install transformers in accordance with manufacturer's written instructions and as shown on the drawings:

A. Anchor transformers to concrete bases according to manufacturer's written instructions and applicable seismic codes.

B. Provide concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit and 4 inches high.

C. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Section 03 30 00 - Cast-in-Place Concrete.

D. Install dowel rods to connect concrete bases to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.

E. Install epoxy-coated anchor bolts, for supported equipment, that extend through concrete base and anchor into structural concrete floor.

F. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions and directions furnished with items to be embedded.

G. Tack-weld or bolt transformers to channel-iron sills embedded in concrete bases. Install sills level and grout flush with floor or base.

3.06 Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and CEC.

3.07 Connections:

A. Primary Device and Transformer: Connections shall be cable or copper flexible braid.

B. Transformer and Secondary Device: Connections shall be copper flexible braid.

C. All connections shall be with copper wire.

D. Ground equipment.

PART 4 - COMMISSIONING

4.01 List of items or systems requiring testing, evaluation, verification, or commissioning: Transformers.

4.02 Documentation required:

A. Field Quality Control: The contractor shall engage a factory-authorized service representative to inspect, test and adjust field-assembled components and equipment installation, including connections and to assist in field testing. Report results in writing.

4.03 Required testing:

A. Perform the following field tests and inspections and prepare test reports:

1. After installing transformers but before primary is energized, verify that grounding system at substation is tested at specified value or less.
2. After installing transformers and after electrical circuitry has been energized, test for compliance with requirements.
3. Testing shall include IR scanning of all electrical connections once energized. Test report shall include digital and thermal photographs of all scans including equipment that is both abnormal and normal.
4. Perform visual and mechanical inspection and electrical test stated in NETA ATS 7.2. Certify compliance with test parameters.
5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace malfunctioning units and retest as specified above.

C. Test Reports: Prepare written reports to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective actions taken to achieve compliance with requirements.

D. Follow up Service: Voltage Monitoring and Adjusting: Perform the following voltage monitoring after Substantial Completion but not more than six months after Final Acceptance

1. During a period of normal load cycles as evaluated by the District's Representative, perform seven days of three-phase voltage recording at secondary terminals of each transformer. Use voltmeters with calibration traceable to National Institute of Science and Technology standards and with a chart speed of not less than 1 inch per hour. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from nominal value by more than plus or minus 5 percent during test period, is unacceptable.
2. Corrective Actions: If test results are unacceptable, perform the following corrective actions, as appropriate

    a. Adjust transformer taps.
    b. Prepare written request for voltage adjustment by electric utility.

3. Retests: After corrective actions have been performed, repeat monitoring until satisfactory

results are obtained.

4. Report: Prepare written report covering monitoring and corrective actions performed.

END OF SECTION

SECTION 26 13 16
MEDIUM VOLTAGE FUSIBLE INTERRUPTER SWITCHGEAR

(Applicable when medium voltage systems are specified & designed)

PART 1 - REQUIREMENTS

1.01 Design considerations specific to components in this section:

1. For purpose of this guideline, this section pertains to Medium Voltage Fusible Interrupter Switchgear. The actual voltage ratings shall be as designed.
2. The entire assembly for the switchgear shall be rated to withstand mechanical forces exerted during short-circuits at available fault current.
3. Codes and standards:

    a. Comply with CEC
    b. Furnish products listed and classified by Underwriters Laboratories, Inc [or by a testing agency acceptable to Authorities Having Jurisdiction] as suitable for purpose specified and indicated.
    c. Comply with IEEE C2
    d. Comply with IEEE C37.20.3

PART 2 - PRODUCTS

2.01 SWITCHGEAR:

A. Manufacturers:

1. Required: Obtain each type of switchgear and associated components through one source from a single manufacturer (all medium voltage equipment shall be from manufacturer).

    a. Square D
    b. Eaton
    c. General Electric
    d. S&C

B. Characteristics:

1. RATINGS:

    a. Maximum System Voltage: 5 kV/15kV
    b. Basic Impulse Level: 95kV
    c. Main-Bus Rating: 600 A, continuous
    d. Short Circuit Current Rating: 500MVA or larger as needed, rms asym
    e. Short Time Current (Two Second): [as needed by project], rms sym
    f. Momentary Current (10 Cycles): [as needed by project], rms asym

2. Enclosure:

    a. Provide NEMA 3R with sloped drip-proof roof for outdoors and NEMA 1 for indoor units.
    b. The enclosures shall be dead front, completely metal enclosed enclosure consisting of free-standing self-supporting floor-mounted equipment bays.
    c. Each equipment bay shall be a separately constructed cubicle

d. Integrated switchgear assembly shall safely withstand effects of closing, carrying and interrupting currents up to maximum short circuit rating.
e. Enclosure, covers, doors shall be minimum 11-guage steel.
f. Provide a removable top cover rear door latch closed by tamper resistant pad lockable latches for each vertical section.
g. Provide a single full length, flanged front door equipped with 2 rotary latch type pad lockable handles for each vertical section.
h. Cubicles are to be designed for front and rear access.
i. Door shall be hinged on the opposite side of the switch operator to provide clear access for operation.
j. All openings shall be screened to prevent the entrance of small animals and barriered to inhibit the entrance of dirt, dust, etc.

3. Bus:

a. Phase buses shall be sliver plated copper, rated 600 /1200 amperes.
b. Provide continuous silver-plated copper ground bus through switchgear assembly. Connect bus to steel frame of vertical section
c. Ground bus shall be sized for rated (2-second) current of switchgear.
d. All bussing shall be braced for the maximum available fault current.
e. Main bus and ground bus shall be drilled to allow for future extensions
f. Cutout areas with removable covers for future extension of busses.

4. Load Interrupter Switch:

a. Fixed mounted, manual three-pole gang operated with stored energy option.
b. Quick-make, quick-break over-toggle-type mechanism with speed of operation independent of operator.
c. Provided with separate main and break contacts
d. Provided with insulating barriers between phases and between phases and enclosure.
e. Provided with OPEN and CLOSED switch position indicators.
f. Provided with provisions for pad locking switch in open or close positions.
g. A viewing window shall be installed in the switch enclosure and located so as to enable visible inspection of the switch blades and blown fuse indicators from outside the enclosure. Each load interrupter switch shall be equipped with infrared viewing window.
h. Provided with a fuse access door interlocked with the switch so that the switch must be opened before access to the fuse is possible and the door must be closed before the switch can be closed.

5. Switch Operators:

a. Spring operator assembly shall be isolated from high voltage and coupled through direct drive shaft.
b. Switch operating handle shall be

1) Permanently attached to front of switchgear
2) Covered by full height solid door for outdoor applications

6. Fuses:

a. Fuses shall be Current limiting type “E” rated.
b. Fuse ampacity: as required.

c. Short Circuit Current Rating: as required and applicable to project.
d. Fuse Maximum Nominal Voltage Rating: 5/15kV as applicable.

7. Surge Arresters:

a. Provide 3 surge arrestors online side of switchgear
b. Surge arresters shall be rated per manufacturer's recommendation.
c. Provide a fully shielded, dead front, metal-oxide, elbow type surge arrester with resistance-graded gap suitable for plugging into inserts.
d. Connect the primary surge arrestors using manufacturers' jumper cables.

8. Wiring Terminations:

a. Provide wiring, terminal blocks and fuse blocks within vertical section as required.
b. Control wiring shall be labeled with wire markers.
c. Wire termination system shall be provided such that no additional cable bracing, tying or lashing is required to maintain short circuit withstanding rating of assembly.
d. Each cubicle sections, which contain lugs for incoming and/or outgoing feeders, shall be equipped with horizontal cable supports.

9. Nameplates:

a. Engraved, laminated-plastic or metal nameplate for each switch, mounted with corrosion-resistant screws.

10. Accessories

a. Key Interlocks:

1) Provide key interlocks on duplex switches such that only one access door can be opened at a time and only if both switches are open.
2) Provide warning sign which states: "Caution – Load side of switch and fuses may be energized unless both switches are open".

PART 3 - INSTALLATION

A. Install switchgear in accordance with manufacturer's written instructions, as required.

B. Switchgear shall be installed and anchored level on minimum 4" high concrete base to withstand seismic forces as required per CBC code.

C. Coordinate final locations of equipment with Contractor and review final locations with Architect/Engineer prior to setting equipment.

D. Protect equipment during installation to prevent twisting or deformations, exposure to potentially damaging environments and work of other trades. Maintain protection until completion of construction.

E. Verify tightness of accessible bolted bus joints with torque wrench prior to energizing switchgear. Tightness shall be in accordance with manufacturer's recommended values.

F. Conductor Bending

1. Bending of high-voltage cables should be avoided or minimized.
2. All necessary bends should meet the minimum radii specified by the cable manufacturer.

G. Identify field-installed wiring and components and provide warning signs.

PART 4 - COMMISSIONING

4.01 List of items or systems requiring testing, evaluation, verification, or commissioning: Switchgear.

4.02 Documentation required:

A. Test reports: The contractor will engage a qualified Independent testing and inspecting agency to perform field tests/inspections and provide reports for all connections/terminations, bussing and protective devices.

B. Protective device Testing: Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Sections 7.1 and 7.5 as appropriate. Certify compliance with test parameters.

4.03 Manufacturer's Field Service:

A. Engage a factory-authorized service representative to inspect and adjust field assembled components and equipment installation, including connections.

B. Prior to energization, factory representative shall visually inspect the switchgear installation to ensure that all switches and motor operators are operable, and connections are complete.

C. Engage a factory-authorized service representative to train District's maintenance personnel to adjust, operate and maintain switchgear.

END OF SECTION

SECTION 26 22 13
LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 - REQUIREMENTS

1.01 Design considerations specific to components in this section:

1. For purpose of this guideline, this section pertains to Dry Type Ventilated Transformers rated 600V and less.
2. All transformers shall be ventilated type with a maximum of 115°C rise above 40°C ambient temperature.
3. All transformers for use in applications with up to 50% non-linear loads shall be regular type.
4. All transformers for use in applications with more than 50% non-linear loads shall be K-4 rated.
5. All transformers for use in specialty applications shall be K-13 rated.
6. All transformers serving sensitive loads (i.e. A/V equipment) shall be equipped with Electrostatic Shielding.

PART 2 - PRODUCTS

2.01 Transformers:

A. Manufacturers:

a. Square D
b. Eaton
c. General Electric

B. Characteristics:

a. The coils' windings shall be copper of the fine-resistant type, air insulated and designed for natural convection cooling through normal air circulation.
b. The coils shall be continuous windings without splices except for taps.
c. The cores shall be of grain-oriented, non-aging silicon steel.
d. The cores' mounting frames and enclosures shall be of the welded and bolted construction with sufficient mechanical strength and rigidity to withstand shipping erection and short circuit stresses.
e. Transformers shall be equipped with four 2-1/2% (2 above and 2 below normal voltage) primary taps.
f. All K-rated transformers shall be equipped with 200% neutral with double size neutral terminal.
g. All transformers shall have a basic impulse insulation level of 10 KV.
h. The sound levels shall meet NEMA ST-20 standards.
i. Transformers shall be low loss type with minimum efficiencies per NEMA TP-1 when operated at 35% of full load capacity. Efficiency shall be tested in accordance with NEMA TP-2.
j. Finish shall be ANSI 61 gray.
k. Transformers with Aluminum coil windings are not permitted.

PART 3 - INSTALLATION

A. Install transformers in accordance with manufacturer's written instructions.

B. Transformers shall be anchored to withstand seismic forces as required per latest CBC code.

C. Provide a minimum 4” high concrete housekeeping pad. Coordinate actual dimensions and extend pad 3” in all directions beyond overall dimension of base. Provide reinforcing bars as required structurally within pad to insure proper support of equipment.

D. Transformers shall be installed to provide adequate air circulation for the removal of the heat they produce, in accordance with manufacturer recommendations.

E. Transformers not specifically designed for wall mounting, shall be spaced a minimum of 6" from adjacent walls and equipment.

F. All wall-mounted transformers shall be installed level and plumb with wall brackets fabricated by transformer manufacturer.

G. Install the transformers on the noise and vibration isolation mounts designed to suppress the transformer noise from the building structure. Select and arrange the mounts in accordance with the weight and mounting of the transformers. These mounts are in addition to any internal vibration pads. Vibration isolating mounts shall be seismically rated for the application.

H. All conduits shall be isolated from the transformer enclosures by the use of neoprene grommets at conduit entrances to enclosure and the use of a grounding bushing. Flexible jumpers shall be installed for grounding continuity from enclosure to conduits or bus ducts.

I. Provide high-pressure compression lugs, for primary and secondary phase and neutral terminations for transformers 45 KVA and larger.

J. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum (+10% or -3% of nameplate voltage at maximum load conditions) voltage conditions at secondary terminals.

PART 4 - COMMISSIONING

4.01 List of items or systems requiring testing, evaluation, verification, or commissioning: Transformers.

A. Test reports: The contractor shall engage a qualified Independent testing and inspecting agency to perform field tests/inspections and provide reports for all connections/terminations, primary and secondary protective devices.

4.02 Testing protocols:

A. Transformer assemblies:

1. Test for proper grounding

B. Electrical Testing: Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.2.

END OF SECTION

SECTION 26 24 13
SWITCHBOARDS

PART 1 - PRODUCTS

1.01 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Switchboards shall withstand the effects of earthquake motions determined according to **ASCE/SEI 7** and latest California Building Codes.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation. Shake-table testing shall comply with ICC-ES AC156.

2. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified **and the unit will be fully operational after the seismic event**."

1.02 SWITCHBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Eaton.
b. General Electric Company.
c. Square D; by Schneider Electric.

A. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Comply with NEMA PB 2.

D. Comply with NFPA 70.

E. Comply with UL 891.

F. Front-Connected, Front-Accessible Switchboards:

1. Main Devices: Mounted integral to switch board line up.

2. Branch Devices: Distribution board mounted.

3. Sections front and rear aligned.

G. Nominal System Voltage: 480Y/277 V or 208Y/120 V.

H. Main-Bus Continuous: 5000/4000/3000/2500/2000/1600/1200 A as required.

I. Seismic Requirements: Fabricate and test switchboards according to IEEE 344 to withstand seismic forces defined in Section "Seismic Controls for Electrical Systems."

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation. Shake-table testing shall comply with ICC-ES AC156.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

J. Indoor Enclosures: Steel, NEMA 250, **Type 1**.

K. Outdoor Enclosures: Type 3R.

1. Finish: Factory-applied finish in manufacturer's **standard** color; undersurfaces treated with corrosion-resistant undercoating.

2. Enclosure: **Downward or rearward sloping** roof; **bolt-on rear covers** for each section, with provisions for padlocking.

L. Service Entrance Rating: Switchboards intended for use as service entrance equipment shall contain from one to six service disconnecting means with overcurrent protection, a neutral bus with disconnecting link, a grounding electrode conductor terminal, and a main bonding jumper.

M. Utility Metering Compartment: Barrier compartment and section complying with utility company's requirements; hinged sealable door; buses provisioned for mounting utility company's current transformers and potential transformers or potential taps as required by utility company. If separate vertical section is required for utility metering, match and align with basic switchboard. Provide service entrance label and necessary applicable service entrance features.

N. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

O. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

P. Buses and Connections: Three phase, four wire unless otherwise indicated.

1. Provide phase bus arrangement A, B, C from front to back, top to bottom, and left to right when viewed from the front of the switchboard.

2. Phase- and Neutral-Bus Material: Silver - plated, hard drawn copper 98% conductivity high-conductivity copper circuit-breaker line connections.

3. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with **mechanical** or **compression** connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.

4. Ground Bus: **Minimum-size required by UL 891,** hard-drawn copper of 98 percent

conductivity, equipped with **mechanical** connectors for feeder and branch-circuit ground conductors.

5. Main-Phase Buses and Equipment-Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.

6. Disconnect Links:

   a. Isolate neutral bus from incoming neutral conductors.
   b. Bond neutral bus to equipment-ground bus for switchboards utilized as service equipment or separately derived systems.

7. Neutral Buses: **100** percent of the ampacity of phase buses unless otherwise indicated, equipped with **mechanical** connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.

Q. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

1.03 SURGE PROTECTION DEVICES

B. Manufacturers:

a. Eaton.
b. General Electric Company.
c. Square D; by Schneider Electric.

A. SPDs: Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1449.

B. Features and Accessories:

1. Integral disconnect switch.

2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.

3. Indicator light display for protection status.

4. Form-C contacts rated at 5 A and 250-V ac one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.

5. Surge counter.

C. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than **200 kA/250kA/300 kA**. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

D. Protection modes and UL 1449 VPR for grounded wye circuits with **480Y/277 V** or **208Y/120 V** as required, three-phase, four-wire circuits shall not exceed the following:

1. Line to Neutral: 1200 V for 480Y/277 V, 700 V for 208Y/120 V.

2. Line to Ground: 1200 V for 480Y/277 V, 1200 V for 208Y/120 V.

3. Line to Line: 2000 V for 480Y/277 V, 1000 V for 208Y/120 V.

1.04 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with **interrupting capacity** to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

a. Instantaneous trip.

b. Long- and short-time pickup levels.
c. Long and short time adjustments.
d. Ground-fault pickup level, time delay, and I squared t response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.

5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.

6. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).

7. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).

8. MCCB Features and Accessories:

a. Standard frame sizes, trip ratings, and number of poles.

b. Lugs: **Mechanical** or **Compression** style, suitable for number, size, trip ratings, and conductor material.

c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.

d. Ground-Fault Protection: **Integrally mounted** relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

e. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
f. Communication Capability: **Integral** or **Din-rail-mounted** communication module with functions and features compatible with power monitoring and control system specified in Section "Electrical Power Monitoring and Control."
g. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at **75** percent of rated voltage.
h. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
i. Auxiliary Contacts: **Two SPDT switches** with "a" and "b" contacts;
j. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

B. Insulated-Case Circuit Breaker (ICCB): **100** percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.

1. **Fixed** circuit-breaker mounting.

2. Two-step, stored-energy closing.

3. **Full**]-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:

a. Instantaneous trip.

b. Time adjustments for long- and short-time pickup.
c. Ground-fault pickup level, time delay, and I squared t response.

4. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.

5. Remote trip indication and control.

6. Communication Capability: Web enabled integral Ethernet communication module and embedded Web server with factory-configured Web pages (HTML file format). Provide functions and features compatible with power monitoring and control system specified in Section "Electrical Power Monitoring and Control."

7. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

8. Control Voltage: 120-V ac.

C. High-Pressure, Butt-Type Contact Switch: Operating mechanism uses butt-type contacts and a spring-charged mechanism to produce and maintain high-pressure contact when switch is closed.

C. Manufacturers:

a. Eaton.
b. General Electric Company.
c. Square D; by Schneider Electric.

1. Main-Contact Interrupting Capability: Minimum of 12 times the switch current rating.

2. Operating Mechanism: Manual handle operation to close switch; stores energy in mechanism for opening and closing.

   a. Electrical Trip: Operation of lever or push-button trip switch, or trip signal from ground-fault relay or remote-control device, causes switch to open.

   b. Mechanical Trip: Operation of mechanical lever, push button, or other device causes switch to open.

3. Auxiliary Switches: Factory installed, SPDT, with leads connected to terminal block, and including one set more than quantity required for functional performance indicated.

4. Service-Rated Switches: Labeled for use as service equipment.

5. Ground-Fault Relay: Comply with UL 1053; self-powered type with mechanical ground-fault indicator, test function, tripping relay with internal memory, and three-phase current transformer/sensor.

   a. Configuration: **Integrally mounted** relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

6. Open-Fuse Trip Device: Arranged to trip switch open if a phase fuse opens.

D. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

1.05 INSTRUMENTATION

A. Instrument Transformers: NEMA EI 21.1, and the following:

1. Potential Transformers: NEMA EI 21.1; 120 V, 60 Hz, **tapped** secondary; disconnecting type with integral fuse mountings. Burden and accuracy shall be consistent with connected metering and relay devices.

2. Current Transformers: NEMA EI 21.1; 5 A, 60 Hz, secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.

3. Control-Power Transformers: Dry type, mounted in separate compartments as required.

4. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker, ground-fault protection.

B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:

1. Switch-selectable digital display of the following values with maximum accuracy tolerances

as indicated:

a. Phase Currents, Each Phase: Plus or minus 0.5 percent.
b. Phase-to-Phase Voltages, Three Phase: Plus or minus 0.5 percent.
c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 0.5 percent.
d. Megawatts: Plus or minus 1 percent.
e. Megavars: Plus or minus 1 percent.
f. Power Factor: Plus or minus 1 percent.
g. Frequency: Plus or minus 0.1 percent.
h. Accumulated Energy, Megawatt Hours: Plus or minus 1 percent; accumulated values unaffected by power outages up to 72 hours.
i. Megawatt Demand: Plus or minus 1 percent; demand interval programmable from five to 60 minutes.
j. Contact devices to operate remote impulse-totalizing demand meter.

2. Mounting: Display and control unit flush or semi flush mounted in instrument compartment door.

C. Watt-Hour Meters and Watt meters:

1. Comply with ANSI C12.1.

2. Three-phase induction type with two stators, each with current and potential coil, rated 5 A, 120 V, 60 Hz.

3. Suitable for connection to three- and four-wire circuits.

4. Potential indicating lamps.

5. Adjustments for light and full load, phase balance, and power factor.

6. Four-dial clock register.

7. Ratchets to prevent reverse rotation.

8. Removable meter with draw out test plug.

9. Semi flush mounted case with matching cover.

10. Appropriate multiplier tag.

D. Impulse-Totalizing Demand Meter:

1. Comply with ANSI C12.1.

2. Suitable for use with switchboard watt-hour meter, including two-circuit totalizing relay.

3. Cyclometer.

4. Four-dial, totalizing kilowatt-hour register.

5. Positive chart drive mechanism.

6. Capillary pen holding a minimum of one month's ink supply.

7. Roll chart with minimum 31-day capacity; appropriate multiplier tag.

8. Capable of indicating and recording **15** - minute integrated demand of totalized system.

1.06 CONTROL POWER

A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.

B. Electrically Interlocked Main and Tie Circuit Breakers: Two control-power transformers in separate compartments, with interlocking relays, connected to the primary side of each control-power transformer at the line side of the associated main circuit breaker. 120-V secondaries connected through automatic transfer relays to ensure a fail-safe automatic transfer scheme.

C. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

D. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

1.07 ACCESSORY COMPONENTS AND FEATURES

A. Portable Test Set: For testing functions of solid-state trip devices without removing from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

B. Spare-Fuse Cabinet: Suitably identified, wall-mounted, lockable, compartmented steel box or cabinet. Arrange for wall mounting.

C. Mounting Accessories: For anchors, mounting channels, bolts, washers, and other mounting accessories, comply with requirements in Section 260548.16 "Seismic Controls for Electrical Systems" or manufacturer's instructions.

1.08 IDENTIFICATION

A. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective device

1.09 INSTALLATION

A. Receive, inspect, handle, and store switchboards according to **NECA 400** and **NEMA PB 2.1**.

B. Install switchboards and accessories according to **NECA 400** and **NEMA PB 2.1**.

C. Equipment Mounting: Install switchboards on concrete base, 6 - inch nominal thickness.

1. Install conduits entering underneath the switchboard, entering under the vertical section where the conductors will terminate. Install with couplings flush with the concrete base. Extend 2 inches above concrete base after switchboard is anchored in place.

2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.

3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

5. Install anchor bolts to elevations required for proper attachment to switchboards.

6. Anchor switchboard to building structure at the top of the switchboard if required or recommended by the manufacturer.

D. Comply with mounting and anchoring requirements specified in Section "Seismic Controls for Electrical Systems."

E. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

F. Install filler plates in unused spaces of panel-mounted sections.

G. Install overcurrent protective devices, surge protection devices, and instrumentation.

1. Set field-adjustable switches and circuit-breaker trip ranges.

H. Install spare-fuse cabinet.

I. Comply with NECA 1.

J. Comply with requirements for terminating feeder bus specified in Section 262500 "Enclosed Bus Assemblies." Drawings indicate general arrangement of bus, fittings, and specialties.

K. Comply with requirements for terminating cable trays specified in Section 260536 "Cable Trays for Electrical Systems." Drawings indicate general arrangement of cable trays, fittings, and specialties.

1.10 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section "Identification for Electrical Systems."

C. Device Nameplates: Label each disconnecting, and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1.11 FIELD QUALITY CONTROL

A. Perform the following tests and inspections[with the assistance of a factory-authorized service representative]:

1. Acceptance Testing:

a. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit. Open control and metering circuits within the switchboard and remove neutral connection to surge protection and other electronic devices prior to insulation test. Reconnect after test.
b. Test continuity of each circuit.

2. Test ground-fault protection of equipment for service equipment per NFPA 70.

3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

4. Correct malfunctioning units on-site where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

B. Switchboard will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

1.12 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories.

END OF SECTION

SECTION 26 24 16
PANELBOARDS

PART 1 - PRODUCTS

1.01 PANELBOARDS COMMON REQUIREMENTS

A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Section ”Seismic Controls for Electrical Systems."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA PB 1.

D. Comply with NFPA 70.

E. Enclosures: Flush and Surface-mounted, dead-front cabinets.

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: NEMA 250, Type 1.

b. Outdoor Locations: NEMA 250, Type 3R.
c. Kitchen, Wash-Down Areas: NEMA 250, Type 4X.
d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 5 or Type 12.

2. Height: 84 inches maximum.

3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims shall cover all live parts and shall have no exposed hardware.

4. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.

F. Incoming Mains Location: Top or Bottom or Convertible between top and bottom as required.

G. Phase, Neutral, and Ground Buses: Hard-drawn copper, 98 percent conductivity.

H. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.

2. Main and Neutral Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.

3. Ground Lugs and Bus-Configured Terminators: Mechanical type, with a lug on the bar for each pole in the panelboard.

4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.

5. Sub-feed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.

I. NRTL Label: Panelboards shall be labeled by an NRTL acceptable to authority having jurisdiction for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards shall have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.

J. Future Devices: Panelboards shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

K. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include label or manual with size and type of allowable upstream and branch devices listed and labeled by an NRTL for series-connected short-circuit rating.

L. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.

1.02 PERFORMANCE:

A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to ASCE/SEI 7 and latest California Building Codes.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

B. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD as required.

1.03 POWER PANELBOARDS

A. Manufacturers:

1. Eaton.
2. General Electric Company; GE Energy Management - Electrical Distribution.
3. Square D; by Schneider Electric.

A. Panelboards: NEMA PB 1, distribution type.

B. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

1. For doors more than 36 inches high, provide two latches, keyed alike.

C. Mains: Circuit breaker.

D. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers.

F. Branch Overcurrent Protective Devices: Fused switches.

G. Contactors in Main Bus: NEMA ICS 2, Class A, mechanically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

1. External Control-Power Source: 120-V branch circuit.

1.04 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

B. Manufacturers:

1. Eaton.
2. General Electric Company; GE Energy Management - Electrical Distribution.
3. Square D; by Schneider Electric.

A. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

B. Mains: Circuit breaker or lugs as applicable.

C. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

D. Contactors in Main Bus: NEMA ICS 2, Class A, mechanically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

1. External Control-Power Source: 120-V branch circuit.

E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

1.05 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

C. Manufacturers:

1. Eaton.
2. General Electric Company; GE Energy Management - Electrical Distribution.
3. Square D; by Schneider Electric.

A. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers:

a. Inverse time-current element for low-level overloads.
b. Instantaneous magnetic trip element for short circuits.
c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

3. Electronic Trip Circuit Breakers:

a. RMS sensing.
b. Field-replaceable rating plug or electronic trip.
c. Digital display of settings, trip targets, and indicated metering displays.
d. Multi-button keypad to access programmable functions and monitored data.
e. Ten-event, trip-history log. Each trip event shall be recorded with type, phase, and magnitude of fault that caused the trip.
f. Integral test jack for connection to portable test set or laptop computer.
g. Field-Adjustable Settings:

1) Instantaneous trip.

2) Long- and short-time pickup levels.
3) Long- and short-time adjustments.
4) Ground-fault pickup level, time delay, and I squared T response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.

5. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).

6. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).

7. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.

8. Sub-feed Circuit Breakers: Vertically mounted.

9. MCCB Features and Accessories:

a. Standard frame sizes, trip ratings, and number of poles.

b. Breaker handle indicates tripped status.
c. UL listed for reverse connection without restrictive line or load ratings.

d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.

e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads.

f. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

g. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.

h. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on

or off position.

i. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

1.06 IDENTIFICATION

A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.

B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.

C. Circuit Directory: Directory card inside panelboard door, mounted in metal frame with transparent protective cover.

1.07 INSTALLATION

A. Comply with NECA 1.

B. Install panelboards and accessories according to NECA 407 and NEMA PB 1.1.

C. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

D. Mount top of trim 90 inches above finished floor unless otherwise indicated.

E. Mount panelboard cabinet plumb and rigid without distortion of box.

F. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

G. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.

H. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.

I. Install filler plates in unused spaces.

J. Stub four 1-inch EMT empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future.

K. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

1.08 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section” Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section" Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Section" Identification for Electrical Systems."

E. Install warning signs complying with requirements in Section" Identification for Electrical Systems" identifying source of remote circuit.

1.09 TESTS AND INSPECTION

A. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

3. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers stated in NETA ATS. Certify compliance with test parameters.

4. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

B. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION

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MOTOR-CONTROL CENTERS

PART 1 - PRODUCTS

1.01 MANUFACTURERS

A. Manufacturers:

1. Eaton.
2. General Electric Company.
3. Square D.

1.02 SYSTEM DESCRIPTION

A. NEMA Compliance: Fabricate and label MCCs to comply with NEMA ICS 18.

B. Ambient Environment Ratings:

1. Ambient Temperature Rating: Not less than 0 deg F and not exceeding 104 deg F, with an average value not exceeding 95 deg F over a 24-hour period.

2. Ambient Storage Temperature Rating: Not less than minus 4 deg F and not exceeding 140 deg F.

3. Humidity Rating: Less than 95 percent (noncondensing).

4. Altitude Rating: Not exceeding 6600 feet.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.03 PERFORMANCE REQUIREMENTS

A. Seismic Performance: MCCs shall withstand the effects of earthquake motions determined according to **ASCE/SEI 7** and latest California Building Codes.

1. The term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified **and the system will be fully operational after the seismic event**."

2. Component Importance Factor: **1.5**.

3. Component Amplification Factor: 2.5.

4. Component Response Modification Factor: 6.0.

B. Capacities and Characteristics:

1. MCC Enclosure and Assembly:

a. Nominal System Voltage: as applicable.

b. Service Equipment Rated: as needed.
c. Enclosure: NEMA 250, Type as applicable.
d. Integrated Short-Circuit Rating for MCC:

1) Combination series rated: Not allowed.
2) Fully rated; kA.

e. Integrated Short-Circuit Rating for Each Unit:

1) Fully rated.

2. Main Disconnect Device:

a. Main Disconnect: MCCB, UL 489 or Fusible switch, UL 98, three pole, Manually operated, electrically tripped.

3. Magnetic Controllers:

4. Reduced-Voltage Solid-State Controllers:

5. VFCs:

1) Bypass Mode: Manual or automatic.
2) Bypass Style: **Two** or **Three** contactor style.
3) Bypass Contactor Classification: Full-voltage (across-the-line) or Reduced-voltage autotransformer.
4) Overload Relays: **Bimetallic** or **Solid state**.
5) Isolated Overload Alarm Contact: **NC** and **NO**.

6. Controller-Mounted Auxiliary Devices:

a. Push Buttons and Selector Switches: **Standard**-duty or as applicable.

1.04 ENCLOSURES

A. Indoor Enclosures: Freestanding steel cabinets unless otherwise indicated. NEMA 250, **Type 1** unless otherwise indicated to comply with environmental conditions at installed location.

B. Space Heaters: Factory-installed electric space heaters of sufficient wattage in each vertical section to maintain enclosure temperature above expected dew point, if required.

C. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's **standard gray** finish over a rust-inhibiting primer on treated metal surface.

D. Outdoor Enclosures: Type 3R**, non-walk-in aisle**.

1. Finish: Factory-applied finish in manufacturer's **standard** color; undersurfaces treated with corrosion-resistant undercoating.

E. Wiring Spaces:

1. Vertical wireways in each vertical section for vertical wiring to each unit compartment; supports to hold wiring in place.

2. Horizontal wireways in **bottom and top** of each vertical section for horizontal wiring between vertical sections; supports to hold wiring in place.

F. Provisions for Future:

1. Compartments marked "future" shall be bused, wired and equipped with guide rails or equivalent, and ready for insertion of new units or new sections to the line up.

2. Compartments marked "spare" shall include provisions for connection to the vertical bus.

G. Integrated Short-Circuit Rating:

1. Short-Circuit Current Rating for Each Unit: **Fully rated** kA.

2. Short-Circuit Current Rating of MCC: **Fully rated** with its main overcurrent device kA.

H. Control Power:

1. 120-V ac supplied centrally from a remote branch circuit or CPT (control power transformer integral to Motor Control Center).

I. Factory-Installed Wiring: Factory installed, with bundling, lacing, and protection included. Use flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

1. Control and Load Wiring: Factory installed, with bundling, lacing, and protection included. Use flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

J. Bus:

1. Main Horizontal and Equipment Ground Buses: Uniform capacity for entire length of MCC's main and vertical sections. Provide for future extensions **from both ends**.

2. Vertical Phase and Equipment Ground Buses: Uniform capacity for entire usable height of vertical sections, except for sections incorporating single units.

3. **Phase- and Neutral** Bus Material: Hard-drawn copper of 98 percent minimum conductivity with **mechanical** or **compression** connectors for outgoing conductors.

4. Ground Bus: Hard-drawn copper of 98 percent minimum conductivity, with pressure connector for ground conductors, minimum size 1/4-by-2 inches. Equip with **mechanical** or **compression** connectors for outgoing conductors.

5. Neutral Disconnect Link: Bolted, uninsulated, 1/4-by-2-inch copper bus, arranged to connect neutral bus to ground bus.

6. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Insulation temperature rating shall not be less than 105 deg C.

1.05 MAIN DISCONNECT AND OVERCURRENT PROTECTIVE DEVICE(S)

A. MCCB (to 1600 A): Fixed mounted, manually operated air-circuit breaker. Comply with UL 489.

1. MCCB shall have quick-make, quick-break, over-center switching mechanism that is mechanically trip-free, its position shall be shown by the position of the handle, and manual push-to-trip push button.

2. Solid-state monitoring and tripping system to show system status monitoring, adjustable time-current protection, and shunt trip.

a. Interchangeable current sensors and timing circuits for adjustable time-current protection settings and status signals.
b. Trip-setting dials or interchangeable plugs to establish the continuous trip of the circuit breaker. Plugs shall not be interchangeable between frames, and the breaker may not be closed without the plug. With neutral ground-fault sensor.
c. Time-current adjustments to achieve protective-device coordination as follows:

1) Adjustable long-time delay.
2) Adjustable short-time setting and delay to shape the time-current curve.
3) Adjustable instantaneous setting.
4) Individually adjustable ground-fault setting and time delay.

d. Built-in connector to test the long-time delay, instantaneous, and ground-fault functions of the breaker. **Provide one test set for testing the installed circuit breakers 225-A frame and higher.**

e. Built-in digital ammeter display, showing load current and tripping cause.

3. Switch operator power shall be from control power specified in "Assembly" Article.

B. MCC Main Disconnect Device: Fusible switch; fixed-mounted, manually operated, **electrically tripped,** quick-make, quick-break switch. Comply with UL 98.

1. Indication whether the switch is open or closed, and provisions for padlocking the operating handle.

2. Fuse clips and fuses.

3. Electrically tripped switches shall include the following:

a. Shunt trip.
b. Ground-fault protection, with adjustable time delay and test panel.
c. Single-phase protection, tripping the switch on loss of a source phase.
d. Blown fuse protection, tripping the switch on a blown fuse, with blown fuse indication.
e. Switch operator power shall be from control power specified in "Assembly" Article.

C. Surge Suppression: Factory installed as an integral part of the incoming feeder, complying with UL 1449.

1.06 MAGNETIC CONTROLLERS

A. Controller Units: Combination controllers.

B. Disconnects:

1. MCP:

a. UL 489, with interrupting capacity complying with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
b. Lockable Handle: For three padlocks and interlocks with cover in closed position.
c. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
d. **NC** and **NO** alarm contact that operates only when MCP has tripped.
e. Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.

2. MCCB:

a. UL 489, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
c. Lockable Handle: For three padlocks and interlocks with cover in closed position.
d. Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
e. **NC** and **NO** alarm contact that operates only when MCCB has tripped.

3. Molded-Case Switch:

a. UL 489, with in-line fuse block for **UL 248-8 Class J** or **UL 248-10 Class L** power fuses (depending on ampere rating), providing an interrupting capacity to comply with available fault currents; MCCB with fixed, high-set instantaneous trip only.
b. Lockable Handle: For three padlocks and interlocks with cover in closed position.
c. Auxiliary contacts "a" and "b" arranged to activate with molded-case switch handle.
d. **NC** or **NO** alarm contact that operates only when molded-case switch has tripped.

C. Controllers: Comply with UL 508.

1. Full-Voltage Magnetic Controllers: Electrically held, full voltage, NEMA ICS 2, general purpose, Class A.

a. Classification: Non reversing.

2. Multispeed Magnetic Controllers: Electrically held, full voltage, NEMA ICS 2, general purpose, Class A.

a. Classification: Non reversing; **consequent pole** or **two winding**.

1) Two speed, with compelling relays to ensure that motor will start only at low speed.
2) Timer Relays: Accelerating, for properly timed acceleration through speeds lower than that selected.
3) Timer Relays: Decelerating, for automatically timed deceleration through each speed.

b. Classification: Reversing; **consequent pole** or **two winding**.

1) Two speed, with compelling relay to ensure that motor will start only at low speed.

c. Timer Relays: Accelerating, for properly timed acceleration through speeds lower than that selected.

d. Timer Relays: Decelerating, for automatically timed deceleration through each speed.

e. Anti-plugging Relays: Time delay when transferring from FORWARD to REVERSE and back.

D. Overload Relays:

1. Melting-Alloy Overload Relays:

a. Inverse-time-current characteristic.
b. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.

2. Bimetallic Overload Relays:

a. Inverse-time-current characteristic.
b. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
c. Ambient compensated.
d. Automatic resetting.

3. Solid-State Overload Relays:

a. Switch or dial selectable for motor-running overload protection.
b. Sensors in each phase.
c. **Class 10/20 selectable** tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.

d. UL 1053 Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.

e. Analog communication module.

4. **NC** and **NO** isolated overload alarm contact.

5. External overload reset push button.

1.07 REDUCED-VOLTAGE SOLID-STATE CONTROLLERS

A. Controller Units: An integrated unit with disconnects, power SCRs, heat sink, microprocessor logic board, door-mounted digital display and keypad, bypass contactor, and overload relays. Comply with UL 508.

1. Suitable for use with NEMA MG 1 Design B, polyphase induction motors.

2. MCP:

a. UL 489, with interrupting capacity complying with available fault currents,

instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

b. Lockable Handle: For three padlocks and interlocks with cover in closed position.

c. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.

d. **NC** or **NO** alarm contact that operates only when MCP has tripped.

e. Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.

3. MCCB:

a. UL 489, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.

b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

c. Lockable Handle: For three padlocks and interlocks with cover in closed position.

d. Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.

e. **NC** and **NO** alarm contact that operates only when MCCB has tripped.

4. Molded-Case Switch:

a. UL 489, with in-line fuse block for **UL 248-8 Class J** or **UL 248-10 Class L** power fuses (depending on ampere rating), providing an interrupting capacity to comply with available fault currents; MCCB with fixed, high-set instantaneous trip only.

b. Lockable Handle: For three padlocks and interlocks with cover in closed position.

c. Auxiliary contacts "a" and "b" arranged to activate with molded-case switch handle.

d. **NC** or **NO** alarm contact that operates only when molded-case switch has tripped.

1.08 VFC

A. Controller Units: Combination controllers, consisting of variable-frequency power converter that is factory packaged in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged for self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency. Comply with NEMA ICS 7, NEMA ICS 61800-2, UL 508C, and **UL 508E**.

1. Units suitable for operation of NEMA MG 1, Design A and Design B motors as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."

2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."

3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

4. Listed and labeled for single-phase use by an NRTL acceptable to authorities having jurisdiction.

B. Disconnects:

1. Disconnect Rating: Not less than 115 percent of VFC input current rating.

2. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFC input current rating, whichever is larger.

3. Auxiliary Contacts: **NC** and **NO**, arranged to activate before switch blades open.

4. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.

5. **NC** and **NO** alarm contact that operates only when circuit breaker has tripped.

C. Operating Requirements:

1. Input AC Voltage Tolerance: Plus 10 and minus **10** percent of VFC input voltage rating.

2. Input AC Voltage Unbalance: Not exceeding **3** percent.

3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.

4. Minimum Efficiency: **97** percent at 60 Hz, full load.

5. Minimum Displacement Primary-Side Power Factor: **96** to **98** percent under any load or speed condition.

6. Overload Capability:

   a. For variable-torque controllers, 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
   b. For constant-torque controllers, 1.5 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.

7. Starting Torque: Minimum of 100 percent of rated torque from 3 to 60 Hz.

8. Speed Regulation: Plus or minus **5** percent.

9. Output Carrier Frequency: Field selectable.

10. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.

11. Internal Adjustability Capabilities:

    a. Minimum Speed: 5 to 25 percent of maximum rpm.
    b. Maximum Speed: 80 to 100 percent of maximum rpm.
    c. Acceleration: **0.1 to 999.9** seconds.
    d. Deceleration: [**0.1 to 999.9** seconds.
    e. Current Limit: 30 to a minimum of 150 percent of maximum rating.

12. Self-Protection and Reliability Features:

    a. Input surge protection by means of SPDs for three-phase protection against damage

from supply voltage surges 10 percent or more above nominal line voltage.

b. Loss of Input Signal Protection: Selectable response strategy including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
c. Under- and overvoltage trips.
d. Inverter overcurrent trips.
e. VFC and Motor Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved and listed and labeled by an NRTL.
f. Critical frequency rejection, with **three** selectable, adjustable dead-bands.
g. Instantaneous line-to-line and line-to-ground overcurrent trips.
h. Loss-of-phase protection.
i. Reverse-phase protection.
j. Short-circuit protection.
k. Motor overtemperature fault.

13. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

14. Motor Temperature Compensation at Slow Speeds: Adjustable current fallback based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

D. Operator Station:

1. Inverter Logic: Microprocessor based, **16** or **32** or 64 bit, isolated from all power circuits.

2. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.

3. Panel-mounted, manufacturer's standard front-accessible, sealed keypad and plain-English-language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.

a. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
b. Security Access: Electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.

E. Displays:

1. Historical Logging Information and Displays:

a. Real-time clock with current time and date.
b. Running log of total power versus time.
c. Total run time.
d. Fault log, maintaining last **four** faults with time and date stamp for each.

2. Indicating Devices: Digital display **and additional readout devices as required,** mounted flush in VFC door and connected to display VFC parameters including the following:

a. Output frequency (Hz).

b. Motor speed (rpm).
c. Motor status (running, stop, fault).
d. Motor current (amperes).
e. Motor torque (percentage).
f. Fault or alarming status (code).
g. PID feedback signal (percentage).
h. DC-link voltage (V dc).
i. Set-point frequency (Hz).
j. Motor output voltage (V ac).
k. <Insert parameter>.

F. Bypass Systems:

1. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually, automatically, or both. Selector switches set modes, and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.

2. Bypass Mode: Manual operation only; requires local operator selection at VFC. Transfer between power converter and bypass contactor and retransfer shall only be allowed with the motor at zero speed.

3. Bypass Mode: Field-selectable automatic or manual, allows local and remote transfer between power converter and bypass contactor and retransfer, either via manual operator interface or automatic control system feedback.

4. Bypass Controller: Two-contactor-style bypass allows motor operation via the power converter or the bypass controller[; with input isolating switch and barrier arranged to isolate the power converter and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode].

   a. Bypass Contactor: Load-break, **NEMA**-rated contactor.

   b. Output Isolating Contactor: Non-load-break, **NEMA** - rated contactor.

   c. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.

5. Bypass Controller: Three-contactor-style bypass allows motor operation via the power converter or the bypass controller **with input isolating switch and barrier** arranged to isolate the power converter input and output and permit safe testing **and troubleshooting** of the power converter, both energized and de-energized, while motor is operating in bypass mode.

   a. Bypass Contactor: Load-break **NEMA**]-rated contactor.
   b. Input and Output Isolating Contactors: Non-load-break, **NEMA**]-rated contactors.

   c. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.

6. NORMAL/BYPASS selector switch.

a. HAND/OFF/AUTO selector switch.

b. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFC while the motor is running in the bypass mode.

c. Contactor Coils: Pressure-encapsulated type **with coil transient suppressors**.

1) Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.

2) Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.

G. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

H. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Auto-speed Search" feature is available and engaged.

I. Bidirectional Auto-speed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

J. Firefighter's Override (Smoke Purge) Input: On a remote contact closure from **the firefighter's control station** or **smoke-control fan controller** the following password-protected input:

1. Overrides all other local and external inputs (analog/digital, serial communication, and all keypad commands).

2. Forces VFC to operate motor, without any other run or speed command, at a field-adjustable, preset speed.

3. Forces VFC to transfer to bypass mode and operate motor at full speed.

4. Causes display of override mode on the VFC display.

5. Reset VFC to normal operation on removal of override signal **automatically**.

K. Communication Port: **Ethernet** or **RS-232 port** and **USB 3.0 port** or equivalent connection Capable of connecting a printer **and a lap top computer**.

1.09 FEEDER TAP UNITS

A. MCCBs (to 1200 A): Fixed mounted, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger. Comply with UL 489, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

1. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

2. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:

a. Instantaneous trip.

b. Long- and short-time pickup levels.
c. Long- and short-time time adjustments.
d. Ground-fault pickup level, time delay, and I^2t response.

3. Communication Capability: **Universal-mounted** or **Integral** with **Din-rail-mounted** communication module with functions and features compatible with power monitoring and control system specified in Section 260913 "Electrical Power Monitoring and Control."

4. With built-in digital ammeter and a digital display, showing tripping cause.

5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.

6. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

7. Auxiliary Contacts: **Two SPDT switches** with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.

8. Alarm Switch: One **NC** and one **NO** contact that operates only when circuit breaker has tripped.

9. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

10. Zone-Selective Interlocking: Integral with **electronic ground-fault** trip unit; for interlocking ground-fault protection function.

11. Electrical Operator: Remote control for on, off, and reset operations.

1.10 CONTROL WIRING INSTALLATION

A. Install wiring between **enclosed controllers** or **master terminal boards** and remote devices **and facility's BAS and facility's central-control system**. Comply with requirements in Section "Control-Voltage Electrical Power Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic-control selection devices where applicable.

1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.

2. Connect selector switches within enclosed controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

1.11 CONNECTIONS

A. Comply with requirements for installation of conduit in Section "Raceways and Boxes for Electrical Systems." Drawings indicate general arrangement of conduit, fittings, and specialties.

B. Comply with requirements in Section "Grounding and Bonding for Electrical Systems."

END OF SECTION

SECTION 26 25 23
AUTONOMOUS PUBLIC ADDRESS SYSTEM

AUDITORIUMS/GYMNASIUMS

(DESIGNER MAY USE LATEST DIGITAL TECHNOLGY AND EQUIPMENT AVAILABLE AT THE TIME OF DESIGN)

PART 1 - GENERAL

1.01 SYSTEM REQUIREMENTS

A. Reproduction of speech shall be clear, high fidelity, and with all frequencies within range of system faithfully reproduced with no detectable noise, hum, or distortion.

B. Reproduction shall be attained at sound levels enough to override noise levels typical for schools, to provide a thoroughly satisfactory and serviceable system.

C. Audio level of telephone intercommunication system shall be attained at sound levels enough to override noise levels typical for schools, to provide a thoroughly satisfactory and serviceable system with a minimum of 70dB isolation between public address and intercommunication signals.

1.02 REQUIREMENTS

A. Furnish catalog cuts, technical data, and descriptive literature on components. Data shall be clearly marked and noted to identify specific ranges, model numbers, sizes, and other pertinent data.

1. Major head end equipment.

2. The product data shall be sufficiently detailed to allow the Architect to evaluate the suitability of the product and to allow other trades to provide necessary coordination.

3. Provide a complete set of scaled drawings of racks, consoles, and cabinets with designations, dimensions, color, operating controls, instrument wiring, and schematic diagrams of circuits, following Drawings as baseline.

4. Provide details as to interfaces of equipment of other Work, identifying numbers of wires, termination requirements, voltages, and other pertinent details. Include front elevations, cabinet dimensions, types of mounting, doors, barriers, catalog number of locks, and finishes for terminal cabinets.

5. Provide Signal Terminal Cabinets: Include a front elevation indicating cabinet dimensions, make, location and capacity of equipment, size of gutters, type of mounting, finish, and catalog number of locks. General layout of internal devices, wiring drawings with wire numbers and device connections, vendor cut sheets of devices in enclosure and bill of materials listing description, manufacturer, part number, and quantity of items shall be included.

6. Indicate equipment locations, wiring and schematics, details, panel configurations, sizes and a point-to-point wiring diagram of all circuits. Indicate interfaces to equipment identifying numbers of wires, termination requirements, and other pertinent details. Responsibility for each end of interfaces shall be noted.

7. Provide details indicating the proposed means of support and attachment of speakers and all wall and floor mounted racks. Calculations shall be based on the maximum load rating of the cabinet by the manufacturer in a Zone 4 seismic environment, not the weight at time of occupancy.

8. Calculations: Power load of PA system shall be calculated and shall be included in design.

9. Design Analysis: Provide an electro-acoustical design analysis. Provide scaled drawings indicating plans and sections of the auditorium along with an elevation of the cluster and shall indicate contours with the maximum predicted sound pressure level for the 1kHz octave with a band limited pink noise test signal, indicate the calculated area within which the specified electro-acoustic frequency response may be maintained for the first arrival sound from the cluster. Submit the name and the organizational affiliation of the individuals responsible for performing the electro-acoustical design analysis. Submit evidence, including appropriate certificates, that these individuals are trained in the specified modeling application. The design shall be generated by or based upon the output of a Computer Aided Electro-Acoustical Design Program such as Ease, Acousta CADD, Bose Modeler, or JBL PHD.

1.03 CODES AND STANDARDS

A. Complete installation shall meet or exceed the latest edition of following standards.

1. EIA/TIA-568: Commercial building telecommunications wiring standard.

2. EIA/TIA-569: Commercial building standard for telecommunications pathways and spaces.

3. EIA/TIA-606: Administration standard for telecommunications infrastructure of commercial buildings.

4. EIA/TIA-607: Commercial building grounding and bonding requirements for telecommunications.

5. California Building Code (CBC).

6. California Electrical Code (CEC).

7. ANSI, ASTM, UL, NEMA, IEEE and FCC standards as applicable.

8. BICSI Telecommunications Distribution Methods Manual, current edition.

1.04 SYSTEM DESCRIPTION

A. The system shall consist of a fully operational autonomous Public Address system that provides loudspeaker coverage for Auditoriums within Schools. The system shall consist of multiple input, output and amplification components integrated into a school operational system.

1.05 QUALITY ASSURANCE

A. Work shall conform to CCR, Title 24 Part 3, Basic Electrical Regulation and National Electrical

Code, latest edition.

B. Only a qualified Installer holding licenses required by legally constituted authorities having jurisdiction over the work, shall do the work.

C. Persons skilled in trade represented by work, and in accordance with all applicable building codes, shall install system in accordance with best trade practice.

D. Work shall be performed by an installer that has completed at least 5 school systems of equal scope to system described herein and shall have been engaged in business of supplying and installing specified type of systems for at least 5 years. Installer shall maintain a fully equipped service organization capable of furnishing repair service to equipment

E. The Installer shall use adequate numbers of skilled workmen who are manufacturer certified, thoroughly trained and experienced on the necessary crafts and completely familiar with the specified requirements and methods needed for the proper performance of the work.

F. The Installer shall coordinate cable runs, and rack equipment locations with the AOR during the initial design of the cable installation. Installer and OAR must agree as to the final location of all devices and the cable plant design.

G. Design analysis shall be performed by certified individuals under the direct observation of the sound engineer responsible for preparation of the Design Drawings.

H. System startup and electro-acoustical testing with the Techron TEF20 instrumentation shall be performed under the direct observation of the sound engineer responsible for preparation of the Shop Drawings.

PART 2 - PRODUCTS

2.01 ANTENNA AND GROUNDING

A. Antenna and Accessories:

1. FM Antenna: Furnish a Blonder Tongue BTY-2-FM, or equal, all-direction FM dipole antenna on the indicated roof location. Lead-in cable shall be 72-ohm weatherproof coaxial type, furnished with necessary weatherproof matching transformer at each end. Cable shall be Belden 8241, or equal. Provide and install a weatherproof surge protector, Polyphaser Model 096-0617P-A, or equal with # 6 AWG grounding conductor to a grounding electrode. The grounding conductor shall be bonded to the mast and surge protector.

2. AM Antenna: Furnish a whip type AM antenna. Insulate antenna from ground. Guy AM antenna whip from mast with an insulated standoff. If signal strength is not adequate from the antenna to provide interference-free reception, provide and install a 30-foot length of hard-drawn 12 gage copper wire between new roof antenna masts. Lead-in wire shall be 72-ohm coaxial cable Belden 8241, or equal, and furnished with necessary matching transformers at each end. Provide and install a weatherproof surge protector, Polyphaser Model 096-0617P-A, or equal with # 6 AWG grounding conductor to a grounding electrode. The grounding conductor shall be bonded to the mast and surge protector.

3. Provide an AM/FM antenna coupler in an outdoor housing mounted on antenna mast. Rauland No. LM0027, or equal.

4. Provide an antenna mast on the roof of the administration building or as indicated on Drawings. Mast shall be 1-1/4-inch galvanized steel and shall be secured to roof joists with steel straps specifically manufactured for specified installation.

5. Provide a 3/4-inch antenna conduit from PA console to antenna.

B. Grounding:

1. Wiring enclosures, terminal cabinets, outlets, frames of cabinet racks, and other enclosures shall be grounded in accordance with the requirements of the California Electrical Code, as specified, or required.

2. Chassis of amplifiers, power supplies, and accessories shall be grounded by being bonded to the control cabinet.

3. Housing, grips of all microphones, conductive housings, and other equipment shall be grounded by means of grounding wire or shield in cord or cable furnished for equipment connections.

4. Circuits shall be grounded as recommended by manufacturer of equipment to which they are connected unless otherwise specified or required.

2.02 ELECTRONIC RECEPTACLES

A. Microphone receptacles shall be Cannon XLR/SLR Series, or equal. Receptacles shall be furnished with mounting brackets for floor boxes, Sierra, or equal, 0.040-inch stainless steel plates, unless noted otherwise on Drawings. Plates shall be engraved with receptacle function in 3/16-inch-high letters filled with black paint. Receptacles shall conform to following:

Type	Description	Model
(A)	Single microphone, male.	LR-3-14, on a one-gang plate receptacle wall mounting.
(B)	Microphone receptacle, male.	Appleton Model RE-725, or ceiling-mounted on a manual Reelite Retractable reel with take-up reel, Belden No. 8412 cable, or equal, and Cannon XLR Series plug and support chain.
(C)	Single microphone, male.	LR-3-14N, with a CA015-0094-000, receptacle floor mounting yoke.

B. Projector receptacles shall be Switchcraft No. D4F or equal and mounted on a Sierra S 13 single-gang stainless steel plate or on a yoke or insert in a floor box.

C. Speaker connectors shall be Neutrik 2- or 4-conductor jacks specifically provided for the specified installation. Stage monitor speaker jacks shall be furnished with one jack on a Sierra No. S-13 plate. Cluster speakers shall be furnished with jacks as required on a custom, brushed, anodized, engraved and filled aluminum plate mounted on a 6 inch x 6 inch x 12 inch screw cover box. Connectors for the assistive listening system FM antenna and the central system override speaker shall be located on this panel. Flush or surface mounting condition and finish shall be as required by Architect.

2.03 CONDUCTOR/CABLES

A. Cable for overriding autonomous PA system shall be one twisted pair, No. 18 conductor; West Penn No. CL2 293, or equal. The furnished cable shall be the same type of cable furnished for zone paging, switching, and interfacing.

B. Cable for microphone and other input sources and speakers shall be one twisted pair of 22 gage stranded tinned copper conductors, polyethylene shielded with an aluminum foil-mylar shield, a 22-gage stranded tinned copper drain wire and polyvinyl jacket. Cable shall be Belden 8761, or equal.

C. Power cables to speakers in the cluster shall be one jacketed, twisted, stranded 12 AWG pair, West Penn CL3 227, or equal.

D. Coaxial cables from wireless microphone antennas to antenna splitters and from assistive listening transmitter to antenna shall be RG-58 A/U, Belden 8219, or equal.

2.04 KEYS AND LOCKS

A. Provide keys and locks for cabinets and equipment; locks shall be keyed to a Corbin No. 60 key, for access to operate equipment and Corbin No. 90 key, for access to service equipment.

2.05 AUDITORIUM AUTONOMOUS PA SOUND SYSTEM

A. System shall provide the following functions:

1. Selective inputs for microphones, central sound rack, projector, AM-FM tuner/cassette tape player and output jacks for a tape recorder with tone, volume, and mixer controls on front panel.

2. "Program All" and "Emergency All" audio shall be reproduced in the auditorium over loudspeakers through parallel speaker system and a relay activated by central console under these conditions. During "program all" and "emergency all" autonomous speakers are automatically disconnected from the Auditorium PA amplifiers using the relay and a speaker load placed on output of that amplifier to prevent damage so that a feed from central sound console to the parallel central sound system may be heard.

3. Auditorium PA system shall provide a line level output to central console.

4. On program transmission mode to or from auditorium PA system, following operations shall be provided:

a. Local PA system shall be manually energized before transmission.
b. “From” line: Program from central PA system is manually switched to local amplifier input and audio level adjusted with local amplifier volume controls.
c. “To” line: Program to central PA system is manually switched to local amplifier output and locally originated program is transmitted to central PA console.
d. “TO” or “FROM” switch shall be located on amplifier front panel.

B. System Components:

1. Equipment shall be contained in a freestanding rack, with matching sides and top panel, providing at least 78-3/4-inch panel space and furnished with a louvered rear door with

recessed handle and lock. Exterior rack dimensions shall be 87-13/16 high x 22-5/32-inch-wide x 22-1/8 inch deep. Rack shall be furnished with key locking steel front and rear doors. Rack finish as selected by the Architect. The rack shall be constructed of 16-gauge steel. Cabinet shall be constructed with mounting rails tapped for No. 10-32 screws on EIA spacing front and rear and shall be provided with Seismic Zone 4 earthquake reinforcing kits. Calculations for seismic bracing shall be based on the maximum load rating of the cabinet by the manufacturer in a Zone 4 seismic environment, not the weight at time of occupancy.

2. Program mixer-preamplifier shall be a Toa M-1264 rack mount stereo mixer, or equal, with 4 stereo line inputs, 6 microphone/line inputs, 6 mix busses, a stereo output, a sum of stereo mono output, one auxiliary output and one monitor output. The mixer shall not occupy more than 2 rack spaces.

3. Automatic microphone mixer/pre-amplifier shall be a Toa AX-1000A, or equal, with modular inputs as required. It shall be possible to link up to 5 mixers together into one unit and the system shall provide an adjustable number of open microphone (NOM) circuits to allow optimization of gain sharing for each situation.

4. AM-FM tuner shall be a Toa DT-920, or equal, with 40AM and/or FM presets, 3 uV FM/26 uV AM sensitivity, and -8dB unbalanced mono output. Tuner shall not occupy more than 2 rack spaces.

5. CD player shall be a Marantz No. PMD371, or equal, 5-disk rotary changer with IR remote control. Features shall include full random play, single or multiple track repeat change disks while playing, index access via remote control audible cue and review, full programming and program editing, automatic music search and AMX controller computability.

6. Digital Sound Processor shall be furnished with two 64-bit processors, 24-bit A/D and D/A converters, and firmware upgradable functionality. It shall be furnished with 2-channel, 31-band, 1/3 octave equalization and 3 bands per channel of parametric equalization and shall have 6 bands of automatic feedback elimination. The processor shall be furnished with real-time analyzer capability with automatic equalization adjustment and dual channel, multi-band limiter, and dual channel noise gate and digital delay. Digital sound processor shall be a Berringer DSP 8024, or equal.

7. Rack-mounted equipment shall be identified by engraved designations mounted either on the vent or blank panels above or below the equipment or on designations mounted between the mounting screws on each side. The designations on the rack shall match those indicated on the Shop Drawings. Designations are to be engraved in 1/4-inch-high white letters on black micarta stock. Bevel the edges of designations.

8. Dual-channel power amplifiers for loudspeakers: Amplifier shall be furnished with a minimum FTC output power rating of 500 watts/channel into 8 ohms at less than 0.25 percent THD from 20Hz to 20KHz. Hum and noise shall be-100 dB or better referred to rated power output into 8 ohms. Amplifier shall be furnished with thermal, short circuit and clipping protection. Provide one amplifier channel for every 2 horn speakers, at a minimum, and provide a controller module, if specified by the manufacturer, appropriate to the associated loudspeakers for each amplifier to optimize array performance. Amplifier shall be Electro-Voice P2000, Apogee Sound CA8000 or QSC CX902. Amplifier and array speakers shall be the products of one manufacturer.

9. Auditorium Loudspeakers: Quantity, selection of coverage patterns and locations shall be

as required to provide specified levels and uniformity of coverage for first arrival sound over the required coverage area. Loudspeaker shall be available with a minimum coverage pattern of 60 x 40 degrees and shall provide a minimum frequency range of 50 Hz to 15 KHz. Speaker shall have sensitivity of at least 95 dB, 1w, 1m at 1KHz. Speakers shall be Electro-Voice Fri+152 series, Apogee AFI-3 or QSC ISIS 122M.The frequency response for first arrival sound from the cluster within the specified coverage area as measured with a Techron TEF 20 shall be plus and minus 4 dB from 60Hz to 15KHz when a 1/3 octave smoothing function is applied. Amplifier and speakers shall be the products of one manufacturer.

10. Flying hardware to hold the cluster speakers together shall be as required, by the manufacturer.

11. Dual-channel power amplifier for the booth monitor speakers shall be a Sampson Servo 260, or equal, with 130 watts per channel into 4 ohms.

12. Booth monitor speakers shall be Tannoy No. CPA-5-point source, or equal, dual concentric single drive, induction coupled full range loudspeaker, not requiring any electronic processor or control unit. The speaker, without control unit, shall provide a frequency response of plus or minus 4 dB 125Hz to 20khz when measured on axis with 1/3 octave smoothed swept signal. The sensitivity shall be 90 dB at 1m with 2.83 volts applied signal. Maximum sound pressure level shall be 110 dB SPL at 1m on axis with band limited noise.

13. Type C1 horn loudspeakers shall be Atlas No. APC-30T, or equal. Speakers shall be used in conjunction with the autonomous system override controlled by the central system PA system.

C. A wireless microphone sub-system shall be furnished and shall accommodate a total of 10 microphones. The antenna splitters and wireless microphone receivers shall be mounted in a wall-mounted rack backstage, near the diversity receiver antennas. The system shall be furnished with 10 wireless lapel microphones and 4 handheld wireless microphones. Any combination totaling 10 microphones may be used at one time. Provide the following:

1. Wireless microphone receivers shall be Telex FMR-70, or equal, VHF true diversity receiver with 0.5 uV RF sensitivity, 90dB of squelch quieting and hum and noise-90dB. Two units shall mount in one rack space and the antennas shall be removable for use with antenna splitters.

2. Wireless microphone splitters shall be Telex AD-200, or equal.

3. Wireless receiver antenna shall be Telex AN-14, or equal, ¼ wave antenna mounted for optimal signal reception from the stage and forestage.

4. Wireless belt pack transmitter shall be Telex WT-80, or equal, with metal case and TA-4 connector.

5. Lapel microphone shall be an ELM-33S, or equal, cardioid microphone with TA-4F connector.

6. Hand-held wireless microphone shall be a Telex HT-200/58, or equal, with Shure SM-58 dynamic microphone element.

D. Production Intercom System:

1. System shall be microprocessor controlled with 2-party line channels and 12 VDC phantom power. The rack-mounted controller shall be furnished with “TALK”, “LISTEN” and “TAB” keys for each channel, an “ALL-TALK” key and a “PA” key. The rack-mounted power supply shall furnish a 2-amp power supply and an amplified 5W speaker. The system shall be provided with wall-mounted intercom and speaker stations as indicated on Drawings. Furnish one single-sided headset and one 30-foot headset extension cable for each station, including the rack mount controller.

2. Component/Accessory Manufacturers:

a. Intercom controller shall be Telex US-2000A, or equal.
b. Intercom power supply shall be a Telex SPS-2001, or equal.
c. Wall-mounted, 2-channel intercom station shall be Telex WM-2000, or equal.
d. Wall-mounted, 2-channel intercom speaker station shall be Telex SS-2000, or equal.
e. Single-sided headset shall be Telex PH-1, or equal.
f. Headset extension cables shall be Telex HE-30, or equal.

E. Hearing Assistance System: FM hearing assistance system shall be as manufactured by Williams Sound, Phonic Ear, or equal, and shall be furnished with the following components:

1. No. PPA-375 base station mounted inside the amplifier cabinet. The base station shall operate in 72 MHz-76MHz band and shall be furnished with remote-mounted antenna to cover a minimum of 500 feet.

2. No. PPA-R7 single channel receiver for use by the listener with standard Walkman-style headset HED 001. Receiver shall be capable of being clipped to a pocket or belt. Unit shall be furnished with 2 AA rechargeable nickel cadmium batteries with 40 receivers furnished and transmitted to the OAR before Substantial Completion.

3. No. CHG-1269A battery charger organizer. Unit shall be capable of storing or recharging up to 12 receivers at one time. The charger shall be capable of recharging the nickel cadmium batteries without removing the batteries from the receiver. A total of 4 battery chargers shall be furnished and transmitted to the OAR before Substantial Completion.

2.06 PORTABLE EQUIPMENT

A. Provide four, low-impedance, dynamic cardioid microphones with floor stands. Microphone shall be a Shure Type SM 58, or equal, with on/off switch and microphone holders. Microphones will be furnished with 15-foot Shure microphone cables. The floor stands shall be Atlas MS-20, or equal.

B. Provide one, 100-foot, one-piece microphone extension cable. Provide 2 cables, 20 gage, shielded, Belden No. 8412, or equal, terminated with Cannon No. XLR-3-11C and No. XLR-3-12C plugs.

C. Provide eighteen, Switchcraft No. 20QD20N0, 2-foot long, 1/4-inch tip, ring, sleeve patch cords.

D. Portable equipment shall remain in the manufacturer boxes and shall be transmitted to the OAR before Substantial Completion.

PART 3 - INSTALLATION

3.01 AUTONOMOUS PUBLIC ADDRESS SYSTEM

A. Console and Cabinet Rack Equipment Installation: Equipment within consoles and cabinet racks shall be logically arranged for convenient accessibility and maintenance. Equipment shall be mounted on shelves or panels and shall be securely attached.

B. Amplifiers, power supplies, and other heavy devices shall be mounted in the lowest available rack spaces on steel shelves fabricated by manufacturer of console and cabinet racks. Amplifiers and other heavy components shall be mounted in the lowest usable spaces in the rack. Cabinets, consoles, and panel faces including drawers shall be the same color.

C. Wiring within console and cabinets shall be installed to conform to standard engineering practice and shall be terminated on terminal strips having a terminal for each required external connection. Wiring shall be cabled, laced, and securely fastened in place so no weight is imposed on any equipment, control switches, or terminals. Wires carrying audio power shall be shielded. Input and output circuits and terminal strips shall be installed to provide separation necessary for proper operation. Wires shall be identified by number and chart.

D. Conductor shields for each system shall be grounded at one location only. Grounding shall be provided within console and cabinet racks. There shall be no metallic connection between systems. Conduits for system and 120-volt AC system shall be bonded together at console and all cabinet racks.

E. Terminate 120-volt AC supply conductors directly on disconnect switches specified and in required raceway.

3.02 DISTRICT QUALITY ASSURANCE CERTIFICATION AND TESTING

A. The Installer shall provide instruments for testing and demonstrate in the presence of the District that the circuits and wiring test free of shorts and grounds.

B. The Installer shall furnish labor, instruments, appliances, equipment, and materials necessary to demonstrate to the Owner the installation performs as required.

C. District has the right to perform independent tests of equipment furnished, to determine whether equipment complies with requirements specified, and to proceed based on results obtained.

D. The system shall be fully tested and operational before final inspection. Test results shall be provided to the District before final inspection.

E. System startup and electro-acoustical testing with the Techron TEF20 instrumentation shall be performed under the direct observation of the engineer responsible for preparation of the Shop Drawings.

F. Reproduction of speech shall be clear, high fidelity, and with all frequencies within range of system faithfully reproduced without detectable noise, hum and distortion.

1. With O dBm sine wave test signal applied at a line input of the TOA M-1264 program mixer, with gain adjusted so that the sum of stereo electronically balanced output has a O

dBm output, and with the Digital Signal Processor bypassed, demonstrate that each channel of the Renkus-Heinz P2800 Cluster Amps can deliver 250 watts RMS or greater into an 8 ohm resistive load from 80Hz to 10,000 Hz within their respective bandwidths, (below 250 Hz for the low-frequency amp, above 250 Hz the high-frequency amp). Record measurements at 80Hz, 125Hz, 200Hz, 315Hz, 315Hz, 1KHz, 3.15KHz, and 10KHz for each amplifier.

2. With setup and gain adjusted as specified above, short the balanced line input with a 620 ohm resistor; 20KHz band limited noise at any cluster amp channel output shall be 80 dB below the level required to produce 250 watts RMS. Record the measured noise level for each line input to a given high-frequency cluster AMP output.

3. With setup and gain adjusted as specified above and with a 500Hz test signal, measure the total harmonic generation and noise (TH&G) throughout the audio chain. THG&N shall be 0.25 percent or less. Record the THG&N for each line input to a give high-frequency cluster amplifier channel. Record the THG&N from given line input to each high frequency cluster amplifier channel.

4. With a 500Hz, 1mV sine wave signal applied to a microphone input of the TOA 1264 program mixer, with the gain adjusted so that the sum of stereo electronically balanced output has a O dBm output, with the digital signal processor bypassed, adjust the level of a given high-frequency cluster amplifier to deliver 250 watts RMS into an 8 ohm resistive load. Record the THG&N for each microphone input to a given high-frequency cluster amplifier channel output. THG&N shall be 0.25 percent or less.

5. With setup as specified above, short the input with a 120-ohm resistor and measure the 20 KHz band limited noise at the output. 20KHz band-limited noise shall be 80 dB below the level required to deliver 250 watts RMS into an 8-ohm resistive load. Record the noise level for each microphone input to the given High Frequency Cluster Amplifier channel output.

6. From a selected line level input to the effects amplifier outputs perform the measurements described above, except adjust the amplifier to deliver 100 watts RMS into an 8-ohm resistive load.

7. Perform measurements of first arrival sound pressure levels to verify compliance with the reviewed design analysis. System shall be capable of producing first arrival levels of 90 dB SPL over the specified 40Hz to 17KHz frequency spectrum in the center of the last row of fixed seating and in more than 90 percent of the fixed seats when measured with the Techron TEF-20 electro-acoustical test equipment. One-third octave smoothed first frequency response is plus and minus 4 dB over the specified 40Hz to 17KHz spectrum and plus and minus 2 dB from 100Hz to 10KHz in more than 90 percent of the fixed seats. First arrival requirements do not apply to areas in the acoustical shadow of columns, etc. Provide full TEF contours at 6 locations to provide the Architect with information on which to base recommendations for acoustical treatment.

3.03 DISTRICT ORIENTATION

A. Before Substantial Completion, provide and arrange for a manufacturer's technical representative to instruct designated District personnel in correct operation of system. Instruction shall be provided on the Project site and shall be a minimum of 4 hours.

END OF SECTION

~~NOTE TO PROJECT ARCHTECT: LAUSD INFORMATION TECHNOLOGY DIVISION IS THE ONLY COGNIZANT AUTHORITY FOR CHANGES OR MODIFICATION OF THIS SPECIFICATION. NO CHANGES OR MODIFICATION SHALL BE MADE WITHOUT SPECIFIC WRITTEN AUTHORIZATION OF ITD.~~

SECTION 26 25 ~~8~~25
AUTONOMOUS PUBLIC ADDRESS SYSTEMS

ATHLETIC FIELDS

(DESIGNER MAY USE LATEST DIGITAL TECHNOLGY AND EQUIPMENT AVAILABLE AT THE TIME OF DESIGN Daktronics - Sports Sound SS -2000 HD system with Digital Audio Façade SSD – 2000; SSR -300)

PART 1 - GENERAL

~~1.01 SUMMARY~~

~~A. Provisions of Division 01 apply to this section.~~
~~B. Principal items of Work in this Section include but are not limited to:~~

1. ~~Furnish~~ Provide a complete athletic field autonomous public address (PA) system.
2. ~~Furnish~~ Provide conductors and terminal strips necessary to provide for functions and requirements specified herein.
3. Provide ~~labor,~~ engineering, design, testing, materials, components and supervision necessary to provide a complete operable installation.
4. Entire system shall be supported by engineering documentation including:

   a. Floor plans indicating devices, conduit runs, wire types, and terminal cabinets.
   b. Block diagrams indicating items and their point-to-point connections in a manner following floor plan layout.

~~C. Related Sections:~~

~~1. Section 16010: Basic Electrical Requirements.~~
~~2. Section 16050: Basic Electrical Materials and Methods.~~
~~3. Section 16060: Grounding and Bonding~~
~~4. Section 16120: Low Voltage Wiring~~
~~5. Section 16130: Raceways and Boxes Fittings and Supports~~
~~6. Section 16445: Panelboards and Signal Terminal Cabinets.~~
~~7. Section 16530: Emergency Power Systems.~~
~~8. Section 16730: Clock and Program System.~~

~~9. Section 25750: Intercommunication Systems~~

~~10. Section 25821: Public Address Systems~~
~~11. Section 25822: Autonomous PA Sound System – Multi-Purpose Rooms~~
~~12. Section 25823: Autonomous PA Sound System – Auditorium~~
~~13. Section 25824: Autonomous PA Sound System in Gymnasium~~

~~D. Acronyms:~~

~~DTMF Dual Tone Multiple Frequency~~
~~IC Intercom~~
~~LCD Liquid Crystal Display~~

~~IOR — Inspector of Record~~
~~OAR — Owner Authorized Representative~~
~~PA — Public Address~~
~~PABX — Private Auxiliary Branch Exchange~~

1.02 SYSTEM REQUIREMENTS

A. Reproduction of speech shall be clear, high fidelity, and with all frequencies within range of system faithfully reproduced with no detectable noise, hum, or distortion.

B. Reproduction and audio levels shall be attained at sound levels ~~sufficient~~enough to override noise levels typical for school athletic fields and to provide a thoroughly satisfactory and serviceable system.

~~1.03 SUBMITTALS~~

~~A. Submit the following in accordance with Division 01~~

1. ~~Furnish~~Provide catalog cuts, technical data, and descriptive literature on components. Data shall be clearly marked and noted to identify specific ranges, model numbers, sizes, and other pertinent data.

~~2. Each submittal shall be bound and shall contain an index organized vertically by assembly and item number and horizontally by columns.~~

~~a. The first assembly shall be the major head end equipment.~~
~~b. The leftmost column shall be the item number; next shall be the description, followed by the applicable specification section number, and followed by the specified item, which is followed by the submitted item.~~
~~c. The rightmost column shall be for notes, which shall be used to reference the reason for submitting items other than as specified.~~

~~3.~~2. Each submittal shall contain product data sheets or catalog cut sheets for each item listed in the Index. These shall be arranged in the same order as the index and if more than one item is shown, the submitted items shall be highlighted or marked with an arrow.

a. The product data shall be sufficiently detailed to allow the Architect to evaluate the suitability of the product and to allow other trades to provide necessary coordination.

~~4. Provide Shop Drawings, in the same size as the Record Drawings. Shop Drawings shall be prepared in latest version of AutoCAD with 3 CD-ROM electronic copies submitted along with full sized Shop Drawings.~~

~~a.~~b. Provide a complete set of scaled drawings of racks, consoles, and cabinets with designations, dimensions, color, operating controls, instrument wiring, and schematic diagrams of circuits, following Drawings as baseline.

~~b.~~c. ~~Shop Drawings shall P~~provide details as to interfaces of equipment of other Work, identifying numbers of wires, termination requirements, voltages, and other pertinent details. Include front elevations, cabinet dimensions, types of mounting, doors, barriers, catalog number of locks, and finishes for terminal cabinets.

~~c.~~d. Include a dimensional ~~Shop~~ Drawing of console nameplate. Nameplate shall contain school name, firm, address, telephone number for warrantee and maintenance, and power load.

d.e. For Signal Terminal Cabinets: (Refer to Premise Wiring Specification, Section 25568) Include a front elevation indicating cabinet dimensions, make, location and capacity of equipment, size of gutters, type of mounting, finish, and catalog number of locks. General layout of internal devices, wiring drawings with wire numbers and device connections, vendor cut sheets of devices in enclosure and bill of materials listing description, manufacturer, part number, and quantity of items shall be included.

e.f. Shop Ddrawings shall indicate equipment locations, wiring and schematics, details, panel configurations, sizes and a point-to-point wiring diagram of all circuits. Shop drawings shall indicate interfaces to equipment furnished by others, identifying numbers of wires, termination requirements, and other pertinent details. Responsibility for each end of interfaces shall be noted on shop drawings.

f. Submit Drawings prepared, signed, and sealed by structural engineer licensed in the State of California. Details shall be provided indicating the proposed means of support and attachment of speakers and all wall and floor mounted racks. Calculations shall be based on the maximum load rating of the cabinet by the manufacturer in a Zone 4 seismic environment, not the weight at time of occupancy.

5. Permits and Inspections: Obtain and pay for required permits and inspections; deliver certificates of inspection to the IOR.

6. Installer shall have completed at least 5 projects of equal scope to systems described herein and shall have been in the business of supplying and installing specified type of systems for at least 5 years. Installer shall include the telephone number of the customer's client contact for each project

7. Installer shall include in the Material List Submission copies of the manufacturers' certifications that the Installer is an authorized distributor and service provider of the submitted manufacturers' products and Installer's staff has been adequately trained and certified in the installation of those products.

8. Installer shall provide a letter from the Manufacturer warranting the availability of spare parts common to proposed system for a period no less than 5 years on all components

9.3. Calculations: Power load of PA system shall be calculated by the Installer on a separate sheet and shall be included in submittal.

4. Design Analysis: Provide an electro-acoustical design analysis. Provide scaled drawings indicating plans and sections of the auditorium along with an elevation of the cluster and shall indicate contours with the maximum predicted sound pressure level for the 1kHz octave with a band limited pink noise test signal, indicate the calculated area within which the specified electro-acoustic frequency response may be maintained for the first arrival sound from the cluster. Submit the name and the organizational affiliation of the individuals responsible for performing the electro-acoustical design analysis. Submit evidence, including appropriate certificates, that these individuals are trained in the specified modeling application. The design shall be generated by or based upon the output of a Computer Aided Electro-Acoustical Design Program such as Ease, Acousta CADD, Bose Modeler, or JBL PHD.

10. Design Analysis: Installer shall submit an electro-acoustical design analysis for review. Provide scale drawings indicating plans and sections of the auditorium along with an elevation of the cluster. One drawing shall indicate contours with the maximum predicted sound pressure level for the 1kHz octave with a band limited pink noise test

~~signal. Another drawing shall indicate the calculated area within which the specified electro-acoustic frequency response may be maintained for the first arrival sound from the cluster. Submit the name and the organizational affiliation of the individuals responsible for performing the electro-acoustical design analysis. Submit evidence, including appropriate certificates, that these individuals are trained in the specified modeling application. The design shall be generated by or based upon the output of a Computer Aided Electro-Acoustical Design Program such as Ease, Acousta CADD, Bose Modeler, or JBL PHD.~~

~~1.04~~1.03 CODES AND STANDARDS

A. Complete installation shall meet or exceed the latest edition of following standards.

1. EIA/TIA-568: Commercial building telecommunications wiring standard.
2. EIA/TIA-569: Commercial building standard for telecommunications pathways and spaces.
3. EIA/TIA-606: Administration standard for telecommunications infrastructure of commercial buildings.
4. EIA/TIA-607: Commercial building grounding and bonding requirements for telecommunications.
5. California Building Code (CBC).
6. California Electrical Code (CEC).
7. ANSI, ASTM, UL, NEMA, IEEE and FCC standards as applicable.
8. BICSI Telecommunications Distribution Methods Manual, current edition.

~~1.05~~1.04 SYSTEM DESCRIPTION

A. The system shall consist of a fully operational autonomous Public Address system that provides loudspeaker coverage for Athletic Fields ~~at Schools~~. The system shall consist of multiple input, output and amplification components integrated into a school operational system.

~~1.06~~1.05 QUALITY ASSURANCE

A. Work shall conform to CCR, Title 24 Part 3, Basic Electrical Regulation and National Electrical Code, latest edition.
B. Only a qualified Installer holding licenses required by legally constituted authorities having jurisdiction over the work, shall do the work.
C. Persons skilled in trade represented by work, and in accordance with all applicable building codes, shall install system in accordance with best trade practice.
D. Work shall be performed by an installer that has completed at least 5 school systems of equal scope to system described herein and shall have been engaged in business of supplying and installing specified type of systems for at least 5 years. Installer shall maintain a fully equipped service organization capable of furnishing repair service to equipment
E. The Installer shall use adequate numbers of skilled workmen who are manufacturer certified, thoroughly trained and experienced on the necessary crafts and completely familiar with the specified requirements and methods needed for the proper performance of the work.
F. The Installer shall coordinate cable runs, and rack equipment locations with the OAR during the initial design of the cable installation. Installer and OAR must agree as to the final location of all devices and the cable plant design.
G. Design analysis shall be performed by certified individuals under the direct observation of the sound engineer responsible for preparation of the Design Drawings.

H. System startup and electro-acoustical testing with the Techron TEF20 instrumentation shall be performed under the direct observation of the sound engineer responsible for preparation of the Shop Drawings.

~~A. Work shall conform to CCR, Title 24 Part 3, Basic Electrical Regulation and National Electrical Code, latest edition.~~

~~B. Only a qualified Installer holding licenses required by legally constituted authorities having jurisdiction over the work, shall do the work.~~

~~C. Persons skilled in trade represented by work, and in accordance with all applicable building codes, shall install system in accordance with best trade practice.~~

~~D. Work shall be performed by an installer that has completed at least 5 school systems of equal scope to system described herein and shall have been engaged in business of supplying and installing specified type of systems for at least 5 years. Installer shall maintain a fully equipped service organization capable of furnishing repair service to equipment~~

~~E. The Installer shall use adequate numbers of skilled workmen who are manufacturer certified, thoroughly trained and experienced on the necessary crafts and completely familiar with the specified requirements and methods needed for the proper performance of the work.~~

~~F. The Installer shall coordinate cable runs, and rack equipment locations with the OAR during the initial design of the cable installation. Installer and OAR must agree as to the final location of all devices and the cable plant design.~~

~~G. The Installer shall provide manpower and tools required to participate in Owners Quality Assurance Testing as detailed in Attachment "A" of this specification.~~

~~1. Items on check list of Attachment "A" will be examined as a minimum at the Public Address Head End, terminal cabinets, ground vaults and classrooms. Should the examination show deficiencies related to items in the checklist, Owners acceptance testing will be discontinued until corrections have been made. When an Installer has completed the corrections, a subsequent Quality Assurance test shall be initiated. This procedure is in addition to the system functionality testing required in section 3.02 below.~~

~~H. Design analysis shall be performed by certified individuals under the direct observation of the sound engineer responsible for preparation of the Shop Drawings.~~

~~I. System startup and electro-acoustical testing with the Techron TEF20 instrumentation shall be performed under the direct observation of the sound engineer responsible for preparation of the Shop Drawings.~~

~~1.07 WARRANTY~~

~~A. Contractor shall warranty that all work executed and materials furnished shall be free from defects of material and workmanship for a period of 3 years from acceptance date of Contract Completion, excluding specific items of work that require a warranty of a greater period as set forth in this Specification. Immediately upon receipt of written notice from the Owner, the Contractor shall repair or replace at no expense to the Owner, any defective material or work that may be discovered before final acceptance of work or within warranty period; any material or work damaged thereby; and adjacent material or work that may be displaced in repair or replacement. Examination of or failure to examine work by the Owner shall not relieve Contractor from these obligations.~~

PART 2 - PRODUCTS

~~1.08~~1.06 GROUNDING

A. Wiring enclosures, terminal cabinets, outlets, frames of cabinet racks, and other enclosures shall be grounded in accordance with the requirements of the California Electrical Code, as specified, or required.

B. Chassis of amplifiers, power supplies, and accessories shall be grounded by being bonded to the control cabinet.

C. Housing, grips of microphone, conductive housings, and other equipment shall be grounded by means of grounding wire or shield in cord or cable furnished for equipment connections.

D. Circuits shall be grounded as recommended by manufacturer of equipment to which they are connected unless otherwise specified.

~~1.09~~1.07 ELECTRONIC RECEPTACLES

A. Microphone receptacles shall be Cannon XLR/SLR Series, or equal. Receptacles shall be furnished with mounting brackets for floor boxes, Sierra, or equal, ~~0.040 inch~~0.040-inch stainless steel plates, unless noted otherwise on Drawings. Each plate shall be engraved with its receptacle function in ~~3/16 inch high~~3/16-inch-high letters filled with black paint. Receptacles shall conform to the following:

Type	Description	Model
(A)	Single microphone, male.	LR-3-14, on a one-gang plate receptacle wall mounting.
(B)	Microphone receptacle, male.	Appleton Model RE-725, or ceiling-mounted on a manual Reelite Retractable reel with take-up reel, Belden No. 8412 cable, or equal, and Cannon XLR Series plug and support chain.
(C)	Single microphone, male.	LR-3-14N, with a CA015-0094-000, receptacle floor mounting yoke.

B. Speaker connectors shall be Neutrik 2- or 4-conductor jacks specifically provided for the specified installation. Cluster speakers shall be furnished with jacks as required on a custom, brushed, anodized, engraved and filled aluminum plate mounted on ~~6 inch~~6-inch x 6 inch x 12 inch screw cover box. Connectors for the assistive listening system FM antenna and the central system override speaker shall be located on this panel. Flush or surface mounting condition and finish shall be as required by Architect.

~~1.010~~1.08 CONDUCTOR/CABLES

A. Cable for overriding Autonomous PA system shall be one twisted pair, No. 18 conductor; West Penn AQC293, or equal. The furnished cable shall be the same type of cable for zone paging, switching, and interfacing.

B. Cables for microphone and other input sources and speakers shall be one twisted pair of 22 gauge stranded tinned copper conductors, polyethylene shielded with an aluminum foil-mylar shield, a ~~22 gauge~~22-gauge stranded tinned copper drain wire, water blocked construction and a sunlight and moisture-resistant PVC jacket. Cable shall be West Penn AQC 291, or equal.

C. Cables to athletic field speakers shall be jacketed, twisted, stranded 12, 14, 16 or 18 AWG pair, with water-blocked construction and sunlight and moisture resistant PVC jacket, West Penn No. AQ 224, 225, 226 or 227, as required by the load and the run length, or equal.

D. Coaxial cables from assistive listening transmitter, if present, to antenna shall be RG-58 A/U, Belden 8219, or equal.

~~1.011~~1.09 KEYS AND LOCKS

A. Provide keys and locks for cabinets and equipment; locks shall be keyed to a Corbin No. 60 key, for access to operate equipment and Corbin No. 90 key, for access to service equipment.

1.0121.010 ATHLETIC FIELD AUTONOMOUS PA SYSTEM

A. Autonomous PA system shall be located as indicated on Drawings, and as follows:

B.

1. Equipment shall be contained in free standing rack, providing at least 42 inches of total mounting space. Rack shall be no more than 46-3/8 inches high x 22-3/8 inches wide x 18-1/2 inches deep. The rack shall be constructed of at least 16 gauge16-gauge steel, heavily reinforced for maximum strength and durability. It shall be furnished with a hinged and key-locking rear door providing authorized personnel with access to equipment, andequipment and shall be finished in black enamel. Rack shall be listed by UL re-examination service. Cabinet shall be constructed with mounting rails tapped for No. 10-32 screws on EIA spacing front and rear, andrear and shall be provided with Zone 4 earthquake reinforcing kits. Calculations for seismic bracing shall be based on the maximum load rating of the cabinet by the manufacturer in a Zone 4 seismic environment, not the weight at time of occupancy. Cabinet shall be provided with the following:
2. Matching Side Panels and Louvered Top Panel.
3. Full-Length, removable Hinged, Key-Locking Front and Rear Doors.
4. Both doors shall be able to swing fully open.

C.B. "Program All" and "Emergency All" audio shall be reproduced in the athletic field area over dedicated loudspeakers. A relay activated by central console under these conditions shall mute the local system.

1. On program transmission mode "from" main console to local PA system, following operations shall be provided:

   a. Local PA system is energized manually prior to transmission.
   b. Level control on input module for program line "from" central PA system is adjusted for proper volume.
   c. Speaker switches are set for program distribution desired and transmission is sent to speakers.

2. On program transmission mode "to" main console from local PA system, following operations shall be provided:

   a. Local PA system is energized manually prior to transmission.
   b. Program line "to" central PA system is connected to local amplifier output via a switch, and locally originated program is transmitted to central PA console for re-distribution.

3. Mixer/preamplifier shall be a TOA M-900 MK2, or equal. It shall be modular in design for maximum flexibility and shall be furnished with high performance circuitry. Conventional mixer/preamplifiers that do not provide both modular input and high-performance circuitry are not permitted:

   a. The unit shall provide input channels furnished with variable mute, with any combination of TOA input modules. The variable mute circuit shall be screwdriver adjustable over a range of at least 60 dB and capable of being activated by either an external contact closure or the mixture's internal priority

circuits. Module ports shall be accessible only from the rear and shall be of the plug in type, using ribbon type connectors with gold plated contact.

b. Each input shall be furnished with 2 controls to set the level of each mix. Bass and treble controls shall be furnished and shall provide plus or minus 10 dB cut or boost at 100Hz and 10KHz, respectively. Tone control defeat switches shall be provided and shall be located in the module port cage.

c. One separate output channel shall be provided, with direct 600-ohm unbalanced, and transformer - coupled 600 ohm balanced taps. Output channel shall provide an independent mix of the program input and up to 8 module input. A separate Master volume control shall set the overall output level of each mix. Front panel LED output level indicators shall be furnished.

d. The frequency response shall be 20 Hz to 20 kHz, +0, -1DB. Distortion levels shall be less than 0.15 percent at the maximum output and shall be typically less than 0.01 percent. The signal-to-noise ratio shall be 72dB with Master control set at maximum. Sensitivity shall be 100mV/10 kilohms for the program and module inputs.

e. Bridging in/out jacks shall be furnished for each channel, for recording and/or for connecting either mixing bus to other D series equipment. Sensitivity for the bridging I/O shall be 100mV/3 kilohms.

f. The mixer/preamplifier shall be designed for continuous duty service ~~on line~~online voltages of 120 V, 60 Hz AC, and shall include an AC line circuit breaker.

4. The Power Amplifier(s) for the Athletic Field Public Address System shall be a Bogen Model HTA250A, or equal, solid-state amplifier incorporating state-of the-art MOSFET power transistors.

a. The amplifier shall deliver an audio output of 250 watts (rms continuous). Total harmonic distortion shall be less than 0.5 percent at the 250-watt rating over frequency range of 20 - 20,000Hz. The rated output shall be obtained with and input that is not greater than 500m V(rms). Hum and noise shall be at least 90 dB below rated output. The frequency response, when measured at full rated output, shall be flat within 1 dB, 20 - 20,000Hz.

b. The amplifier shall provide either balanced or unbalanced constant-voltage outputs of 25 volts and 70 volts, plus 4 and 8 ohm balanced or unbalanced outputs. Output regulation shall be within 2dB from no load to full load.

c. The amplifier shall provide and input of 50,000 ohms unbalanced high impedance or 600 ohms balanced/unbalanced low impedance, or line bridging with optional accessory plug-in transformers. Overall gain shall be adjustable by means of a single level control located on the rear panel. An internal low-cut filter (-10 dB at 100Hz) shall also be provided. The front of the amplifier shall be furnished with an illuminated on/off power switch.

d. The amplifier shall incorporate electronic shutdown circuitry, which shall activate whenever and overload or short occurs on the output of the amplifier. A front panel overload shutdown LED shall illuminate to indicate the discontinuance of power output once the cause of the shutdown condition has been removed.

e. The amplifier shall operate from a 120VAC, 60Hz source and shall consume 60watts or less at idle, and 520 watts full rated output.

f. The amplifier shall be furnished with thermostatic control to prevent operation at excessive ambient temperatures. The amplifier shall also be furnished with electronic overload limiting, short-circuit protection, and a ~~7 amp~~7-amp Slo-Blo fuse.

g. The standard amplifier shall be furnished with an EIA 19-inch front panel suitable for rack mounting. The amplifier shall be 19 inches wide x 5-1/4 inches high and 11 inches deep, finished in black.

5. Hearing Assistance System: FM hearing assistance system shall be as manufactured by Williams Sound, Phonic Ear, or equal and shall be furnished with the following components:

a. No. PPA-375 base station mounted inside the amplifier cabinet. The base station shall operate in 72 MHz-76MHz band and shall be furnished with remote mounted antenna to cover a minimum of 1,000 ft.
b. No. PPA-R7 single channel receiver for use by the listener with standard Walkman-style headset HED 001. Receiver must be capable of being clipped to a pocket or belt. Unit must be furnished with 2 AA rechargeable nickel cadmium batteries with 40 receivers furnished and transmitted to the OAR before Substantial Completion.
c. No. CHG 1269A battery charger organizer shall be capable of storing or recharging up to 12 receivers at one time. The charger must be capable of recharging the nickel-cadmium batteries without removing the batteries from the receiver. A total of 4 battery chargers shall be furnished and transmitted to the OAR before Substantial Completion.

6. Relays used to mute PA audio circuits shall be a 5K ohm sensitive, plug-in type, Potter Brumfield Series S10, or equal. Contacts shall be provided for functions specified herein. Plug-in relays shall be enclosed in dust-tight cases.
7. Furnish necessary power supplies, relays, networks, and other required components to provide an operational system.
8. Provide a 7-inch deep rack mounted storage drawer, Atlas Sound SD-7 165FP, or equal.
9. Athletic Field Loudspeakers shall be Atlas Sound APC-30T, or equal. Quantity and locations shall be as indicated on the Drawings.
10. Provide a custom protective enclosure fabricated from expanded metal and one inch angle iron and supported from structure for the loudspeaker assemblies.
11. Microphone Outlets and Power Outlets: Replace microphone and power outlets and microphone cable at locations indicated on Drawings. Microphone and power outlets shall comply with requirements of other sections.
12. Central system speakers shall be reentrant horns with wide dispersion, Atlas APC - 30T, or equal. They shall be mounted with the field speakers and shall be connected directly to the central system. During emergency all calls, the feed to the local system shall be muted by an override relay controlled from the central system.

~~1.013~~1.011 PORTABLE EQUIPMENT

A. Provide 2 low-impedance, dynamic cardioid microphones with a floor stand and a desk stand. Microphone shall be a Shure SM 58 type, or equal, with on/off switch and microphone holders. Microphones will be furnished with 15' Shure microphone cables. Floor stands shall be Atlas MS-20, or equal; desk stands shall be Atlas DS-7E, or equal.
B. Provide one, 100-foot, one-piece microphone extension cable. Cable shall be two 20 gauge, shielded, Belden No. 8412, or equal, terminated with Cannon No. XLR-3-11C and No. XLR-3-12C plugs.
C. Portable equipment shall remain in manufacturer boxes and shall be transmitted to the OAR before Substantial Completion.

~~1.014~~1.012 LOADS ON EQUIPMENT AND COMPONENTS

A. Equipment and component parts shall carry continuously, without undue heating or change in rated value, loads connected thereto and rated output loads where such are specified. Equipment shall be properly fused and rated for continuous operation.
B. Operating voltages on capacitors shall not exceed 60 percent of their rated working voltages.
C. Operating wattages to be dissipated by resistors shall not exceed 25 percent of their ratings.

PART 3 - EXECUTION AND INSTALLATION

~~1.015 AUTONOMOUS PUBLIC ADDRESS SYSTEMS (ATHLETIC FIELDS) INSTALLATION~~

~~A.~~D. Console and Cabinet Rack Equipment Installation: Equipment within each console and cabinet rack shall be logically arranged for convenient accessibility and maintenance. Equipment shall be mounted on shelves or panels and shall be securely attached.

~~B.~~E. Amplifiers, power supplies, and other heavy devices shall be mounted in the lowest practical area of the rack on steel shelves fabricated by manufacturer of console and cabinet racks. Cabinets, consoles, and panel faces including drawers shall be the same color.

~~C.~~F. Wiring within console and cabinets shall be installed to conform to standard engineering practice and shall be terminated on terminal strips having a terminal for each required external connection. Wiring shall be cabled, laced, and securely fastened in place so no weight is imposed on any equipment, control switches, or terminals. Wires carrying audio power shall be shielded. Input and output circuits and terminal strips shall be installed to provide separation necessary for proper operation. Wires shall be identified by number and chart.

~~D.~~G. Conductor shields for each system shall be grounded at one location only. Grounding shall be provided within console and cabinet racks. There shall be no metallic connection between systems. Conduits for system and ~~120 volt~~120-volt AC system shall be bonded together at console and all cabinet racks.

~~E. EXAMINATION AND OPERATION: The IOR shall observe and inspect installation of all underground cable runs, and main aboveground cable runs. Notify the OAR not less than 2 working days before commencement of installation.~~

~~1.016~~1.013 ~~OWNERS~~DISTRICT QUALITY ASSURANCE CERTIFICATION AND TESTING

A. Provide instruments for ~~testing, and~~testing and demonstrate in the presence of the ~~Owner~~ District that the circuits and wiring test free of shorts and grounds.
B. Furnish labor, instruments, appliances, equipment, and materials necessary to demonstrate to the Owner the installation performs as required.
C. ~~Owner~~ District has the right to perform independent tests of equipment furnished, to determine ~~whether or not~~whether equipment complies with requirements specified, and to proceed based on results obtained.
D. The system shall be fully tested and operational before final inspection. Test results shall be provided to the ~~Owner~~ District before final inspection.
E. System startup and electro-acoustical testing with the Techron TEF20 instrumentation shall be performed under the direct observation of the sound engineer responsible for preparation of the ~~Shop~~ Drawings.
F. Reproduction of speech shall be clear, high fidelity, and with all frequencies within range of system faithfully reproduced without detectable noise, hum and distortion.
G. Provide measured electro-acoustic test data indicating that first arrival levels over the specified frequency spectrum comply with Specification requirements at 6 locations as required by the Architect. Measurements shall be performed with the Techron TEF 20 and associated instruments. Provide both raw curves and1/3 octave smoothed curves for first ~~arrivals, and~~arrivals and provide full time-energy-frequency contours and computed RT60s of the athletic field from at least 6 locations as required by the Architect.

~~1.017 PROJECT RECORD DOCUMENTS~~

A. As-Built Documentation

1. Provide 3 Blue line copies size E (30" X 42") of Project site and building plans, indicating location of equipment, conduit, cable routing, ground vaults terminal cabinets, pull boxes and other installation information.
2. Provide two copies of the record Drawings in .DWG format prepared using the most recent version of AutoCAD on a labeled CD-ROM for use on a Windows platform.

    a. LAUSD utilizes layers as a key tool in controlling visibility of drawing elements and to provide consistent information between drawings, yet provide control over what is seen on each sheet. Public Address wiring shall be shown on a separate layer, labeled as "Public Address" that uses both building floor plans and conduit supporting structure layers below. The use of any version control blocks or company logos shall be on a layer separate from the premise wiring as-built drawings.

3. Floor plans indicating all devices, terminal cabinets and cross connect locations, conduit runs, ground vaults, wire types, cable routing of all cables, both underground and in each building with conduit fill and count, and as-built coding used on each cable.

    a. Drawings shall include block diagrams indicating all items and their point-to-point connections in a manner following floor and site plan layout. Drawings shall also include as-built single line diagram, cable site plot plan and floor plans indicating all cables, both underground and in each building with conduit, and as-built coding used on each cable
    b. Floor plans shall indicate all devices, terminal cabinets and cross connect locations, conduit runs, ground vaults, wire types, cable routing of all cables, both underground and in each building with conduit fill and count, and as-built coding used on each cable

B. Operating and Servicing Manuals, Record Drawings:

1. Deliver three copies of operating and servicing manual. Each complete manual shall be bound in three ring binders and all data shall be typewritten or drafted.
2. Each manual shall include a page with Project site and Project name, date of Substantial Completion, Contractor name, address, telephone, and fax numbers.
3. Each manual shall contain a letter, signed by an officer of the company indicating the beginning and ending date of any warranties described in subsection 1.07 of this specification and shall describe the companies' commitment to service the warranty during the terms specified.
4. Each manual shall include all instructions necessary for proper operation and servicing of system and shall include:

    (1) A single line diagram of the system indicating all items and their point-to-point connections in a manner following floor and site plan layout.
    (2) A complete 2 wire diagram of all connections made between components inside the system console.
    (3) A wiring destination schedule for each circuit leaving console and each rack.
    (4) All custom fabricated circuits, components and connections not detailed in the manufacturer's manuals shall have wiring diagrams detailing to component level, the manner in which the circuits are connected.

(5) A schematic diagram of each amplifier and other components, transistor complements and replacement part numbers.

b. Each manual shall also include as-built single line diagram, cable site plot plan and floor plans indicating all cables, both underground and in each building with conduit, and as-built coding used on each cable. Drawings Size A (8-1/2 inches x 11 inches) and size B (11 inches x 17 inches) shall be bound into the manual. Larger drawings shall be folded and inserted into transparent envelopes bound into the manual. Programming forms of each system shall be submitted with complete information.

1.018 PROTECTION

A. Protect the work of this section until substantial completion.

1.019 CLEANUP

A. Remove rubbish, debris and waste materials and legally dispose of off the project site.

1.014 DISTRCIT ORIENTATION

A. Before Substantial Completion, provide and arrange for a manufacturer's technical representative to instruct designated District personnel in correct operation of system. Instruction shall be provided on the Project site and shall be a minimum of 4 hours.

1.020 OWNER ORIENTATION

A. Before Substantial Completion, provide a four (4) hour Owner instruction period to designated Owner personnel. This training may be combined with instruction provided for the public address system.
B. Instruction shall be based on manufacturers written operating instructions covering those features of interest to the Owner and applicable to the Work.
C. After Substantial Completion, and before Final Completion, provide two (2) additional one (1) hour "refresher" instruction sessions at times agreed upon by the Owner.

attachment "a"

Safety and Technology Owners Quality Assurance

Site Location
Code / Name _____ _____
Network
Engineer _____ **IOR** _____
PM _____ **Electrical**
Recommendation _____ _____

Owner is to examine the following items based on the criteria defined in sections 25825. Owner is to examine 100% of rack contents. Other items not included in main rack will be tested at 10% rate. If deficiencies are noted, the system will be failed. As a courtesy, Owner will consider continuing testing at a 20% rate to determine the integrity of the system.

Autonomous Public Address System Check List	**Pass**	**Fail**
Check all conduit and raceway layout and installation for each low voltage systems and verify that they meet all project specifications and Record Documents.	-	-
Examine Head-end equipment installation, cable cross connection, system configuration for compliance with specification and conformance to Record Documents..	-	-
Equipment rack installation, including placement in the communications room, seismic bracing and attachment to the floor are in conformance with specification and Structural Engineers Submittal Drawings.	-	-
Are all cables clearly and indelibly marked?	-	-
Is the cross-connect field clearly marked?	-	-
Are all terminations punched down singly and cross-connected?	-	-
Has a wiring index and destination chart been placed within the system console?	-	-
Ensure that all active components, terminal cabinets, cross-connects are located in a secure location.	-	-
Verify that "program transmission modes" to Main Public Address/Intercom Console are fully functional.	-	-
Verify that all-call override is in place and functions per Specification.	-	-
Important Note: Failure on any category, constitute failure of the entire system	-	-

END OF SECTION

SECTION 26 27 26
WIRING DEVICES

PART 1 - PRODUCTS

1.01 GENERAL WIRING-DEVICE REQUIREMENTS

A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. Comply with NFPA 70.

C. RoHS compliant.

D. Comply with NEMA WD 1.

E. Device Color:

1. Wiring Devices Connected to Normal Power System: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.

2. Wiring Devices Connected to Essential Electrical System: Red

3. SPD Devices: Blue.

4. Isolated-Ground Receptacles: Orange triangle on face.

F. Wall Plate Color: For plastic covers/stain less steel, match device color.

G. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

1.02 STANDARD-GRADE RECEPTACLES, 125 V, 20 A

A. Duplex Receptacles, 125 V, 20 A

1. Manufacturers:

a. Eaton (Arrow Hart).
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Two pole, three wire, and self-grounding.

3. Configuration: NEMA WD 6, Configuration 5-20R.

4. Standards: Comply with UL 498 and FS W-C-596.

B. Tamper-Resistant Duplex Receptacles, 125 V, 20 A:

1. Manufacturers:

a. Eaton (Arrow Hart).
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle.

3. Configuration: NEMA WD 6, Configuration 5-20R.

4. Standards: Comply with UL 498 and FS W-C-596.

5. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" Article.

C. Weather-Resistant Duplex Receptacle, 125 V, 20 A:

1. Manufacturers:

a. Eaton (Arrow Hart).
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.

3. Configuration: NEMA WD 6, Configuration 5-20R.

4. Standards: Comply with UL 498.

5. "Marking" Subparagraph below requires compliance with NFPA 70, Articles 406.9 and 406.12.

6. Marking: Listed and labeled as complying with NFPA 70, "Receptacles in Damp or Wet Locations" Article.

D. Tamper- and Weather-Resistant Duplex Receptacles, 125 V, 20 A:

1. Manufacturers:

a. Eaton (Arrow Hart).
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.

3. Configuration: NEMA WD 6, Configuration 5-20R.

4. Standards: Comply with UL 498.

5. "Marking" Subparagraph below requires compliance with NFPA 70, Articles 406.9 and 406.12.

6. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" and "Receptacles in Damp or Wet Locations" articles.

1.03 STANDARD-GRADE RECEPTACLES, 125 V, 15 A

A. Duplex Receptacles, 125 V, 15 A

1. Manufacturers:

a. Eaton (Arrow Hart).
b. Leviton Manufacturing Co., Inc.
c. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Two pole, three wire, and self-grounding.

3. Configuration: NEMA WD 6, Configuration 5-15R.

4. Standards: Comply with UL 498 and FS W-C-596.

B. Tamper-Resistant Duplex Receptacles, 125 V, 15 A

1. Manufacturers:

a. Eaton (Arrow Hart).
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle.

3. Configuration: NEMA WD 6, Configuration 5-15R.

4. Standards: Comply with UL 498 and FS W-C-596.

5. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" Article.

C. Weather-Resistant Duplex Receptacle, 125 V, 15 A

1. Manufacturers:

a. Eaton (Arrow Hart).
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.

3. Configuration: NEMA WD 6, Configuration 5-15R.

4. Standards: Comply with UL 498.

5. Marking: Listed and labeled as complying with NFPA 70, "Receptacles in Damp or Wet Locations" Article.

D. Tamper- and Weather-Resistant Duplex Receptacles, 125 V, 15 A:

1. Manufacturers:

a. Eaton (Arrow Hart).
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.

3. Configuration: NEMA WD 6, Configuration 5-15R.

4. Standards: Comply with UL 498.

5. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" and "Receptacles in Damp or Wet Locations" articles.

1.04 USB RECEPTACLES

A. USB Charging Receptacles:

1. Manufacturers:

a. Eaton (Arrow Hart).
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Single-piece, rivet less, nickel-plated, all-brass grounding system. Nickel-plated, brass mounting strap.

3. USB Receptacles: Dual and quad, USB Type A, 5 V dc, and 2.1 A per receptacle (minimum).

4. Standards: Comply with UL 1310 and USB 3.0 devices.

B. Tamper-Resistant Duplex and USB Charging Receptacles:

1. Manufacturers:

a. Eaton (Arrow Hart).
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.

d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Single piece, rivet less, nickel-plated, all-brass grounding system. Nickel-plated, brass mounting strap. Integral shutters that operate only when a plug is inserted in the line voltage receptacle.

3. Line Voltage Receptacles: Two pole, three wire, and self-grounding; NEMA WD 6, Configuration 5-20R.

4. USB Receptacles: Dual USB Type A, 5 V dc, and 2.1 A per receptacle (minimum).

5. Standards: Comply with UL 498, UL 1310, USB 3.0 devices, and FS W-C-596.

6. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" Article.

1.05 GFCI RECEPTACLES, 125 V, 20 A

A. Duplex GFCI Receptacles, 125 V, 20 A :

1. Manufacturers:

a. Eaton (Arrow Hart).
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding.

3. Configuration: NEMA WD 6, Configuration 5-20R.

4. Type: Feed through.

5. Standards: Comply with UL 498, UL 943 Class A, and FS W-C-596.

B. Tamper- and Weather-Resistant, GFCI Duplex Receptacles, 125 V, 20 A:

1. Manufacturers:

a. Eaton (Arrow Hart).
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.

3. Configuration: NEMA WD 6, Configuration 5-15R.

4. Type: Feed through.

5. Standards: Comply with UL 498 and UL 943 Class A.

6. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" and "Receptacles in Damp or Wet Locations" articles.

1.06 TOGGLE SWITCHES, 120/277 V, 15 A

A. Single-Pole Switches, 120/277 V, 15 A

1. Manufacturers:

a. Eaton (Arrow Hart).
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

2. Standards: Comply with UL 20 and FS W-S-896.

B. Two-Pole Switches, 120/277 V, 15 A:

1. Manufacturers:

a. Eaton (Arrow Hart).
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

2. Comply with UL 20 and FS W-S-896.

3. Description: Contact surfaces treated with a coating that kills 99.9 percent of certain common bacteria within two hours when regularly and properly cleaned.

4. Standards: Comply with UL 20 and FS W-S-896.

C. Three-Way Switches, 120/277 V, 15 A

1. Manufacturers:

a. Eaton (Arrow Hart).
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

2. Comply with UL 20 and FS W-S-896.

D. Four-Way Switches, 120/277 V, 15 A:

1. Manufacturers:

a. Eaton (Arrow Hart).
b. Hubbell Incorporated; Wiring Device-Kellems.

c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

2. Standards: Comply with UL 20 and FS W-S-896.

E. Pilot-Light, Single-Pole Switches: 120/277 V, 15 A:

1. Manufacturers:

a. Eaton (Arrow Hart).
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Illuminated when switch is on.

3. Standards: Comply with UL 20 and FS W-S-896.

F. Lighted Single-Pole Switches, 120/277 V, 15 A:

1. Manufacturers:

a. Eaton (Arrow Hart).
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Handle illuminated when switch is on.

3. Standards: Comply with NEMA WD 1, UL 20, and FS W-S-896.

1.07 TOGGLE SWITCHES, 120/277 V, 20 A

A. Single-Pole Switches, 120/277 V, 20 A

1. Manufacturers:

a. Eaton (Arrow Hart).
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

2. Standards: Comply with UL 20 and FS W-S-896.

B. Two-Pole Switches, 120/277 V, 20 A:

1. Manufacturers:

a. Eaton (Arrow Hart).
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.

d. Pass & Seymour/Legrand (Pass & Seymour).

2. Comply with UL 20 and FS W-S-896.

C. Three-Way Switches, 120/277 V, 20 A >:

1. Manufacturers:

a. Eaton (Arrow Hart).
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

2. Comply with UL 20 and FS W-S-896.

D. Four-Way Switches, 120/277 V, 20 A

1. Manufacturers:

a. Eaton (Arrow Hart).
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

2. Standards: Comply with UL 20 and FS W-S-896.

E. Lighted Single-Pole Switches, 120/277 V, 20 A

1. Manufacturers:

a. Eaton (Arrow Hart).
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Handle illuminated when switch is on.

3. Standards: Comply with NEMA WD 1, UL 20, and FS W-S-896.

1.08 DECORATOR-STYLE DEVICES, 15 A

A. Decorator Duplex Receptacles, 125 V, 15 A

1. Manufacturers:

a. Eaton (Arrow Hart).
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Two pole, three wire, and self-grounding. Square face.

3. Configuration: NEMA WD 6, Configuration 5-15R.

4. Standards: Comply with UL 498.

B. Decorator, Tamper-Resistant, Duplex Receptacles, 125 V, 15 A,

1. Manufacturers:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.

3. Configuration: NEMA WD 6, Configuration 5-15R.

4. Standards: Comply with UL 498.

5. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" Article.

C. Decorator, Tamper- and Weather-Resistant, Duplex Receptacles, 125 V, 15 A:

1. Manufacturers:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.

3. Configuration: NEMA WD 6, Configuration 5-15R.

4. Standards: Comply with UL 498.

5. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" and "Receptacles in Damp or Wet Locations" articles.

D. Decorator Single-Pole Switches, 120/277 V, 15 A:

1. Manufacturers:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Comply with UL 20.

E. Decorator Single-Pole Lighted Switches,120/277 V, 15 A:

1. Manufacturers:

    a. Eaton (Arrow Hart).
    b. Hubbell Incorporated; Wiring Device-Kellems.
    c. Leviton Manufacturing Co., Inc.
    d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Square face illuminated when circuit is switched off.

3. Standards: Comply with UL 20.

1.09 DECORATOR-STYLE DEVICES, 20 A

A. Decorator Duplex Receptacles, 125 V, 20 A:

1. Manufacturers:

    a. Eaton (Arrow Hart).
    b. Hubbell Incorporated; Wiring Device-Kellems.
    c. Leviton Manufacturing Co., Inc.
    d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Two pole, three wire, and self-grounding. Square face.

3. Configuration: NEMA WD 6, Configuration 5-20R.

4. Standards: Comply with UL 498.

B. Decorator Tamper-Resistant Duplex Receptacles, 125 V, 20 A:

1. Manufacturers:

    a. Eaton (Arrow Hart).
    b. Hubbell Incorporated; Wiring Device-Kellems.
    c. Leviton Manufacturing Co., Inc.
    d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.

3. Configuration: NEMA WD 6, Configuration 5-20R.

4. Standards: Comply with UL 498.

5. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" Article.

C. Decorator, Tamper- and Weather-Resistant, Duplex Receptacles, 125 V, 20 A:

1. Manufacturers:

    a. Eaton (Arrow Hart).

b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.

3. Configuration: NEMA WD 6, Configuration 5-20R.

4. Standards: Comply with UL 498.

5. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" and "Receptacles in Damp or Wet Locations" articles.

D. Decorator Single-Pole Switches, 120/277 V, 20 A:

1. Manufacturers:

a. Eaton (Arrow Hart).
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

2. Comply with UL 20.

E. Decorator Single-Pole Lighted Switches,120/277 V, 20 A

1. Manufacturers:

a. Eaton (Arrow Hart).
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Square face illuminated when circuit is switched off.

3. Standards: Comply with UL 20.

1.10 OCCUPANCY SENSORS

A. Wall and ceiling Sensor Light Switch, Dual Technology:

1. Manufacturers:

a. Leviton
b. Sensor Switch
c. Watt Stopper

2. Description: Switchbox-mounted, combination lighting-control sensor and conventional switch lighting-control unit using dual (ultrasonic and passive infrared) technology.

3. Standards: Comply with UL 20.

4. Rated 960 W at 120 V ac for tungsten lighting, 10 A at 120 V ac or 10 A at 277 V ac for fluorescent or LED lighting, and 1/4 hp at 120 V ac.

5. Adjustable time delay of 15 minutes.

6. Able to be locked to Automatic and Manual-On mode.

7. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc.

8. Connections: Provisions for connection to BAS.

9. Connections: RJ-45 communications outlet.

10. Connections: Integral wireless networking.

1.11 TIMER LIGHT SWITCH

A. Digital Timer Light Switch:

1. Manufacturers:

a. Leviton
b. Intermatic
c. Watt Stopper
d. Tork

2. Description: Switchbox-mounted, combination digital timer and conventional switch lighting-control unit, with backlit digital display, with selectable time interval in [10] [20]-minute increments.

3. Standards: Comply with UL 20.

4. Rated 960 W at 120 V ac for tungsten lighting, 10 A at 120 V ac or 10 A at 277 V ac for fluorescent or LED lighting, and 1/4 hp at 120 V ac.

5. Integral relay for connection to BAS.

B. Fan-Speed Controls <Insert drawing designation>:

1. Manufacturers: Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Eaton (Arrow Hart).
b. Hubbell Premise Wiring.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Modular, 120 or 277-V ac, full-wave, solid-state units with integral, quiet on-off switches and audible frequency and EMI/RFI filters.

3. Standards: Comply with UL 1917.

4. Continuously adjustable slider 5 A.

5. Three-speed adjustable slider, 1.5 A.

C. Telephone Outlet <Insert drawing designation>:

1. Description: Single RJ – 45 jack for terminating[Category 6, balanced twisted pair cable complying with Section "Communications Copper Horizontal Cabling."

2. Standards: Comply with UL 1863.

1.12 DIMMERS

A. Wall-Box Dimmers:

2. Manufacturers: Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Eaton (Arrow Hart).
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.
d. Lutron Electronics Co., Inc.
e. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Modular, full-wave, solid-state dimmer switch with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.

3. Control: Continuously adjustable slider; with single-pole or three-way switching.

4. Standards: Comply with UL 1472.

5. Incandescent Lamp Dimmers: 120 V; control shall follow square law dimming curve. On-off switch positions shall bypass dimmer module.

a. 600 W; dimmers shall require no derating when ganged with other devices. Illuminated when "off."

6. LED Lamp Dimmer Switches: 0-10Volt Modular; compatible with LED lamps; trim potentiometer to adjust low-end dimming; capable of consistent dimming with low end not greater than 20 percent of full brightness.

1.13 WALL PLATES

A. Single Source: Obtain wall plates from same manufacturer of wiring devices.

B. Single and combination types shall match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.

2. Material for Finished Spaces: 0.035-inch- thick, satin-finished, Type 302 stainless steel or as selected by Architect.

3. Material for Unfinished Spaces: Galvanized steel.

4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

C. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

1.14 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:

1. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.

2. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.

3. Install wiring devices after all wall preparation, including painting, is complete.

C. Device Installation:

1. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.

2. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

D. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles down and on horizontally mounted receptacles to the right.

E. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

F. Dimmers:

1. Install dimmers within terms of their listing.

2. Verify that dimmers used for fan-speed control are listed for that application.

3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device, listing conditions in the written instructions.

G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

H. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

1.15 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test Instruments: Use instruments that comply with UL 1436.

2. Test Instrument for Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

B. Tests for Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.

2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.

3. Ground Impedance: Values of up to 2 ohms are acceptable.

4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.

5. Using the test plug, verify that the device and its outlet box are securely mounted.

C. Test straight-blade convenience outlets in patient-care areas for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz.

D. Wiring device will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION

SECTION 26 27 46

ELECTRIC VEHICLE CHARGING EQUIPMENT (ECS) - DC LEVEL 2

PART 1 - PRODUCTS

1.01 MANUFACTURERS

A. <Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ChargePoint.
2. Eaton.
3. Schneider Electric USA, Inc.

A. Source Limitations: Obtain EVSE from single manufacturer.

1.02 PERFORMANCE REQUIREMENTS

A. Seismic Performance: EVSE shall withstand the effects of earthquake motions determined according to ASCE/SEI 7 and California Building Codes.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Component Importance Factor: 1.5.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

C. Comply with UL 2231-1 and UL 2594.

D. Surge Withstand: 6 kV at 3000 A.

E. EV Charging Levels:

1. Single vehicle, DC Level 2 at up to100 kW per vehicle.

1.03 EVSE DESCRIPTION

A. Comply with SAE J1772 and CHAdeMO.

B. Comply with ADA-ABA Accessibility Guidelines.

C. Metering: Revenue or Nonrevenue grade meter as determined by Distrcit.

D. Input Power: 50 A, 480-V ac, 60 Hz, three phase per charger.

E. Integral GFCI.

F. Auto-GFCI fault retry.

G. EV Charging Equipment Mounting: Pedestal mount or Pole mount or Wall mount As required.

H. Enclosures:

1. Rated for environmental conditions at installed location.

a. Outdoor Locations: NEMA 250, Type 3R.

b. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
c. Lockable.
d. Tamper resistant.

I. EV Cable and Connectors:

1. SAE J1772 Combo or CHAdeMO connector as required.

2. Single or Double connectors with locking holster.

3. 18-foot or 24-foot cable with cable management system.

4. Field-replaceable connector and cable assembly.

J. Status Indicators:

1. LEDs to indicate power, charging, charging complete, system status, faults, and service.

K. Display Screen:

1. Daylight viewable, UV-protected display with human-machine interface capability.

2. Displays power, charging, charging complete, remote control, system status, faults, and service.

L. Networking:

1. WAN Communications: Cellular or GSM/GPRS or CDMA as determined by District.

2. LAN Communications: 802.11b/g/n 10/100/1000 Base T Ethernet.

3. Capable of remote configuration and reporting.

M. Payment System:

1. RFID or NFC or Contactless credit card reader.

2. PCI compliant.

3. Capable of remote control and authorization.

N. Charging Network: Compatible with the service provider selected by District. EV charging network.

1. Individual units shall be capable of indicating station status and availability.

1.04 DISCONNECT

A. Comply with requirements for disconnect in Section 262816 "Enclosed Switches and Circuit Breakers."

B. Lockable open, in NEMA 3R or NEMA 4X enclosure.

1.05 INSTALLATION

A. Comply with NECA 1 and NECA 413.

B. Concrete Base Mounting:

1. Install EVSE on 6-inch nominal-thickness concrete base. Comply with requirements for concrete base.

C. Wall Mounting:

1. Install EVSE so that its receptacles or holders are not less than 18 inches and not more than 4 feet above finished floor.

2. Ensure that EVSE is plumb and rigid without distortion of box.

3. Secure EVSE according to manufacturer's written instructions.

D. Pole Mounting:

1. Allow a minimum of 24 inches of clearance around EV charging equipment.

2. EVSE receptacles or holders shall be not less than 24 inches and not more than 4 feet above finished grade.

3. Mount EVSE plumb and rigid without distortion of enclosure.

4. Secure EVSE according to manufacturer's written instructions.

E. Comply with mounting and anchoring requirements specified in Section "Seismic Controls for Electrical Systems."

F. Wiring Method: Install cables in raceways and cable trays. Conceal raceway and cables, except in unfinished spaces.

1. Comply with requirements for raceways and boxes specified in Section ”Raceways and Boxes for Electrical Systems."

2. Comply with requirements for underground raceways and enclosures specified "Underground Ducts and Raceways for Electrical Systems."

G. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

H. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

I. Disconnect: Install disconnect in a readily accessible location.

J. Cybersecurity:

1. Software:

a. Coordinate security requirements with IT department responsible for IT security.
b. Ensure that latest stable software release is installed and properly operating.
c. Disable or change default passwords to password using a combination of uppercase and lower letters, numbers, and symbols at least eight characters in length. Record passwords and turn over to party responsible for system operation and administration.

2. Hardware:

a. Coordinate location and access requirements with IT department responsible for IT security.
b. Enable highest level of wireless encryption that is compatible with District’s ICT network.
c. Disable dual network connections.

1.06 CONNECTIONS

A. Connect wiring according to Section” Low-Voltage Electrical Power Conductors and Cables."

B. Comply with grounding requirements in "Grounding and Bonding for Electrical Systems."

C. Comply with requirements for installation of conduit in Section” Raceways and Boxes for Electrical Systems." Drawings indicate general arrangement of conduit, fittings, and specialties.

D. Tighten electrical connectors and terminals according to manufacturer's published torque-

tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

E. Verify that all electrical connections have been made according to the manufacturer's instructions. Remove all burrs, shavings, and detritus from inside the enclosure.

F. After confirming all connections, install covers and tighten fasteners to according to manufacturer's instructions.

1.07 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section" Identification for Electrical Systems."

1.08 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Tests and Inspections:

1. For each unit of EV charging equipment, perform the following tests and inspections:

a. Unit self-test.

b. Operation test with load bank.

c. Operation test with EV.

d. Network communications test.

C. EVSE will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION

SECTION 26 28 13
FUSES

PART 1 - PRODUCTS

1.01 MANUFACTURERS

A. Manufacturers:

1. Bussmann, an Eaton business.
2. Littelfuse, Inc.

1.02 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

1. Type RK-1: 250/600-V, 0 - to 600-A rating, 200 kAIC, time delay.

2. Type RK-5: [250/600-V, 0 - to 600-A rating, 200 kAIC, time delay.

3. Type CC: 600-V,0 - to 30-A rating, 200 kAIC fast acting/time delay.

4. Type J: 600-V, zero- to 600-A rating, 200 kAIC, time delay.

5. Type L: 600-V, 601- to 6000-A rating, 200 kAIC, time delay.

6. Type T: 250-V, 0 - to 1200-A, 600-V, zero- to 800-A, rating, 200 kAIC, very fast acting , time delay.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA FU 1 for cartridge fuses.

D. Comply with NFPA 70.

E. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

F. Provide spare fuse cabinet with one set of fuses for each type with identification.

1.03 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Install spare-fuse cabinet(s) in location as indicated in the field by Architect/Construction Manager/District.

1.04 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Section "Identification for Electrical Systems" and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION

SECTION 26 28 16
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - PRODUCTS

1.01 REQUIREMENTS

A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to **ASCE/SEI 7** and California Building Codes.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified **and the unit will be fully operational after the seismic event**."

1.02 GENERAL REQUIREMENTS

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer same as Switchboards and panel Boards.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

D. Comply with NFPA 70.

1.03 FUSIBLE SWITCHES

A. Manufacturers:

1. Eaton.
2. General Electric Company.
3. Square D; by Schneider Electric.

A. Type HD, Heavy Duty:

1. **Single** throw.

2. **Three** poles.

3. **240** pr **600** -V ac as applicable.

4. 1200 A and smaller.

5. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate **specified** fuses.

6. Lockable handle with capability to accept three padlocks and interlocked with cover in

closed position.

B. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.

2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.

4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.

5. Service-Rated Switches: Labeled for use as service equipment.

1.04 NONFUSIBLE SWITCHES

B. Manufacturers:

1. Eaton.
2. General Electric Company.
3. Square D; by Schneider Electric.

A. Type GD, General Duty, Three Pole, Single Throw, 240-V ac, 600 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

B. Type HD, Heavy Duty, Three Pole, Single Throw, **240** or **600** - V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.

2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.

4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.

5. Service-Rated Switches: Labeled for use as service equipment.

1.05 SHUNT TRIP SWITCHES

C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bussmann, an Eaton business.
2. Littelfuse, Inc.

A. General Requirements: Comply with **ASME A17.1,** UL 50, and UL 98, with Class J fuse block and 200-kA interrupting and short-circuit current rating.

B. Type HD, Heavy-Duty, Three Pole, Single-Throw Fusible Switch: **240**/**600**-V ac, **30**/**60**/**100** A; UL 98 and NEMA KS 1; integral shunt trip mechanism; horsepower rated, with clips or bolt pads to accommodate **specified** fuses; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

C. Type HD, Heavy-Duty, Three Pole, Single-Throw Non fusible Switch: **240**/**600**-V ac, **30**/**60**/**100** A; UL 98 and NEMA KS 1; integral shunt trip mechanism; horsepower rated, lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

D. Control Circuit: 120-V ac; obtained from **integral control power transformer, with primary and secondary fuses** with a control power **transformer** of enough capacity to operate shunt trip, pilot, indicating and control devices.

E. Accessories:

1. Oil tight key switch for key-to-test function.
2. Oil tight **green** ON pilot light.
3. Isolated neutral lug; **100** percent rating.
4. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
5. Three-pole, double-throw, fire-safety and alarm relay; **120-V ac** coil voltage.
6. Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.
7. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
8. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
9. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
10. Service-Rated Switches: Labeled for use as service equipment.

1.06 MOLDED-CASE CIRCUIT BREAKERS

D. Manufacturers:

1. Eaton.
2. General Electric Company.
3. Square D; by Schneider Electric.

A. Circuit breakers shall be constructed using glass-reinforced insulating material. Current carrying components shall be completely isolated from the handle and the accessory mounting area.

B. Circuit breakers shall have a toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. The circuit-breaker handle shall be over center, be trip free, and reside in a tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon shall be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit-breaker tripping mechanism for maintenance and testing purposes.

C. The maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker. Circuit breakers shall be **100 percent rated or Fuse/circuit breaker** combinations for series connected interrupting ratings shall be listed by UL as recognized component combinations. Any series rated combination used shall be marked on the end-use equipment along with the statement "Caution - Series Rated System. _____ Amps Available. Identical Replacement Component Required."

D. MCCBs shall be equipped with a device for locking in the isolated position.

E. Lugs shall be suitable for **140 deg F** rated wire on 125-A circuit breakers and below **167 deg F (**rated wire] **94 deg F** rated wire, sized according to the **167 deg F** temperature rating in NFPA 70.

F. Standards: Comply with UL 489 with interrupting capacity to comply with available fault currents.

G. Thermal-Magnetic Circuit Breakers: Inverse time-current thermal element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

H. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

I. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:

1. Long- and short-time pickup levels.

2. Long- and short-time time adjustments.

3. Ground-fault pickup level, time delay, and I-squared t response.

J. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

K. Accessories:

1. Standard frame sizes, trip ratings, and number of poles.

2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.

3. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.

4. Auxiliary Contacts: **Two SPDT switches** with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.

5. Alarm Switch: One **NO** and **NC** contact that operates only when circuit breaker has tripped.

1.07 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

B. Enclosure Finish: The enclosure shall be [finished with] [gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (NEMA 250 Type 1)] [gray baked enamel paint, electrodeposited on cleaned, phosphatized galvannealed steel (NEMA 250 Types 3R, 12)] [a brush finish on Type 304 stainless steel (NEMA 250 Type 4-4X stainless steel)] [copper-free cast aluminum alloy (NEMA 250 Types 7, 9)].

C. Conduit Entry: NEMA 250 Types 4, 4X, and 12 enclosures shall contain no knockouts. NEMA 250 Types 7 and 9 enclosures shall be provided with threaded conduit openings in both end walls.

D. Operating Mechanism: The circuit-breaker operating handle shall be [externally operable with the operating mechanism being an integral part of the box, not the cover] [directly operable through the front cover of the enclosure (NEMA 250 Type 1)] [directly operable through the dead front trim of the enclosure (NEMA 250 Type 3R)] [externally operable with the operating mechanism being an integral part of the cover (NEMA 250 Types 7, 9)]. The cover interlock mechanism shall have an externally operated override. The override shall not permanently disable the interlock mechanism, which shall return to the locked position once the override is released. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.

E. Enclosures designated as NEMA 250 Type 4, 4X stainless steel, 12, or 12K shall have a dual cover interlock mechanism to prevent unintentional opening of the enclosure cover when the circuit breaker is ON and to prevent turning the circuit breaker ON when the enclosure cover is open.

F. NEMA 250 Type 7/9 enclosures shall be furnished with a breather and drain kit to allow their use in outdoor and wet location applications.

1.08 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the

following environmental ratings.

1. Indoor, Dry and Clean Locations: NEMA 250, **Type 1**.

2. Outdoor Locations: NEMA 250, **Type 3R or Type 4X**.

3. Kitchen, Wash-Down Areas: NEMA 250, Type 4X or stainless steel.

4. Other Wet or Damp, Indoor Locations: NEMA 250, **Type 4**.

5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

1.09 INSTALLATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

C. Comply with mounting and anchoring requirements specified in Section "Seismic Controls for Electrical Systems."

D. Install fuses in fusible devices.

E. Comply with NFPA 70 and NECA 1.

F. Set field-adjustable circuit-breaker trip ranges.

1.10 IDENTIFICATION

A. Comply with requirements in Section "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.

2. Label each enclosure with engraved metal or laminated-plastic nameplate.

1.11 FIELD QUALITY CONTROL

A. Perform tests and inspections

B. Tests below are specific to switches and are derived from the NETA ATS.

C. Tests and Inspections for Switches:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, grounding, and clearances.
c. Verify that the unit is clean.

d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
e. Verify that fuse sizes and types match the Specifications and Drawings.
f. Verify that each fuse has adequate mechanical support and contact integrity.
g. Inspect bolted electrical connections for high resistance using one of the two following methods:

1) Use a low-resistance ohmmeter.

i) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

i) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.
i. Verify correct phase barrier installation.
j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.

2. Electrical Tests:

a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
b. Measure contact resistance across each switchblade fuse holder. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
e. Perform ground fault test according to NETA ATS 7.14 "Ground Fault Protection Systems, Low-Voltage."

D. Tests and Inspections for Molded Case Circuit Breakers:

1. Visual and Mechanical Inspection:

a. Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.
b. Inspect physical and mechanical condition.

c. Inspect anchorage, alignment, grounding, and clearances.
d. Verify that the unit is clean.
e. Operate the circuit breaker to ensure smooth operation.
f. Inspect bolted electrical connections for high resistance using one of the two following methods:

1) Use a low-resistance ohmmeter.

i) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

i) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

g. Inspect operating mechanism, contacts, and chutes in unsealed units.
h. Perform adjustments for final protective device settings in accordance with the coordination study.

2. Electrical Tests:

a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
c. Perform a contact/pole resistance test. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
d. Perform insulation resistance tests on all control wiring with respect to ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values shall be no less than two megohms.
e. Determine the following by primary current injection:

1) Long-time pickup and delay. Pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
2) Short-time pickup and delay. Short-time pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current

characteristic tolerance band, including adjustment factors.

3) Ground-fault pickup and time delay. Ground-fault pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
4) Instantaneous pickup. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances.

f. Test functionality of the trip unit by means of primary current injection. Pickup values and trip characteristics shall be as specified and within manufacturer's published tolerances.

g. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils shall be as indicated by manufacturer.

h. Verify correct operation of auxiliary features such as trip and pickup indicators; zone interlocking; electrical close and trip operation; trip-free, anti-pump function; and trip unit battery condition. Reset all trip logs and indicators. Investigate units that do not function as designed.

i. Verify operation of charging mechanism. Investigate units that do not function as designed.

3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

E. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

1. Test procedures used.

2. Include identification of each enclosed switch and circuit breaker tested and describe test results.

3. List deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION

SECTION 26 29 23
VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 - PRODUCTS

1.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB Low Voltage HVAC Drives.
2. Eaton.
3. General Electric Company.
4. Schneider Electric USA, Inc.

1.02 SYSTEM DESCRIPTION

A. General Requirements for VFCs:

1. VFCs and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508A, UL 508C.

B. Application: Constant torque and variable torque.

C. VFC Description: Variable-frequency motor controller, consisting of power converter that employs pulse-width-modulated inverter, factory built and tested in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.

1. Units suitable for operation of NEMA MG 1 motors.

2. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

D. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

E. Output Rating: Three phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range or 66 Hz, with torque constant as speed changes; maximum voltage equals input voltage.

F. Unit Operating Requirements:

1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFC input voltage rating.

2. Input AC Voltage Unbalance: Not exceeding 3 percent.

3. Input Frequency Tolerance: Plus, or minus 3 percent of VFC frequency rating.

4. Minimum Efficiency: 97 percent at 60 Hz, full load.

5. Minimum Displacement Primary-Side Power Factor: 98 percent under any load or speed condition.

6. Minimum Short-Circuit Current (Withstand) Rating: as required and applicable in kA.

7. Ambient Temperature Rating: Not less than 32 deg F and not exceeding 104 deg F.

8. Humidity Rating: Less than 95 percent (noncondensing).

9. Altitude Rating: Not exceeding 3300 feet.

10. Vibration Withstand: Comply with NEMA ICS 61800-2.

11. Overload Capability: 1.5 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.

12. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.

13. Speed Regulation: Plus, or minus 5/10 percent.

14. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.

15. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.

G. Inverter Logic: Microprocessor based, 32 bit, isolated from all power circuits.

H. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.

1. Signal: Electrical.

I. Internal Adjustability Capabilities:

1. Minimum Speed: 5 to 25 percent of maximum rpm.

2. Maximum Speed: 80 to 100 percent of maximum rpm.

3. Acceleration: 0.1 to 999.9seconds.

4. Deceleration: 0.1 to 999.9 seconds.

5. Current Limit: 30 to minimum of 150 percent of maximum rating.

J. Self-Protection and Reliability Features:

1. Surge Suppression: Factory installed as an integral part of the VFC, complying with UL 1449 SPD, Type 1 or Type 2.

2. Surge Suppression: Field-mounted surge suppressors complying with Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits," UL 1449 SPD, Type 2.

3. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.

4. Under- and overvoltage trips.

5. Inverter overcurrent trips.

6. VFC and Motor-Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor-overload alarm and trip; settings selectable via the keypad.

7. Critical frequency rejection, with three selectable, adjustable dead bands.

8. Instantaneous line-to-line and line-to-ground overcurrent trips.

9. Loss-of-phase protection.

10. Reverse-phase protection.

11. Short-circuit protection.

12. Motor-overtemperature fault.

13. <Insert protection or reliability feature>.

K. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

L. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.

M. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

N. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

O. Motor Temperature Compensation at Slow Speeds: Adjustable current fallback based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

P. Integral Input Disconnecting Means and OCPD: UL 489, instantaneous-trip circuit breaker or UL 489, molded-case switch, with power fuse block and current-limiting fuses or UL 489, thermal-magnetic circuit breaker with pad-lockable, door-mounted handle mechanism.

1. Disconnect Rating: Not less than 115 percent of VFC input current rating.

2. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFC input current rating, whichever is larger.

3. Auxiliary Contacts: NO or NC, arranged to activate before switch blades open.

4. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.

5. NC and NO alarm contact that operates only when circuit breaker has tripped.

1.03 PERFORMANCE REQUIREMENTS

A. Seismic Performance: VFCs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7. The designated VFCs shall be tested and certified by an NRTL as meeting the ICC-ES AC 156 test procedure requirements.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.04 CONTROLS AND INDICATION

A. Status Lights: Door-mounted LED indicators displaying the following conditions:

1. Power on.

2. Run.

3. Overvoltage.

4. Line fault.

5. Overcurrent.

6. External fault.

B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English-language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.

1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.

2. Security Access: Provide electronic security access to controls through identification and password with at least one level of access: View only; view and operate; and view, operate, and service.

a. Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.

C. Historical Logging Information and Displays:

1. Real-time clock with current time and date.

2. Running log of total power versus time.

3. Total run time.

4. Fault log, maintaining last Six faults with time and date stamp for each.

D. Indicating Devices: Digital display and additional readout devices as required, mounted flush in VFC door and connected to display VFC parameters including, but not limited to:

1. Output frequency (Hz).
2. Motor speed (rpm).
3. Motor status (running, stop, fault).
4. Motor current (amperes).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (V dc).
9. Set point frequency (Hz).
10. Motor output voltage (V ac).
11. <Insert parameter>.

E. Control Signal Interfaces:

1. Electric Input Signal Interface:

   a. A minimum of two programmable analog inputs: 0- to 10-V dc, 4- to 20-mA dc, Operator-selectable "x"- to "y"-mA dc.

   b. A minimum of six multifunction programmable digital inputs.

2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the DDC system for HVAC or other control systems:

   a. 0- to 10-V dc.
   b. 4- to 20-mA dc.
   c. Potentiometer using up/down digital inputs.
   d. Fixed frequencies using digital inputs.
   e. Output Signal Interface: A minimum of one programmable analog output signal(s) 0- to 10-V dc, 4- to 20-mA dc, Operator-selectable "x"- to "y"-mA dc, which can be configured for any of the following:
   f. Output frequency (Hz).
   g. Output current (load).
   h. DC-link voltage (V dc).
   i. Motor torque (percent).
   j. Motor speed (rpm).
   k. Set point frequency (Hz).
   l. <Insert indication>.

F. PID Control Interface: Provides closed loop set point, differential feedback control in response to dual feedback signals. Allows for closed-loop control of fans and pumps for pressure, flow, or temperature regulation.

1. Number of Loops: One or Two.

1.05 BYPASS SYSTEMS

A. Bypass Operation: Manually transfers motor between power converter output and bypass circuit. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.

B. Bypass Mode: Manual operation only; requires local operator selection at VFC. Transfer between power converter and bypass contactor, and retransfer shall only be allowed with the motor at zero speed.

C. Bypass Controller: Two-contactor-style bypass allows motor operation via the power converter or the bypass controller with input isolating switch and barrier arranged to isolate the power converter and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode].

1. Bypass Contactor: Load-break, NEMA-rated contactor.

2. Output Isolating Contactor: Non-load-break, NEMA - rated contactor.

3. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.

D. Bypass Contactor Configuration: Full-voltage (across-the-line type.

1. NORMAL/BYPASS selector switch.

2. HAND/OFF/AUTO selector switch.

3. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFC while the motor is running in the bypass mode.

4. Contactor Coils: Pressure-encapsulated type with coil transient suppressors.

a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
b. Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.

5. Control Circuits: 120 V ac; obtained from integral CPT, with primary and secondary fuses.

a. CPT Spare Capacity: 250 VA.

6. Overload Relays: NEMA ICS 2.

1.06 OPTIONAL FEATURES

A. Damper control circuit with end-of-travel feedback capability.

B. Firefighter's Override (Smoke Purge) Input: On a remote contact closure from the smoke-control fan controller , this password-protected input:

1. Overrides all other local and external inputs (analog/digital, serial communication, and all keypad commands).

2. Forces VFC to operate motor, without any other run or speed command, at a field-adjustable, preset speed.

3. Forces VFC to transfer to bypass mode and operate motor at full speed.

4. Causes display of override mode on the VFC display.

5. Reset VFC to normal operation on removal of override signal automatically.

C. Communication Port: RS-232 port, USB 3.0 port, or equivalent connection capable of connecting a printer and a lap top computer.

1.07 ENCLOSURES

A. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.

1. Dry and Clean Indoor Locations: Type 1

2. Outdoor Locations: Type 3R or Type 4X.

3. Kitchen/Wash-Down Areas: Type 4X.

4. Other Wet or Damp Indoor Locations: Type 4.

5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.

B. Plenum Rating: UL 1995; NRTL certification label on enclosure, clearly identifying VFC as "Plenum Rated."

1.08 ACCESSORIES

A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFC enclosure cover unless otherwise indicated.

1. Push Buttons: Covered.

2. Pilot Lights: Push to test.

3. Selector Switches: Rotary type.

B. NC/NO bypass contactor auxiliary contact(s).

C. Control Relays: Auxiliary and adjustable solid-state time-delay relays.

D. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.

1. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.

E. Supplemental Digital Meters:

1. Elapsed-time meter.

2. Kilowatt meter.

3. Kilowatt-hour meter.

F. Breather and drain assemblies, to maintain interior pressure and release condensation in NEMA 250, Type 4/Type 4X/Type 12 enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

G. Space heaters, with NC auxiliary contacts, to mitigate condensation in NEMA 250, Type 3R /Type 4X/Type 12 enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

H. Cooling Fan and Exhaust System: For NEMA 250, Type 1]/Type 12; UL 508 component recognized: Supply fan, with composite/stainless-steel intake and exhaust grills and filters; 120 -V ac; obtained from integral CPT.

1.09 INSTALLATION

A. Wall-Mounting Controllers: Install with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor, unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."

B. Roof-Mounting Controllers: Install VFC on roofs with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished roof surface unless otherwise indicated, and by bolting units to curbs or mounting on freestanding, lightweight, structural-steel channels bolted to curbs. Seal roof penetrations after raceways are installed.

C. Seismic Bracing: Comply with requirements specified in Section "Seismic Controls for Electrical Systems."

D. Install fuses in each fusible-switch VFC.

E. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

F. Comply with NECA 1.

1.10 CONTROL WIRING INSTALLATION

A. Install wiring between VFCs and remote devices and facility's central-control system. Comply with requirements in Section "Control-Voltage Electrical Power Cables."

B. Bundle, train, and support wiring in enclosures.

1.11 IDENTIFICATION

A. Identify VFCs, components, and control wiring. Comply with requirements for identification specified in Section "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.

2. Label each VFC with engraved nameplate.

3. Label each enclosure-mounted control and pilot device.

1.12 FIELD QUALITY CONTROL

A. Perform tests and inspections with the assistance of a factory-authorized service representative].

B. Acceptance Testing Preparation:

1. Test insulation resistance for each VFC element, bus, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

C. Tests and Inspections:

1. Inspect VFC, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.

2. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.

3. Test continuity of each circuit.

4. Verify that voltages at VFC locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Architect/Construction Manager/District before starting the motor(s).

5. Test each motor for proper phase rotation.

6. Perform tests according to the Inspection and Test Procedures for Adjustable Speed Drives stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. VFCs will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies the VFC and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

1.13 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

C. Adjust the trip settings of instantaneous-only circuit breakers and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to 6 times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed 8 times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Architect/Construction Manager/District before increasing settings.

D. Set the taps on reduced-voltage autotransformer controllers.

E. Set field-adjustable pressure switches.

1.14 DEMONSTRATION

A. Train District's maintenance personnel to adjust, operate, reprogram, and maintain VFCs.

END OF SECTION

SECTION 26 32 13
GENERATORS

1.01 REQUIREMENTS

A. Engine generator assembly and accessories shall provide source of power for Level 1 and Level 2 applications in accordance with NFPA 110.

B. The packaged engine generator set shall be complete and consist of engine generator with all parts, radiator, sound attenuated enclosure, exhaust silencer with insulation, fully rated circuit breakers, emergency power off switch, under base fuel tank, batteries, chargers, lights inside enclosure, panelboard, etc.

C. Provide a generator set that fully complies with the applicable emission regulations of the South Coast Air Quality Management District (SCAQMD) at the time it is to be commissioned and go into operation.

D. Comply with South Coast Air Quality Management District (SCAQMD), current applicable requirements, including but not limited to:

1. SCAQMD Permitting Assistance for an Emergency Generator that is subject to Rule1470 Emission Reduction & Rule 212 30-day Public Notification Requirements.

2. The South Coast Air Quality Management District (SCAQMD) has mandated that diesel generators over 50 brake horsepower must have a permit to construct before installation and a permit to operate when commissioning, 30-day public notification is also required by state law and SCAQMD Rule 212.

3. The services provided shall include the following:

a. Task 1: Regulatory review and submit application documentation to secure permit.
b. Assist the District perform a regulatory review to help ensure the new generator meet the SCAQMD regulatory requirements. Prepare the necessary application documentation and engineering calculation to help the District secure the Permit to Construct & Operate. The document shall be signed and submitted to SCAQMD processing.
c. Advise the district on the most current SCAQMD regulatory development and how it may affect the acceptability of the proposed generator make and model.
d. Provide an in-depth review of the relevant documents to help ensure accurate technical information is provided or available to the SCAQMD in a timely manner.
e. Assist the District evaluate the compliance status of the proposed generator set and emission control device, when applicable, before submitting the application package.
f. Research emission data and other specification of the regulated equipment units as required by the SCAQMD during the permitting process.
g. Submit application documentation under a certification of a SCAQMD Certified Permitting Professional (CPP). Applications submitted by a CPP will be placed in a preferential track at the SCAQMD. This should be helpful in securing the permitting coverage in a timely manner. Whenever it is applicable, shall provide adequate computerized air modeling and health risk assessment to satisfy the New Source Review or AB2588 requirements.
h. Serve as primary liaison with SCAQMD relating to the permitting process.
i. Complete the AQMD Rule 212 30-day Public Notification requirements.
j. Before the issuance of a permit the applicant must successfully complete the public notification procedure as required by State laws and SCAQMD Rule 212. The public notice must be distributed to each address within a 1,000 feet radius of the outer boundary of the property.
k. Assist District fulfill the mandatory notification requirements. In the event there

are concerns from the public during the 30-day period directly related to the proposed generator installation and operation,

E. Submittals:

1. Manufacturer's product data sheets for all components.
2. Dimensioned drawings for the generator and a project specific equipment layout with dimensions of generator, adjacent equipment and structures.
3. Wiring diagrams and interconnection diagrams
4. Generator / Fire Alarm interface
5. Installation Instructions
6. Programming Manuals
7. Factory Test Certification
8. SAQMD Certification
9. Warranty Certificate
10. Service Agreement

PART 2 - PRODUCTS

A. Manufacturers:

1. MTU Onsite Energy
2. Caterpillar
3. Cummins
4. Kohler

B. All the components, including the exhaust silencer and particulate filter shall be installed inside the weather-proof enclosure.

C. All accessories shall be provided with the generator set, factory installed; including but not limited to batteries, cables, racks, battery charger, EPO, controller, panelboard, jacket heater, mat heater, and lights.

D. The discharge air section shall be an acoustic turn scoop at opposite end to discharge the air in an upward direction.

E. The interior of enclosure shall be covered with acoustical insulation made of mineral wool and in compliance with UL Fire Hazard Ratings as per ASTM specification E-84 or latest edition.

F. Provide (1) GFCI type duplex receptacles with weatherproof cover plate mounted inside of the the generator enclosure.

G. The weather-protective sound attenuated enclosure shall be rated for 65dBA measured at 23' for all projects within 100' of any occupied building and 75dBA beyond 100' of any occupied building.

H. The fuel tank shall be UL listed double-wall, under-base tank, rated for a minimum of 24-hour continuous operation or as directed by the District Representative. The fuel tank shall include Mechanical overfill prevention valve and 5-gallon spill containment with leak detection and four level sensors - high alarm, high, low and low alarm.

I. Generator sets shall have integral panelboard to serve all genset accessories, fed from the associated building or structure's normal power system.

J. Generator sets shall have emergency power off (EPO) switch as part of generator set controller and a remote EPO switch in line of site of the generator enclosure or as directed by local fire department.

K. Provide a digital generator-mounted control panel. The controller shall be a fully featured power metering and protective relaying with engine and generator control and monitoring capability. The panel shall be capable to tie to a District BMS System (Honeywell EBI with BACnet protocol).

L. The generator shall be ANSI/NEMA MG 1, class F, 0.8 power factor, 130°C continuous temperature rise, 3-phase, 4-pole, 60 Hz, re- connectable brushless synchronous type with brushless exciter.

M. The generator shall have a permanent magnet generator (PMG) excitation in accordance with IEEE standards for 50°C rise. The PMG and controls shall be capable of sustaining and regulating current supplied to a 1-phase or 3-phase fault at approximately 300% of rated current for 10 seconds.

N. The generator shall have a digital voltage regulator (V/Hz) to match engine and generator characteristics, with voltage regulation ±1/4% during steady state conditions and ±1% from no load to full load. Generator output voltage drift shall not exceed ±1% of rated value over ambient temperature range of 40°C to 70°C.

O. The governor shall be electronic Isochronous type to maintain engine speed to within 0.25% at steady state and 5% at no load to full load with recovery period of 3 seconds after sudden load changes.

P. Batteries shall be low-maintenance type (1000 hours) and have a minimum of 5-year life.

Q. Battery charger shall be current limiting, designed to float at 2.17V per cell and equalize at 2.33V per cell. Include overload protection, full wave rectifier, DC voltmeter and ammeter and 120 volts AC fused input. Include alarm contacts for charger malfunction, low and high battery voltage.

R. Breakers shall be NEMA AB 1 molded case with two-step stored energy operation on generator output with integral solid-state trip unit. Circuit breaker(s) shall have minimum AIC rating based on fault current analysis, be 100% rated, solid state with ground fault wired only for alarm annunciation.

S. The generator controller shall be equipped with customer programmable protective relaying which is used as alarm or shutdown to protect against “Under-voltage”, “Over-voltage”, “Under–frequency”, “Over-frequency, “Over-current” and “Reverse-power”.

T. Provide remote annunciator panel, coordinate location with Architect.

U. Provide an active Particulate Matter (DPF) Filter sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer’s engine backpressure requirements. Active DPF shall also meet the following:

1. Filter manufacturer must have California Air Resource Board (CARB) verification to Level 3+ for emissions reduction.

2. Shall be a minimum of 80% porous, and shall regenerate when energized electrically, independent of exhaust temperatures

3. Shall include differential pressure sensors to initiate and control regeneration process as a function of backpressure. Backpressure must not exceed 90% of engine manufacturer’s specification.

4. Shall receive power directly from the Genset and shall operate when Genset is in operation. All wiring, conduit, transformer and breaker installation shall meet NEC/CEC and be

included by the Genset supplier.

5. Shall meet the following minimum requirements:
    a. PM Reduction: 85%
    b. Hydrocarbon reduction: 75%
    c. Carbon Monoxide reduction: 90%
    d. Nitrogen Dioxide reduction: 40%
6. Shall be sized to limit backpressure to a maximum of 90% of the allowable limit specified by engine manufacturer.
7. Engine exhaust outlets shall be coupled to DPF(s) by means of adequately sized section of stainless corrugated flex. Flex connector(s) shall be flanged at both ends for mating to the engine and exhaust system.
8. Shall give operators visual notification and contact closure when:
    a. Operating normally
    b. Backpressure exceeds normal operation conditions.
9. Must be able to operate effectively within the engine manufacturer's recommended operating profile, while operating within the acceptable backpressure range as specified by engine manufacturer without limiting variation in engine loading levels and/or number of cold starts beyond specification by engine manufacturer.

V. Natural gas generators are used, it shall be provided with a dedicated gas pressure regulator per genset and compliance with all regulations.

W. Emergency primary and secondary vents shall extend up and out of enclosure.

X. Passive particulate matter filters are not permitted.

2.02 INSTALLATION

A. Install generator set in accordance with manufacturer's written instructions at a location determined by Architect and acceptable to district.

B. Mount on structural steel base, supported on suitable spring-type vibration isolators sized for minimum 1" static deflection that meet the seismic requirements of the State of California.

C. Provide a minimum of 6 to 8-inch-high (or higher per anchorage and seismic calculations) concrete housekeeping pad or structural platform beneath equipment that extends maximum of 6" only above finished grade. Coordinate actual sizes of equipment base with shop drawings and extend pad or platform 6 inches in all directions beyond overall dimension of base.

D. Clearances shall follow the CEC and manufacturer's recommendations; preferred clearances include 8' clear in front of generator for air intake and minimum of 5' clearance around sides.

2.03 EVALUATION

A. The design specifications shall list of items or systems requiring testing, evaluation, verification, or commissioning.

B. Documentation required:

1. Test reports: An Independent testing agency (engaged by the contractor) and manufacturer's authorized dealer shall provide test reports for all generator components, connections/terminations, ventilation, exhaust, fuel, battery, EPOs, protective devices, etc.

C. Testing:

1. Manufacturer's Authorized Dealer Shop tests, witnessed by the District's Representative:

a. Run at rated full load and 0.8 power factor for 2 hours minimum with Load Bank or time required to reach operating temperature.
b. Monitor and record the required data at 15-minute intervals for Ambient temperature, Voltage, Frequency, Ampere, Power Factor, Kilowatts, Oil & Fuel pressure, Jacket water temperature, DC volts, Date & time of day.
c. Monitor voltage regulation.
d. Verify transient and steady-state governing.
e. Verify single step load pickup.
f. Monitor engine operating parameters; coolant temperature, oil pressure and alike.
g. Operate safety shutdowns.
h. Do not use engine generator control instruments for reading load bank values. Compare load bank measured values to generator control instrument values. Calibrate generator instruments as required.

D. Field inspection and testing:

1. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection for "AC Generators and for Emergency Systems" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.

2. Acceptance Tests:

   a. Perform tests required by NFPA 110 that are additional to those specified here or as deemed necessary by manufacturer.

3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.

   a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
   b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
   c. Verify acceptance of charge for each element of the battery after discharge.
   d. Verify that measurements are within manufacturer's specifications.

4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.

5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.

6. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg (120 kPa). Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.

7. Exhaust Emissions Test: Comply with applicable government test criteria.

8. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 25%, 50%, 75%, and 100% step-load increases and 100%, 75%, 50%, and 25% step- load decreases and verify that performance is as specified. Step loads shall be performed going from from 0 to the step and then back to 0 again (example 0 load to 25% load then to 0 load). Provide graphical report of oscilloscope reading as part of test report

9. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits

10. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at locations shown on drawings and compare measured levels with required values.
11. Include the minimum pre-start checks before starting the engine: Oil & water levels, Day tank fuel level, Battery connection and charge condition, Engine control interlocks completed, Engine generator intake/exhaust obstructions, Engine room ventilation obstructions where applicable, Removal of all packing materials.
12. A portable resistive load bank with capacity to test emergency system load for a single generator set. Run each engine generator for a minimum of 4 hours at rated load and power factor.
13. Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases and verify that performance is as specified.
14. Monitor and record the following data at 15-minute intervals during 4-hour test: Ambient temperature, Ampere & Voltage all 3-phases, Frequency & DC volts, Oil & Fuel pressure, Jacket water & Exhaust gas temperatures Power Factor & Kilowatts when included w/instrumentation package, Date & time of day.
15. Demonstrate proper operation of controls, engine shutdown and safety devices.

E. Minimum Training and Maintenance:

1. Instruct the District’s Representative in the proper use, operation and maintenance of the generator set.
2. Contractor shall include a minimum of one day of factory-trained instruction to the District's personnel.

END OF DOCUMENT

SECTION 26 33 23.11
CENTRAL BATTERY EQUIPMENT FOR EMERGENCY LIGHTING

PART 1 - PRODUCTS

1.01 REQUIREMENTS

A. Seismic Performance: Central battery equipment shall withstand the effects of earthquake motions determined according to ASCE/SEI 7 and latest California Building Codes. The designated central battery equipment shall be tested and certified by an NRTL as meeting ICC-ES AC 156 test procedure requirements.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event]"

1.02 INTERRUPTIBLE (FAST-TRANSFER) CENTRAL BATTERY EQUIPMENT

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Industries, Inc.
2. Dual-Lite.
3. Myers Power Products, Inc.
4. Thomas & Betts Corporation; A Member of the ABB Group.

A. General Requirements for Interruptible (Fast-Transfer) Central Battery Equipment:

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. NRTL Compliance: Fabricate and label central battery equipment to comply with UL 924 and UL 1778.

3. Comply with the IBC, NFPA 70, and NFPA 101.

4. Comply with NEMA PE 1.

B. Performance Requirements:

1. Fast-Transfer Central Battery Equipment: Line-interactive (on-line) system. Automatically sense loss of normal ac supply and use a solid-state static switch to transfer load. Transfer in 2-4 ms or less from normal supply to battery-inverter supply.

2. Automatic Operation:

a. Normal Conditions: Supply the load with ac power flowing from normal ac power input terminals, bypassing inverter, with battery connected in parallel via rectifier/charger output.
b. Abnormal Supply Conditions: If normal ac supply deviates from specified voltage, transfer switch operates and battery supplies constant, regulated ac power through the

inverter to the load, with a momentary loss of power to the load.

c. If normal power fails, transfer switch operates and battery supplies constant, regulated ac power through the inverter to the load, with a momentary loss of power to the load.
d. If a fault occurs in system when being supplied by inverter and current flows in excess of the overload rating of inverter, inverter automatically protects itself against damage from overloads and short circuits by shutting down.
e. When normal ac power is restored at input supply terminals of unit, controls automatically retransfer the load back to the normal ac supply, with a momentary loss of power to the load. Rectifier/charger then recharges battery.
f. If normal power failure is prolonged (more than 90 minutes), integral low-voltage battery protective circuit disconnects battery and prevents battery from damage due to deep discharge.
g. If battery becomes discharged, and when normal ac supply is again available, rectifier/charger recharges battery. When battery is fully charged, rectifier/charger automatically shifts to float-charge mode.
h. If battery is disconnected, and normal ac power is available, central battery equipment continues to supply power to the load with no degradation of its regulation of voltage and frequency of output bus.

C. Unit Operating Requirements:

1. Input AC Voltage Tolerance: Plus 10 and minus 15 percent of central battery equipment input voltage rating.

2. Input Frequency Tolerance: Plus or minus 3 percent of central battery equipment frequency rating.

3. Synchronizing Slew Rate: 1 Hz per second, maximum.

4. Minimum Off-Line Efficiency: 95 percent at 60 Hz, full load.

5. Minimum Displacement Primary-Side Power Factor: 96 percent under any load or operating condition.

6. Ambient Temperature Rating (Other Than Batteries): Not less than 68 deg F and not exceeding 86 deg F.

7. Ambient Storage Temperature Rating (Other Than Batteries): Not less than minus 4 deg F and not exceeding 158 deg F.

8. Ambient Temperature Rating (Batteries): Not less than 32 deg F and not exceeding 104 deg F.

9. Ambient Storage Temperature Rating (Batteries): Not less than 0 deg F and not exceeding 104 deg F.

10. Humidity Rating: Less than 95 percent (noncondensing).

11. Altitude Rating: Not exceeding 3300 feet.

12. Off-Line Overload Capability: 1.1times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.

D. Inverter and Controls Logic: Microprocessor based, isolated from all power circuits; provides complete self-diagnostics, periodic automatic testing and reporting; with alarms.

E. Controls and Indication:

1. Status Indication: Door-mounted, labeled LED indicators or digital screen displaying the following conditions:

a. Normal power available.
b. Status of system.
c. Battery charging status.
d. On battery power.
e. System fault.
f. External fault.
g. <Insert condition>.

2. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.

a. Keypad: In addition to required programming and control keys, include the following:

1) Keys for METER, CONTROL, PROGRAM, and CLEAR modes.
2) Security Access: Provide electronic security access to controls through identification and password with at least two levels of access: View only; and view, operate, and service.
3) Control Authority: Supports at least three conditions: Off, local manual control at unit and local automatic control at unit.
4) <Insert feature>.

b. Digital Display: Plain-English language messages on a digital display; provide the following historical logging information and displays:

1) Real-time clock with current time and date.
2) Tests and Events Logs: Record and store up to 50 tests and events.

i) Dates.
ii) Times.
iii) Durations.
iv) Output voltage and currents.

3) Alarm Logs: Record and store up to 50 alarms.

i) Dates.
ii) Times.
iii) Alarm type.

4) Metering Functions: Display central battery equipment metering parameters including, but not limited to, the following:

i) Input and output voltage (V ac) and output current (A ac).
ii) Battery voltage (V dc) and current (A ac).
iii) Fault or alarming status (code).
iv) Power output (VA).

v) Inverter load (W).
vi) Ambient temperature (deg F).
vii) System run time (cumulative days).
viii) Inverter run time (cumulative minutes).

5) Alarm Functions: Digital display mounted flush in unit door and connected to display central battery equipment parameters including, but not limited to, the following:

i) High/low battery charge voltage.
ii) High/low input voltage.
iii) Battery nearing low-voltage condition.
iv) Battery low voltage.
v) High ambient temperature.
vi) Inverter fault.
vii) Output fault.
viii) Output overload.

3. Remote Signal Interfaces:

a. Remote Indication Interface: A minimum of one programmable (Form C) dry-circuit relay output(s) (120-V ac, 2 A) for remote indication of the following:

1) Fault or status indication.
2) On bypass.
3) Low battery.
4) <Insert indication>.

b. Communications Interface: Factory-installed hardware and software to enable a remote PC to program central battery equipment and monitor and display status and alarms using RS-232 or RS-485 port.

F. Self-Protection and Reliability Features:

1. Input surge protection by means of SPDs to provide protection against damage from supply voltage surges as defined in IEEE C62.45, Category B and C.

2. Integral, programmable, self-diagnostic and self-test circuitry; with alarms and logging.

3. Battery deep-discharge and self-discharge protection; with alarms.

4. Battery self-test circuitry; with alarms and logging.

5. <Insert feature>.

G. Integral Input Disconnecting Means and OCPD: Thermal-magnetic circuit breaker, complying with UL 489.

1. Integrated Equipment Minimum Short-Circuit Current (Withstand) Rating: as required from coordination studies with minimum of 22 kA.

H. Inverter:

1. Description: Solid-state, high-frequency, PWM type, with the following operational features:

   a. Automatically regulate output voltage to within plus or minus 3 percent, for all load ranges and for maximum 25 percent step-load changes; regulation may increase to 8 percent for 100 percent step-load changes.
   b. Automatically regulate output frequency to within plus or minus 1Hz, from no load to full load, at unity power factor, over the operating range of battery voltage.
   c. Output Voltage Waveform: Sine wave with maximum 3 percent TDD throughout battery operating-voltage range, for 100 percent linear load.
   d. Inverter Overload Capability: 115 percent for 10 minutes; 150 percent surge for 10 seconds.
   e. Load Power Factor: 0.5 lead to 0.5 lag.

I. Rectifier/Battery Charger:

1. Description: Solid state, variable rate, temperature compensated; automatically maintains batteries in fully charged condition when normal power is available.

2. Maximum Battery Recharge Time from Fully Discharged State: 24 hours.

3. Low voltage disconnect circuit reduces battery discharge during extended power outages, monitors battery voltage, and disconnects inverter when battery voltage drops to no less than 85.7 percent of nominal voltage.

J. Batteries:

1. Description: Premium VRLA or NiCd, wet-cell batteries.

   a. Capable of sustaining full-capacity output of inverter unit for minimum of 90 minutes

2. Battery Disconnect and OCPD: Manufacturer's standard.

K. Maintenance Bypass Systems:

1. Maintenance Bypass Mode: Internal; manual operation only; bypasses central battery equipment power circuits (inverter and static transfer switch); requires local operator selection at central battery equipment. Transfer and retransfer shall be break-before-make, with temporary disrupting power to the load.

2. Maintenance Bypass Mode: External; manual operation only; bypasses central battery equipment completely; requires local operator selection at external switch enclosure remote from central battery equipment. Transfer and retransfer shall be break-before-make, with disrupting power to the load.

3. Bypass Overload Capability: 1.5 times the base load current.

L. Integral Output Disconnecting Means and OCPD:

1. Single-Output OCPD: Thermal-magnetic circuit breaker, complying with UL 489; manufacturer's standard ratings based on unit output ratings.

2. Multiple-Output OCPDs: Thermal-magnetic circuit breakers, complying with UL 489; voltage rating matching unit output voltage rating; 20 A, single pole.

    a. Normally Closed: 2 with trip alarm; with time delay.
    b. Normally Open: 2 with trip alarm.

1.03 ACCESSORY FEATURES

A. Factory-Installed Options and Accessories:

1. Auto-dialer.

2. Audible alarm with silencer switch.

3. Remote Summary Alarm Panel: Labeled LEDs on panel faceplate shall indicate five basic status conditions. Audible signal indicates alarm conditions; silencing switch in face of panel silences signal without altering visual indication.

    a. Cabinet and Faceplate: Surface or flush mounted to suit mounting conditions indicated.
    b. Maximum Distance from Main Unit: 1000 feet.

1.04 INSTALLATION

A. Coordinate layout and installation of central battery equipment with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Wall-Mounted Central Battery Equipment: Install central battery equipment on walls with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For units not on walls, provide freestanding racks complying with Section” Hangers and Supports for Electrical Systems."

C. Floor-Mounted Central Battery Equipment: Install central battery equipment on 4-inch nominal-thickness concrete base.

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.

2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

4. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Seismic Bracing: Comply with requirements specified in Section "Vibration and Seismic Controls for Electrical Systems."

E. Comply with NECA 1.

F. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters[and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used for low-voltage control and alarm wiring]. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.

2. Comply with requirements for raceways and boxes specified in Section "Raceways and Boxes for Electrical Systems."

G. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

H. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

I. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

1. Separately Derived Systems: Make grounding connections to grounding electrodes and bonding connections to metallic piping systems as indicated; comply with NFPA 70.

J. Install control wiring between central battery equipment and remote devices and facility's central-control system. Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."

K. Identify central battery equipment, components, and control wiring. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1.05 FIELD QUALITY CONTROL

A. Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Tests and Inspections:

1. Inspect central battery equipment, wiring, components, connections, and equipment installation. Test and adjust components and equipment.

2. Test insulation resistance for all external branch circuit, feeder, control, and alarm wiring connected to central battery equipment element and component.

3. Test continuity of each circuit.

4. Perform each visual and mechanical inspection and electrical test stated in manufacturer's written instructions and in NETA Acceptance Testing Specification, including specifically those for batteries, battery chargers, and UPS, regardless of the type of central battery equipment provided. Certify compliance with test parameters.

5. Perform a load-duration test at rated voltage and rated output current to verify the correct

functional operation of the unit under full-load stable operating conditions for the minimum time limits required by UL 924. Monitor and record ambient temperature and temperatures within the unit.

6. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

7. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

C. Central battery equipment will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports, including a certified report that identifies central battery equipment and describes all test results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

1.06 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain central battery equipment, and to use and reprogram microprocessor-based control, monitoring, and display functions.

END OF SECTION

SECTION 26 33 53
STATIC UNINTERRUPTIBLE POWER SUPPLY

PART 1 - GENERAL

A. Section Includes:

1. Three-phase, on-line, double-conversion, static-type, UPS units with the following features:

a. Surge suppression.
b. Rectifier-charger.
c. Inverter.
d. Controls and indications.
e. Static bypass transfer switch.
f. Output distribution section.
g. Battery and battery disconnect device.

PART 2 - PRODUCTS

2.01 OPERATIONAL REQUIREMENTS

A. Automatic operation includes the following:

1. Double Conversion, Standard Efficiency:

a. Normal Conditions: Load is supplied with power flowing from the normal power input terminals, through the rectifier-charger and inverter, with the battery connected in parallel with the rectifier-charger output.
b. Abnormal Supply Conditions: If normal supply deviates from specified and adjustable voltage, voltage waveform, or frequency limits, the battery supplies energy to maintain constant, regulated inverter power output to the load without switching or disturbance.
c. Power Failure: If normal power fails, energy supplied by the battery through the inverter continues supply-regulated power to the load without switching or disturbance.

2. Double Conversion, Line Interactive:

a. Normal Conditions: Load is supplied with power flowing from the normal power input terminals, with the rectifier-charger and inverter turned off and the battery disconnected.
b. Abnormal Supply Conditions: If normal supply deviates from specified and adjustable voltage, voltage waveform, or frequency limits, the rectifier-charger and inverter turn on and the battery supplies energy to provide constant, regulated inverter power output to the load with minimum of 98 percent UPS system efficiency.
c. Power Failure: If normal power fails, there is a maximum 4-microsecond delay while the rectifier-charger and inverter turn on and the battery supplies energy to re-establish constant, regulated power output to the load.

3. Double Conversion, IGBT:

a. Normal Conditions: Load is supplied with power flowing from the normal power input terminals, through the rectifier-charger and inverter, with the battery connected in parallel with the rectifier-charger output. High-efficiency carrier stored trench IGBT, in

both rectifier-charger and inverter circuits, provides a minimum of 97 percent efficiency for the UPS system at full load and a minimum of 94 percent efficiency at 50 percent load.

b. Abnormal Supply Conditions: If normal supply deviates from specified and adjustable voltage, voltage waveform, or frequency limits, the battery supplies energy to provide constant, regulated inverter power output to the load.

c. Power Failure: If normal power fails, the rectifier-charger and inverter use energy from the battery to supply constant, regulated power output to the load without switching or disturbance.

4. When power is restored at the normal supply terminals of the system, controls shall automatically synchronize the inverter with the external source before transferring the load. The rectifier-charger shall supply power to the load through the inverter and simultaneously recharge the battery.

5. If the battery becomes discharged and normal supply is available, the rectifier-charger shall charge the battery. The rectifier-charger shall automatically shift to float-charge mode on reaching full charge.

6. If any element of the UPS system fails and power is available at the normal supply terminals of the system, the static bypass transfer switch shall switch the load to the normal ac supply circuit without disturbance or interruption.

7. The output power converters shall produce up to 300 percent of rated full-load current for short-circuit clearing. The inverter shall sustain steady-state overload conditions of up to 200 percent of rated full-load current for 60 seconds in normal operation.

8. The inverter shall be capable of sustaining 150 percent of system capacity for 30 seconds while powered from the battery.

9. Should overloads persist past the time limitations, the automatic static transfer switch shall switch the load to the bypass output of the UPS. When the fault has cleared, the static bypass transfer switch shall return the load to the UPS system.

10. If the battery is disconnected, the UPS shall supply power to the load from the normal supply with no degradation of its regulation of voltage and frequency of the output bus.

B. Manual operation includes the following:

1. Turning the inverter off causes the static bypass transfer switch to transfer the load directly to the normal ac supply circuit without disturbance or interruption.

2. Turning the inverter on causes the static bypass transfer switch to transfer the load to the inverter.

C. Maintenance Bypass/Isolation Switch Operation: Switch is interlocked so it cannot be operated unless the static bypass transfer switch is in the bypass mode. Device provides manual selection among the three conditions described below without interrupting supply to the load during switching:

1. Full Isolation: Load is supplied, bypassing the UPS. Normal UPS ac input circuit, static bypass transfer switch, and UPS load terminals are completely disconnected from external

circuits.

2. Maintenance Bypass: Load is supplied, bypassing the UPS. UPS ac supply terminals are energized to permit operational checking, but system load terminals are isolated from the load.

3. Normal: Normal UPS ac supply terminals are energized, and the load is supplied through the static bypass transfer switch and the UPS rectifier-charger and inverter, or the battery and the inverter.

D. Environmental Conditions: The UPS shall be capable of operating continuously in the following environmental conditions without mechanical or electrical damage or degradation of operating capability, except battery performance:

1. Conditions in four subparagraphs below are standard for commercial UPS equipment. A separate ambient temperature range applies for the UPS battery, and the range of temperature conditions for the battery environment stated here is greater than that allowed by typical special battery warranties. If unusual service conditions for UPS equipment exist and cannot be eliminated, specify them here by revising subparagraphs below. See the Evaluations for discussion of service conditions.

2. Ambient Temperature for Electronic Components: 32 to 104 deg F.

3. If the battery must operate within the temperature range specified in "Ambient Temperature for Battery" Subparagraph below rather than in the environment specified in the special battery warranty, special battery selection requirements may apply. Consult battery manufacturers.

4. Ambient Temperature for Battery: 41 to 95 deg F (5 to 35 deg C).

5. Relative Humidity: Zero to 95 percent, noncondensing.

6. Altitude: Sea level to 4000 feet

2.02 PERFORMANCE REQUIREMENTS

A. Seismic Performance: UPS shall withstand the effects of earthquake motions determined according to ASCE/SEI 7 and Division of State Architect per California Code Regulations.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

B. UL Compliance: Listed and labeled by an NRTL to comply with UL 1778.

C. NFPA Compliance: UPS components shall be listed and labeled by an NRTL as suitable for installation in computer rooms according to NFPA 75.

D. The UPS shall perform as specified in this article while supplying rated full-load current, composed of any combination of linear and nonlinear load, up to 100 percent nonlinear load

with a maximum load crest factor of 3.0, under the following conditions or combinations of the following conditions:

1. Inverter is switched to battery source.

2. Second option in first subparagraph below is a more stringent requirement, but most UPS systems can meet this. Delete second option and retain first option in subparagraph to allow more competition.

3. Steady-state ac input voltage deviates up to plus or minus 10percent from nominal voltage.

4. Steady-state input frequency deviates up to plus or minus 5 percent from nominal frequency.

5. THD of input voltage is 15 percent or more with a minimum crest factor of 3.0, and the largest single harmonic component is a minimum of 5 percent of the fundamental value.

6. Choice of performance figure in subparagraph below affects ability of the UPS to maintain specified performance capability under continuous unbalanced load conditions. Retaining a high figure may limit competition and increase cost. Retain lowest percentage of continuous load unbalance reasonably expected to occur for this Project.

7. Load is 100 percent unbalanced continuously.

E. Minimum Duration of Supply: If battery is sole energy source supplying rated full-load UPS current at 80 percent power factor, duration of supply is twenty 20 minutes.

F. Input Voltage Tolerance: System steady-state and transient output performance remains within specified tolerances when steady-state ac input voltage varies plus 10 percent and minus 15 percent from nominal voltage.

G. Overall UPS Efficiency: Equal to or greater than 95 percent at 100 percent load.

H. Maximum Acoustical Noise: 45db, "A" weighting, emanating from any UPS component under any condition of normal operation, measured from nearest surface of component enclosure.

I. Maximum Energizing Inrush Current: Six times the full-load current, Soft start linear input current rise to 100 percent over a 1- to 40-second period, factory set at 10 seconds.

J. AC Output-Voltage Regulation for Loads 100 Percent Unbalanced: Maximum of plus or minus 2 percent over the full range of battery voltage.

K. Output Frequency: 60 Hz, plus or minus 0.1 percent over the full range of input voltage, load, and battery voltage.

L. Limitation of harmonic distortion of input current to the UPS shall be as follows:

1. Description: Rectifier-charger circuits shall limit THD to 5 percent, maximum, at rated full-load UPS current, for power sources with X/R ratio between 2 and 30. Provide tuned harmonic filter if required to meet harmonic distortion limit.

M. Maximum Harmonic Content of Output-Voltage Waveform: 5 percent rms total and 3 percent

rms for any single harmonic, for rated full load with THD up to 50 percent, with a load crest factor of 3.0.

1. "Minimum Overload Capacity of UPS at Rated Voltage" Paragraph below is one way of specifying UPS overload performance. Other methods may be used. Consult manufacturers' data and revise paragraph to suit Project. Retain if overload performance is required.

N. Minimum Overload Capacity of UPS at Rated Voltage: 125 percent of rated full load for 10 minutes, 200 percent for 60 seconds in normal operation, and 150 percent for 30 seconds in battery operating mode.

O. Maximum Output-Voltage Transient Excursions from Rated Value: For the following instantaneous load changes, stated as percentages of rated full UPS load, voltage shall remain within stated percentages of rated value and recover to, and remain within, plus or minus 2 percent of that value within 50 ms:

1. 50 Percent: Plus, or minus 3 percent.

2. 100 Percent: Plus, or minus 5 percent.

3. Loss of AC Input Power: Plus, or minus 1 percent.

4. Restoration of AC Input Power: Plus, or minus 1 percent.

5. For units rated less than 15 kVA, manufacturer's input power factor rating is normally lower.

P. Input Power Factor: A minimum of 0.90 lagging when supply voltage and current are at nominal rated values and the UPS is supplying rated full-load current without additional filters.

Q. Output Power Factor Rating: Loads with power factor of 0.9 leading to 0.8 lagging shall not require derating of the UPS. For loads with power factors outside this range, de-rate the UPS output as recommended by manufacturer.

R. EMI Emissions: Comply with FCC rules and regulations and with 47 CFR 15 for Class A equipment.

2.03 UPS SYSTEMS

A. Description: Self-contained, battery backup device and accessories that provides three-phase electrical power in the event of failure or sag in the normal power system.

A. Manufacturers:

1. APC by Schneider Electric.
2. Eaton.
3. Liebert; a brand of Vertiv.

1. See Section "Engine Generators" for features required to make generator sets compatible with the UPS systems they supply.

B. Electronic Equipment: Solid-state devices using hermetically sealed, semiconductor elements. Devices include rectifier-charger, inverter, static bypass transfer switch, and system controls.

C. Enclosures: Comply with NEMA 250, Type 1, unless otherwise indicated.

D. Configuration: Single-cabinet or Multi- cabinet modular style units.

E. Control Assemblies: Mount on modular plug-ins, readily accessible for maintenance.

F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Seismic-Restraint Design: UPS assemblies, subassemblies, and components (and fastenings and supports, mounting, and anchorage devices for them) shall be designed and fabricated to withstand static and seismic forces required by latest California Building Codes.

H. Output Circuit Neutral Bus, Conductor, and Terminal Ampacity: Rated phase current times a multiple of 1.73, minimum.

2.04 SURGE SUPPRESSION

A. Protect internal UPS components from surges that enter at each ac power input connection including main disconnect switch, static bypass transfer switch and maintenance bypass/isolation switch. Protect rectifier-charger, inverter, controls, and output components.

1. Use factory-installed surge suppressors tested according to IEEE C62.41.1 and IEEE C62.41.2.

2. Additional Surge Protection: Protect internal UPS components from low-frequency, high-energy voltage surges described in IEEE C62.41.1 and IEEE C62.41.2. Design the circuits connecting with external power sources and select circuit elements, conductors, conventional surge suppressors, and rectifier components and controls so input assemblies will have adequate mechanical strength and thermal and current-carrying capacity to withstand stresses imposed by 400-Hz, 180 percent voltage surges described in IEEE C62.41.1 and IEEE C62.41.2.

2.05 RECTIFIER-CHARGER

A. Description: Voltage source converter, IGBT rectifier.

B. Capacity: Adequate to supply the inverter during rated full output load conditions and simultaneously recharge the battery from fully discharged condition to 95 percent of full charge within 10 times the rated discharge time for duration of supply under battery power at full load.

C. Output Ripple: Limited by output filtration to less than 0.5 percent of rated current, peak to peak.

D. Control Circuits: Immune to frequency variations within rated frequency ranges of normal and emergency power sources.

1. Response Time: Field adjustable for maximum compatibility with local generator-set power source.

E. Battery Float-Charging Conditions: Comply with battery manufacturer's written instructions for battery terminal voltage and charging current required for maximum battery life. The battery charger shall be matched to the battery type supplied.

F. NiCd Battery Charger: Sense full charge by measuring the rate of temperature increase. Battery charging shall be terminated when the rate of temperature rise reaches 1.8 deg F per minute. If the battery reaches 140 deg F prior to reaching this rate of temperature rise, charging shall terminate. Chargers that determine full charge by voltage measurement to sense a 10-mV drop per cell when reaching full charge are also acceptable.

2.06 INVERTER

A. Description: Pulse-width modulated, IGBT with sinusoidal output.

B. Description: Pulse-width modulated, IGBT with sinusoidal output. Include a bypass phase synchronization window adjustment to optimize compatibility with local engine-generator-set power source.

2.07 CONTROLS AND INDICATIONS

A. Description: Group displays, indications, and basic system controls on a common control panel on front of UPS enclosure.

B. Minimum displays, indicating devices, and controls include those in lists below. Provide sensors, transducers, terminals, relays, and wiring required to support listed items. Alarms include audible signals and visual displays.

1. LCD messaging in "Indications" Paragraph below may be unavailable for some models rated 10 kVA and less.

C. Indications: Plain-language messages on a digital LCD.

1. Quantitative indications shall include the following:

a. Input voltage, each phase, line to line.
b. Input current, each phase, line to line.
c. Bypass input voltage, each phase, line to line.
d. Bypass input frequency.
e. System output voltage, each phase, line to line.
f. System output current, each phase.
g. System output frequency.
h. DC bus voltage.
i. Battery current and direction (charge/discharge).
j. Elapsed time discharging battery.

2. Basic status condition indications shall include the following:

a. Normal operation.
b. Load-on bypass.
c. Load-on battery.
d. Inverter off.
e. Alarm condition.

3. Alarm indications shall include the following:

    a. Bypass ac input overvoltage or undervoltage.
    b. Bypass ac input over frequency or underfrequency.
    c. Bypass ac input and inverter out of synchronization.
    d. Bypass ac input wrong-phase rotation.
    e. Bypass ac input single-phase condition.
    f. Bypass ac input filter fuse blown.
    g. Internal frequency standard in use.
    h. Battery system alarm.
    i. Control power failure.
    j. Fan failure.
    k. UPS overload.
    l. Battery-charging control faulty.
    m. Input overvoltage or undervoltage.
    n. Input transformer overtemperature.
    o. Input circuit breaker tripped.
    p. Input wrong-phase rotation.
    q. Input single-phase condition.
    r. Approaching end of battery operation.
    s. Battery undervoltage shutdown.
    t. Maximum battery voltage.
    u. Inverter fuse blown.
    v. Inverter transformer overtemperature.
    w. Inverter overtemperature.
    x. Static bypass transfer switch overtemperature.
    y. Inverter power supply fault.
    z. Inverter transistors out of saturation.
    aa. Identification of faulty inverter section/leg.
    bb. Inverter output overvoltage or undervoltage.
    cc. UPS overload shutdown.
    dd. Inverter current sensor fault.
    ee. Inverter output contactor open.
    ff. Inverter current limit.

4. Controls shall include the following:

    a. Inverter on-off.
    b. UPS start.
    c. Battery test.
    d. Alarm silence/reset.
    e. Output-voltage adjustment.

D. Dry form "C" contacts shall be available for remote indication of the following conditions:

1. UPS on battery.

2. UPS on-line.

3. UPS load-on bypass.

4. UPS in alarm condition.

5. UPS off (maintenance bypass closed).

E. Emergency Power off Switch: Capable of local operation and operation by means of activation by external dry contacts.

2.08 STATIC BYPASS TRANSFER SWITCH

A. Description: Solid-state switching device providing uninterrupted transfer with a contactor or electrically operated circuit breaker to automatically provide electrical isolation for the switch.

B. Switch Rating: Continuous duty at the rated full-load UPS current, minimum.

C. Input SPD: 160 kA.

2.09 BATTERY

A. Description: Valve-regulated, heavy-duty, industrial, recombinant, pocket plate design, NiCd units in polypropylene containers, complete with battery disconnect switch and intercell connectors.

1. Coordinate mounting options below with manufacturer.

2. Factory assembled in an isolated compartment of UPS cabinet.

3. Arrange for draw out removal of battery assembly from cabinet for testing and inspecting.

B. Manufacturers:

1. Eaton.
2. Exide Technologies.
3. Panasonic Corporation of North America; Industrial Devices.

B. Seismic-Restraint Design: Battery racks, cabinets, assemblies, subassemblies, and components (and fastenings and supports, mounting, and anchorage devices for them) shall be designed and fabricated to withstand static and seismic forces.

2.10 BASIC BATTERY MONITORING

A. This article specifies alternatives for optional monitoring of UPS batteries.

B. Description: Continuous, real-time capture of battery performance data.

C. Manufacturers:

1. APC by Schneider Electric.
2. Eaton.
3. Emerson Network Power Connectivity Solutions.

C. Battery Ground-Fault Detector: Initiates alarm when resistance to ground of positive or negative bus of battery is less than 5000 ohms

D. Battery compartment high-temperature detector initiates an alarm when smoke or a temperature greater than 167 deg F occurs within the compartmen

E. Annunciation of Alarms: At UPS control panel and remotely.

2.11 BATTERY-CYCLE WARRANTY MONITORING

A. Automatically measure and record each discharge event, classify it according to duration category and total discharges according to warranty criteria, and display remaining warranted battery life on front panel display.

B. Additional monitoring functions and features shall include the following:

1. Functions in six subparagraphs below represent optional features available for battery-cycle monitors. Retain those required or those that are not provided by separate UPS battery-monitoring features specified in previous articles in this Section.

2. Measuring and Recording: Total voltage at battery terminal. Initiate an alarm for excursions outside the proper float-voltage level.

3. Monitoring: Ambient temperature at battery; initiate an alarm if temperature deviates from normally acceptable range.

4. Keypad on Device Front Panel: Provide access to monitored data using front panel display.

5. Alarm Contacts: Arrange to initiate [local] [remote] alarm for [battery discharge events] [abnormal temperature] [abnormal battery voltage or temperature].

6. Memory: Store recorded data in nonvolatile electronic memory.

7. Ethernet Port: Permits downloading of data to a PC.

2.12 GROUNDING

A. Separately Derived Systems: If not part of a listed power supply for a data-processing room, comply with NFPA 70 requirements for connecting to grounding electrodes and for bonding to metallic piping near isolation transformer. Comply with requirements in Section "Grounding and Bonding for Electrical Systems."

B. Separately Derived Systems: If part of a listed power supply for a data-processing room, comply with manufacturer's written instructions that include grounding requirements in excess of NFPA 70 requirements for connecting to grounding electrodes and for bonding to metallic piping near isolation transformer. Comply with requirements in Section "Grounding and Bonding for Electrical Systems."

2.13 BATTERY EQUALIZATION

A. Equalize charging of battery cells according to manufacturer's written instructions. Record individual-cell voltages.

2.14 Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the UPS.

END OF SECTION

SECTION 26 3623
AUTOMATIC TRANSFER SWITCHES

1.01 REQUIREMENTS

A. Design considerations specific to components in this section:

a. This guideline pertains to Automatic Transfer & bypass-isolation Switches (ATS) used in conjunction with emergency standby & life Safety backup generators.
b. All ATSs shall conform to the requirements of UL 508 & 1008, NFPA 70 & 110, NFPA 99 (applicable for health care facilities only), IEEE 241 & 446 and NEMA ICS10 (Part 1) standards.
c. ATSs used for fire pumps shall conform to the requirements of NFPA 20.
d. All ATSs shall be a combination Automatic Transfer and Bypass/Isolation:

1) The Automatic Transfer switches and associated Bypass/Isolation switch shall have identical electrical ratings.
2) The Bypass/Isolation switch shall provide manual bypass of the load to either source and permit isolation of the Automatic Transfer switch from all source and load conductors.

e. All ATSs shall be open-transition type with break before make and time delay provisions.
f. The Bypass/Isolation switches shall be load-break type.
g. Automatic Transfer switches with overlapping neutral and Automatic Transfer switches which cannot be completely withdrawn when isolated by Bypass/Isolation operation is not permitted.

1.02 PRODUCTS

A. AUTOMATIC TRANSFER SWITCH WITH BYPASS/ISOLATION OPERATION

1. Manufacturers:

1) ASCO, 7000 series
2) Russelectric, RTS-03 series
3) Eaton
4) CAT
5) Cummins

2. Characteristics:

1) The combination Automatic Transfer Bypass/Isolation switch shall be mounted in a single enclosure. Both units shall be bussed together to provide a complete pre-tested assembly. The Automatic Transfer switch shall be completely isolated from the Bypass/Isolation switch by means of insulating barriers and separate access doors.
2) All bus bars shall be silver plated copper. All bus bars shall be formed, cut and punched prior to silver plating. The neutral bus bars where required shall be fully rated.
3) For all 3-phase, 4-wire systems, utilizing ground fault protection, a true 4-pole switch shall be supplied with all four poles mounted on a common shaft. The continuous current rating and the closing and withstand rating of the fourth pole shall be identical to the rating of the main poles.

1.03 AUTOMATIC TRANSFER SWITCH:

1. The Transfer switch unit shall be double throw, electrically operated and mechanically held.

The electrical operators shall be momentarily energized and connected to the transfer mechanism with a minimum contact-to-contact transfer time. The switch shall be mechanically interlocked to ensure only one of two possible positions “Normal or Emergency”.

2. The switch shall be positively locked and unaffected by voltage variations, short circuit currents, or momentary outages so that contact pressure is maintained at a constant value and temperature rise at the contacts is minimized for maximum reliability and operating life.
3. All main contacts shall be silver composition. Switches rated 800 amperes and above shall have segmented blow-on construction for high withstand current capability and be protected by separate arcing contacts.
4. Inspection of all contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors. Switches rated 600 amps and higher shall have front removable and replaceable contacts. All stationary and moveable contacts shall be replaceable without removing power conductors and/or bus bars.
5. All switches shall be equipped with a safe external manual operator with the same contact to contact transfer speed as the electrical operation. The external manual operator shall be safely operated from outside the transfer switch enclosure while the enclosure door is closed.

1.04 BYPASS/ISOLATION SWITCH:

1. Bypass/Isolation switches shall provide a safe and convenient means for manually bypassing and isolating the Automatic Transfer switch, regardless of the position or condition of the Automatic Transfer switch, with the ability to be used as an emergency backup system in the event the transfer switch should fail. In addition, the Bypass/Isolation switch shall be utilized to facilitate maintenance and repair of the Automatic Transfer switch.
2. A 2-way Bypass/Isolation switch shall provide manual bypass of the load to either source and permit isolation of the Automatic Transfer switch from all source and load power conductors. All main contacts shall be manually driven. The switching mechanism shall provide “Quick-Break,” “Quick- Make” operation of the contacts.
3. All main contacts and operating linkages of the Bypass/Isolation switches shall be identical to the Automatic Transfer switches except that the operation shall be manual. The Bypass/Isolation switch shall have the same electrical ratings of ampacity, voltage, short circuit withstand rating and temperature rise capability as the associated Automatic Transfer switch.
4. Separate bypass and isolation handles shall be provided for clear distinction between the functions. Handles shall be permanently affixed and operable without opening the enclosure door.
5. The only field installed power connections shall be at the incoming and load terminals of the Bypass/Isolation switch.
6. Control components and wiring shall be front accessible. All control wiring shall be provided with disconnect plugs. All control wire terminations shall be identified with tubular sleeve type markers.
7. Indicating lights or mechanical indicators shall be provided to show the Bypass/Isolation switches in the bypass position and in the fully isolated position. Positive sequencing of all contacts, with no possible intermediate position shall be accomplished through manual operators from a dead front location.

8. Bypass to the load-carrying source shall be accomplished with no interruption of power to the load (make-before-break contacts). Designs that disconnect the load when bypassing are not acceptable. The bypass handle shall have three operating modes: "Bypass to Normal," "Automatic," and "Bypass to Emergency." The operating speed of the bypass contacts shall be the same as the associated Transfer switch and shall be independent of the speed at which the manual handle is operated. In the "Automatic" mode, the bypass contacts shall be out of the power circuit so that they will not be subjected to fault currents to which the system may be subjected.
9. The isolation handle shall provide (3) operating modes: "Closed," "Test," and "Open." The "Test" mode shall permit testing of the entire emergency power system, including the Automatic Transfer switches with no interruption of power to the load. The "Open" mode shall completely isolate the Automatic Transfer switches from all source and load power conductors. When in the "Open" mode, it shall be possible to completely withdraw the Automatic Transfer switch for inspection or maintenance to conform to code requirements without removal of power conductors or the use of any tools.
10. When the isolation switch is in the "Test" or "Open" mode, the bypass switch shall function as a manual transfer switch.
11. The primary bus work of the draw-out Automatic Transfer switch shall be connected to the stationary bus stabs in the freestanding cubicle by silver plated segmented, self aligning, primary disconnect fingers to facilitate proper alignment between the removable draw-out when the Automatic Transfer switch is withdrawn and shall be available for inspection without disturbing or de-energizing the main bus
12. All necessary controls shall be provided to ensure that the "Engine Run" circuit remains closed when the switch is in the “Bypass-to-Emergency” position, even though the associated Transfer switch is in the "Normal" position or completely removed from the enclosure.
13. ATSs using circuit breakers, contactors or parts thereof which have not been intended for continuous duty, repetitive switching or transfer between two active power sources are not acceptable.
14. ATSs that cannot be completely withdrawn when isolated.

1.05 MICROPROCESSOR CONTROL MODULE:

A. Required:

1. All Transfer switches shall be equipped with a Microprocessor Controller with a Power Supply Module, CPU and I/O Modules for all voltage and ampere ratings. The controller shall be capable of either Serial and Ethernet communications.
2. The controller shall be connected to the Transfer switch through an interconnecting wiring harness. Interfacing relays shall be provided to isolate the controller from abnormal voltages applied to any and all customer input and output wiring terminals. The wiring harness shall include a keyed disconnect plug to enable the control module to be disconnected from the transfer switch for routine maintenance.
3. All customer connections shall be wired to a common terminal block to simplify field-wiring connections.
4. The control module shall be completely enclosed with a protective cover and be mounted separately from the transfer switch unit for safety and ease of maintenance.
5. Sensing and control logic shall be provided on plug-in printed circuit boards for maximum reliability. Interfacing relays shall be industrial control grade plug-in type with dust covers. All relays shall be identical to minimize the number of unique parts.

6. The controller shall contain voltage sensing modules capable of direct single phase or three phase sensing of each source from 120VAC to 600VAC. The voltage sensing shall be true RMS type and shall be accurate to ± 1% of nominal voltage. The frequency sensing shall be accurate to ± 0.2%. The panel operating temperature range shall be -4°F to 140°F and storage from -67°F to 185°F.
7. A color LCD display and keypad shall be an integral part of the controller for viewing all available data and setting desired operational parameters. Operational parameters shall also be available for viewing and limited control through the serial communications input port.
8. The control panel shall meet or exceed the voltage surge withstand capability in accordance with IEEE Standard 472 (ANSI C37.90A-1974) and the impulse withstand voltage test in accordance with the proposed NEMA Standard ICS 1-109.
9. The control module shall meet the requirements of Section 26 09 13 Electrical Power Monitoring and Control for connection to the University's building management system.

1.06 OPERATION:

1. Voltage, Frequency and Phase Rotation Sensing:
   a. Voltage and frequency on both the normal and emergency sources (as noted below) shall be continuously monitored, with the following pickup, dropout and trip setting capabilities (values shown as % of nominal unless otherwise specified):

Parameter	Sources	Dropout / Trip	Pickup / Reset
Under-voltage	N+E,3ϕ	70 to 98%	85 to 100%
Over-voltage	N+E,3ϕ	102 to 115%	2% below trip
Under-frequency	N+E,3ϕ	85 to 98%	90 to 100%
Over-frequency	N+E,3ϕ	102 to 110%	2% below trip
Volt unbalance	N+E,3ϕ	5 to 20%	1% below dropout

   b. Repetitive accuracy of all settings shall be within ± 0.5% over an operating temperature range of -4°F to 140°F.
   c. Settings shall be adjustable in 1% increments either through the keypad, USB port or remotely via communications.
   d. The controller shall monitor phase rotation of both sources and inhibit transfer if both sources are not the same phase rotation (ABC or CBA).
   e. Source status screens shall be provided for both normal & emergency to pro-vide digital readout of voltage on all 3 phases, frequency, and phase rotation.
2. Time Delays:
   a. The controller shall include an adjustable time delay of 0-6 seconds to momentarily override normal source power outages and to delay engine starting. The time delay shall be expandable up to 60 minutes if an external 24VDC power supply is provided for ATS control.
   b. The controller shall include an adjustable 0-60-minute time delay- Transfer to Emergency, factory set at 0 seconds.
   c. The controller shall include an adjustable 0-60-minute time delay - Transfer to Normal on Source Fail time delay, factory set at 15 minutes.
   d. The controller shall include a time delay – Transfer to Normal on Test time delay adjustable 0-60 minutes, factory set at 0. Time delay shall be automatically bypassed if the emergency source fails and the normal source is acceptable.
   e. The controller shall include a time delay - Engine Cool Down adjustable 0-60 minutes, factory set at 5 minutes.
   f. A time delay activated output signal shall also be provided to drive an external relay(s)

for selective load disconnect control. The controller shall have the ability to activate an adjustable 0 to 5-minute time delay in any of the following modes:

1) Prior to transfer only.
2) Prior to and after transfer.
3) Normal to emergency only.
4) Emergency to normal only.
5) Normal to emergency and emergency to normal.
6) All transfer conditions or only when both sources are available.

g. All time delays shall be adjustable in 1second increments, except the extended parallel time, which shall be adjustable in .01 second increments. All time delays shall be adjustable via the graphical display, the front USB port or configuration software using the USB, serial or Ethernet communications port.

3. Additional Features:

a. Test Switch: A 2 or 3 position test switch (key-operated or password protected) shall be provided either as part of the controller or separately to simulate normal power failure. The reset position shall bypass the time delays on either transfer to emergency or retransfer to normal.
b. Engine Start Signal: A SPDT contact, rated 10A @ 30VDC shall be provided to start the engine generator in the event of a normal source outage. The start signal shall prevent dry cranking of the engine by requiring the generator set to reach proper output and run for the duration of the cool down setting, regardless of whether the normal source restores before the load is transferred.
c. ATS Position Signal: Auxiliary source connected contacts rated 10A
d. @ 120VAC or 250VAC shall be provided to signal when the ATS is connected to each source. One contact closed when the ATS is connected to the normal source and one contact closed, when the ATS is connected to the emergency source.
e. Source Connected LED's: LED indicating lights shall be provided; "Green" to indicate when the ATS is connected to the normal feed "Red" to indicate when the ATS is connected to the emergency feed.
f. Source Availability LED's: LED indicating lights shall be provided and energized by controller outputs. The lights shall provide true source availability of the normal and emergency sources.
g. Commit/No-Commit Transfer Selector: The controller shall include a programmable selector to configure the controller to commit to transferring the load to emergency (or not) in the event the normal source returns prior to the generator being ready to accept load.
h. ATS/Engine Exerciser: The controller shall include a user configurable engine exerciser. The engine exerciser shall allow the user to program up to seven different exercise routines. Each event shall be configurable for Test "with Load" and "without Load". Each event shall include user adjustable start time, date and test duration. All time and date settings shall be stored in non-volatile memory. The controller shall include full programmability for daylight savings time.
i. In-phase Monitor: An in-phase monitor shall be built-in to the ATS for transfer and retransfer of motor loads so that inrush currents do not exceed normal starting currents. The monitor shall compare the phase relationship and frequency difference between the normal and emergency sources and permit transfer the first time the sources are within 15 electrical degrees and only if transfer can be accomplished within 60 electrical degrees as determined by monitoring the frequency difference. In-phase retransfer shall be accomplished if both sources are within 2 Hz of nominal frequency and 85% or more of nominal voltage.
j. Auto/Manual Selector: The controller shall be capable of accepting a normally open contact that will allow the Transfer switch to function in a non-automatic mode using

an external control device.

k. Inhibit Transfer Signals: The controller shall be capable of accepting transfer control inputs that inhibit transfer of the ATS to either source.
l. Diagnostics: The controller shall contain self and system diagnostic screens for the purpose of detecting and troubleshooting abnormal system events.
m. System Status: The controller LCD display shall include a “System Status” screen that is readily accessible and displays a clear description of the active operating sequence and switch position.
n. Event/Data logger: The controller shall have the ability to log data and to maintain the last 99 events, even in the event of total power failure.
o. Communications Interface: The controller shall be capable of interfacing via serial or Ethernet communications ports integral to the controller with a network of transfer switches, locally (up to 4000 ft.) or remotely through modem. Standard software specific for transfer switch applications shall allow for the monitoring, control and setup of parameters. Both serial and Ethernet communication shall be Modbus open protocol.

4. Accessories:

a. Communications Module: The controller shall be capable of supporting Serial (RS485) or Ethernet (TSP/IP) shall be installed in the ATS controller to enable communications. The serial communications shall be capable of a direct connect or multi-drop configured network. This module shall allow for the seamless integration of existing or new communication transfer devices. (For Ethernet communication, a Serial to Ethernet converter equal to ASCO Accessory 72E or 72SW shall be provided unless controller has Ethernet communication capability).
b. External Power Supply: The controller shall be capable of being connected to an external 24VDC power supply to permit full operation and communications of the controller when both sources are de-energized (ASCO Accessory 1G or equal).
c. Transfer Test/Retransfer Time Delay Bypass Selector: A 3-position selector, spring return Left, maintained Right. Test position (maintained) simulates a normal source failure with override retransfer to normal in the event of any Emergency source failure (ASCO Accessory 5L or equal).
d. Selective Load Disconnect: Selective load disconnect control contacts (2 provided) which operate with time delay prior to and/or after load transfer and retransfer (ASCO Accessory 31Z or equal).
e. Power Manager: The ATS shall be furnished with power manager for monitoring ATS load. It shall consist of Electronic Access Module (EAM), which measures voltage frequency and current. The power manager uses these measurements to calculate power, energy parameters and power factor. The (EAM) can communicate data to host devices that are part of ATS communications systems (ASCO Accessory 75L/85L or equal).

1.07 WITHSTAND AND CLOSE RATINGS:

1. All switches shall be UL listed in accordance with UL 1008 for 3-cycle close and withstand ratings. The Automatic Transfer and Bypass/Isolation switch shall be tested as a complete connected unit.

2. All switches shall be fully rated to withstand the available “rms symmetrical” short circuit current at the switch terminals without any internal or external overcurrent protective devices. Separate arcing contacts with magnetic blowouts shall be provided on all Transfer switches.

3. Minimum UL listed close & withstand ratings at 480VAC:

a. 100 – 400A switches shall be 42kA.

b. 600 – 800A switches shall be 65kA.
c. 1000 – 1200A switches shall be 85kA.
d. 1600 – 4000A switches shall be 100kA.

4. Larger size ATSs shall be utilized to meet the required close & withstand ratings that are higher than the listed values above. ATSs that are not tested and labeled with 3-cycle (any breaker) ratings and have series, or specific breaker ratings only, are not acceptable.

1.08 MISCELLANEOUS REQUIREMENTS:

1. Provide additional auxiliary dry contacts from the ATS to each elevator machine room for projects that elevators are on emergency power:

   a. One dry contact to open when normal power fails, and emergency standby power becomes available and to close when normal power returns to signal elevator controllers.
   b. One dry contact to open on emergency power and to close 30 to 60 seconds prior to transfer back to normal power to allow elevators to come to rest prior to normal power resumption.

2. Sensing and control logic shall be provided on plug-in printed circuit boards for maximum reliability. Interfacing relays shall be industrial control grade plug-in type with dust covers. All relays shall be identical to minimize the number of unique parts.

1.09 INSTALLATION

1. Installation shall conform to the requirements of CEC and manufacturer's recommendations

2. ATSs shall be anchored and braced to withstand seismic forces as required.

3. Tighten electrical connectors and terminals; including screws and bolts, in accordance with equipment manufacturer’s published torque-tightening values for equipment connectors. Where manufacturers torque requirements are not indicated, tighten connectors and terminals to comply with tightening torque specified in NETA Standard Tables.

1.10 EVALUATION

A. List of items or systems requiring testing, evaluation, verification, or commissioning: Automatic Transfer Switches.

   1. Test reports: The contractor shall engage a qualified Independent testing and inspecting agency to perform field tests/inspections and provide reports for all connections/terminations, controls and settings.

B. Testing protocols:

   1. ATS assemblies:

      a. Inspect physical and mechanical condition.
      b. Verify tightness of all terminations/connections, including controls wiring.
      c. Inspect all bolted electrical connections for high resistance per NETA.
      d. Perform manual transfer operation.
      e. Verify positive mechanical interlocking between both power sources.

C. Electrical Tests:

   1. The contractor shall furnish labor, equipment and incidentals for and shall perform all field tests in accordance to NETA ATS 7.22-3 and as described below. Work affected by deficiencies shall be completely retested at the Contractor's expense. The manufacturer's factory representative shall assist the Contractor with the field test and inspection. Field tests shall include the following:

a. Set all adjustable timers and control and protective devices.
b. Simulate power failure and demonstrate complete ATS operation. Contractor shall show by demonstration in service that all the ATSs are in good operating condition.
c. Conduct 15-minute load run utilizing portable load banks.
d. The switch shall be subjected to a dielectric strength test per NEMA Standard ICS1-109.21.

2. All production units shall be subjected to the following factory tests:

a. The complete combination Automatic Transfer Bypass/Isolation switch assembly shall be tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that the operating transfer time, voltage, frequency and time delay settings follow the specification requirements.
b. During 3-cycle closing & withstand tests per UL 1008, there shall be no contact welding or damage. The 3-cycle test shall be performed without the use of current limiting fuses. The tests shall verify that contact separation has not occurred, and there is contact continuity across all phases.
c. When conducting temperature rise tests to UL-1008, the manufacturer shall include post-endurance temperature rise tests to verify the ability of the ATS to carry full rated current after completing the overload and endurance tests.
d. Upon request, the manufacturer shall provide a notarized letter certifying compliance with all of the requirements of this specification including compliance with the above codes and standards and withstand current ratings. The certification shall identify, by serial number(s), the equipment involved. No exceptions to the specifications, other than those stipulated at the time of submittal, shall be included in the certification.

END OF DOCUMENT

SECTION 26 43 13
SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - PRODUCTS

1.01 GENERAL SPD REQUIREMENTS

A. SPD with Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

C. Comply with UL 1449.

D. MCOV of the SPD shall be the nominal system voltage.

1.02 SERVICE ENTRANCE AND TRANSFER SWITCH SUPPRESSOR

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB Electrification Products.
2. Eaton.
3. Schneider Electric USA, Inc.

A. SPDs: Comply with UL 1449, Type 1 or Type 2.

1. SPDs with the following features and accessories:

a. Integral disconnect switch.

b. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.

c. Indicator light display for protection status.

B. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 240kA or 320 kA or as required. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

C. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V & 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:

1. Line to Neutral: 1200 V for 480Y/277 V; 700 V for 208Y/120 V.

2. Line to Ground: 1200 V for 480Y/277 V; 1200 V for 208Y/120 V.

3. Line to Line: 2000 V for 480Y/277 V; 1000 V for 208Y/120 V.

D. Protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits shall not exceed the following:

1. Line to Neutral: 700 V.
2. Line to Ground: 700 V.
3. Line to Line: 1000 V.

E. SCCR: Equal or exceed 100 kA or 200 kA.

F. Nominal Rating: 20 kA.

1.03 PANEL SUPPRESSORS

B. Manufacturers::

1. Eaton.
2. Schneider Electric USA, Inc.
3. SSI, an ILSCO Company.

A. SPDs: Comply with UL 1449, Type 1 or Type 2 as required.

1. Include LED indicator lights for power and protection status.
2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.

B. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 100 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

C. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V; 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:

1. Line to Neutral: 1200 V for 480Y/277 V; 700 V for 208Y/120 V.
2. Line to Ground: 1200 V for 480Y/277 V; 1200 V for 208Y/120 V.
3. Line to Line: 2000 V for 480Y/277 V; 1000 V for 208Y/120 V.

D. Protection modes and UL 1449 VPR for 240/120-V, single-phase, three-wire circuits shall not exceed the following:

1. Line to Neutral: 700 V.
2. Line to Ground: 700 V.
3. Neutral to Ground: 700 V.
4. Line to Line: 1200 V.

E. SCCR: Equal or exceed 100 kA or 200 kA as required.

F. Nominal Rating: 20 kA or 10 kA as required.

1.04 ENCLOSURES

A. Indoor Enclosures: NEMA 250, Type 1.

1.05 INSTALLATION

A. Comply with NECA 1.

B. Install an OCPD or disconnect as required to comply with the UL listing of the SPD.

C. Install SPDs with conductors between suppressor and points of attachment as short and straight as possible and adjust circuit-breaker positions to achieve shortest and straightest leads. Do not splice and extend SPD leads unless specifically permitted by manufacturer. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

D. Use crimped connectors and splices only. Wire nuts are unacceptable.

E. Complete startup checks according to manufacturer's written instructions. Energize SPDs after power system has been energized, stabilized, and tested.

1.06 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative.

1. Compare equipment nameplate data for compliance with Drawings and Specifications.

2. Inspect anchorage, alignment, grounding, and clearances.

3. Verify that electrical wiring installation complies with manufacturer's written installation requirements.

B. An SPD will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION

SECTION 26 51 19
LED INTERIOR LIGHTING

PART 1 - PRODUCTS

1.01 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7 latest California Building Codes.

B. Seismic Performance: Luminaires and lamps shall be labeled vibration and shock resistant.

1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."

C. Ambient Temperature: 41 to 104 deg F.

1. Relative Humidity: Zero to 95 percent.

D. Altitude: Sea level to 1000 feet.

1.02 LUMINAIRE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency and listed by Design Lights Consortium (DLC) and marked for intended location and application.

B. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:

a. "USE ONLY" and include specific lamp type.
b. Lamp diameter, shape, size, wattage, and coating.
c. CCT and CRI.

C. Recessed luminaires shall comply with NEMA LE 4.

D. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.

E. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

F. California Title 24 compliant.

1.03 CYLINDER

A. Manufacturers: Lithonia, Acuity Brands or approved equal.

B. Nominal Operating Voltage: 120 V ac or 277 V ac.

C. Housings:

1. Extruded-aluminum housing and heat sink.
2. powder-coat finish.

D. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit re lamping without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during re lamping and when secured in operating position.

E. Diffusers and Globes:

1. Tempered Fresnel glass or Clear, UV-stabilized acrylic.
2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3. Glass: Annealed crystal glass unless otherwise indicated.

F. With integral mounting provisions.

G. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.
3. UL Listing: Listed for damp location.
4. DLC Listed.

1.04 DOWNLIGHT.

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Lithonia, Acuity Brands or approved equal.

B. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.
3. UL Listing: Listed for damp location.
4. Recessed luminaires shall comply with NEMA LE 4.
5. DLC Listed.

C. Open Recessed Downlight and Open Wall wash

1. Each luminaire shall consist of an assembly that utilizes LEDs as the light source. In addition, a complete luminaire shall consist of a housing, LED array, and electronic driver (power supply) and integral controls as per this specification.
2. Each luminaire shall be designed to operate at an average operating temperature of 25°C.
3. The operating temperature range shall be 0°C to +25°C.
4. Each luminaire shall meet all parameters of this specification throughout the minimum operational life when operated at the average operating temperature.
5. Nominal luminaire dimensions:

a) Type *XX* – Aperture 6 ¼", Ceiling opening 7 1/8", above ceiling, 15 7/8" (40.3cm) x 13 3/16' (38.3cm), Depth – 7 9/16" (19.1cm) max.

b) Type *YY* - Aperture 6 ¼", Ceiling opening 7 1/8", above ceiling, 15 7/8" (40.3cm) x 13 3/16' (38.3cm), Depth – 7 9/16" (19.1cm) max.

D. Luminaire Construction:

a) Luminaire housing shall be constructed of 16-gauge galvanized steel and have preinstalled telescopic mounting bars with maximum 32" and minimum 15" extension and 4" vertical adjustment.

b) The luminaire shall be a single, self-contained device, not requiring onsite assembly for installation. The power supply and circuit board for the luminaire shall be integral to the unit and be accessible through aperture.

c) Luminaires shall be suitable for installation in ceilings up to 1 ½" thick. (specify ceiling thickness adapter to extend frame to accommodate ceiling thickness up to 2")

d) Sloped ceiling adapter – as per specification for specific degree of slope from 10 to 30 degrees in 5-degree increments.

e) Toolless adjustments shall be possible after installation.

f) Cone Finish: anodized reflector in semi-specular, matte diffuse or specular as specified and be self-flanged.

g) Cone and Trim Color shall be as specified, *clear, pewter, wheat, gold, white or black.*

h) Self-flanged cone to have an overlap matching cone color, white or black painted flange shall be optional. Overlap is as follows:

   a. 4" downlight – 5 7/16" OD
   b. 6" downlight – 7 ¾" OD
   c. 8" downlight – 9 ¼" OD

i) Flangeless cone trims shall be as specified and luminaire shall be provided with mud ring, plaster guard and installation instructions.

j) Vandal resistant or decorative trims accessory shall be as per specification.

k) Wall wash fixture shall have anodized kicker reflector.

l) Polymeric materials (if used) of enclosures containing either the power supply or electronic components of the luminaire shall be made of UL94VO flame retardant materials.

m) The assembly and manufacturing process for the SSL luminaire shall be designed to assure all internal components are adequately supported to withstand mechanical shock and vibration.

E. LED Sources

a) LED's shall be manufactured by, Nichia, Samsung or Osram.

b) Lumen Output – minimum initial lumen output of the luminaire shall be selected for the particular usage and range from 600 lumens to 17500 lumens as follows for the lumens exiting the luminaire in the 0-90-degree zone - as measured by IESNA Standard LM-79-08 in an accredited lab. Exact tested lumen output shall be clearly noted on the shop drawings.

a. 750 initial lumens, 10 watts (4" aperture)
b. 1000 initial lumens, 12 watts (4" & 6" apertures)
c. 1500 initial lumens, 17 watts (4") 18 watts (6")
d. 2000 initial lumens, 23 watts (4" & 6" apertures)
e. 2500 initial lumens, 29 watts (4" & 6" apertures)
f. 3000 initial lumens, 37 watts (4" & 6" apertures)
g. 3500 initial lumens, 42 watts (6" aperture)
h. 4000 initial lumens, 48 watts (6" aperture)
i. 4500 initial lumens, 47 watts (6" aperture)
j. 5000 initial lumens, 48.6 watts (6" aperture)
k. 6000 initial lumens, 57 watts (6" aperture)
l. 8000 initial lumens, 75 watts (6" aperture)
m. 10000 initial lumens, 97 watts (6" aperture)
n. 4500 initial lumens, 47 watts (6" aperture)
o. 12000 initial lumens, 115 watts (6" aperture)
p. 4500 initial lumens, 47 watts (6" aperture)
q. 15000 initial lumens, 150 watts (6" aperture)
r. 17500 initial lumens, 175 watts (6" aperture)

c) Lumen output shall not decrease by more than 30% over the minimum operational life of 60,000 hours.

d) Individual LEDs shall be connected such that a catastrophic loss or the failure of one LED will not result in the loss of the entire luminaire.

e) LED light engine shall be suitable for field maintenance or service from below the ceiling with plug-in connectors. LED light engine shall be upgradable.

f) Light Color/Quality-

a. Correlated Color Temperature (CCT) range as per specification, between 2700K, 3000K, 3500K and 4000K, 5000K shall be correlated to chromaticity as defined by the absolute (X,Y) coordinates on the 2-D CIE chromaticity chart.

b. The color rendition index (CRI) shall be 85 or greater with option for 90+ CRI.

c. Color shift over 6,000 hours shall be <0.007 change in u' v' as demonstrated in IES LM80 report.

d. Color appearance from luminaire to luminaire of the same type and in all configurations, shall be consistent both initially and at 6,000 hours as described in 2.2.7 f) c. and operate within a tolerance of ≤ 3 MacAdam ellipse as defined by a point at the intersection of the CCT line and the black body locus line in CIE chromaticity space.

e. All color characteristics, CCT, CRI, Color Fidelity, CIE Chromaticity Coordinates shall be consistent across the entire dimming range.

F. Power Supply and Drive

a) Driver: Acceptable manufacturer: eldoLED
b) Ten-year expected life while operating at maximum case temperature and 90 percent non-condensing relative humidity.
c) Driver shall be UL Recognized under the component program and shall be modular for simple field replacement. Drivers that do not meet these requirements will not be accepted.
d) Electrical characteristics: 120 - 277 volt, UL Listed, CSA Certified, Sound Rated A+. Driver shall be > 80% efficient at full load across all input voltages. Input wires shall be 18AWG solid copper minimum.
e) Dimming: Driver shall be suitable for full-range dimming. LED dimming shall be equal in range and quality to a commercial grade incandescent dimmer. Quality of dimming to be defined by dimming range, freedom from perceived flicker or visible stroboscopic flicker, smooth and continuous change in level (no visible steps in transitions), natural square law response to control input, inaudible in 26db environment, and stable when input voltage conditions fluctuate over what is typically experienced in a commercial environment. Demonstration of this compliance to dimming performance will be necessary for substitutions or prior approval.
a. The luminaire shall be capable of continuous dimming without perceivable flicker over a range of 100 – 10%, 100 – 1.0% or 100 – 0.1% of rated lumen output with a smooth shut off function to step to 0%. (edit for the specific dimming range required)

f. Driver shall include ability to provide no light output when the analog control signal drops below 0.5V, or the DALI/DMX digital signal calls for light to be extinguished and shall consume 0.5 watts or less in this standby. Control dead band between .5 and .65V shall be included to allow for voltage variation of incoming signal without causing noticeable variation in fixture to fixture output.

g. Driver shall be capable of configuring a linear or logarithmic dimming curve, allowing fine grained resolution at low light levels.

h. Driver must be capable of 20-bit dimming resolution for white light LED driver.

i. Drivers shall track evenly across multiple fixtures at all light levels and shall have an input signal to output light level that allows smooth adjustment over the entire dimming range.

f) Control Input
   a. 4-Wire (0-10V DC Voltage Controlled) Dimming Drivers
      - Must meet IEC 60929 Annex E for General White Lighting LED drivers.
      - Connect to devices compatible with 0 to 10V Analog Control Protocol, Class 2, capable of sinking 0.6 ma per driver at a low end of 0.3V. Limit the number of drivers on each 0-10V control output based on voltage drop and control capacity.
      - Must meet ESTA E1.3 for RGBW LED drivers
   b. Digital Multiplex (DMX Low Voltage Controlled) Dimming Drivers
      - Must meet DMX / RDM: USITT DMX512A and ANSI E1.20 (Explore & Address)
      - Capable of signal interpolation and smoothing of color and intensity transitions

g) Flicker: Driver and luminaire electronics shall deliver illumination that is free from objectionable flicker as measured by flicker index (ANSI/IES RP-16-10). At all points within the dimming range from 100-0.1 percent luminaire shall have:

   a. Less than 1 percent flicker index at frequencies below 120 Hz.

   b. Less than 12 percent flicker index at 120 Hz and shall not increase at greater than 0.1 percent per Hz to a maximum of 80 percent flicker index at 800Hz.

h) Driver disconnect shall be provided where required to comply with codes.

i) The electronics/power supply enclosure shall be internal to the SSL luminaire and be accessible per UL requirements.

j) The surge protection which resides within the driver shall protect the luminaire from damage and failure for transient voltages and currents as defined in ANSI/IEEE C64.41 2002 for Location Category A, where failure does not mean a momentary loss of light during the transient event.

G. Electrical

a) Power Consumption: Maximum power consumption, +/- 5% when operating between 120 – 277V (or 346V) shall be as follows:

   j. 12W (90 downlight & 87 wall wash, Lumens per Watt)

   k. 23W (89 downlight & 87 wall wash, Lumens per Watt)

   l. 29W (88 downlight & 86 wall wash, Lumens per Watt)

   m. 48W (84 downlight & 81 wall wash, Lumens per Watt)

b) Operation Voltage - The luminaire shall operate from a 50 or 60 Hz ±3 Hz AC line over a voltage ranging from 120 VAC to 277 VAC. The fluctuations of line voltage shall have no visible effect on the luminous output. The standard operating voltages are 120 VAC, 277 VAC, 347 VAC.

c) Power Factor: The luminaire shall have a power factor of 90% or greater at all standard operating voltages and full luminaire output.

d) THD: Total harmonic distortion (current and voltage) induced into an AC power line by luminaire shall not exceed 20 percent at any standard input voltage and meet ANSI C82.11 maximum allowable THD requirements at full output. THD shall at no point in the dimming curve allow imbalance current to exceed full output THD.

e) Surge Suppression: The luminaire shall include surge protection to withstand high repetition noise and other interference.

f) In Rush Current: Meet or exceed NEMA 410 driver inrush standard of 430 Amps per 10 Amps load with a maximum of 370 Amps2 – seconds.

g) RF Interference: The luminaire and associated onboard circuitry must meet Class A emission limits referred in Federal Communications Commission (FCC) Title 47, Subpart B, Section 15 Non-Consumer requirements for EMI/RFI emissions.

h) Driver must support automatic adaptation, allowing for future luminaire upgrades and enhancements and deliver improved performance:

   a. Adjustment of forward LED voltage, supporting 3V through 60V.

   b. Adjustment of LED current from 200mA to 1.05A at the 100 percent control input point in increments of 1mA.

   c. Adjustment for operating hours to maintain constant lumens (within 5 percent) over the 50,000-hour design life of the system, and deliver up to 20 percent energy savings early in the life cycle.

i) Electrical connections between normal power and driver must be modular utilizing a snap fit connector. All electrical components must be easily accessible after installation and be replaceable without removing the fixture from the ceiling.

h) All electrical components shall be RoHS compliant.

H. Photometric Requirements

a) Luminaire performance shall be tested as described herein.

a. Luminaire performance shall be judged against the specified minimum illuminance in the specified pattern for a particular application.

b. Luminaire lighting performance shall be adjusted (depreciated) for the minimum life expectancy (Section 2.2.7c)).

c. The performance shall be adjusted (depreciated) by using the LED manufacturer's data or the data from the IESNA Standard TM-21 test report, which ever one results in a higher level of lumen depreciation.

d. The luminaire may be determined to be compliant photometrically, if:
- The initial minimum illuminance level is achieved in 100% of the area of the specified lighting pattern
- The measurements shall be calibrated to standard photopic calibrations.

(Add specific project requirements.)

I. Thermal Management

a) The thermal management (of the heat generated by the LEDs) shall be of sufficient capacity to assure proper operation of the luminaire over the expected useful life (Section 2.2.7 (c)).

b) The LED manufacturer's maximum junction temperature for the expected life shall not be exceeded at the average operating ambient (Section 2.2.2).

c) The LED manufacturer's maximum junction temperature for the catastrophic failure shall not be exceeded at the maximum operating ambient.

d) The luminaires are CSA certified for US and Canadian standards; wet location, covered ceiling.

e) The Driver manufacturer's maximum case temperature shall not be exceeded at the maximum operating ambient. Thermal management shall be passive by design. The use of fans or other mechanical devices shall not be allowed.

J. Optics

a) Optical system shall consist of a self-flanged semi-specular, matt diffuse or specular lower reflector as per specification.

b) Cone shall provide 45° cutoff to source and source image and have top-down flash characteristic.

c) Optical distribution for downlight shall be as specified from the following:
   a. VND – very narrow (0.5 s/mh) (6" aperture)
   b. ND – narrow (0.7 s/mh) (6" aperture)
   c. MD – medium (0.9 s/mh)
   d. MWD – Medium wide (1.0 s/mh)

e. WD – wide (1.2 s.mh)

d) Wall wash cone to have asymmetric distribution with an anodized kicker reflector.

K. Digital Controls (Providet as required for specific project requirements)

a) Luminaire shall be equipped with interface for Sensor Switch nLight network with integral power supply as per specification.

b) Digital manual wall control shall integrate with the SSL luminaire via CAT5E cable and be self-commissioning.

c) Digital occupancy sensor shall integrate with the SSL luminaire via CAT5E cable and be self-commissioning.

d) Digital photocell shall integrate with the SSL luminaire via CAT5E cable and be self-commissioning.

e) Each luminaire shall be supplied with a unique network address. This address shall be printed on two identification labels. One label shall be permanently affixed to the luminaire and one label shall be easily removed for network control commissioning purposes. Both labels shall be in a location which is easily accessible by the installing contractor.

f) All components on the system shall operate consistently from component to component and on the system level.

L. Luminaire Identification

a) Each luminaire shall have the manufacturer's name, trademark, model number, serial number, date of manufacture (month-year), and lot number as identification permanently marked inside each unit and the outside of each packaging box.

b) The following operating characteristics shall be permanently marked inside each unit: rated voltage and rated power in Watts and Volt-Ampere.

M. Quality Assurance

a) The luminaires shall be manufactured in accordance with a manufacturer quality assurance (QA) program. The QA program shall include two types of quality assurance: (1) design quality assurance and (2) production quality assurance. The production quality assurance shall include statistically controlled routine tests to ensure minimum performance levels of the modules built to meet this specification. These tests, utilizing LM63, LM79 and LM80 methods shall include: CCT, CRI, Lumen output, and wattage. In addition, the following tests shall be performed: surge, line fluctuations, ramp-input voltage, leakage current,

steady-state characteristics, dimming stability and immunity to frequency variations. Tests shall be recorded, analyzed and maintained for future reference.

b) QA process and test results documentation shall be kept on file for a minimum period of seven years.

c) LED luminaire designs not satisfying design qualification testing and the production quality assurance testing performance requirements described below shall not be labeled, advertised, or sold as conforming to this specification.

1.05 LINEAR INDUSTRIAL

A. Manufacturers: Lithonia Lighting; Acuity Brands Lighting, Inc. or approved equal.

B. Lamp:

1. Minimum 5,000 lumens.
2. Minimum allowable efficacy of 80 lumens/W.
3. CRI of minimum 80. CCT of 2700 K/3000 K/4100 K per application.
4. Rated lamp life of 50,000 hours to L70.
5. Dimmable from 100 percent to 1 percent of maximum light output.
6. Internal driver.

C. Housings:

1. Extruded-aluminum housing and heat sink.
2. Powder-coat finish.

D. Housing and Heat Sink Rating:

1. Class 1, Division 2 Group(s) A/B/C/D as applicable.
2. NEMA 4X.
3. IP 54.
4. IP 66.
5. Wet locations.
6. DLC Listed

E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit re lamping without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during re lamping and when secured in operating position.

F. Diffusers and Globes:

1. Tempered Fresnel glass or Clear, UV-stabilized acrylic.
2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3. Glass: Annealed crystal glass unless otherwise indicated.

G. With integral mounting provisions.

H. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.

1.06 LOWBAY

A. Manufacturers: Lithonia Lighting; Acuity Brands Lighting, Inc.

B. Nominal Operating Voltage: 120 V ac or 277 V ac.

C. Lamp:

1. Minimum 10,000 lumens.
2. Minimum allowable efficacy of 80 lumens/W.
3. CRI of minimum 80. CCT of 2700 K/3000 K/4100 K as applicable.
4. Rated lamp life of 50,000 hours to L70.
5. Dimmable from 100 percent to 1 percent of maximum light output.
6. Internal driver.

D. Housings:

1. Extruded-aluminum housing and heat sink.
2. Powder-coat finish.

E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit re lamping without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during re lamping and when secured in operating position.

F. Diffusers and Globes:

1. Tempered Fresnel glass Clear, UV-stabilized acrylic.
2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3. Glass: Annealed crystal glass unless otherwise indicated.

G. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.
3. UL Listing: Listed for damp location.
4. DLC listed

1.07 HIGHBAY

A. Manufacturers: Lithonia Lighting; Acuity Brands Lighting, Inc. JCBL or approved equal

1. Nominal Operating Voltage: 120 V ac or 277 V ac.

2. Each luminaire shall consist of an assembly that utilizes LEDs as the light source. In addition, a complete luminaire shall consist of a housing, LED array, and electronic driver (power supply) and integral controls as per this specification.
3. The operating temperature range shall be 0°C to +55°C. It is required that this temperature be listed on the CSA/UL operating temperature label that is attached to the fixture.
4. Each luminaire shall meet all parameters of this specification while operating within the specified temperature range.
5. Nominal luminaire dimensions: 16.3" X 15.9 "Round form factor.

B. Luminaire Construction:

a). Luminaire heatsink should be constructed of Aluminum.

b). The luminaire shall be a single, self-contained device, not requiring onsite assembly for installation. The power supply and circuit board for the luminaire shall be integral to the unit.

c). Luminaire Optics should have IP65 glass optics for dust/water protection of the LED's

d). Finish: Post Paint White

e). Luminaire shall have enclosed driver in a smooth, centered, aesthetically pleasing driver housing. Driver should be serviceable, and not fully potted

f). Luminaire shall offer a diffuse reflector, in both acrylic and Aluminum. Luminaire shall offer a bottom lens to hide direct view of LED's

g). Driver compartment shall be fully isolated and separate from the Optical assembly.

C. LED Sources

- Lumen Output – minimum initial lumen output of the luminaire shall be as follows for the lumens exiting the luminaire in the 0-90-degree zone - as measured by IESNA Standard LM-79-08 in an accredited lab. Exact tested lumen output shall be clearly noted on the shop drawings.

- Luminaire shall offer LPW options for all lumen packages at **80CRI/5000K** and a **diffuse Acrylic reflector** greater than **160LPW**

- Lumen output shall not decrease by more than **9%** over the minimum operational life of 60,000 hours, documented and tested per TM21 standards

- Individual LEDs shall be connected such that a catastrophic loss or the failure of one LED will not result in the loss of the entire luminaire

- Fixture optics should include an IP65 sealed glass lens, and diffuse prismatic acrylic reflector, as well as a diffuse bottom lens to fully enclose the optical assembly and eliminate direct view of LED's. No pixilation allowed.
- Fixture reflectors should provide 14% up light when using the acrylic frosted (diffuse) reflector
- Lumen Output at maximum ambient temperature (55C) should exceed 95%, tested and documented. **Luminaire spec sheet shall provide a complete Lumen output vs Temperature table by lumen package**
- LED binning must fall within 5 Macadam Ellipse at 80CRI

D. Electrical

a) Power Consumption: Maximum power consumption, +/- 5% when operating between 120 – 277V (or 347V) shall be as follows:

-15000LM – 103 Watts

-18000LM – 125 Watts

-24000LM – 160 Watts

-30000LM – 204 Watts

-36000LM – 249 Watts

b) Operation Voltage - The luminaire shall operate from a 50 or 60 HZ ±3 HZ AC line over a voltage ranging from 120 VAC to 277 VAC. Luminaire shall offer 347V/480V without the use of a stepdown transformer

C) Luminaire shall ship standard with 6kV (mvolt) and an inline, replaceable 10kV (Hvolt) surge protection module, tested to **ANSI C82.77-5-2015 Standards and Procedures**

D) Luminaire must not use more than 1 driver for lumen packages up to 30,000L

E) Luminaire drivers shall have documented life of 100,000 Hours at 40C fixture ambient operating temperature. Driver shall have 6kV surge protection standard on the front end

F) Luminaire shall offer integrated Title 24 compliant, both networked and non-networked, installed from the factory

G) Luminaire must have options to ship with modular cord sets and Reloc connectors installed from the factory

D) Luminaire must offer title-20 approved emergency batter pack solutions from the factory, deliver over 2,400 Lumens

1.08 HIGHBAY

A. Manufacturers: Lithonia Lighting; Acuity Brands Lighting, Inc. IBG or approved equal

1. Nominal Operating Voltage: 120 V ac or 277 V ac.

B. Each luminaire shall consist of an assembly that utilizes LEDs as the light source. In addition, a complete luminaire shall consist of a housing, LED array, and electronic driver (power supply) and integral controls as per this specification.

C. The operating temperature range shall be 0°C to +55°C. **It is required that this temperature be listed on the CSA/UL operating temperature label that is attached to the fixture.**

D. Each luminaire shall meet all parameters of this specification while operating within the specified temperature range.

E. Nominal luminaire dimensions:

a) 8000L - 25.6” X 11.8” X 2.68”

b) 12000L, 15000L – 25.6” X 15.51” X 2.68”

c) 18,000L, 24000L, 30,000L IBG Standard – 25.6” X 20.71” X 2.68”

d) 18,000L, 24000L, 30000L, 36,000L IBG Narrow – 47.28” X 11.8” X 2.6”

e) 36,000L, 48,000L, 60,000L IBG Standard – 47.28” X 20.71” X 2.68”

F. Luminaire Construction:

n) Luminaire channel should be constructed of steel, heatsink should be constructed of Aluminum

o) The luminaire shall be a single, self-contained device, not requiring onsite assembly for installation. The power supply and circuit board for the luminaire shall be integral to the unit.

p) Luminaire Optics should have IP5X optics standard for dust protection. Optics should be easily replaceable without requiring any tools. There should be a separate optic over each individual row of LED’s

q) Finish: Post Paint White

r) Luminaire shall have isolated and separate light modules for heat dissipation

s) Standard lens shall be impact modified acrylic, diffuse for LED concealment and glare control

t) Luminaire must offer a version that is less than 12” wide for fire sprinkler regulations

G. LED Sources

a). Lumen Output – minimum initial lumen output of the luminaire shall be as follows for the lumens exiting the luminaire in the 0-90-degree zone - as measured by IESNA Standard LM-79-08 in an accredited lab. Exact tested lumen output shall be clearly noted on the shop drawings.

a. Luminaire shall offer LPW options for all lumen packages at **80CRI/5000K** and a **diffuse lens** should be greater than 182 LPW

b). Lumen output shall not decrease by more than **9%** over the minimum operational life of 60,000 hours, documented and tested per TM21 standards

c). Individual LEDs shall be connected such that a catastrophic loss or the failure of one LED will not result in the loss of the entire luminaire

d). Fixture optics should have end to end illumination, and no pixilation of individual LED's

e). Lumen Ouput at maximum ambient temperature (55C) should exceed 95%, tested and documented.

f). Luminaire shall offer distributions including General, Narrow, and Wide

g). LED binning must fall within 5 Macadam Ellipse at 80CRI

h). Electrical

a). Power Consumption: Maximum power consumption, +/- 5% when operating between 120 – 277V (or 347V/480V) shall be as follows:

Lumen package	Wattage							
	Standard efficiency				High efficiency			
	120V	277V	347V	480V	120V	277V	347V	480V
8000LM	55	54	58	61	50	49	51	54
12000LM	79	77	77	76	70	69	68	67
15000LM	97	95	97	96	87	86	86	86
18000LM	114	112	114	115	102	100	102	103
24000LM	154	150	150	150	136	133	135	135
30000LM	193	186	188	188	176	171	173	173
36000LM	225	221	227	229	200	197	203	206
48000LM	301	293	301	302	267	261	269	270
60000LM	385	374	378	377	332	323	330	330

b). Operation Voltage - The luminaire shall operate from a 50 or 60 HZ ±3 HZ AC line over a voltage ranging from 120 VAC to 277 VAC and 347V/480V without use of a step down transformer.

C) Luminaire shall ship standard with 6kV (mvolt) and an inline, replaceable 10kV (Hvolt) surge protection module, tested to **ANSI C82.77-5-2015 Standards and Procedures**

D) Luminaire must not use more than 1 driver for lumen packages up to 30,000L

E) Luminaire drivers shall have documented life of 100,000 Hours at 40C fixture ambient operating temperature. Driver shall have 6kV surge protection standard on the front end

F) Luminaire shall offer integrated Title 24 compliant sensors in the channel, both networked and non-networked, installed from the factory

G) Luminaire must have options to ship with modular cord sets and Reloc connectors installed from the factory

D) Luminaire must offer title-20 approved emergency batter pack solutions from the factory, deliver over 2,400 Lumens

1.09 RECESSED, LINEAR

A. Manufacturers: Lithonia Lighting; Acuity Brands Lighting, Inc.

B. Nominal Operating Voltage: 120 V ac or 277 V ac.

C. Lamp:

1. Minimum 1,500 or 2,000 or 3,000 lumens per application.
2. Minimum allowable efficacy of 85 lumens/W.
3. CRI of minimum 80. CCT of 2700 K or 3000 K or 4100 K per application.
4. Rated lamp life of 50,000 hours to L70.
5. Dimmable from 100 percent to 1 percent of maximum light output.
6. Internal driver.
7. User-Replaceable Lamps:

    a. Bulb shape complying with ANSI C78.79.
    b. Lamp base complying with ANSI C81.61.

D. Housings:

1. Extruded-aluminum housing and heat sink.
2. Powder-coat finish.
3. With integral mounting provisions.

E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit re lamping without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during re lamping and when secured in operating position.

F. Diffusers and Globes:

1. Prismatic acrylic or Clear, UV-stabilized acrylic.
2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

3. Glass: Annealed crystal glass unless otherwise indicated.

G. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.
3. UL Listing: Listed for damp location.
4. NEMA LE 4.
5. DLC Listed

1.10 STRIP LIGHT.

A. Manufacturers: Lithonia Lighting; Acuity Brands Lighting, Inc. or approved equal.

B. Nominal Operating Voltage: 120 V ac or 277 V ac.

C. Lamp:

1. Minimum 1,500 or 2,000 or 3,000 lumens per application.
2. Minimum allowable efficacy of 85 lumens/W.
3. CRI of minimum 80. CCT of 2700 K or 3000 K or 4100 K per application.
4. Rated lamp life of 50,000 hours to L70.
5. Dimmable from 100 percent to 1 percent of maximum light output.
6. Internal driver.

D. Housings:

1. Extruded-aluminum housing and heat sink.
2. Powder-coat finish.
3. With integral mounting provisions.

E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit re lamping without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during re lamping and when secured in operating position.

F. Diffusers and Globes:

1. Prismatic acrylic or Clear, UV-stabilized acrylic.
2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3. Glass: Annealed crystal glass unless otherwise indicated.

G. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.
3. UL Listing: Listed for damp location.
4. NEMA LE 4.
5. DLC Listed

1.11 SURFACE MOUNT, LINEAR

A. Manufacturers: Lithonia Lighting; Acuity Brands Lighting, Inc. or approved equal.

B. Nominal Operating Voltage: 120 V ac or 277 V ac.

C. Lamp:

1. Minimum 1,500 or 2,000 or 3,000 lumens per application.
2. Minimum allowable efficacy of 85 lumens/W.
3. CRI of minimum 80. CCT of 2700 K or 3000 K or 4100 K per application.
4. Rated lamp life of 50,000 hours to L70.
5. Dimmable from 100 percent to 1 percent of maximum light output.
6. Internal driver.

D. Housings:

1. Extruded-aluminum housing and heat sink.
2. Powder-coat finish.
3. With integral mounting provisions.

E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit re lamping without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during re lamping and when secured in operating position.

F. Diffusers and Globes:

1. Prismatic acrylic or Clear, UV-stabilized acrylic.

2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

3. Glass: Annealed crystal glass unless otherwise indicated.

G. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.
3. UL Listing: Listed for damp location.
4. NEMA LE 4.
5. DLC Listed

1.12 SURFACE MOUNT, NONLINEAR

A. Manufacturers: Lithonia Lighting; Acuity Brands Lighting, Inc. or approved equal

A. Nominal Operating Voltage: Nominal Operating Voltage: 120 V ac or 277 V ac.

B. Lamp:

1. Minimum 1,500 or 2,000 or 3,000 lumens per application.
2. Minimum allowable efficacy of 85 lumens/W.
3. CRI of minimum 80. CCT of 2700 K or 3000 K or 4100 K per application.
4. Rated lamp life of 50,000 hours to L70.
5. Dimmable from 100 percent to 1 percent of maximum light output.
6. Internal driver.

C. Housings:

1. Extruded-aluminum housing and heat sink.
2. Powder-coat finish.
3. With integral mounting provisions.

D. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit re lamping without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during re lamping and when secured in operating position.

E. Diffusers and Globes:

1. Prismatic acrylic or Clear, UV-stabilized acrylic.
2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3. Glass: Annealed crystal glass unless otherwise indicated.

F. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.
3. UL Listing: Listed for damp location.
4. NEMA LE 4.
5. DLC Listed

1.13 SUSPENDED, LINEAR

A. Manufacturers: Lithonia, Acuity Brands GRD or approved equal.

B. Nominal Operating Voltage: 120 V ac or 277 V ac.

1. Each fixture shall consist of an assembly that utilizes LEDs as the light source. In addition, a complete fixture shall consist of a housing, LED array, and electronic driver (power supply) and integral controls as per this specification.
2. The operating temperature range shall be 0°C to +25°C.
3. Each fixture shall meet all parameters of this specification while operating within the specified temperature range.
4. Nominal fixture dimensions:

- 4’ single section – Length – 4’-11 ½”, Width – 8-1/4”, Depth – 1-3/4”

- 4’ section in run - Length – 4’-3/8”, Width – 8-1/4”, Depth – 1-3/4”

- 8’ single section - Length – 7’-11 ½”, Width – 8-1/4”, Depth – 1-3/4”

- 8’ section in run – Length – start fixture of run - 7’-11 1/8”, middle of run fixture – Length – 8’-0”, Width – 8-1/4”, Depth – 1-3/4”

C. Fixture Construction:

- Fixture housing to have no visible welding, screws, springs, hooks, rivets, or bare LED’s from the room side.

- The fixture shall be a single, self-contained device, not requiring onsite assembly for installation. The power supply and circuit board for the luminaire shall be integral to the unit.

- Nominal 8-1⁄4” x 1-3⁄4” rectangular housing is formed from cold-rolled steel. Fixture may be mounted individually and wired in continuous rows.

- End caps are mechanically attached with no exposed fasteners.

- Finish Options available are: C110 Painted aluminum (low gloss), C210 White (fine textured), C202 Black (fine textured).

- Fixture ceiling mounting options are: F1 – T-bar (universal mounting brackets), F1A -T-bar (UMB with integrated J-box), F2- Hard ceiling (horizontal J-Box).

- Lens shall be impact modified acrylic and shall provide LED concealment. Lens will be rectangular shape.

- Fixture is a Linear suspended product.

D. LED Sources

- Lumen Output – minimum initial lumen output of the luminaire shall be as per the initial lumens requested along with Led color temperature the lumens exiting the luminaire in the 0-90-degree zone - as measured by IESNA Standard LM-79-08 in an accredited lab. Exact tested lumen output shall be clearly noted on the LM79.

- Lumen output shall not decrease by more than 30% over the minimum operational life of 60,000 hours.

- Four LED Lumen output packages ID800LMF, ID1000LMF, ID1300LMF, ID1500LMF.

- Five LED color temperature options 2700K, 3000K, 3500K, 4000K, 5000K – all within 2.5 MacAdam ellipses.

E. Electrical

c) LED Light engine – Consisting of Modular LED boards and dimming driver – is rated for >60,000 hours (L80) at 25° ambient temperature when operating with 120V or 277V..

d) One Control module per 4' section

1.14 SUSPENDED, NONLINEAR

A. Manufacturers: Lithonia Lighting; Acuity Brands Lighting, Inc. or approved equal.

B. Nominal Operating Voltage: 120 V ac or 277 V ac.

C. Lamp:

1. Minimum 1,500 or 2,000 or 3,000 lumens per application.
2. Minimum allowable efficacy of 85 lumens/W.
3. CRI of minimum 80. CCT of 2700 K or 3000 K or 4100 K per application.
4. Rated lamp life of 50,000 hours to L70.
5. Dimmable from 100 percent to 1 percent of maximum light output.
6. Internal driver.

D. Housings:

1. Extruded-aluminum housing and heat sink.
2. Powder-coat finish.
3. With integral mounting provisions.

E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit re lamping without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during re lamping and when secured in operating position.

F. Diffusers and Globes:

1. Prismatic acrylic or Clear, UV-stabilized acrylic.
2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3. Glass: Annealed crystal glass unless otherwise indicated.

G. Standards:

1. ENERGY STAR certified.

2. RoHS compliant.
3. UL Listing: Listed for damp location.
4. NEMA LE 4.
5. DLC Listed

1.15 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Steel:

1. ASTM A36/A36M for carbon structural steel.
2. ASTM A568/A568M for sheet steel.

C. Galvanized Steel: ASTM A653/A653M.

D. Aluminum: ASTM B209.

1.16 METAL FINISHES

A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

1.17 LUMINAIRE SUPPORT

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.

C. Wires: ASTM A641/A641M, Class 3, soft temper, zinc-coated steel, 12 gage.

D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

1.18 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Install lamps in each luminaire.

D. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and re lamping.
3. Provide support for luminaire without causing deflection of ceiling or wall.
4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

E. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

1.19 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION

SECTION 26 52 13
EMERGENCY AND EXIT LIGHTING

PART 1 - PRODUCTS

1.01 REQUIREMENTS

A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7 and latest California Building Codes.

1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."

1.02 GENERAL REQUIREMENTS FOR EMERGENCY LIGHTING

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NRTL Compliance: Fabricate and label emergency lighting units, exit signs, and batteries to comply with UL 924.

C. Comply with NFPA 70 and NFPA 101.

D. Comply with NEMA LE 4 for recessed luminaires.

E. Comply with UL 1598 for recessed luminaires.

F. Internal Type Emergency Power Unit: Self-contained, modular, battery-inverter unit, factory mounted within luminaire body and compatible with ballast in compliance with CA T-20 and T-24 Compliance.

1. Emergency illumination shall be arranged to provide initial average illumination of at least 1 foot-candle (11 lux), and a minimum of 0.1 foot-candle (1 lux), at any point measured along the path of egress at floor level. This average illumination level is permitted to decline to 0.6 foot-candle (6 lux), and a minimum of 0.06 foot-candle (0.6 lux), at any point along the path of egress at the end of the required emergency lighting time duration. In either case, a maximum-to-minimum illumination uniformity ratio of 40 to 1 is not permitted to be exceeded. Per Section 7.3.3 of National Fire Protection Association (NFPA) 110-13 standard per Chapter 35 and Section 2702.1 of CBC, the average illumination level in the emergency or standby generator rooms shall not be less than 3 foot-candles (32.3 lux) at the floor level

2. Emergency Connection: Operate LED lamp(s) continuously at an output of code required lumens (Section 1006 of CBC and 1008.1.6 of CBC for exit discharge doorways in buildings required to have two or more exits) each upon loss of normal power. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.

3. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.

4. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

    a. Ambient Temperature: Less than 0 deg F or exceeding 104 deg F, with an average value exceeding 95 deg F over a 24-hour period.

    b. Ambient Storage Temperature: Not less than minus 4 deg F and not exceeding 140 deg F.
    c. Humidity: More than 95 percent (condensing).
    d. Altitude: Exceeding 3300 feet

5. Test Push-Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.

    a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
    b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

6. Battery: Sealed, maintenance-free, nickel-cadmium type.

7. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.

8. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

G. External Type: Self-contained, modular, battery-inverter unit, suitable for powering one or more lamps, remote mounted from luminaire.

1. Emergency Connection: Operate LED lamp continuously. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire driver.

2. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.

3. Nightlight Connection: Operate lamp in a remote fixture continuously.

4. Battery: Sealed, maintenance-free, nickel-cadmium type.

5. Charger: Fully automatic, solid-state, constant-current type.

6. Housing: NEMA 250, Type 1 enclosure listed for installation inside, on top of, or remote from luminaire. Remote assembly shall be located no less than half the distance recommended by the emergency power unit manufacturer, whichever is less.

7. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.

8. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

9. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

1.03 EMERGENCY LIGHTING

A. General Requirements for Emergency Lighting Units: Self-contained units.

B. Emergency Luminaires:

A. Manufacturers:

1. Cooper Lighting, an Eaton business.
2. Dual-Lite.
3. Lithonia Lighting; Acuity Brands Lighting, Inc.
4. Philips Lighting Company.

1. Emergency Luminaires: As indicated on the design documents with the following additional features:

a. Operating at nominal Input voltage of 120 V ac or 277 V ac.
b. Internal or External emergency power unit.
c. Rated for installation in damp locations, and for sealed and gasketed fixtures in wet locations.

C. Emergency Lighting Unit:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Lighting, an Eaton business.
2. Dual-Lite.
3. Evenlite, Inc.
4. Lithonia Lighting; Acuity Brands Lighting, Inc.

1. Operating at nominal Input voltage of 120 V ac or 277 V ac

1.04 EXIT SIGNS

A. The path of exit travel to and within a building shall be identified by exit signs conforming to the requirements of Section 1011 of CBC. In general, exit signs are required to be installed in rooms or areas that require two or more exits or exit accesses. An exit sign shall be readily visible from any direction of approach. Exit signs shall be located in the exit or in the path of exit as necessary to clearly indicate the direction of egress travel. No point shall be more than 100 feet from the nearest visible sign, unless shorter viewing distance is required due to the exit sign listing or approval. Required exit signs may be internally or externally illuminated as required per Section 1011.3 of CBC. The face of an externally illuminated exit sign is required per section 1011.6.2 of CBC to be illuminated to an intensity of not less than 5 foot-candles, by an approved external emergency luminaire..

B. FLOOR LEVEL EXIT SIGN AND PATH MARKING

a. Floor level exit sign or path marking systems are required in occupancies noted in Sections 1011.2, 1011.7 and 1011.8 of CBC., Except as indicated below, when exit signs are required in a building, floor level exit signs are required to be installed in all interior corridors of Group A, E, I occupancies .Floor-level exit signs are exempt to be installed in the following occupancies as specified:
1. Group A occupancy that are protected throughout by an approved supervised fire sprinkler system.
2. Group E occupancy where direct exit has been provided from each classroom.
3. Group I and R-2.1 occupancies which are provided with smoke barriers constructed in accordance with Section 407.4 of CBC.
4. Group I-3 occupancy. Floor level exit signs may be internally or externally illuminated approved photoluminescent or self-luminous as required per Section 1011.7 of CBC. The path marking shall be either installed at the floor level or no higher than 8 inches above the floor level in all interior rated exit corridors of un sprinklered Group A, R-1, and R-2 occupancies where an exit sign is required. The path marking shall be continuous except for interruptions by doorways, corridors, or other architectural features and it shall provide a visible delineation along the path of travel.
Internally Lighted Signs:

C. Internally Lighted Signs:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Cooper Lighting, an Eaton business.
b. Hubbell Industrial Lighting; Hubbell Incorporated.
c. Lithonia Lighting; Acuity Brands Lighting, Inc.
d. Philips Lighting Company.

2. Operating at nominal Input voltage of 120 V ac or 277 V ac

3. Lamps for AC Operation: LEDs; 50,000 hours minimum rated lamp life.

C. Self-Luminous Signs: Not Allowed

1.05 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Install lamps in each luminaire.

D. Supports:

1. Sized and rated for luminaire and emergency power unit weight.

2. Able to maintain luminaire position when testing emergency power unit.

3. Provide support for luminaire and emergency power unit without causing deflection of

ceiling or wall.

4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire and emergency power unit weight and vertical force of 400 percent of fixture weight.

E. Perform the following tests and inspections:

1. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

F. Luminaire will be considered defective if it does not pass operation tests and inspections.

G. Prepare test and inspection reports.

END OF SECTION

SECTION 26 55 50
THEATRICAL PRODUCTION LIGHTING

PART 1 - GENERAL

1.01 GENERAL

A. The purpose of this document is to describe the requirements of the Production Lighting systems in Compton High School in order to provide a preliminary specification for Production Lighting. The Compton High School is a new build project in Compton, CA USA. The lighting equipment will be required to provide flexibility and efficiency while providing powerful tools for lighting a performance in effective and creative ways. It must include infrastructure with power and data tie lines within the venue that will complement and complete the anticipated needs of the productions.

B. The lighting systems shall be primarily based on the Altman Lighting line of products or approved equal. All equipment shall be of high quality. The Production Lighting systems will be designed to be highly flexible and configurable allowing for medium and large-scale events, music and other performance. Close coordination will be required between the contractors of various works during installation to efficiently design and construct the theatre.

C. This document is preliminary and is based upon the latest set of architectural general arrangement drawings as available at the time. Should the layout of the building or equipment change substantially, this specification must be updated.

D. The scope of work in this section includes, but is not limited to, the full design, engineering, production of shop drawings, manufacture, procurement, installation, setting to work, testing, commissioning, hand over to client and training.

E. This document is a performance specification indicating design intent only. The integrator or specialist contractor which is contracted to complete the work in this package shall accept full responsibility for supplying a complete, fit for purpose system which complies with the design intent and performance criteria specified herein.

F. If the integrator / specialist contractor believes any aspect of this performance specification is erroneous, impractical, incomplete or unachievable, this should be explained in writing before the contract is agreed. A detailed list of alternatives and additions shall be produced for the consideration of the design team.

1.02 SCOPE

A. The following Systems as applicable to the project requirements:

1. Power Control / Relay Racks
2. Electronics Racks
3. Control Consoles and Accessories
4. Architectural control processors
5. Data Communications Devices and Network
6. Production Lighting Box facility panels
7. Production Lighting Luminaires and Accessories
8. Cables
9. Accessories

B. Provision of materials, components, modifications, assemblies, equipment, installation works and services as specified herein and as required by project commercial and contractual

requirements. These include, but are not limited to:

1. Verify site dimensions and conditions and notify the client in writing of any inaccuracies or errors which may affect installation of equipment within this section.
2. Drawing and sample submittals of all custom-manufactured items and receive approval prior to fabrication and installation. Approval of drawings in no way absolves Specialist Contractor of obligation to produce a fully functional system.
3. Engineering of equipment and systems as required by the Contract Documents
4. Manufacture of equipment and systems as required by the Contract Documents
5. Scheduling, sequencing, supervision and coordination with other integrators, workforce, and trades as necessary
6. Installation and supervision for equipment and systems specified herein and elsewhere in the Contract Documents
7. Testing and demonstration of equipment and systems as specified herein
8. Equipment Samples
9. Additional installation of equipment as directed by the client to demonstrate that the system is complete and fit for purpose.
10. Disposal of all packaging / trash.
11. Submittal of test reports, operational manuals and as-built documentation as specified herein
12. The security of the Specialist Contractors own tools and equipment.
13. Guarantee all equipment and components for the warranty period commencing from the date of practical completion.
14. Warranty and training, provision of maintenance services for the specified period commencing from the date of completion and any other post-completion services as specified

1.03 REFERENCES

A. Technical Reference Standards:

B. ANSI Standards

1. ANSI E1.11 - 2008 (R2013) Entertainment Technology - USITT DMX512-A, Asynchronous Serial Digital Data Transmission Standard for Controlling Lighting Equipment and Accessories
2. ANSI E1.17-2010 Entertainment Technology - Architecture for Control Networks
3. E1.20-2006 Entertainment technology – Remote Device Management
4. E1.20-2-2009 Entertainment Technology – Recommended Practice for Installing Control Cables
5. E1.30-7-2009, EP129 - Allocation of Internet Protocol Version 4 Addresses to ACN Hosts
6. E1.31-2009 Entertainment Technology - Lightweight streaming protocol for transport of DMX512 using ACN

C. Institute of Electrical and Electronics Engineers, Inc.:

1. 802.3 Gigabit Ethernet

2. 802.11 b-g-n Specifications for implementation of Wireless Local Area Networks

1.04 CODE REQUIREMENTS

A. The Specialist Contractor shall be required to comply with all current Statutory Requirements, Local and National Regulations. These shall include but not be limited to:

B. National Fire Protection Association – National Electrical Code

1.05 LIGHTING SYSTEMS SUMMARY

A. The lighting in the performance space will be made up from several systems, each comprising several elements:

B. Performance lighting system – describes all theatrical lighting used to illuminate the performers or scenic elements during a performance, for the purpose of enhancing their presentation.

1. Production Lighting - describes all functional luminaires used to illuminate the performers or scenic elements during a performance, for the purpose of enhancing their presentation.

2. Lighting Rigging and Accessory Equipment – describes all the ancillary equipment used in conjunction with the fixtures to position them effectively.

C. House Lighting– describes all functional lighting used to illuminate the auditorium prior to and after a performance, to allow audience members to safely locate their seats.

1. Architectural Lighting - describes all aesthetic lighting used to illuminate the auditorium prior to (sometimes during) and after a performance, to highlight and accent architectural features.

2. Emergency lighting - describes all functional lighting used to illuminate the stage and auditorium for the purpose of save evacuation in the event of an emergency.

3. Illuminated signage - describes all functional lighting used to highlight emergency exits and facilities on the stage and auditorium for the purpose of safe evacuation in the event of an emergency.

D. Work Lighting - describes all functional lighting used to illuminate the stage and auditorium for set-up, configuration some rehearsals and cleaning.

1. Rehearsal Lighting - describes all functional lighting used to illuminate the performers or scenic elements during a rehearsal, this system is similar to that of the Concert platform lighting, but typically used high efficiency, low energy sources.

2. Backstage Lighting – (often known as blues) describes all functional lighting used to illuminate technical areas during a performance, typically blue light to reduce noticeable spill.

3. Task Lighting - describes all functional lighting used to illuminate specific technical work areas at any time.

1.06 RELIABILITY

A. Equipment shall have a minimum expected useful operating life of 10 years, unless otherwise stated. LEDs shall be rated for a minimum of 50,000 hours to L70. Equipment shall be designed to require only minimal scheduled maintenance. In addition to requirements described elsewhere the Specialist Contractor shall provide a preventative maintenance and support programmed to achieve an availability of the systems represented by less than one breakdown within 10,000 hours of operation which gives rise to a failure lasting more than 30 minutes.

B. All major line item offered equipment must have a proven track record of reliable operation in a theatrical environment. No equipment without a clear and proven record of operation and function in a theatrical environment shall be accepted.

C. High quality components and materials with known and predictable performance shall be used throughout. Particular care shall be taken in the selection of items known to be a frequent cause of reliability problems. Manufacture, assembly and installation shall take place in a quality-controlled environment with comprehensive records kept of inspection and testing procedures.

D. Systems shall be tolerant of brief fluctuations to power supply and shall shut down in a controlled manner in case of power failure. When power returns, the system shall return to the current status rather than resetting. No data shall be lost during a forced shut down.

E. It is desirable for the system to have fault tolerant features wherever practical.

PART 2 - INSTALLED AND PORTABLE EQUIPMENT

2.01 PERFORMANCE LIGHTING CONTROL CONSOLE

A. General

1. The lighting control console shall be suitable for control of fixed focus tungsten-based fixtures, moving lights, and LED based fixtures.
2. The console shall be portable in order to relocate as needed.
3. The console shall have onboard memory for saving shows and ability to save to USB drives.
4. The console shall be a computerized console capable of bi-directional operation in a networked data installation utilizing E1.31 Streaming ACN.
5. The control console shall provide E1.11 – 2008, USITT DMX512-A based control from the console along with E1.37-1 Remote Device Management, No nodes or equipment shall be required to output DMX or RDM.
6. Console shall be able to patch fixtures in a software patch and shall come preloaded with a current fixture library of LED or moving fixtures from the following companies:
    a. Altman or equal by ETC
7. All current software shall be provided at the time of installation.
8. Console shall be rated UL, ETL or equally accredited 3rd party compliance certified.
9. *Approved Product: Client Nominated*

B. Physical

1. The console shall be no larger than the following dimensions:
    a. 36 inches width
    b. 24 inches length
    c. 8 inches depth

C. Electrical

1. The fixture shall be equipped with 100V to 240V 50/60 Hz universal power supply.

D. Hardware

1. 802.3af ethernet port x 1
2. DMX512 with RDM via 5 pin XLR female x 2
3. VGA port x 1 with support for a minimum of SVGA resolution
4. USB port x 2
5. Solid state memory on board

E. Control

1. Palette type control for Intensity, Focus, Color and Beam with the following:
    a. Color picker
    b. Pan & Tilt
    c. Gobo
    d. Zoom / Focus
2. 1024 outputs
3. Maximum 999 cue recording and memory capacity
4. 24 submaster slider type faders
5. Dedicated “Go” button
6. Grand Master Fader

2.02 DMX MERGER MODULE

A. General

1. The eDIN DMX Merger Module shall combine, in a user-determined manner, DMX512 inputs from two sources or controllers (DMX A and DMX B), into one DMX output stream.
2. Multiple modules, up to four levels deep, may be cascaded together, DMX output to DMX input.
3. The interface module shall be designed to mount on 35mm DIN rail.
4. The DMX Merger Module(s) shall be Pathway Connectivity eDIN model #1007.

B. Features

1. HTP (highest-takes-precedence) Merge with 2 second status quo. DMX A and DMX B shall be merged together using highest level takes precedence, on a channel-by-channel basis. If all DMX input is lost, the last valid DMX levels shall be held for 2 seconds, then stop.
2. HTP Merge with 5 minute status quo. DMX A and DMX B shall be merged together using highest level takes precedence, on a channel-by-channel basis. If all DMX input is lost, the last valid DMX levels shall be held for 5 minutes, then stop.
3. HTP Merge with offset and 2 second status quo. Input channels below the DMX channel offset assigned to DMX B shall be ignored. Channels above and including the offset shall be merged using highest-takes-precedence, on a channel-by-channel basis, with the corresponding channel input from DMX A. If all DMX input is lost, the last valid DMX levels shall be held for 2 seconds, then stop.
4. HTP Merge with offset and 5 minute status quo. Input channels below the DMX channel offset assigned to DMX B shall be ignored. Channels above and including the offset shall be merged using HTP, on a channel-by-channel basis, with the corresponding channel input from DMX A. If all DMX input is lost, the last valid DMX levels shall be held for 5 minutes, then stop.
5. Auto Backup with 2 second status quo. DMX B shall be ignored as long as signal is present on DMX A. If DMX A is lost, output shall immediately switch to DMX B. If DMX A is restored, output shall immediately switch back. If all DMX input is lost, the last valid DMX levels shall be held for 2 seconds then stop.
6. Auto Backup with 5 minute status quo. DMX B shall be ignored as long as signal is present on DMX A. If DMX A is lost, output shall immediately switch to DMX B. If DMX A is restored, output shall immediately switch back. If all DMX input is lost, the last valid DMX levels shall

be held for 5 minutes then stop.

7. External Switch Backup with 2 second status quo. DMX B shall be ignored until the contact closure input is shorted. If the contact closure is opened, DMX A shall be restored immediately. Output source shall be controlled solely by the switch. If all DMX input is lost, the last valid DMX levels shall be held for 2 seconds then stop.
8. External Switch Backup with 5 minute status quo. DMX B shall be ignored until the contact closure input is shorted. If the contact closure is opened, DMX A shall be restored immediately. Output source shall be controlled solely by the switch. If all DMX input is lost, the last valid DMX levels shall be held for 5 minutes then stop.
9. Append with 2 second status quo. DMX B shall be appended to DMX A starting at the DMX address offset. Appended channels shall not be merged. If DMX input is lost, the last valid DMX levels shall be held for 2 seconds then stop.
10. Append with 5 minute status quo. DMX B shall be appended to DMX A starting at the DMX address offset. Appended channels shall not be merged. If DMX input is lost, the last valid DMX levels shall be held for 5 minutes then stop.
11. Test mode with channel fade. When this operating mode is combined with TEST mode, the selected channel shall smoothly autofade up and down. DMX A and DMX B are ignored.
12. The Module shall provide an output test mode to allow the user to activate a selected DMX channel via the onboard user interface.
13. The Module shall have a diagnostic test mode, activated by pressing a pushbutton during power-up.

C. User Interface

1. A three-digit LED display and three pushbuttons shall provide the user interface to set DMX start address and operating mode, and to access test functions.
2. LED indicators shall provide status reporting for power, processor status, and DMX A&B input.
3. Each DMX input shall be provided with an end-of-line termination switch.

D. Electrical

1. The power input shall be supplied by a Class 2 circuit. It shall accept a range of 9 to 30 volts DC and shall consume no more than 6 watts.
2. Each DMX input port shall be capable of withstanding short-term application of up to 250V without damage to internal components.
3. Input protection shall be self-healing, rated for 250V. Replaceable fuses shall not be acceptable.
4. All DMX ports shall be optically isolated from each other to 1500 volts to between the DMX signals and and module electronics.
5. All input, output and power connections shall utilize pluggable Phoenix-type screw terminal blocks, capable of accepting solid or stranded wire sizes from #26 to #16 AWG.

E. Physical

1. The DMX Merger Module shall be designed to snap on to 35mm DIN rail without the use of tools.
2. The Module shall measure 3.6”W x 4.5”L x 1.5”H (91mm x 114mm x 38mm).

3. The Module shall weigh 0.42 lb. (190g).

F. Environmental

1. The ambient operating temperature shall be -10° to 50°C (14° to 122°F).
2. The storage temperature shall be -40° to 70°C (-40° to 158°F).
3. The operating humidity shall be 5% - 95% non-condensing.

G. Compliance

1. The DMX Merger Module shall meet be compliant with USITT DMX512 (1990) and ANSI E1.11 DMX512-A.
2. 7.2 The DMX Merger Module shall be compliant with the EU RoHS (2002/95/EC) directive.
3. 7.3 The DMX Merger Module shall conform to all FCC and CE requirements.
4. 7.4 The DMX Merger Module shall be powered by a UL1310 Class 2 Low Voltage circuit.
5. 7.5 The module circuit board shall be manufactured from FR-4 glass epoxy laminate with a UL 94 flammability rating of V0. The board shall be clearly marked as such.
6. 7.6 The module carrier housing shall be manufactured from extruded rigid PVC with a UL 94 flammability rating of 5VA

2.03 DMX/RDM REPEATER MODULE

A. General

1. The eDIN DMX/RDM Repeater Module shall permit star-wiring and repeating of DMX512 and RDM lighting control signals over the connected data cabling.
2. The Module shall fully isolate and protect DMX transmitters and receivers, and RDM controllers and responders from high common mode voltages, ground loop currents and other potentially damaging or disrupting electrical faults.
3. The Module shall have one input port, one pass-thru port and four output ports. All ports shall be bi-directional.
4. There shall be no in-line processing of the input signal, to ensure that all output signals are exact duplicates of the input signal with no processing delays.
5. The Module shall be capable of repeating and distributing simplex protocols other than DMX512, provided they meet the electrical requirements of EIA-RS422 or RS485.
6. The Module shall be designed to mount on standard 35mm DIN rail.
7. The DMX/RDM Repeater Module(s) shall be Pathway eDIN model #1009.

B. Features

1. LED indicators shall be provided for Power, Data-In and CPU status, as well as for DMX/RDM activity on each of the four output ports.
2. The Module shall be capable of regenerating four (4) exact duplicate data streams from the original source input data stream.
3. Each output shall be capable of driving up to 32 DMX-only receiving devices over a maximum 500-meter (1600-ft.) length of cable.
4. Each output shall be capable of driving up to 31 DMX/RDM responding devices over a maximum 300-meter (1000-ft.) length of cable.

5. One (1) DMX/RDM pass-thru port shall be provided. The pass-thru port shall be active, i.e. electrically repeated.
6. For installations requiring DMX and RDM functionality, up to four repeater modules may be cascaded together. For installations requiring only DMX functionality, up to eight repeater modules may be cascaded together.
7. The Module itself shall act as an RDM responder.
8. It shall be possible to field-update the module firmware via the DMX input port.

C. Electrical

1. The power input shall be supplied by a Class 2 circuit. It shall accept a range of 9 to 30 volts DC and shall consume no more than 6 watts.
2. Multiple modules, up to the RDM-specified limitation of four (4), may be cascaded (looped) on the same DMX/RDM input data line using the pass-thru ports or any output ports.
3. In DMX-only installations, up to eight (8) modules may be cascaded (looped) on the same DMX input data line using the pass-thru ports or any output ports.
4. All DMX/RDM input and output ports shall be capable of withstanding short-term application of up to 250V without damage to internal components.
5. Port protection shall be self-healing, rated for 250V. Replaceable fuses shall not be acceptable.
6. The DMX/RDM input port shall provide 1500-volt optical isolation between the input signal wiring and output signal wiring.
7. DMX/RDM output ports shall be fully optically isolated from each other and floating with respect to earth ground.

D. Physical

1. The DMX/RDM Repeater module shall be designed to snap on to 35mm DIN rail without the use of tools.
2. The Module shall measure 3.6”W x 6.25”L x 1.5”H (91mm x 160mm x 38mm).
3. The Module shall weigh 0.54 lb. (245g).
4. All DMX and power connections shall utilize pluggable Phoenix-type screw terminal blocks, capable of accepting solid or stranded wire sizes from #26 to #16 AWG.

E. Environmental

1. The ambient operating temperature shall be -10° to 50°C (14° to 122°F).
2. The storage temperature shall be -40° to 70°C (-40° to 158°F).
3. The operating humidity shall be 5% - 95% non-condensing.

F. Compliance

1. The DMX/RDM Repeater Module shall meet the requirements of USITT DMX512 (1990), ANSI E1.11 DMX512-A and ANSI E1.20 RDM.
2. The DMX/RDM Repeater Module shall be compliant with the EU RoHS (2002/95/EC) directive.
3. The DMX/RDM Repeater Module shall conform to all FCC and CE requirements.
4. The DMX/RDM Repeater Module shall be powered by a UL1310 Class 2 Low Voltage circuit.

5. The module circuit board shall be manufactured from FR-4 glass epoxy laminate with a UL 94 flammability rating of V0. The board shall be clearly marked as such.
6. The module carrier housing shall be manufactured from extruded rigid PVC with a UL 94 flammability rating of 5VA.

2.04 CHALICE 70/150 SINGLE POINT LED DOWNLIGHT PENDANT

A. General

1. The luminaire shall be a full spectrum fixed white LED downlight employing a single 7,400/10,000 lumen emitter that is convection cooled. The Luminaire shall be the Chalice 70/150 down light by Altman Stage Lighting, Inc or approved equal.
2. The luminaire shall incorporate a state-of-the-art microprocessor-controlled solid-state LED light engine, and on-board power supply.
3. The luminaire shall have the ability to house several different fixed white LED choices of 2700K, 3000K, 4000K, & 5000K each with an output of greater than 92 CRI.
4. The luminaire's light source shall incorporate silent, convection cooling without employing the use of fans or filters. Any luminaire not employing a light source convection cooling shall not be accepted.
5. The luminaire shall utilize a high efficiency reflector system to determine beam angle with Seven (7) different choices.
6. IES Photometric files shall be available upon request from the manufacturer to model light output using the industry standard design software.
7. For DMX controlled models: The luminaire shall comply with USITT DMX-512 A and RDM ANSI E1.20 Standards.
8. For Mains Dimmable models: The luminaire shall be able to be controlled from a phase cut dimming system in either forward or reverse phase (leading or trailing edge) and shall not require additional power sources for capacitance voltage control.
9. The luminaire shall be constructed of a spun aluminum housing with steel fittings and attachment components, all free of pits and burrs.
10. Standard finish shall be Epoxy Sandex White, electrostatic application. The luminaire shall be available with optional Black and additional custom color finishes available upon request.
11. Each luminaire's power supply, cooling and electronics shall be integral to each unit.
12. The housing shall serve as a directional chimney to guide heat away from the LED array, integral driver and integral power supply.
13. The LED substrate is coupled to a highly efficient heat sink and cooling system for prolonged life of the LEDs.
14. The Luminaire shall be capable of, dependent upon model, Pendant Mounting, Aircraft Cable Mounting, Yoke Mounting, or Wall Mounting.

B. Electrical

1. Supply Voltage shall be 120 to 277VAC, 60Hz. (+/- 10% auto-ranging)
2. The luminaires current draw shall not exceed 0.58 amps (120VAC) or 0.31 amps (220VAC) or 0.25 amps (277VAC) luminaires that do not meet these criteria shall not be accepted.
3. The light engine source shall be one (1) 2700K, 3000K, 4000K, or 5000K 70 Watt LED chip.

4. The luminaire shall be cETL us Listed.

C. Control

1. The DMX luminaire shall be equipped with an LED system compatible with standard 8-bit input, and utilizing PWM high resolution dimming.
2. The Mains Dimmable luminaire shall be equipped with an LED control system compatible with both forward and reverse phase dimming systems, and utilizing a PWM high resolution dimming.
3. The luminaire shall interact seamlessly with conventional sources.
4. The luminaire shall be digitally driven using high-speed Pulse Width Modulation (PWM)
5. The DMX luminaire shall have a local control keypad with an LED display for configuration and control of:
   a. DMX-512A device address
   b. Luminaire personality
   c. Standalone operation
6. It shall be possible to lock out the control keypad on the DMX model on the luminaire to prevent accidental change in luminaire configuration. Locking and unlocking the luminaire shall be via a predefined key sequence.
7. Luminaire shall have an available “Master” function to provide control of intensity of additional luminaires on the DMX string, when applicable.
8. Luminaire shall provide full range dimming performance based upon its DMX input control signal and configuration and shall be equipped with an LED system compatible with standard 8-bit input, with high resolution dimming.
9. The luminaire shall be capable of standalone operation, activated and configured at the keypad.

D. Physical

1. The Chalice 70 Downlight LED Light shall not exceed 12-inches in height by 8-inches in diameter.
2. The Chalice 150 Down Light Light Led Shall not exceed 16” H x 10” in Diameter.
3. The addition of optional add on reflectors shall not protrude past the outer housing of the luminaire. Optional reflectors shall include the options for 20, 29, 39, 46, 51, 64, & 91 degrees.
4. The construction of the unit shall be a machined aluminum, sheet metal and molded engineering grade plastic.
5. The luminaire shall be capable of, dependent upon model: Pendant Mounting, Aircraft cable mounting, Yoke Mounting, or Wall Mounting.

2.05 COLOR MIXING OR WHITE LED ZOOM SPOTLIGHT

A. General

1. The fixture shall be an Altman PHX 150 Profile Spotlight as manufactured by Altman Stage Lighting. or approved equal. Fixtures that do not meet the following performance criteria in this specification will not be acceptable.
2. The fixture shall be an LED based focusable, zoom luminaire with a range of beam angles provided via multiple lens tubes with differing beam angles.

3. The fixture shall provide silent convection cooled operation. No fan cooling shall be incorporated into the design of the fixture. Fixtures requiring fans for cooling will not be acceptable.
4. The fixture shall utilize a 150-watt maximum multi-LED array for light generation.
5. Unit shall be IP20 rated for indoor use.
6. A push button control interface shall be located on the rear of the fixture for ease of control.
7. The fixture shall be ETL, cETL LISTED and CE MARKED, and shall be so labeled when delivered to site. The fixture shall be ETL LISTED under Portable Luminaires (UL Standard 1573) and Surface Mount Luminaires (UL Standard 1598).
8. Ambient operating temperature shall be between -14°F to 104°F (-10°C to 40°C).
9. Power supply, cooling and electronics shall be included inside each unit.
10. Normal operation of optical and control functions of the fixture shall not require tools.

B. Physical

1. The fixture shall have a die cast aluminum housing and major components, free of defects such as burrs, pits and malformations.
2. Finish shall be Epoxy Sandtex black, electrostatic application. Custom colors based on the RAL color system shall be available.
3. Fixture shall not weigh more than 25.5 lbs. (11.56 kgs.).
4. Fixture shall have double clutch positive locking yoke locks on both sides of the housing.
5. The unit shall have 4 qty. tool free, stainless steel shutters equipped with insulated handles. The fixture shall include a lever located on each side to facilitate locking the shutters into position.
6. Shutters to be made of high quality steel. Shutter warping and burnout in normal use shall be unacceptable.
7. The focus barrel portion of the body shall be able to rotate 360° without the use of tools.
8. Fixture shall feature a standard size accessory slot with a sliding cover to eliminate uncontrolled light spill. Accessory slot shall accept the following accessories:
    a. A and B size steel gobo pattern holders.
    b. A and B size glass gobo pattern holders.
    c. Iris.
    d. Rotating gobo holder.
9. Fixture shall be supplied with:
    a. Steel yoke constructed from rigid flat steel and with two mounting positions and indexed tilt angle markings.
    b. Cast iron C-clamp (Altman #510) suitable for use on up to 2” O.D. pipe. Clamp shall incorporate a 360-degree rotational “Safety Stud” with locking bolt.
    c. 18 inch safety cable.
    d. Color frame.
    e. Soft focus pattern holder.
    f. Lens tube and locking hardware.
    g. 5 foot power cable with powerCON™ socket outlets and the following options for plug type:
10. Parallel Blade NEMA 5-15 “Edison” Male.

11. 2 pin + ground Stage Pin Male.
12. NEMA L5-20P Twist Lock Male.
13. Bare end cable.

C. Electrical

1. The fixture shall be equipped with 100V to 240V 50/60 Hz auto-ranging internal power supply.
2. Power input and through shall be via lockable and separately keyed powerCON™ type connections.
3. Power supply shall have power factor correction.
4. Power supply outputs shall have resetting current-limiting protection.

D. Thermal

1. The fixture shall utilize thermal management to maintain LED life to an average of 70% intensity after 50,000 hours of use.
2. Thermal management shall include multiple temperature sensors within the housing to include:
    a. LED Temperature sensor.
    b. Power supply Temperature sensor.
    c. Display Board Temperature sensor.
    d. Heat Sink interface Temperature sensor.

E. Control

1. The unit shall be controlled using ANSI 1.11 USITT DMX512-A / ANSI E1.20 RDM (Remote Device Management). The DMX-512A device address for each fixture shall be user selectable.
2. Up to 16-bit virtual dimming control of the fixture shall provide full range (0-100%) dimming without exhibiting flicker or stepping. Dimming curves shall be optimized for smooth dimming at low intensities and over longer timed fades.
3. Control input and through function shall be via 5-pin XLR connections.
4. Console free playback options with Master and Slave modes shall be programmed into the onboard memory on RGB A/W versions. Functions shall include adjustable color fades.

F. Optical

1. LED arrays shall be available in the following combinations:
    a. Color Mixing RGBA.
    b. Color Mixing RGBW.
    c. Fixed white color temperature 3000K.
    d. Fixed white color temperature 5600K.
    e. Variable white 3000K-5600K.
2. LED emitters should be rated for nominal 50,000-hour LED life to L70.
3. Fixture shall be calibrated at factory to achieve consistent color and intensity output between fixtures built at different times and/or from different LED lots or bins.
4. Fixtures shall have an internal automatically adjustable PWM frequency up to 18Khz with automatic variable low end novel dimming methodology to avoid flicker on camera.
5. Color mixing fixtures shall be optimized for low saturate colors (pastels) as well as high

saturate colors used in theatrical applications. Fixtures utilizing 3-color (Red, Green, and Blue) mixing systems cannot produce sufficient skin tones or saturate ambers, lavenders, or oranges and shall not be accepted.

6. Manufacturer of LED systems shall utilize an advanced production LED binning process to maintain color consistency.
7. A minimum of six (6) lens barrels shall be available including 5°, 10°,19°, 26°, 36°, and 50° angle options.
8. Shutter assembly shall use 3 planes to ensure sharp focusing ability without halation.

2.06 COLOR MIXING LED WASH FIXTURE

A. General

1. The fixture shall be Red, Green, Blue, and White LED luminaire with motorized zoom and DMX control. The fixture shall be the AP-150 RGBW by Altman Stage Lighting, Inc. or approved equal.
2. The fixture shall incorporate a state of the art microprocessor-controlled solid state LED light engine, and on-board power supply.
3. The fixture shall utilize active cooling and feature advanced cooling mitigation and control from either the DMX controller or via an active cooling system on board settings.
4. The fixture shall utilize a high efficiency optics and zoom mechanism to achieve greater than 1,900 lumens of output with a 12°- 65° beam angle motorized zoom.
5. IES photometric files, at multiple beam angles shall be available upon request from the manufacturer to model light output using the industry standard design software.
6. The fixture shall comply with USITT DMX-512 A, ANSI E1.20-2006, and ANSI E1.37-2 (2015) Remote Device Management over USITT DMX 512A Standard (RDM) for DMX controlled models. Luminaires not utilizing E1.37.2 (2015) RDM standard shall not be acceptable.
7. The fixture shall be ETL Listed to UL1573, and UL8750 LED for stage and studio use as well as Portable Electric Luminaires (UL Standard 153) and CE marked.
8. Fixtures which do not comply with this specification shall not be accepted.

B. Physical

1. The fixture shall be constructed in majority of an aluminum die cast shell. Construction shall employ all corrosion-resistant materials and hardware and shall be free of pits and burrs.
2. Standard finish shall be epoxy black, electrostatic application. The fixture shall be available with a black color finish.
3. Power supply, cooling and electronics shall be integral to each unit.
4. Fixture dimensions shall be 10.2” (259mm) L x 13.62” (346mm) H x 9.06” 230m) Dia. and weigh 11lbs (5.08 kg) without accessories.
5. The fixture shall include a blending optic to reduce the projection of multiple shadows from the different color sources in the fixture.
6. Fixture shall be equipped with a dual slot accessory holder with tool-free quick release accessory holder clips with self-locking accessory retaining latch.
7. An integrated rigid flat steel kick stand yoke with locking tilt handle shall be available for stand-alone floor and overhead pipe mounting.

8. Pipe mounted fixtures shall be supplied as an additional accessory, a cast iron C-clamp Altman #510 suitable for use on up to 2" nominal (50.8 mm) O.D. pipe. Clamp must incorporate a 360-degree rotational "safety stud" with locking bolt. Any clamp not offering this safety feature will not be acceptable.
9. Fixtures shall be supplied, as an additional accessory, with safety cable for use when securing the fixture to a pipe.

C. Thermal

1. The fixture shall be cooled via an active cooling system and shall be capable of Progressive Output Management (POM): where the fixtures' logic follows a set of rules based upon the operators operational preferences. This logics shall include:
2. Direct DMX control: the fixture's DMX channel will control the fan's output, in conjunction with the Progressive Output Management when the luminaire is on. This control will enable the end user to silence the fan when low intensity is required.
3. Static (fixed) fan settings: When the unit is set to a defined "fixed" fan speed - if the LED reaches a maximum threshold temperature, the output of the luminaire will be reduced until thermal equilibrium is reached.
4. Automatic fan settings: when the unit is set to automatic fan control, fan cooling will slowly increase and decrease based upon the operating temperature.
5. Under normal operating conditions, the LED engine shall be capable of 50,000 hours rated lifespan to LM-70 / 70% maximum calibrated intensity with Progressive Output Management cooling, units not utilizing this style of cooling management shall not be accepted.

D. Electrical

1. The fixture shall be equipped with 100V to 240V 50/60 Hz auto-ranging internal power supply and requires power from a constant "non-dim" power source for.
2. The fixture shall receive power via a PowerCon™ blue power inlet and thru power via a PowerCon™ grey power outlet.

E. Control and User Interface

1. A local control keypad with a graphical user LCD display shall be provided for configuration, control, and review of:
    a. DMX-512A Device Address
        1) Status
        2) Manual settings
        3) Zoom Control
        4) Fan Control
        5) General Settings
    b. It shall be possible to lock out the control keypad at the fixture to prevent accidental change in fixture configuration during operation. Locking and unlocking the control keypad shall be via predefined keypad lock.
    c. Each fixture shall be compatible with the USITT DMX512-A control protocol, ANSI E1.20-2006 and ANSI E1.37-2 (2015) Remote Device Management over DMX512-A (RDM) standards.
    d. The DMX-512A device address for each fixture shall be user selectable.
    e. It shall be possible to set the DMX-512A device address for the fixture both locally and while the fixture is installed and connected to the system via the RDM (ANSI E1.20-2006 protocol) and an appropriate device such as a PC, lighting console, or a handheld

programmer.

f. Fixtures which do not allow for setting of the DMX address via both local controls at the fixture and remotely while installed via RDM shall not be accepted.
g. The fixture shall have an available “Master Channel” function to provide control of intensity without changing the color of the output of the fixture. The master shall operate in either 8-bit or 16-bit resolution as defined by the configuration of the fixture.
h. The fixture shall have user selected personalities to correctly match response to the application and control system utilized. Personalities shall provide the following options which may be combined as desired:

    1) RGB, HSIC, 8 or 16 Bit DMX operation
    2) On board preset color operation
    3) Strobe (up to 30 hz)
    4) Stand-alone effects
    5) Stand-alone fixed output

i. The fixture shall be capable of standalone operation, activated and configured at the control keypad. Standalone modes shall include the following:
j. Fixed color temperature defined with local control presets or DMX control.
k. Strobe with user selectable color and speed – up to 30 HZ.

F. Optical

1. A 4:1 matrix of LEDs shall provide color or tunable white light or fixed white light, via an RGBW emitter. Fixtures not utilizing built in white points or color presets shall not be accepted.
2. All lenses to feature cosine beam and field distribution and feature a 4:1 beam to field distribution ratio.
3. The fixture shall feature a motorized zoom from spot (12°) to flood (65°) via DMX or manual settings with five (5) different nominal bean angle stop points of:

    a. VNSP (Very Narrow Spot)
    b. NSP (Narrow Spot)
    c. MFL (Medium Flood)
    d. WFL (Wide Flood)
    e. XWFL (Extra Wide Flood)

4. Fixtures not utilizing a motorized zoom with both manual and Dmx control shall not be accepted.
5. The fixture’s optics shall be designed so as not to produce color shadows when used with beam shaping accessories such as barn doors or top-hats.
6. The fixture shall have an available dimming curve settings mode which makes PWM control of LED levels imperceptible to video cameras and related broadcast equipment.
7. A custom color control algorithm shall control the calibration of the colors from luminaire to luminaire. Color calibration shall be able to be turned on or off via the menu system or RDM. Fixtures not employing advanced color control calibration shall not be accepted.

G. Light Emitting Diodes

1. The fixture shall use a specific 4:1 LEDs for a wide range of color mixing or tuning for color models the standard configuration shall be Red, Green, Blue, and White LEDs with a white point of 6,500° Kelvin.
2. The fixtures led’s shall be discretely binned in concert with the color calibration system to ensure color consistency from fixture to fixture.

H. Dimming Engine

1. The fixture shall provide full range dimming performance based upon its DMX input control signal and configuration and shall be equipped with an LED system compatible with standard 8-bit and 16-bit input, with high resolution dimming.
2. Dimming curves shall be optimized for smooth dimming at low intensities and over longer timed fades. Dimming curve settings to include:
   a. Standard
   b. Incandescent
   c. Linear
3. LEDs shall be driven by Pulse Width Modulation. (PWM)
4. Additional smoothing algorithms shall be available to augment the high resolution dimming engine.

2.07 COLOR MIXING OR WHITE LED PROFILE SPOTLIGHT

A. General

1. The fixture shall be an Altman PHX 250 Profile as manufactured by Altman Stage Lighting. or approved equal. Fixtures that do not meet the following performance criteria in this specification will not be acceptable.
2. The fixture shall be an LED based focusable, single beam angle luminaire with a range of beam angles provided via multiple lens tubes.
3. The fixture shall utilize a 250-watt maximum multi-LED array for light generation.
4. Unit shall be IP20 rated for indoor use.
5. A push button control interface shall be located on the rear of the fixture for ease of control.
6. The fixture shall be ETL, cETL and CE LISTED, and shall be so labeled when delivered to site. The fixture shall be ETL LISTED under Portable Luminaires (UL Standard 1573) and Surface Mount Luminaires (UL Standard 1598).
7. Ambient operating temperature of -14°F to 104°F (-10°C to 40°C).
8. Power supply, cooling and electronics shall be included inside each unit.
9. Normal operation of optical and control functions of the fixture shall not require tools.

B. Physical

1. The fixture shall have a die cast aluminum housing and major components, free of defects such as burrs, pits and malformations.
2. Finish shall be Epoxy Sandtex black, electrostatic application. Custom colors based on the RAL color system shall be available.
3. Fixture shall not weigh more than 26.45 lbs. (11.99kgs.).
4. Fixture shall have double clutch positive locking yoke locks on both sides of the housing.
5. The unit shall have 4 qty. tool free, stainless steel shutters equipped with insulated handles. The fixture shall include a lever located on each side to facilitate locking the shutters into position.
6. Shutters to be made of high quality steel. Shutter warping and burnout in normal use shall be unacceptable.
7. The focus barrel portion of the body shall be able to rotate 360° without the use of tools.

8. Lens tubes shall incorporate a fully enclosed color filter and front accessory holder with locking accessory slot cover made from die cast aluminum.
9. Fixture shall feature a standard size accessory slot with a sliding cover to eliminate uncontrolled light spill. Accessory slot shall accept the following accessories:
    a. A and B size steel gobo pattern holders.
    b. A and B size glass gobo pattern holders.
    c. Iris.
    d. Rotating gobo holder.
10. Fixture shall be supplied with:
    a. Steel yoke constructed from rigid flat steel and with two mounting positions and indexed tilt angle markings.
    b. Cast iron C-clamp (Altman #510) suitable for use on up to 2" O.D. pipe. Clamp shall incorporate a 360-degree rotational "Safety Stud" with locking bolt.
    c. 18 inch safety cable.
    d. Color frame.
    e. Soft focus pattern holder.
11. Lens tube and locking hardware.
12. 5 foot power cable with powerCON™ socket outlets and the following options for plug type:
    a. Parallel Blade NEMA 5-15 "Edison" Male.
    b. 2 pin + ground Stage Pin Male.
    c. NEMA L5-20P Twist Lock Male.
    d. Bare end cable.

C. Electrical
1. The fixture shall be equipped with 100V to 240V 50/60 Hz auto-ranging internal power supply.
2. Power input and through shall be via lockable and separately keyed powerCON™ type connections.
3. Power supply shall have power factor correction.
4. Power supply outputs shall have resetting current-limiting protection.

D. Thermal
1. The fixture shall utilize near an active fan cooling and thermal management to maintain LED life to an average of 70% intensity after 50,000 hours of use.
2. Thermal management shall include multiple temperature sensors within the housing to include:
    a. LED Temperature sensor.
    b. Power supply Temperature sensor.
    c. Display Board Temperature sensor.
    d. Heat Sink interface Temperature sensor.

E. Control
1. The unit shall be controlled using ANSI 1.11 USITT DMX512-A / ANSI E1.20 RDM (Remote Device Management). The DMX-512A device address for each fixture shall be user selectable.
2. Up to 16-bit virtual dimming control of the fixture shall provide full range (0-100%) dimming without exhibiting flicker or stepping. Dimming curves shall be optimized for smooth

dimming at low intensities and over longer timed fades.

3. Control input and through function shall be via 5-pin XLR unified d-shell connections.
4. Console free playback options with Master and Slave modes shall be programmed into the onboard memory on RGB A/W versions. Functions shall include adjustable color fades and strobes.

F. Optical

1. LED arrays shall be available in the following combinations:
   a. Color Mixing RGBA.
   b. Color Mixing RGBW.
   c. Fixed white color temperature 3000K.
   d. Fixed white color temperature 5600K.
   e. Variable white 3000K-5600K.
2. LED emitters should be rated for nominal 50,000-hour LED life to L70.
3. Fixture shall be calibrated at factory to achieve consistent color and intensity output between fixtures built at different times and/or from different LED lots or bins.
4. Fixtures shall have adjustable PWM frequency up to 8Khz with variable low end PWM variation to 10 Khz to avoid flicker on camera. PWM Settings shall be adjustable by the user at the fixture via Video mode, if necessary to avoid any visible interference to video cameras and related equipment.
5. Color mixing fixtures shall be optimized for low saturate colors (pastels) as well as high saturate colors used in theatrical applications. Fixtures utilizing 3-color (Red, Green, and Blue) mixing systems cannot produce sufficient skin tones or saturate ambers, lavenders, or oranges and shall not be accepted.
6. Manufacturer of LED systems shall utilize an advanced production LED binning process to maintain color consistency.
7. A minimum of 6 qty. lens barrels shall be available including 5, 10, 19, 26, 36 and 50 degree field angle options.
8. All lenses shall have anti-reflective coatings to maximize light transmission.
9. Shutter assembly shall use 3 planes to ensure sharp focusing ability without halation.

2.08 CYCLORAMA LIGHTING

A. General

1. The fixture shall be a compact, lightweight color-mixing LED asymmetrical wash fixture with 8 or 16 bit DMX control of intensity and color. The fixture shall be the Spectra-Cyc 200 as manufactured by Altman Stage Lighting, Inc. or approved equal.
2. The fixture shall incorporate a state of the art microprocessor-controlled solid-state LED light engine incorporating Red, Green, Blue, Amber / White color LEDs, and an on-board power supply.
3. The fixture shall incorporate a hammer-tone aluminum asymmetrical reflector in combination with a blended linear LED engine to provide even coverage on vertical and horizontal surfaces without “scalloping” or hot spots.
4. The fixture shall be incorporate silent, convection cooling without employing the use of fans or filters. Fixtures incorporating fan cooling systems generate unacceptable levels of noise are not equal and shall not be accepted.

5. IES Photometric files shall be available from the manufacturer to model light output using industry standard design software.
6. The fixture shall comply with USITT DMX-512 A and ANSI E1.20-2006 Remote Device Management over USITT DMX-512A Standard (RDM).
7. The fixture shall be UL1573, and UL8750 LED listed and CE compliant for stage and studio use.
8. Fixtures which do not comply with this specification shall not be accepted.

B. Physical

1. The fixture shall be constructed of 18-gauge steel. Construction shall employ all corrosion-resistant materials and hardware and shall be free of pits and burrs.
   a. Standard Finish shall be Epoxy Sandtex black, electrostatic application and shall be available in white, black, and custom color finishes as specified.
   b. Power supply, cooling and electronics shall be integral to each unit.
   c. The housing shall serve as a convection chimney when installed in a vertical or horizontal orientation to provide for convection cooling of the LED array, integral driver, and integral power supply.
2. Fixture dimensions shall be 25” (635mm) L x 11.2” (384.5mm) H x 7.45” 189.2mm) D. and weigh 18lbs. (8.1kg)
3. The fixture shall provide even asymmetrical distribution of light on a vertical or horizontal surface by use of a linear LED source and a hammer-tone asymmetrical reflector. Fixtures requiring the installation of spread lenses or other linear diffusion media to approximate asymmetrical distribution of light are not equal and shall not be accepted.
4. The fixture shall incorporate independently adjustable rubber leveling feet on the bottom of the fixture to provide for adjustment when used to light a vertical surface from the bottom.
5. An optional rigid flat steel yoke with locking dog tilt handle shall be available for overhead pipe mounting.
6. Pipe mounted fixtures shall be supplied with a cast iron C-clamp Altman #510 suitable for use on up to 2” (50mm) O.D. pipe. Clamp must incorporate a 360-degree rotational “safety stud” with locking bolt. Any clamp not offering this safety feature will not be acceptable.
7. Fixtures shall be supplied with safety cable for use when securing the fixture to a pipe.
8. An optional rugged 18-gauge steel joining bracket shall be available to safely lock multiple units together. Units not incorporating this feature shall not be acceptable. Hanging Irons shall be available to support multiple fixture configurations from a pipe batten.
9. The fixture shall be designed to provide flat and even coverage of light when placed 4’-0” (1.2m) away from the surface being lit, 10’-0” (3.04) on center. There shall be no visible dip in coverage or “scalloping” between fixtures when so placed.
10. Power supply, cooling and electronics shall be integral to each unit.

C. Thermal

1. The luminaire shall be cooled via natural convention with no aide of fans or other cooling systems.
2. Under normal operating conditions, the LED engine shall be capable of 50,000 hours rated lifespan to Led manufacturers recommended LM-70 / 70% maximum calibrated intensity with convective cooling, units utilizing active cooling shall not be accepted.
3. Ambient operating temperature shall be 32°F to 104°F (0 – 40 °C) non-condensing and IP-

20 rated for indoor dry location use.

4. The LED substrate is coupled to a highly efficient heat sink and cooling system for prolonged life of the LEDs. LED fixture housing shall transfer heat from the LED board and associated electronics to the outside environment.

D. Electrical

1. The fixture shall be equipped with 100V to 240V 50/60 Hz auto-ranging internal power supply and requires power from a constant “non-dim” power source.
2. The fixture shall receive power via a Neutrik power con blue connector and 5’-0” (1.5m) power cord with:
   a. 2 P&G (Stage Pin)
   b. NEMA 5-15P
   c. NEMA L520 (Twistlock)
   d. Territory Power Plug
3. The fixture shall be equipped with a Neutrik Power con Gray to allow for “Daisy Chaining” of fixtures from a single power source. The receptacle shall be protected by an integral 10amp circuit breaker.

E. Control and User Interface

1. A local control keypad with a three digit LCD display shall be provided for configuration and control of:
   a. DMX-512A Device Address
   b. Fixture Personality
   c. Stand Alone (Manual) Operation
      1) It shall be possible to lock out the control keypad at the fixture to prevent accidental change in fixture configuration during operation. Locking and unlocking the control keypad shall be via predefined key sequence.
      2) Each fixture shall be compatible with the USITT DMX512-A control protocol and ANSI E1.20-2006 Remote Device Management over DMX512-A (RDM) standard.
      3) The DMX-512A device address for each fixture shall be user selectable.
      4) It shall be possible to set the DMX-512A device address for the fixture while the fixture is installed and connected to the system via the RDM (ANSI E1.20-2006 protocol) and an appropriate device such as a PC or a handheld programmer.
      5) Fixtures which do not allow for setting of the DMX address via both local controls at the fixture and remotely while installed via RDM shall not be accepted.
      6) The fixture shall have an available “Master Channel” function to provide control of intensity without changing the color of the output of the fixture. The Master shall operate in either 8-bit or 16-bit resolution as defined by the configuration of the fixture.
      7) The fixture shall have user selected personalities to correctly match response to the application and control system utilized. Personalities shall provide the following options which may be combined as desired:
         i) 8 or 16 Bit DMX operation
         ii) Master Channel On / Off
         iii) Smoothing On / Off
         iv) Stand-alone effects
         v) Stand-alone fixed output
      8) The fixture shall be capable of standalone operation, activated and configured at the control keypad. Standalone modes shall include the following:

i) Fixed color temperature defined with local controls
ii) Strobe with user selectable color and speed
iii) Slave

F. Optical

1. Fixture shall feature a custom matrix of LEDs to provide color or tunable white light or fixed white light. Variations of LED matrices to include:

   a. Red, Green, Blue, Amber
   b. Red, Green, Blue, White
   c. 3000, 6000 Kelvin white tune-able
   d. Fixed white (3000 or 6000 Kelvin)
   e. Custom arrays.

2. Fixture shall utilize a patented mixing lens and reflector system to deliver an asymmetrical beam pattern onto the projection back drop or wall. Cyc lights utilizing only a lens system and not utilizing the aforementioned style system shall not be accepted.

3. The fixture shall optimize for low saturate colors (pastels) as well as high saturate colors used in theatrical applications. Fixtures utilizing 3-color (Red, Green, and Blue) mixing systems cannot produce sufficient skin saturate ambers, lavenders, or oranges and shall not be accepted.

G. Light Emitting Diodes

1. The fixture shall use a variety of LEDs for a wide range of color mixing or tuning for color models the standard configurations shall be Red, Green, Blue, and Amber LEDs or Red, Green, Blue and White LEDs. For white models the standard configurations shall be white LEDs at 3,000° Kelvin color temperatures or variable white between 3,000° and 6,000° Kelvin, with custom arrays available.

2. Manufacturer of LED systems shall utilize an advanced production LED binning process to maintain color consistency.

3. LED emitters should be rated for nominal 50,000 hour LED life

4. LED system shall comply with all relevant patents.

H. Dimming Engine

1. Luminaire shall provide full range dimming performance based upon its DMX input control signal and configuration and shall be equipped with an LED system compatible with standard 8-bit and 16-bit input, with high resolution dimming.

2. Dimming curves shall be optimized for smooth dimming at low intensities and over longer timed fades.

3. LEDs shall be driven by Pulse Width Modulation. (PWM)

4. Additional smoothing algorithms shall be available to augment the high-resolution dimming engine

2.09 LINEAR WASH LIGHTING

A. General

1. The fixture shall be a compact, lightweight linear color-mixing LED grazing wash fixture with 8 or 16 bit DMX control of intensity and color. The fixture shall be the Spectra-Strip as manufactured by Altman Stage Lighting, Inc. or approved equal.

2. The fixture shall incorporate a state of the art microprocessor-controlled solid-state LED light engine incorporating Red, Green, Blue, Amber / White color LEDs, and an on-board

power supply.

3. The fixture shall incorporate a multi-cell design in combination with an LED engine to provide even coverage on vertical and horizontal surfaces through use of individual cell diffusion without “scalloping” or hot spots.
4. The fixture shall be incorporate silent, convection cooling without employing the use of fans or filters. Fixtures incorporating fan cooling systems generate unacceptable levels of noise are not equal and shall not be accepted.
5. IES Photometric files (single cell) shall be available from the manufacturer to model light output using industry standard design software.
6. The fixture shall comply with USITT DMX-512 A and ANSI E1.20-2006 Remote Device Management over USITT DMX-512A Standard (RDM).
7. The fixture shall be UL1573, and UL8750 LED listed for stage and studio use.
8. Fixtures which do not comply with this specification shall not be accepted.

B. Physical

1. The fixture shall be constructed of 18-gauge steel and extruded aluminum componentry. Construction shall employ all corrosion-resistant materials and hardware and shall be free of pits and burrs.
   a. Standard Finish shall be Epoxy Sandtex black, electrostatic application and shall be available in white, black, and custom color finishes as specified.
   b. Power supply, cooling and electronics shall be integral to each unit.
   c. The housing shall serve as a convection chimney when installed in a vertical or horizontal orientation to provide for convection cooling of the LED array, integral driver, and integral power supply.
2. Fixture dimensions shall be:
   a. 24” model (4 Cell): 24.75” (628.6mm) L x 9.5” (241.3mm) H x 8.3” (210.8mm) D. and weigh 16lbs (7.25kg).
   b. 48” model (8 Cell): 48.75” (1238.25mm) L x 9.5” (241.3mm) H x 8.3” (210.8mm) D. and weigh 32lbs (14.5kg).
   c. 72” model (12 Cell): 72.75” (1847.8mm) L x 9.5” (241.3mm) H x 8.3” (210.8mm) D. and weigh 48lbs (21.7kg).
3. The fixture shall provide even linear distribution of light on a vertical or horizontal surface by use of a multi-cell design in conjunction with individual cell diffusion.
4. The fixture shall incorporate independent floor trunions on the bottom of the fixture to provide for adjustment when used to light a vertical surface from the bottom, and for C-Clamp mounting when pipe mounted.
5. Pipe mounted fixtures shall be supplied with a cast iron C-clamp Altman #510 suitable for use on up to 2” (50mm) O.D. pipe. Clamp must incorporate a 360-degree rotational “safety stud” with locking bolt. Any clamp not offering this safety feature will not be acceptable.
6. Fixtures shall be supplied with safety cable for use when securing the fixture to a pipe.
7. The fixture shall be designed to maintain pixel pitch between luminaires when installed in a linear layout. The maintenance of this spacing is to provide flat and even coverage of light when placed parallel from the surface being lit. There shall be no visible dip in coverage or “scalloping” between fixtures when so placed.
8. Power supply, cooling and electronics shall be integral to each unit.

C. Thermal

1. The luminaire shall be cooled via natural convention with no aide of fans or other cooling systems.
2. Under normal operating conditions, the LED engine shall be capable of 50,000 hours rated lifespan to Led manufacturers recommended LM-70 / 70% maximum calibrated intensity with convective cooling, units utilizing active cooling shall not be accepted.
3. Ambient operating temperature shall be 32°F to 104°F (0 – 40 °C) non-condensing and IP-20 rated for indoor dry location use.
4. The LED substrate is coupled to a highly efficient heat sink and cooling system for prolonged life of the LEDs. LED fixture housing shall transfer heat from the LED board and associated electronics to the outside environment.

D. Electrical

1. The fixture shall be equipped with 100V to 240V 50/60 Hz auto-ranging internal power supply and requires power from a constant “non-dim” power source.
2. The fixture shall receive power via a Neutrik power con blue connector and 5’-0” (1.5m) power cord with:
   a. 2 P&G (Stage Pin)
   b. NEMA 5-15P
   c. NEMA L520 (Twistlok)
   d. Territory Power Plug
3. The fixture shall be equipped with a Neutrik Power con Gray to allow for “Daisy Chaining” of fixtures from a single power source. The receptacle shall be protected by an integral 10 amp circuit breaker.

E. Control and User Interface

1. A local control keypad with a three digit LCD display shall be provided for configuration and control of:
   a. DMX-512A Device Address
   b. Fixture Personality
   c. Stand Alone (Manual) Operation
2. It shall be possible to lock out the control keypad at the fixture to prevent accidental change in fixture configuration during operation. Locking and unlocking the control keypad shall be via predefined key sequence.
3. Each fixture shall be compatible with the USITT DMX512-A control protocol and ANSI E1.20-2006 Remote Device Management over DMX512-A (RDM) standard.
4. The DMX-512A device address for each fixture shall be user selectable.
5. It shall be possible to set the DMX-512A device address for the fixture while the fixture is installed and connected to the system via the RDM (ANSI E1.20-2006 protocol) and an appropriate device such as a PC or a handheld programmer.
6. Fixtures which do not allow for setting of the DMX address via both local controls at the fixture and remotely while installed via RDM shall not be accepted.
7. The fixture shall have an available “Master Channel” function to provide control of intensity without changing the color of the output of the fixture. The Master shall operate in either 8-bit or 16-bit resolution as defined by the configuration of the fixture.
8. The fixture shall have user selected personalities to correctly match response to the

application and control system utilized. Personalities shall provide the following options which may be combined as desired:

a. 8 or 16 Bit DMX operation
b. Master Channel On / Off
c. Smoothing On / Off
d. Stand-alone effects
e. Stand-alone fixed output

9. The fixture shall be capable of standalone operation, activated and configured at the control keypad. Standalone modes shall include the following:

a. Fixed color temperature defined with local controls
b. Strobe with user selectable color and speed
c. Slave

F. Optical

1. Fixture shall feature a custom matrix of LED Cells to provide color or tunable white light or fixed white light. Variations of LED matrices to include:

a. Red, Green, Blue, Amber
b. Red, Green, Blue, White
c. 3000, 6000 Kelvin white tune-able
d. Fixed white (3000 or 6000 Kelvin)
e. Custom arrays.

2. The fixture shall optimized for low saturate colors (pastels) as well as high saturate colors used in theatrical applications. Fixtures utilizing 3-color (Red, Green, and Blue) mixing systems cannot produce sufficient skin saturate ambers, lavenders, or oranges and shall not be accepted.

3. Lens assemblies shall be available in variations of:

a. 60° x 1° light shaping diffuser
b. 95° x 25° light shaping diffuser
c. 30° spread lens
d. 40° spread lens
e. 60° spread lens

4. Light Emitting Diodes

a. The fixture shall use a variety of LEDs for a wide range of color mixing or tuning for color models the standard configurations shall be Red, Green, Blue, and Amber LEDs or Red, Green, Blue and White LEDs. For white models the standard configurations shall be white LEDs at 3,000° Kelvin color temperatures or variable white between 3,000° and 6,000° Kelvin, with custom arrays available.
b. Manufacturer of LED systems shall utilize an advanced production LED binning process to maintain color consistency.
c. LED emitters should be rated for nominal 50,000 hour LED life
d. LED system shall comply with all relevant patents.

G. Dimming Engine

1. Luminaire shall provide full range dimming performance based upon its DMX input control signal and configuration and shall be equipped with an LED system compatible with standard 8-bit and 16-bit input, with high resolution dimming.

2. Dimming curves shall be optimized for smooth dimming at low intensities and over longer timed fades.

3. LEDs shall be driven by Pulse Width Modulation. (PWM)
4. Additional smoothing algorithms shall be available to augment the high-resolution dimming engine.

2.10 LED FOLLOW SPOT

A. General - Luminaire

1. The luminaire shall be a 7600K fixed white LED 780 watt ollow spot luminaire capable of producing over 14,000 lumens. The luminaire shall be the AFS-700 LED Follow Spot from Altman Lighting Inc. or approved equal.
2. The luminaire shall incorporate a microprocessor-controlled solid-state LED light engine, and on-board power supply.
3. The luminaire shall incorporate quiet active cooling no greater than 30 dBA at .5m to maintain luminous intensity.
4. The luminaire shall utilize high efficiency and patented optics to render a homogenized shade of white at the focal plane.
5. Photometric files shall be available upon request from the manufacturer.
6. The luminaire shall comply with USITT DMX-512 A.
7. Luminaire shall be rated ETL or equally accredited 3rd party compliance certification and be CE listed.
8. The luminaire shall be UL1573 and UL8750 LED listed for stage and studio use.
9. The luminaire shall ship with:
    a. AFS-700 Control Module
    b. Adjustable and collapsible black Tripod
    c. 5’ Neutrik PowerCon™ to Edison power cable as standard.
    d. AFS-700 Manual
    e. AFS-700 LED Follow spot containing:
        1) Internal Seven (7) facet automated Dichroic color wheel
        2) Internal three (3) facet automated Dichroic CTO Wheel
        3) Internal eighteen (18) Leaf automated iris
        4) Internal 7°-13° Automated Zoom Lens
        5) Internal Automated Focus Lens
10. Luminaires that do not provide the above feature sets as a standard option shall not be considered.
11. Available connector options shall include but not be limited to:
12. Raw cable-end, 20A Stage-Pin, 20A Twist-lock, or 16A CEE type equipped power leads.

2.11 Luminaire shall be rated IP20

A. General – Control Panel

1. The luminaire control panel shall have the ability to be located anywhere on the luminaires control accessory mounting rail allowing for left and righthanded operation. The control panel can be removed – unplugged from the luminaire when under DMX control. Luminaires not employing a moveable control panel shall not be accepted.
2. Each luminaire control panel shall have the ability to control one or more AFS-700 follow spots thought a DMX daisy chain between luminaires.

3. The control panel will employ back lit indicator lights for each color and led on/off status.
4. The controller shall have control of:
    a. LED on/off
    b. Dimmer – Slider for controlling output intensity
    c. Strobe – Slider for controlling strobe rate.
    d. CTO - Slider for controlling Color Temperature.
    e. Iris – Slider for opening and closing luminaires iris.
    f. Focus – Slider for controlling beam sharpness.
    g. Zoom – slider for controlling beam size.
    h. Color (8) Eight Back lit buttons

B. Physical

1. The luminaire shall be constructed of extruded aluminum, refined and without burrs, pits, or rough edges. Plastic and steel components shall be used within the luminaire.
2. Luminaire shall weigh no more than 40 pounds (18.14kg).
3. Luminaire shall feature an external rail system capable of supporting balancing weights, additional handles, AFS-700 Control module.
4. The luminaire shall contain a specialized LED array light engine, optimized specifically for this luminaire's optical system.
5. Overall dimensions of the luminaire shall not be larger than the following dimensions:
    a. 13.38" (339.9mm) tall – including yoke
    b. 11" (279 mm) wide
    c. 40" (1016 mm) long
6. All major parts and components shall be black. Luminaire body shall be anodized, not painted.
7. An additional accessory holder for standard 7.5" x 7.5" shall be completely boxed in on three (3) sides, guarding filter frames from damage. Filter frame shall be capable of supporting industry standard 7.5" x 7.5" accessories.
8. All system components (including electronics, power supply, and cooling shall be integral to each unit. Units utilizing external power supplies, ballasts, or transformers shall not be accepted.

C. Electrical

1. The luminaire shall be equipped with 100V to 240V 50/60 Hz universal power supply.
2. Luminaire shall feature up to a 780 watt long-life LED emitter matrix. Luminaire shall not consume more than 800W in normal operation.
3. Power input shall be via Neutrik Powercon.
4. Automatic power correction power supply shall be standard.
5. Quiescent power load shall be no more than 60 watts.
6. PWM frequency shall be variable, based upon dimming timing - with an upper limit of 15 kHz.

D. Thermal

1. Under normal operating conditions, the LED engine shall be capable of 50,000 hours rated lifespan to LM-70 / 70% maximum calibrated intensity with active cooling.

2. Ambient operating temperature 32°F to 104°F (0 – 40 °C).
3. Active cooler shall consist of a pulse width modulation-controlled fan.
4. Fan shall automatically adjust for lowest possible noise output for a given luminance output
5. Luminaire shall employ temperature sensors on all temperature sensitive equipment to ensure to ensure stated LM rating.

E. Control and User Interface

1. The luminaire shall provide full range (0-100%) dimming without exhibiting flicker or stepping to both the eye and HD camera. Dimming curves shall be optimized for smooth dimming at low intensities and over longer timed fades.
2. A local control keypad with LCD display shall be provided for configuration and control of:
    a. DMX-512A Device Address
    b. Luminaire Personality
    c. Stand Alone Operation
    d. Individual attribute lock out
3. It shall be possible to lock out the control keypad at the luminaire to prevent accidental change in luminaire configuration during operation. Locking and unlocking the control keypad shall be via predefined key sequence.
4. Each luminaire shall be compatible with the USITT DMX512-A control protocols.
5. DMX or Local Control shall be connected via integral flush mount 5-Pin XLR input and output connectors.
6. Luminaire shall include integral flush mount 5-pin XLR output connector for DMX pass through or “Daisy Chain”. Luminaires not including an output receptacle for DMX pass through shall not be acceptable.
7. DMX pass through shall also be utilized in stand alone or Lead follow spot mode where a single follow spot controller will control multiple attributes of additional follow spots connected to the same DMX Lan.
8. The DMX-512A device address for each luminaire shall be user selectable.
9. The luminaire shall be capable of standalone operation, activated and configured at the control keypad. Standalone functions shall include the following:
    a. Fixed Color defined with local controls
    b. Zoom
    c. Focus
    d. Strobe
    e. CTO
    f. Iris
    g. Dimmer
    h. Led on/off
    i. Slave
10. Control keypad shall be remote from the luminaire and able to be mounted anywhere on the control rail. Luminaires which cannot be fully controlled from either side of the luminaire will not be accepted.

F. Optical

1. Luminaire shall feature a custom matrix of LEDs to provide fixed color temperature white light. Variations of LED matrices to produce a 7600K native white beam with color and CCT

variations via integrated color and CTO wheels.

2. Luminaire shall feature a fully homogenized output at the focal plane to enable color temperature changes without visible colors at the lens.
3. Lenses to feature cosine beam and field distribution and feature a 2:1 beam to field distribution ratio.
4. Zoom range shall automated and controlled from either DMX or via the onboard AFS-700 controller and shall provide a range no less than 7 – 13 degrees in beam angle.
5. Focus Lens system shall be automated and controlled from either DMX or via the onboard AFS-700 controller and shall provide a crisp concise beam with a sharp edge and allow for a soft edged beam with out affecting the previously set zoom.
6. An Automated 18 facet iris shall be capable of shaping the beam edge to reduce the over all beam diameter allowing for a 2.5 degree beam when fully closed.
7. An Automated CTO wheel capable of thee (3) different CTO settings shall be integral to the AFS-700 and shall be able to achieve 5600K, 4500K, and 3200K color temperatures. Luminaires with out CTO capability shall not be accepted.
8. A seven (7) position color wheel capable of adding color to the beam in conjunction with the CTO wheel shall be capable of full or split colors.
9. A LED ON/OFF button (DMX Channel) shall allow for instant ON/OFF of the LED array following the luminaires initial calibration start up.
10. A variable strobe function up to 20hz (20 times a second) shall be available standard on the luminaire. Any luminaire not offering strobe functionality shall not be accepted.
11. A range of accessories shall be available from the manufacturer including but not limited to:
    a. Cylindrical Hood (top hat)
    b. Front Accessory Holder 7.5” x 7.5”
    c. Color frame
    d. Accessory Color Boomerang (6 Color)
    e. Weighted handle
    f. Follow spot Handle
    g. Balancing counterweight

G. Light Emitting Diodes

1. The luminaire shall utilize a proprietary mix of white LEDs to produce the output as specified.
2. LEDs shall be from reputable manufacturers with a proven track record for quality.
3. All LEDs shall be subject to rigorous single binning and mixing procedures.
4. LEDs shall be calibrated to an absolute nm wavelength CIE1931 X & Y coordinates.
5. Burn-in procedure to be no less than 8 hours.

H. Dimming Engine

1. LEDs shall be driven by Pulse Width Modulation. (PWM)
2. PWM rates shall be variable and above 9800hz, ensuring no camera phasing, image flip or roll.
3. Dimming curves shall be smooth with no perceptible steps over long fades. Follow spots utilizing flag or chop mechanical dimmers shall not be accepted.

4. Luminous Output: Shall meet or exceed 14000 lumens output at narrow beam and produce no less than 130fc (1400 LUX) at 100'-0" (30.48M)

2.12 GHOST LIGHT

A. General

1. The fixture shall be a standalone ghost light. The fixture shall be the Altman Ghost Light or approved equal.
2. Fixture shall be rated UL listed or equally accredited 3rd party compliance certification.

B. Physical

1. The fixture shall be of steel construction.
2. The fixture shall be 72" high caged light on stand with 15-foot cable and castered iron base or approved equal.
3. The fixture shall not be larger than the following dimensions:
   a. 72 tall including casters
   b. 26" wide including base
   c. Color shall be black. Lamp cage shall be purple.
4. Overall weight shall be no more than 55 lbs.

C. Electrical

1. The fixture shall be supplied with a 15' 12/3 SJ cable with NEMA 5-15 male Edison plug.
2. Lamp base shall be medium screw base for type-A Edison socket lamps.

2.13 LED WASH FIXTURE

A. General

1. The fixture shall be a white LED wash. The fixture shall be the LED Work Light from Altman Lighting Inc. or approved equal.
2. The fixture shall incorporate a state of the art microprocessor-controlled solid state LED light engine, and on-board power supply.
3. The fixture shall incorporate silent, convection cooling only.
4. The fixture shall utilize a high efficiency hammertone reflector in combination with diffusion material to change beam angle and shape.
5. IES Photometric files shall be available upon request from the manufacturer.
6. Fixture shall be rated ETL or equally accredited 3rd party compliance certification.

B. Physical

1. The fixture shall be constructed of lightweight aluminum and steel construction.
2. The fixture shall contain a chip-on-board style LED light engine.
3. The fixture shall be yoke mount with adjustable pan and tilt adjustment
4. The fixture shall not be larger than the following dimensions:
   a. 12.6" (320cm) wide including yoke.
   b. 8.05" (205cm) tall including yoke
   c. 6" (152cm) deep
5. Available colors shall include but not be limited to:

a. Black
b. White
c. Custom

C. Electrical

1. The fixture shall be equipped with 100V to 277V 50/60 Hz universal power supply.
2. Fixture shall feature a 130W long-life LED emitter.

D. Thermal

1. Under normal operating conditions, the LED engine shall be capable of 50,000 hours rated lifespan to LM-70 / 70% maximum calibrated intensity with convection cooling.
2. Normal operating range shall be degrees 0° to 25° Celsius

E. Control

1. Fixture shall be switchable, not dimmable.

F. Optical

1. Fixture shall feature Bridgelux COB LEDs to provide high quality fixed white
2. Accessories shall be available from the manufacturer including but not limited to:

a. 4-Way barn doors
b. Color / diffusion frame

END OF SECTION

SECTION 26 56 13
LIGHTING POLES AND STANDARDS

PART 1 - PRODUCTS

1.01 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Foundation and pole shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."

2. Component Importance Factor: 1.5.

B. Structural Characteristics: Comply with AASHTO LTS-6-M.

C. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied according to AASHTO LTS-6-M.

D. Live Load: Single load of 500 lbf distributed according to AASHTO LTS-6-M.

E. Wind Load: Pressure of wind on pole and luminaire, calculated and applied according to AASHTO LTS-6-M.

1. Basic wind speed for calculating wind load for poles 50 feet high or less is 100 mph.

a. Wind Importance Factor: 1.0
b. Minimum Design Life: 25 years.
c. Velocity Conversion Factor: 1.0

F. Strength Analysis: For each pole, multiply the actual EPA of luminaires and brackets by a factor of 1.1 to obtain the EPA to be used in pole selection strength analysis.

G. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

1.02 STEEL POLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American Lite Pole.
2. Cooper Lighting, an Eaton business.
3. Hubbell Incorporated.
4. Lithonia Lighting; Acuity Brands Lighting, Inc.
5. LSI Industries.

A. Source Limitations: For poles, obtain each color, grade, finish, type, and variety of pole from single source with resources to provide products of consistent quality in appearance and

physical properties.

B. Poles: Comply with ASTM A500/A500M, Grade B carbon steel with a minimum yield of 46,000 psig; one-piece construction up to 40 feet in height with access handhole in pole wall.

1. Shape: Round, tapered or Round, straight or Square, tapered or Square, straight.

2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

C. Steel Mast Arms: Single-arm type, continuously welded to pole attachment plate. Material and finish same as plate.

D. Brackets for Luminaires: Detachable, cantilever, without underbrace.

1. Adaptor fitting welded to pole, allowing the bracket to be bolted to the pole-mounted adapter, then bolted together with stainless or galvanized - steel bolts.

2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire. Match pole material and finish.

E. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

F. Fasteners: Stainless steel or Galvanized steel, size and type as determined by manufacturer. Corrosion-resistant items compatible with support components.

1. Materials: Compatible with poles and standards as well as the substrates to which poles and standards are fastened and shall not cause galvanic action at contact points.

2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot dip galvanized after fabrication unless otherwise indicated.

G. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Section 260526 "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size indicated, and accessible through handhole.

H. Handhole: Oval shaped, with minimum clear opening of 2-1/2 by 5 inches with cover secured by stainless-steel captive screws.

I. Intermediate Handhole and Cable Support: Weatherproof, 3-by-5-inch handhole located at midpoint of pole, with cover for access to internal welded attachment lug for electric cable support grip.

J. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported load multiplied by a 5.0 safety factor.

K. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.

L. Galvanized Finish: After fabrication, hot dip galvanized according to ASTM A123/A123M.

M. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces according to SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, according to SSPC-SP 5/NACE No. 1 or SSPC-SP 8.

2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.

3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high gloss, high-build polyurethane enamel.

    a. Color: As selected by Architect from manufacturer's full range.

N. Powder-Coat Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces according to SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair powder coat bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, according to SSPC-SP 5/NACE No. 1 or SSPC-SP 8.

2. Powder Coat: Comply with AAMA 2604.

    a. Electrostatic-applied powder coating; single application and cured to a minimum 2.5- to 3.5-mils dry film thickness. Coat interior and exterior of pole for equal corrosion protection.
    b. Color: [As selected by Architect from manufacturer's full range.

1.03 ALUMINUM POLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American Lite Pole.

2. Cooper Lighting, an Eaton business.

3. Hubbell Incorporated.

4. Lithonia Lighting; Acuity Brands Lighting, Inc.

B. Poles: Seamless extruded structural tube complying with ASTM B221, Alloy 6063-T6, with access handhole in pole wall.

1. Shape: Round, tapered or Round, straight or Square, tapered or Square, straight.

2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

C. Mast Arms: Aluminum type, continuously welded to pole attachment plate. Material and finish same as plate.

D. Brackets for Luminaires: Detachable, cantilever, without underbrace.

1. Adaptor fitting welded to pole, allowing the bracket to be bolted to the pole-mounted adapter, then bolted together with stainless or galvanized steel bolts.

2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire. Match pole material and finish.

E. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

F. Grounding and Bonding Lugs: Bolted 1/2-inch threaded lug, complying with requirements in Section "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

G. Fasteners: Stainless steel or Galvanized steel, size and type as determined by manufacturer. Corrosion-resistant items compatible with support components.

1. Materials: Compatible with poles and standards as well as to substrates to which poles and standards are fastened and shall not cause galvanic action at contact points.

2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot dip galvanized after fabrication unless otherwise indicated.

H. Handhole: Oval shaped, with minimum clear opening of 2-1/2 by 5 inches with cover secured by stainless-steel captive screws.

I. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.

J. Aluminum Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20 requirements; and seal aluminum surfaces with clear, hard-coat wax.

3. Class I, Clear-Anodic Finish: AA-M32C22A41 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I clear coating of 0.018 mm or thicker), complying with AAMA 611.

4. Class I, Color-Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: Medium; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I integrally colored or electrolytically deposited color coating 0.018 mm or thicker), complying with AAMA 611.

K. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, according to SSPC-SP 5/NACE No. 1 or SSPC-SP 8.

2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal

corrosion protection.

3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

   a. Color: As selected by Architect from manufacturer's full range.

L. Powder-Coat Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair powder coat bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, according to SSPC-SP 5/NACE No. 1 or SSPC-SP 8.

2. Powder coat shall comply with AAMA 2604.

   a. Electrostatic applied powder coating; single application with a minimum 2.5- to 3.5-mils dry film thickness; cured according to manufacturer's instructions. Coat interior and exterior of pole for equal corrosion protection.
   b. Color: As selected by Architect from manufacturer's full range.

1.04 POLE ACCESSORIES

A. Base Covers: Manufacturers' standard metal units, finished same as pole, and arranged to cover pole's mounting bolts and nuts.

B. Transformer-Type Base: Same material and color as pole. Coordinate dimensions to suit pole's base flange and to accept [ballast(s)] [indicated accessories]. Include removable flanged access cover secured with bolts or screws.

1.05 MOUNTING HARDWARE

A. Anchor Bolts: Manufactured to ASTM F1554, Grade 55.

1. Galvanizing: Hot dip galvanized according to ASTM A153, Class C.

2. Threading: Uniform National Coarse Class 2A.

B. Nuts: ASTM A563, Grade A, Heavy-Hex.

1. Galvanizing: Hot dip galvanized according to ASTM A153, Class C.

2. Two or Four nuts provided per anchor bolt, shipped with nuts pre-assembled to the anchor bolts.

C. Washers: ASTM F436, Type 1.

1. Galvanizing: Hot dip galvanized according to ASTM A153, Class C.

2. Two washer(s) provided per anchor bolt.

1.06 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

1.07 POLE FOUNDATION

A. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Structural steel complying with ASTM A36/A36M and hot-dip galvanized according to ASTM A123/A123M; and with top-plate and mounting bolts to match pole-base flange and strength required to support pole, luminaire, and accessories. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."

1.08 POLE INSTALLATION

A. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Section "Cast-in-Place Concrete."

B. Foundation-Mounted Poles: Mount pole with leveling nuts and tighten top nuts to torque level according to pole manufacturer's written instructions.

C. Poles and Pole Foundations Set in Concrete-Paved Areas: Install poles with a minimum 6-inch- wide, unpaved gap between the pole or pole foundation and the edge of the adjacent concrete slab. Fill unpaved ring with pea gravel. Insert material to a level 1 inch below top of concrete slab.

1.09 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum using insulating fittings or treatment.

B. Steel Conduits: Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch thick, pipe-wrapping plastic tape applied with a 50-percent overlap.

1.10 GROUNDING

A. Ground Metal Poles and Support Structures: Comply with requirements in Section "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole..

2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

B. Ground Poles and Support Structures: Comply with requirements in Section "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole.

2. Install grounding conductor and conductor protector.

3. Ground metallic components of pole accessories and foundation.

END OF SECTION

SECTION 26 56 19
LED EXTERIOR LIGHTING

PART 1 - PRODUCTS

1.01 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to **ASCE/SEI 7** and latest California Building Codes.

B. Seismic Performance: Luminaires and lamps shall be labeled vibration and shock resistant.

1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified **and the luminaire will be fully operational during and after the seismic event**."

1.02 REFERENCE STANDARDS

- National Energy Policy Act of 2005, Public Law No. 109-58.
- IESNA LM-63 - ANSI Approved Standard File Format for Electronic Transfer of Photometric Data and Related Information; 2002.
- NFPA 70 - National Electrical Code; National Fire Protection Association; 2008.
- IESNA LM-79-08 IESNA - Approved Method for Electrical and Photometric Measurements of Solid-State Lighting Products; 2008
- IESNA LM-80-08 IESNA - Approved Method for Measuring Lumen Maintenance of LED Light Sources
- IESNA TM-21-2011 – Projecting Long Term Lumen Maintenance of LED Light Sources
- IESNA TM-15-11 – Luminaire Classification System for Outdoor Luminaires
- UL 8750 – Light Emitting Diode (LED) Equipment for Use in Lighting Products
- UL 1598 – Luminaries
- OSHA 29CFR1910.7 – Luminaires shall be listed by national recognized testing laboratory approved by United Stated Department of Labor, Occupational Safety and Health Administration (OSHA)
- IEC 60529 – Degrees of Protection by Enclosures (IP Codes)

1.03 DEFINITIONS

BUG Ratings — Backlight, Up light, and Glare ratings used to evaluate luminaire optical performance related to light trespass, sky glow and high angle brightness control (per IES TM-15-11)

CALiPER	DOE Commercially Available LED Product Evaluation and Reporting program for the testing and monitoring of commercially available LED luminaires and lights. http://www1.eere.energy.gov/buildings/ssl/caliper.html
CCT	Correlated Color Temperature: The temperature in units of kelvin of a blackbody whose chromaticity most nearly resembles that of the light source in question.
cd	Candela: SI Unit of luminous intensity, equal to 1 lumen per steradian (lm/sr)
CIE Chromaticity Diagrams	Two-dimensional quantitative diagram formed by plotting one of the three chromaticity coordinates against another.
CRI	Color Rendering Index – Measure of the degree of color shift of reference objects when illuminated by the light source as compared to a reference source of comparable color temperature.
fc	Footcandle: Unit of illuminance, equal to 1 lm/ft^2
L70	The extrapolated life in hours of the luminaire when the luminous output depreciates 30 percent from initial values.
LED	Light Emitting Diode
METS	Material Engineering and Testing Services of the Translab
MacAdam Ellipse	Shape on the CIE chromaticity diagram that illustrates how much one can “stray” from the target before perceiving a difference from the target color.
NEMA	National Electrical Manufacturers Association
NRTL	Nationally Recognized Testing Laboratory
NVLAP	National Voluntary Laboratory Accreditation Program - A program under the US DOE to accredit independent testing laboratories to qualify
PF	Power Factor - The ratio of the real power component flowing to the load, to the total (complex) power component or apparent power in the circuit.
Rated power	Power consumption that the luminaire was designed and tested for at ambient temperature (70°F or 21°C)
RoHS	Compliance aims to restrict certain dangerous substances commonly used in electronic equipment, including Lead, Cadmium, Mercury and others.
SPD	Surge Protection Device - A subsystem or component(s) that can protect the unit against short duration voltage and current surges
SSL	Solid State Lighting
THD	Total Harmonic Distortion - The amount of higher frequency power on the power line.

1.04 LUMINAIRE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.

C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

D. UL Compliance: Comply with UL 1598 **and listed for wet location**.

E. Lamp base complying with **ANSI C81.61**.

F. CRI of minimum 80 or higher. CCT of 3000 K or 4100 K.

G. L70 lamp life of **50,000** hours or greater.

H. Lamps dimmable from 100 percent to 0 percent of maximum light output.

I. Nominal Operating Voltage: **120 V ac** - **277 V ac**.

J. In-line Fusing: On the primary for each luminaire.

K. Lamp Rating: Lamp marked for **outdoor use and in enclosed locations**.

L. Source Limitations: Obtain luminaires from single source from a single manufacturer.

M. Source Limitations: For luminaires, obtain each color, grade, finish, type, and variety of luminaire from single source with resources to provide products of consistent quality in appearance and physical properties.

PART 2. PRODUCTS

2.1 MANUFACTURERS (Products of Lithonia/Acuity Brands)

2.1.1 All luminaires shall be pretested prior to shipping.

2.1.2 Conformance: Luminaires shall be manufactured in strict accordance with the Contract Drawings and Specifications.

2.1.3 Codes: Materials and installation shall be in accordance with the latest revision of the National Electrical Code and any applicable Federal, State, and local codes and regulations.

2.1.4 UL Listing: All luminaires shall be manufactured in strict accordance with the appropriate and current requirements of the “Standards for Safety" to UL 1598 or others as they may be applicable. A listing shall be provided for each luminaire type, and the appropriate label or labels shall be affixed to each luminaire in a position concealing it from normal view.

2.1.5 Luminaire shall be DLC Certified (Design Lights Consortium) for the base parts number. *Specific low lumen or low CRI versions of luminaires may not meet DLC, if so delete line.*

2.1.6 Specifications and scale drawings are intended to convey the salient features, function and character of the luminaire only, and do not undertake to illustrate or set forth every item or detail necessary for the work.

2.1.7 Manufacturers: Are listed on luminaire specifications. Manufacturers listed without accompanying catalog numbers are responsible for meeting the quality standards and photometric distribution set by the specified product.

2.2 LUMINAIRES

2.2.1 Each luminaire shall consist of an assembly that utilizes LEDs as the light source. In addition, a complete luminaire shall consist of a die-cast aluminum housing and door,

LED array, and electronic driver (power supply) and integral controls as per this specification.

2.2.2 One-piece aluminum housing shall have integral heat sink fins, electrical compartment and architectural mounting arm. All exposed parts must be painted.

2.2.3 Each luminaire shall be designed for a projected operational life of 100,000 hours (per IESNA TM-21-11 calculation methodology) to maintain 85% of initial lumen output (at 100,000 hours) in an average ambient temperature of 25°C (104°F), based on 10,000 hours of LED testing (per IESNA LM-80-08).

2.2.4 Light engines shall be IP66.

2.2.5 LED light engines shall be modular and replaceable.

2.3 TECHNICAL REQUIREMENTS

2.3.1 ELECTRICAL

a) Power Consumption varies based on the number of LEDs specified and the drive current. LEDs to be mounted to a metal-core circuit board and covered by a precision-molded UV-stabilized acrylic lenses.

b) Operation Voltage - The luminaire shall operate from a 50 or 60 Hz ±3 Hz AC line over a voltage ranging from 120 VAC to 480 VAC. The fluctuations of line voltage shall have no visible effect on the luminous output. The standard operating voltages are 120 VAC, 208 VAC, 240 VAC, 277 VAC, 347 VAC and 480 VAC.

c) Power Factor: The luminaire shall have a power factor of 90% or greater at all standard operating voltages and full luminaire output.

d) THD: Total harmonic distortion (current and voltage) induced into an AC power line by a luminaire shall not exceed 20 percent at any standard input voltage.

e) Surge Suppression: The luminaire shall include surge protection to withstand high repetition noise and other interference. Surge protection device shall be easily serviceable, UL recognized and wired in front of the light engine(s) and driver(s) and protect the luminaire to a minimum Category C low (per ANSI/IEEE C62.41.2).

f) Surge protection performance shall be tested per the procedures in ANSI/IEEE C62.45 based on ANSI/IEEE C62.42 definitions for standard and optional waveforms for Location Category C-Low

2.3.2 DRIVER

g) Standard, Class 1 constant current electronic drivers with expected life of 100,000 hours with <1% failure rate per applicable standards.

h) Driver shall include an automatic thermal fold-back feature, such that if the driver's temperature rises above its design limit, the driver automatically reduces current to bring itself below temperature limit.

i) All drivers shall be RoHS compliant.

j) Maximum stand-by power shall be 0 Watts, excluding control devices.

k) RF Interference: The luminaire and associated on-board circuitry must meet Class A emission limits referred in Federal Communications Commission (FCC) Title 47, Subpart B, Section 15 Non-Consumer requirements for EMI/RFI emissions.

l) All electrical components must be easily accessible after installation and be able to be replaced from the open door.

2.3.3 PHOTOMETRIC REQUIREMENTS

a) Lumen Output shall be tested in accordance with IESNA LM-79-08 for the specific configuration of LEDs, driver mA, and distribution type.

b) The lumen output shall not decrease by more than 20% over the minimum operational life of Section 2.2.4.

c) LED's shall be manufactured by Nichia

d) UV-stabilized acrylic lenses shall be design engineered for the specific area lighting distribution specified.

e) The luminaire performance shall be tested as described herein.

f) Luminaire performance shall be judged against the specified minimum illuminance in the specified pattern for a particular application.

g) Luminaire lighting performance shall be adjusted (depreciated) for the life expectancy (Section 2.2.4).

h) The performance shall be adjusted (depreciated) by using the LED manufacturer's LM80 data or the data from the IESNA Standard TM-21 test report, which ever one results in a higher level of lumen depreciation.

m) Luminaire to have zero up light and be consistent with the requirements of LEED and CAL GREEN criteria.

2.3.4 LIGHT COLOR AND QUALITY

a). Correlated Color Temperature (CCT) of 3000K, 4000K and 5000K shall be correlated to chromaticity as defined by the absolute (X, Y) coordinates on the 2-D CIE chromaticity chart.

b). The color rendition index (CRI) shall be 70 or greater.

2.3.5 THERMAL MANAGEMENT

a). The thermal management (of the heat generated by the LEDs) shall be of sufficient capacity to assure proper operation of the luminaire over the expected useful life

b). The LED manufacturer's maximum junction temperature for the expected life shall not be exceeded at the average operating ambient

c). The Driver shall be mounted in direct contact with the housing to promote low operating temperature and long life. Driver manufacturer's maximum case temperature shall not be exceeded at the maximum operating ambient. Thermal management shall be passive by design. The use of fans or other mechanical devices shall not be allowed.

2.3.6 PHYSICAL AND MECHANICAL REQUIREMENTS

a). The luminaire shall be a single, self-contained device, not requiring on-site assembly for installation. The power supply and circuit board for the luminaire shall be integral to the unit and be easily maintained or upgraded.

b). Luminaire housing to have no visible welding, springs, hooks or rivets.

c). The assembly and manufacturing process for the SSL luminaire shall be designed to assure all internal components are adequately supported to withstand mechanical shock and vibration.

d). The optical assembly of the luminaire shall consist of precision molded propriety optic lens.

2.3.7 DIGITAL CONTROLS

a). Each mounted luminaire shall be equipped controls as per specification.

b). Luminaire shall contain NEMA twist-lock receptacle.

c). Luminaire shall contain 0-10V dimming driver.

d). Motion sensing shall be through an embedded motion sensor and 0-10 VDC dimmable driver. Sensors to be factory set per specification and can ramp down to a pre-set level with a 5-minute ramp down and 3 second ramp up when any motion is detected. Motion sensor shall be capable of functioning up to a 30' mounting height of the luminaire.

e). Bi-level switching to 30% or 50% shall be provided as per specification.

f). Luminaire shall be suitable for use with control modules to interface with Roam digital wireless control system as per specification section, 26 0943.19 Wireless Network Controls.

2.3.8 MATERIALS

a). Luminaire housing and door shall be fabricated from die-cast aluminum with integral heat sink fins.

b). Finish: Exterior parts shall be protected by a zinc-infused Super Durable TGIC thermoset powder coat finish. Minimum 3 mils finish thickness.

2.3.9 LUMINAIRE IDENTIFICATION

a). Each luminaire shall have the manufacturer's name, trademark, model number, serial number, date code, and lot number as identification permanently marked inside each unit and the outside of each packaging box.

b). The following operating characteristics shall be permanently marked inside each unit: rated voltage and rated power in Watts and Volt-Ampere.

2.4 QUALITY ASSURANCE

2.4.1 The luminaires shall be manufactured in accordance with a manufacturer quality assurance (QA) program. The QA program shall include two types of quality assurance: (1) design quality assurance and (2) production quality assurance. The production quality assurance shall include statistically controlled routine tests to ensure performance. These

tests shall include: CCT, CRI, Lumen output and wattage. Tests shall be recorded, analyzed and maintained for future reference.

2.4.2 QA process and test results documentation shall be kept on file for a minimum period of seven years.

2.4.3 LED luminaire designs not satisfying design qualification testing and the production quality assurance testing performance requirements described below shall not be labeled, advertised, or sold as conforming to this specification.

2.5 DESIGN QUALIFICATION TESTING

2.5.1 Design Qualification Testing shall be performed by a National Voluntary Laboratory Accreditation Program (NVLAP) testing facility. Such testing may be performed by the manufacturer or an independent testing lab hired by the manufacturer on new luminaire designs, and when a major design change has been implemented on an existing design. A major design change is defined as a design change (electrical or physical) which changes any of the performance characteristics of the luminaire, results in a different circuit configuration for the power supply or changes the layout of the individual LED's in the module.

2.5.2 A quantity of two units for each design shall be submitted for Design Qualification Testing.

2.5.3 Luminaire shall be tested per IESNA LM 79-08.

2.6 FINISHES

2.6.1 Variations in Finishes: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.6.2 Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

2.6.3 Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

2.6.3.1 Surface Preparation: Clean surfaces to comply with SSPC-SP 1, to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.

2.6.3.2 Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

- Color: As selected by Architect from manufacturer's full range.

PART – 3 GENERAL INSTALLATION REQUIREMENTS

a. Comply with NECA

b. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
c. Fasten luminaire to structural support.
d. NFPA 70 requires minimum support for luminaires.
e. Supports:

- Sized and rated for luminaire weight.
- Able to maintain luminaire position after cleaning and re lamping.
- Support luminaires without causing deflection of finished surface.
- Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

f. Wall-Mounted Luminaire Support:

- Attached to structural members in walls or Attached to a minimum **1/8-inch** backing plate attached to wall structural members or Attached using through bolts and backing plates on either side of wall as applicable.

g. Wiring Method: Install cables in raceways. Conceal raceways and cables.
h. Install luminaires level, plumb, and square with finished grade and at height and aiming angle as required.

i. Coordinate layout and installation of luminaires with other construction.

j. Adjust luminaires that require field adjustment or aiming. [Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.]
k. Comply with requirements in Section "Low-Voltage Electrical Power Conductors and Cables" and Section "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.
- INSTALLATION OF INDIVIDUAL GROUND-MOUNTED Luminaires
- Aim as indicated on Drawings.
- Install on concrete base with top **4 inches** above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth.

l. Illumination Tests:

Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IES testing guide(s):

- IES LM-5.
- IES LM-50.
- IES LM-52.
- IES LM-64.
- IES LM-72.

m. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.

END OF SECTION

SECTION 27 05 26
GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Grounding conductors.
2. Grounding connectors.
3. Grounding busbars.
4. Grounding rods.
5. Grounding labeling.

1.02 DEFINITIONS

A. BCT: Bonding conductor for telecommunications.

B. EMT: Electrical metallic tubing.

C. TGB: Telecommunications grounding busbar.

D. TMGB: Telecommunications main grounding busbar.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.04 INFORMATIONAL SUBMITTALS

A. As-Built Data: Plans showing as-built locations of grounding and bonding infrastructure, including the following:

1. Ground rods.
2. Ground and roof rings.
3. BCT, TMGB, TGBs, and routing of their bonding conductors.

B. Qualification Data: For Installer, installation supervisor, and field inspector.

C. Qualification Data: For testing agency and testing agency's field supervisor.

D. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Installation Supervision: Installation shall be under the direct supervision of ITS Technician who shall be present at all times when Work of this Section is performed at Project site.

2. Field Inspector: Currently registered by BICSI as a registered communications distribution designer (RCDD) to perform the on-site inspection.

PART 2 - PRODUCTS

2.01 SYSTEM COMPONENTS

A. Comply with J-STD-607-A.

2.02 CONDUCTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Harger Lightning & Grounding.

2. Panduit Corp.

3. Tyco Electronics Corp.

B. Comply with UL 486A-486B.

C. Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.

1. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.

2. Cable Tray Equipment Grounding Wire: No. 6 AWG.

D. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.

2. Stranded Conductors: ASTM B 8.

3. Tinned Conductors: ASTM B 33.

4. Bonding Cable: 28 kcmils 14 strands of No. 17 AWG conductor, and 1/4 inch in diameter.

5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.

6. Bonding Jumper: Tinned-copper tape, braided conductors terminated with two-hole copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.03 CONNECTORS

A. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Burndy; Part of Hubbell Electrical Systems.

2. Chatsworth Products, Inc.

3. Harger Lightning & Grounding.

4. Panduit Corp.

5. Tyco Electronics Corp.

C. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.

1. Electroplated tinned copper, C and H shaped.

D. Busbar Connectors: Cast silicon bronze, solderless compression or exothermic-type, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch centers for a two-bolt connection to the busbar.

E. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.04 GROUNDING BUSBARS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Chatsworth Products, Inc.

2. Harger Lightning & Grounding.

3. Panduit Corp.

B. TMGB: Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper, 1/4 by 4 inches in cross section, length as indicated on Drawings. The busbar shall be NRTL listed for use as TMGB and shall comply with J-STD-607-A.

1. Predrilling shall be with holes for use with lugs specified in this Section.

2. Mounting Hardware: Stand-off brackets that provide a 4-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.

3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

C. TGB: Predrilled rectangular bars of hard-drawn solid copper, 1/4 by 2 inches in cross section, length as indicated on Drawings. The busbar shall be for wall mounting, shall be NRTL listed as complying with UL 467, and shall comply with J-STD-607-A.

1. Predrilling shall be with holes for use with lugs specified in this Section.

2. Mounting Hardware: Stand-off brackets that provide at least a 2-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.

3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

D. Rack and Cabinet Grounding Busbars: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with J-STD-607-A. Predrilling shall be with holes for use with lugs specified in this Section.

1. Cabinet-Mounted Busbar: Terminal block, with stainless-steel or copper-plated hardware for attachment to the cabinet.

2. Rack-Mounted Horizontal Busbar: Designed for mounting in 19- or 23-inch equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.

3. Rack-Mounted Vertical Busbar: 72 or 36 inches long, with stainless-steel or copper-plated hardware for attachment to the rack.

2.05 GROUND RODS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Harger Lightning & Grounding.

2. Tyco Electronics Corp.

B. Ground Rods: Copper-clad 3/4 inch by 10 feet in diameter.

2.06 LABELING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Brother International Corporation.

2. Hellermann Tyton.

3. Panduit Corp.

B. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

C. Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height

shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine the ac grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of the electrical system.

B. Inspect the test results of the ac grounding system measured at the point of BCT connection.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with connection of the BCT only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Bonding shall include the ac utility power service entrance, the communications cable entrance, and the grounding electrode system. The bonding of these elements shall form a loop so that each element is connected to at least two others.

B. Comply with NECA 1.

C. Comply with J-STD-607-A.

3.03 APPLICATION

A. Conductors: Install solid conductor for 12 AWG and smaller and stranded conductors for No. 10AWG and larger unless otherwise indicated.

1. The bonding conductors between the TGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.

2. The bonding conductors between the TMGB and structural steel of steel-frame buildings shall not be smaller than No. 6AWG.

B. Underground Grounding Conductors: Install bare copper conductor, No. 2/0 AWG minimum.

C. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.

2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.

3. Connections to Ground Rods at Test Wells: Bolted connectors.

4. Connections to Structural Steel: Welded connectors.

D. Conductor Support:

1. Secure grounding and bonding conductors at intervals of not less than 36 inches.

E. Grounding and Bonding Conductors:

1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.

2. Install without splices.

3. Support at not more than 36-inch intervals.

4. Install grounding and bonding conductors in 3/4-inch PVC conduit until conduit enters a telecommunications room. The grounding and bonding conductor pathway through a plenum shall be in EMT. Conductors shall not be installed in EMT unless otherwise indicated.

a. If a grounding and bonding conductor is installed in ferrous metallic conduit, bond the conductor to the conduit using a grounding bushing that complies with requirements in Section 270528 "Pathways for Communications Systems," and bond both ends of the conduit to a TGB.

3.04 GROUNDING ELECTRODE SYSTEM

A. The BCT between the TMGB and the ac service equipment ground shall not be smaller than No. 3/0 AWG.

3.05 GROUNDING BUSBARS

A. Indicate locations of grounding busbars on Drawings. Install busbars horizontally, on insulated spacers 2 inches minimum from wall, 12 inches above finished floor unless otherwise indicated.

B. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

3.06 CONNECTIONS

A. Bond metallic equipment in a telecommunications equipment room to the grounding busbar in that room, using equipment grounding conductors not smaller than No. 6AWG.

B. Stacking of conductors under a single bolt is not permitted when connecting to busbars.

C. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:

1. Use crimping tool and the die specific to the connector.

2. Pre-twist the conductor.

3. Apply an antioxidant compound to all bolted and compression connections.

D. Primary Protector: Bond to the TMGB with insulated bonding conductor.

E. Interconnections: Interconnect all TGBs with the TMGB with the telecommunications backbone conductor. If more than one TMGB is installed, interconnect TMGBs using the grounding equalizer conductor. The telecommunications backbone conductor and grounding equalizer conductor size shall not be less than 2 kcmils/linear foot of conductor length, up to a maximum size of No. 3/0 AWG unless otherwise indicated.

F. Telecommunications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install top-mounted /vertically mounted rack grounding busbar unless the enclosure and rack are manufactured with the busbar. Bond the equipment grounding busbar to the TGB No. 2 AWG bonding conductors.

G. Structural Steel: Where the structural steel of a steel frame building is readily accessible within the room or space, bond each TGB and TMGB to the vertical steel of the building frame.

H. Electrical Power Panelboards: Where an electrical panelboard for telecommunications equipment is located in the same room or space, bond each TGB to the ground bar of the panelboard.

I. Shielded Cable: Bond the shield of shielded cable to the TGB in communications rooms and spaces. Comply with TIA/EIA-568-B.1 and TIA/EIA-568-B.2 when grounding screened, balanced, twisted-pair cables.

J. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.

3.07 IDENTIFICATION

A. Labels shall be preprinted or computer-printed type.

1. Label TMGB(s) with "fs-TMGB," where "fs" is the telecommunications space identifier for the space containing the TMGB.

2. Label TGB(s) with "fs-TGB," where "fs" is the telecommunications space identifier for the space containing the TGB.

3. Label the BCT and each telecommunications backbone conductor at its attachment point: "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

3.08 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

2. Test the bonding connections of the system using an ac earth ground-resistance tester,

taking two-point bonding measurements in each telecommunications equipment room containing a TMGB and a TGB and using the process recommended by BICSI TDMM. Conduct tests with the facility in operation.

a. Measure the resistance between the busbar and the nearest available grounding electrode. The maximum acceptable value of this bonding resistance is 100 milliohms.

3. Test for ground loop currents using a digital clamp-on ammeter, with a full-scale of not more than 10 A, displaying current in increments of 0.01 A at an accuracy of plus/minus 2.0 percent.

a. With the grounding infrastructure completed and the communications system electronics operating, measure the current in every conductor connected to the TMGB and in each TGB. Maximum acceptable ac current level is 1 A.

C. Excessive Ground Resistance: If resistance to ground at the BCT exceeds 5 ohms, notify Architect promptly and include recommendations to reduce ground resistance.

D. Grounding system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION

SECTION 27 05 28
PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Metal conduits and fittings.
2. Nonmetallic conduits and fittings.
3. Optical-fiber-cable pathways and fittings.
4. Surface pathways.
5. Boxes, enclosures, and cabinets.
6. Handholes and boxes for exterior underground cabling.

B. Related Requirements:

1. Section 260533 "Raceways and Boxes for Electrical Systems" for conduits, wireways, surface raceways, boxes, enclosures, cabinets, hand holes, and faceplate adapters serving electrical systems.
2. Section 280528 "Pathways for Electronic Safety and Security" for conduits, surface pathways, innerduct, boxes, and faceplate adapters serving electronic safety and security.

1.02 ACTION SUBMITTALS

A. Product Data: For surface pathways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.
2. Laboratory Test Reports for Credit IEQ 4: For solvent cements and adhesive primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Shop Drawings: For custom enclosures and cabinets.

1.03 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For pathway racks, enclosures, cabinets, equipment racks and their mounting provisions, including those for internal components, from manufacturer.

1.04 PRODUCTS (Refer to Technology Drawaings for exact requirements and coordination)

1.05 METAL CONDUITS AND FITTINGS

A. General Requirements for Metal Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Comply with TIA-569-B.

B. GRC: Comply with ANSI C80.1 and UL 6.

C. ARC: Comply with ANSI C80.5 and UL 6A.

D. EMT: Comply with ANSI C80.3 and UL 797.

E. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.

2. Fittings for EMT:

a. Material: Steel or die cast.
b. Type: compression.

3. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions where installed, and including flexible external bonding jumper.

F. Joint Compound for GRC or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

1.06 NONMETALLIC CONDUITS AND FITTINGS

A. General Requirements for Nonmetallic Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Comply with TIA-569-B.

B. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

C. Continuous HDPE: Comply with UL 651B.

D. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

E. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

F. Solvent cements and adhesive primers shall comply with the testing and product

requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

1.07 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

A. Description: Comply with UL 2024; flexible-type pathway, approved for plenum/riser or general-use installation unless otherwise indicated.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Comply with TIA-569-B.

1.08 BOXES, ENCLOSURES, AND CABINETS

A. General Requirements for Boxes, Enclosures, and Cabinets:

1. Comply with TIA-569-B.

2. Boxes, enclosures and cabinets installed in wet locations shall be listed for use in wet locations.

B. Sheet-Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy/aluminum, Type FD, with gasketed cover.

D. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

E. Metal Floor Boxes: Refer to Section 26 27 26 “Wiring Devices”

F. Cabinets:

1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.

2. Hinged door in front cover with flush latch and concealed hinge.

3. Key latch to match panel boards.

4. Metal barriers to separate wiring of different systems and voltage.

5. Accessory feet where required for freestanding equipment.

1.09 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND CABLING

A. General Requirements for Handholes and Boxes:

1. Boxes and hand holes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.

2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

3. Comply with TIA-569-B.

PART 2 - EXECUTION

2.01 PATHWAY APPLICATION

A. Outdoors: Apply pathway products as specified below unless otherwise indicated:

1. Exposed Conduit: GRC.

2. Concealed Conduit, Aboveground: GRC.

3. Underground Conduit: RNC, Type EPC-40-PV Concrete encased.

4. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R

B. Indoors: Apply pathway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.

2. Exposed, Not Subject to Severe Physical Damage: EMT.

3. Exposed and Subject to Severe Physical Damage: GRC.

4. Concealed in Ceilings and Interior Walls and Partitions: EMT.

5. Damp or Wet Locations: GRC.

6. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: EMT

7. Pathways for Optical-Fiber or Communications-Cable Risers in Vertical Shafts: Riser-type, communications-cable pathway EMT.

8. Pathways for Concealed General-Purpose Distribution of Optical-Fiber or Communications Cable: Riser-type, optical-fiber-cable pathway EMT.

9. Boxes and Enclosures: NEMA 250 Type 1.

C. Minimum Pathway Size: 1 ¼ inch trade size. Minimum size for optical-fiber cables is 2 inch.

D. Pathway Fittings: Compatible with pathways and suitable for use and location.

1. Rigid Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.

2. EMT: Use compression fittings. Comply with NEMA FB 2.10.

E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

F. Install surface pathways only where indicated on Drawings.

G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F .

2.02 INSTALLATION

A. Comply with NECA 1, NECA 101, and TIA-569-B for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum pathways. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.

B. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.

C. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.

D. Arrange stub-ups so curved portions of bends are not visible above finished slab.

E. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches of changes in direction. Utilize long radius ells for all optical-fiber cables.

F. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

G. Pathways Embedded in Slabs:

1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot intervals.

2. Arrange pathways to cross building expansion joints at right angles with expansion fittings.

3. Arrange pathways to keep a minimum of 3 inches of concrete cover in all directions.

4. Do not embed thread less fittings in concrete unless specifically approved by Architect for each specific location.

H. Stub-ups to Above Recessed Ceilings:

1. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

I. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.

J. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.

K. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

L. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

M. Spare Pathways: Install pull wires in empty pathways. Cap underground pathways designated as spare above grade alongside pathways in use.

N. Pathways for Optical-Fiber and Communications Cable: Install pathways as follows:

1. 1- Inch Trade Size and Smaller: Install pathways in maximum lengths of 50 feet.

2. 1-Inch Trade Size and Larger: Install pathways in maximum lengths of 75 feet.

3. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements.

O. Install pathway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound.

P. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.

2. Where an underground service pathway enters a building or structure.

3. Where otherwise required by NFPA 70.

Q. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F, and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.

2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:

a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.

b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
d. Attics: 135 deg F temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.

4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.

5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

R. Mount boxes at heights indicated on Drawings in accordance with ADA requirements. Install boxes with height measured to center] [top] [bottom] of box unless otherwise indicated.

S. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.

2.03 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe less than 6 inches in nominal diameter.

2. Install backfill as specified in Section 312000 "Earth Moving."

3. After installing conduit, backfill and compact. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."

4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.

   a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.
   b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.

5. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

2.04 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.

C. Install hand holes with bottom below frost line, below grade.

D. Field cut openings for conduits according to enclosure manufacturer's written instructions.

2.05 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544.

2.06 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

2.07 PROTECTION

A. Protect coatings, finishes, and cabinets from damage or deterioration.

END OF SECTION

SECTION 27 10 00
DATA /VOICE NETWORK CABLING SYSTEM

(*All products specified here in is based on Belden products – Designer may choose to use equal products from Berk-Tek, Leviton Network Solutions or Superior Essex and data racks and Cabinets from Chatsworth Products Inc. (CPI))

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. The requirements of this section are in addition to the requirements of Division 1, General Conditions and Supplementary Conditions.

1.02 SUMMARY

A. Scope: Provide all material and labor required for the installation of the data infrastructure (campus computer network system), complete and fully operational as described in the Specification and shown on the Drawings. In general, data infrastructure wiring shall be a Belden Structured Cabling system*. Field-test the entire system.

B. Provide and install all components required for proper system operation whether specifically specified or not and all items of equipment, support structure, devices, etc., incidental to the installation. Coordinate with other trades to provide additional power outlets, wiring, or raceway as may be required in addition to that shown on the Drawings. Costs for these "additional installations" shall be included in the bid proposal for work to be performed under this Section of the Specifications. The requirements of Division 1 and the other Sections of this Division 26 apply to this Section.

1.1 APPLICABLE PUBLICATIONS

A. American National Standards Institute (ANSI) Publication: C2-93 National Electrical Safety Code

B. Electronic Industries Alliance and Telecommunication Industries Association (EIA/TIA) Publications:

1. EIA/TIA 568A, 568-B.1, B.2, B.3- Commercial Building Telecommunications Wiring Standards
2. EIA/TIA 569B - Commercial Building Standard for Telecommunications Pathways and Spaces
3. EIA/TIA 606A – Administrative Standard for telephone infrastructure.
4. EIA/TIA 607A - Commercial Building Grounding and Bonding Requirements for telecommunications
5. EIA/TIA 758 – Customer Owned Outside Plant Telecommunications Cabling Standard
6. TIA/ATIS-JSTD-607A -2002 Commercial Building Grounding and Bonding Requirements for Telecommunications.

C. Institute of Electrical and Electronic Engineers (IEEE) Publication: 142-1991 Recommended Practice for Grounding of Industrial and Commercial Power Systems

D. National Fire Protection Association (NFPA) Publication: 70- National Electrical Code (NEC)

E. The California State District (CSU), Office of the Chancellor, Publication: Telecommunications Infrastructure Planning Standards dated July 2003, including any supplements.

F. Underwriters Laboratories, Inc. (U.L.) Publication:

1. 83-2008 Thermoplastic Insulated Wires

2. 467 -2013 Grounding and Bonding

G. California State District, Office of the Chancellor - Telecommunications Infrastructure Planning (TIP) Standards dated February 2014

1.03 QUALITY ASSURANCE

A. All components shall comply with applicable standards of the Underwriter's Laboratories, Inc.

B. The installation of the data infrastructure shall meet ANSI/TIA 568-C- series optical fiber cabling Standards. The ANSI/TIA-568 family of Telecommunications Standards contains the requirements for balanced twisted-pair and optical fiber cabling, which provide the foundation for the design, installation, and maintenance best practices described in BICSI's Telecommunications Distribution Methods Manual (TDMM). With the published '568-C.0, '568-C.1, '568-C.2, and '568-C.3 Standards to ensure support of these future data transmission speeds, the District has selected specific wiring components as the approved standard to be used during permanent, new data cable installation. These component standards are described in this specification section. The District has chosen a structured network cabling system that provides a standardized media and layout for the backbone and horizontal cabling, standard connection interfaces and a consistent and uniform network design across all buildings on this project. In support of this system, the District has chosen the Belden Partner Alliance “PA” copper connectivity, copper cable, and fiber optic cable; and Mohawk Company outside plant copper cable as the preferred components for the network. The project shall be completed by a Belden PA capable of offering the Belden Networking Systems Warranty in compliance to receive Belden’s 25-year warranty.

C. Review the Drawings and Specifications for work and material provided by others that might affect work specified under this Division. Contractor is required to coordinate with other trades, equipment suppliers, contractors, etc. to insure a high quality reliable installation with a minimum of construction delays. All work required to be re-accomplished due to lack of coordination shall be done at the Contractor's expense.

D. Work and materials shall meet or exceed the requirements of the rules and regulations of the State of California, NFPA, CAL-OSHA, AND NECA - "Standard of Installation". Installation showing evidence of poor workmanship or not in accordance with these Specifications or the Drawings shall be re-accomplished or repaired to the satisfaction of the Architect at the Contractor's expense.

E. All equipment and systems specified in this Section shall be provided and installed by a single Special Systems Contractor who will be responsible for proper operation of all these systems.

F. All new outlets shall conform to the ANSI/TIA/ 568-C series of standards and addenda. The District requires that 4-pair Category 6A, UTP be used in all new cabling installations to support a 10G BaseT LAN configuration and that the 4 pairs be terminated on their own dedicated data cross-connect blocks using the 568B wiring configuration. Voice and data cables must be in separate sheaths.

1.04 NETWORK SYSTEM CONTRACTOR REQUIREMENTS

A. The Contractor shall hold a valid and active California State C-7 Low Voltage Systems and C-10 Electrical Contractor's license.

B. The Contractor must be currently certified as a Belden PA installer that shall remain valid during the course of the installation agreement, with no known pending action or intent by Belden and/or the Contractor to terminate or limit status as a manufacturer certified designer and installer. Note: Respondent status as a Belden PA certified PA certified designer and installer applicant or pending Belden certified designer and installer approval from Belden is unacceptable.

C. The Network System Contractor shall have at least one prior year with Belden Partner Alliance

certified status including the right and ability to deliver a completed installation conforming to Belden warranty program requirements; additionally, the Contractor must have completed at least five similar projects as a certified designer and installer. The contractor shall have personnel specifically trained and certified under the manufacturer's installation training program, including the willingness and intent to assign installation project resources in a manner which utilizes certified personnel for each and every project manager and foreman/supervisor position associated with providing services to meet District installation requirements.

D. The Contractor shall have been in the structured cabling pathway implementation business under his current organizational structure, either directly or under wholly owned predecessor for a minimum of five years. Contractor must maintain a full time service staff at an established business location having the appropriate parts and service facilities. An individual operating out of residential facilities or without the required facilities, staff, or tenure will not be considered as an acceptable contractor for this project.

E. Other requirements the Contractor must have:

1. A profitable status for at least the two preceding fiscal years (three years if privately held and not submitting financial statements).

2. No significant pending litigations, which may subject the company to financial risk exceeding twenty percent of its value.

At least one Registered Communication Distribution designer (RCDD) certified by Building Industries Consultant Services International employed, including the willingness and intent to assign such personnel to this project as project engineer or project manager.

1.05 SUBMITTALS

A. Equipment submittals are to be made as required in Section 01300.

B. Preface the material submittal for the equipment specified in this Section with the notarized statements and other evidence as applicable to prove compliance with the requirements of paragraph 1.04 above.

C. Submit shop drawings, product data sheets, and wiring diagrams as required to demonstrate compliance with the requirements of these Specifications. This submittal shall include but not be limited to the following:

1. Complete list of materials with model and part numbers and the corresponding product data sheets. All standard and special components and materials shall be described and illustrated.

2. A complete set of detailed manufacturers specifications describing the features and capabilities of the proposed systems and equipment.

3. A complete set of electronic (AutoCAD) drawings of special items.

4. A one-line block diagram showing the engineered systems and exactly the manner in which the contractor proposes to install the systems.

5. Illustrations and scale drawing of the equipment racks and special cabinets with all equipment shown and identified.

6. Drawings shall include designations, dimensions, operating controls, instruments, etc.

7. Following successful review of the systems submittals, prepare detailed installation drawings to augment the contract documents showing all specific installation to be accomplished under other sections of this Specification Division 16000. Submit for review prior to release for construction.

8. At the conclusion of each phase of work the contractor will provide documentation, cabling layouts, diagrams and test results for the completed phase prior to the beginning of the next phase of work. At the conclusion of all phases the contractor shall provide a complete package inclusive of all phases to the District as the final submittal.

1.06 WARRANTY

A. The Belden Partner Alliance Contractor shall assume all responsibility for the proper operation of the entire system. The complete system shall be guaranteed free from defects in material or workmanship for a period of two years after filing of the "Notice of Completion". Provide on-site service for all systems for the duration of the guarantee period at no additional cost to the District. Where system trouble is caused by misuse, abuse, or accident, current labor rates shall be chargeable for the service call otherwise, the service shall be free. Service shall normally be available from a factory authorized service center during normal working hours and within 24 hours of receiving a call.

1.07 WIRING METHOD

H. The cables and conductors of all systems specified under this Section are required to be installed in raceway. Raceway and line voltage wiring shall be installed under Section 16050 as required for proper system operation. Network systems cable shall be provided under this Section as directed. All Wiremold raceways shall be provided with wire holding clips to retain wires in Wiremold raceway.

PART 2 - PRODUCTS

2.01 REQUIREMENTS FOR MATERIAL AND EQUIPMENT *

A. Copper Cable Standards

1. Horizontal Station Cabling

a. For horizontal station cabling within walls and ceilings, the following cable is required:

Cable Type	Vendor Product Number	Description
Indoor/ Outdoor	Belden 2148A Cat 6A Indoor/Outdoor CMR/CMX Outdoor rated	24 AWG bare copper conductors with Black FR Polyolefin jacket and flooded for moisture protection
Plenum	Belden 10GXS13 Cat 6A 500 MHZ Copper Cable	All interior cables shall be rated for Plenum to match other projects completed or under construction. 23AWG bare copper bonded pair Cat 6A Small OD (.265) cable.
Non Plenum	Belden 10GXS12 Cat 6A 500 MHZ Copper Cable	with thermoplastic insulation 23AWG bare copper bonded pair Cat 6A Small OD (.265) cable.

b. These cables are certified by ITS labs (ETL), to meeting ANSI/TIA/EIA-568-C.1, and 1000BASE-T requirements. The contractor will ensure that the cable will be installed with no less than a 10 foot service loop at both ends of cables (Where the cable is only in conduit or raceway, leave 2' of loop at the IDF Cabinet). The contractor will ensure that all runs of station cabling do not exceed 90 meters (295 feet) from patch panel to wall outlet. Service loops need to be coiled and secured to a j-hook (This is to be done only in areas where j hooks are used).

c. Cable runs supported by j-hooks require maximum distance of 48 inches between j-hooks.

2. Outside Plant Copper

   a. The outside plant Category 6 copper cable shall be Belden Gel-Filled; District Standard, no “or equals” or “substitutions” allowed. These shall be used where outlets are served by an IDF Cabinet in a different building and the cables are placed in underground conduit.

Type	Vendor Product Number	Description
Belden OSP6AU Outside Plant rated Cat 6A cable	Belden OSP6AU	Category 6A Rated Outside Plant Cable

   b. These cables are certified by ITS labs (ETL), to meeting ANSI/TIA/EIA-568-C.1, 1000BASE-T requirements. The contractor will ensure that the cable will be installed with no less than a 10 foot service loop at both ends of cables. The contractor shall ensure that all runs of station cabling do not exceed 90 meters (295 feet), from patch panel to wall outlet.

3. Station Jacks

   a. Data Center shall be cabled with Belden 10GX Copper cabling system and Key Connect faceplates for information outlets. These connectors are component rated and rated for 10G00 transmission.

Type	Vendor Product Number	Description
Individually-Packed	Belden 10GX Modular Jacks RVAMJKUIV-S1 **Colors to be used shall be verified with District Rep prior to submittals.**	RevConnect 10GX UTP Modular Jack, T568 A/B, Single Pack

   b. **The** following enclosures are acceptable:

Type	Vendor Product Number	Description
Wall Mount Faceplate	Belden AX103922	Single Outlet Faceplate, Electric - Ivory
Wall Mount Faceplate	Belden AX103923	Duplex Outlet Faceplate, Electric - Ivory
Wall Mount Faceplate	Belden AX102248	Quad Outlet Faceplate, Electric - Ivory
Surface Mount	Wiremold 5500, or equal.	Non-metallic surface molding with 3 compartments. To be screwed to the wall in addition to adhesive.
Surface Mount Vertical Molding for Teacher Stations	Wiremold 5500, or equal.	Non-metallic surface molding with 3 compartments. To be screwed to the wall in addition to adhesive.
Rectangular Faceplate	Belden AX103927	Rectangular Faceplate, Electric Ivory
Surface Box Mounting	Belden AX104134	4 Port Side-Entry Universal Mount Surface Box.
Angled 4 Port Faceplate	Belden 102432	Electric Ivory 4 Port angled Faceplate.

4. Patch Cords

   a. Patch cords within the wiring closets will conform to Belden's 10GXD structured cabling system specifications. Patch Cords shall be provided in various lengths to support the varying size of the cabinets and to ensure that patching is provided in a neat and orderly fashion. All new installations will use the Belden 10GX Bonded Pair Patch Cord.
   b. The contractor will provide sufficient patch cords to connect all data jacks to the network electronics, as follows:

Type	Vendor Product Number	Description
Modular 4-pair cord	Belden CAD11106XXX	CAT 6A UTP, length (xxx), blue color, small diameter.

   c. The contractor will label all patch cords at both ends, with the jack label, using mitos Unified School District's standard labeling scheme. Before a labeling scheme is actually started, obtain approval from the District Information Technology Rep and the Telecom Engineer.
   d. Patch cords shall be made available before each phase of construction begins. Contractor shall be responsible for installation of all patch cords in a professional manner within vertical and/or horizontal management trays. Patch cord placement will be reviewed by the District and/or District Representative and at the District's request will be redone if not installed satisfactorily. Patch cords shall be installed by the Contractor 2 weeks prior to completion of each phase. Contractor shall notify the District when complete so that District may review the installation.

5. Station Cords

   a. The contractor will furnish station cords to be used within the classroom / admin environment. Station cables will be 1 meter, and 3 meters in length. For wireless access point locations provide one meter length, for clock / speaker locations provide one meter length, for all other workstation locations provide 3 meter length. All new installations will use Belden 10GX Bonded Pair UTP Modular Cords.
   b. The contractor will provide sufficient patch cords to connect all data jacks to the network electronics, as noted in a. above.
   c. All station cords will need to be available before first phase of construction begins. Visual inventory shall be performed by the District Technology Consultant. The appropriate amount of station cords needed to complete each phase shall be distributed to the District IT Department two weeks prior to the end of the phase.
   d. Computer Lab (Media Center) station cords. Provide custom length station cords for all computer stations located at Media Center computer Lab. Patch cords shall be secured in furniture chase. The station cord lengths shall be submitted to district based on the final arrangement of computer lab furniture and computer layout. Coordinate with District prior to customizing station patch cords.

6. Patch Panels

   a. Horizontal station cabling must not terminate directly onto the network electronics. Cables will terminate in the wiring closets on RJ-45 patch panels with flexible modular panels. Each jack termination on the patch panels will be labeled according to School District cable labeling standards (Again, coordinate with IT Rep before commencing labeling). All horizontal station cables will terminate on the modular panels and be wiring compliant with the Cat 6A UTP standards. The following patch panels have been selected:

Type	Vendor Product Number	Description
48-port patch panel kit	Berk-Tek Leviton 49256-D48 Berk-Tek Leviton 49256-H48	1RU 48 port Angled Patch Panel

		2 RU 48 port Angled Patch Panel EXTREME CAT 6+ 110-STYLE AND QUICKPORT PATCH PANELS • Exceed requirements for Category 6 described in ANSI/TIA-568-C.2 and Class E requirements described in ISO/IEC 11801 • Independently tested and verified by Intertek (ETL) to meet all TIA component, permanent link, and channel requirements • Available in 110-Style and QuickPort flat, angled, recessed angled, recessed and Zero-U configurations in 12-96 port counts • Gas-tight insulation displacement contacts provide excellent conductor retention and resistance to surface contact oxidation for life of the system • Include color codes for T568A/B wiring schemes

B. Fiber Optic Cable Standards

1. Outside Plant Fiber

a. The fiber cable for MDF-to-IDF feeds will be laser optimized (OM4) multimode 50/125-micron (TIA – 492AAAD, ANSI/TIA – 568 -D.3) & 12 strand multi-mode with 12 strands of OS2 single mode where indicated on the drawings, all dielectric, general purpose.

b. The multimode cable must comply with the following minimum transmission parameters:

Attenuation[1]		Bandwidth[2]	
850 nm	1300 nm	850 nm	1300 nm
3.0 dB/km	1.2 dB/km	3500 MHz km	500 MHz km

[1]Maximum Individual Fiber Loss (cabled).
[2]Minimum Individual Fiber Bandwidth (cabled).

c. Outside Plant cable must be terminated in a fiber distribution panel within 50' of the “point-of-emergence” if not in conduit.

d. These cables must meet ANSI/TIA/EIA-568-C, and 1000BASE-T requirements. The contractor will ensure that the cable will be installed with no less than a 10 foot service loop at both ends of cables.

Type	Vendor Product Number	Description
OSP Fiber Optic Cable	Berk-Tek Leviton - LTPK012FB3010/F5	12 x OM4+ Adventum Plenum

	Berk-Tek Leviton LTP012AB0403	12 strand OS2, Indoor / Outdoor Rated. Berk-Tek's revolutionary Outdoor/Indoor Adventum cables are designed to be used in plenum rated environments. Adventum supports the latest Gigabit Communications Protocols, including Gigabit Ethernet and ATM. This cable design utilizes dry water-blocking technology that utilizes super absorbent polymers to replace the messy gel filler inside the fiber tubes. It is the only fire-rated cable designed to withstand the rigors of the outside plant environment. Adventum is rated for plenum installations and has no gel filler.

2. Fiber Optic Connectors
   a. Field connections are required for all fiber strands in the MDF and IDF's. All connectors to be glass-in-ceramic Leviton 49991-MSC FastCAM™ Pre-Polished SC-compatible field-installable connectors.
   b. The contractor will provide fiber optic patch cords for use in the closets. At *the MDF,* dual fiber patch cords (1 meter in length) will be provided for 50% of the available terminations. At the IDF's, two (2) dual fiber patch cords (1 meter in length) will be provided for each. Prior to ordering fiber optic patch cable verify connection type and length with Owner. The following fiber optic patch cords have been selected:

Type	Vendor Product Number	Description
SC-LC Fiber Optic Patch cords	Leviton 50/125 µm LOMM (OM4), Duplex patch cord	FIBER OPTIC PATCH CORDS • Riser-rated simplex or duplex zip-cord multimode cable • < 0.4 dB insertion loss, > 25 dB back reflection • Additional patch cords available as Make-To-Order*

3. Fiber Optic Patch Panels
   a. For IDF Cabinets with less than 24 fiber terminations, District has standardized on rack-mountable patch panels Fiber Enclosures, with terminations of up to 24 connections. The recommended products are:

Type	Vendor Product Number	Description
Fiber termination shelf	Leviton 500i SDX 1RU Flush Mount Fiber Distribution and Splice Enclosure, empty; Accepts up to (3) SDX adapter plates or SDX MTP cassettes to patch up to 72 LC fibers per RU.	Flush-mount adapter bulkhead makes moves, adds, and changes easy Stackable fiber rings simplify cable routing and organization One-piece removable cover on enclosure allows for

		complete accessibility to the back of the enclosure and protect fibers Constructed of 16-gauge steel, powder-coated black Add-on patch cord cable management tray (sold separately) shares existing rack unit with the mounted enclosure
Connector Panel	Opt X® SDX Enterprise Cassettes	Leviton Opt-X SDX Cassettes are pre-terminated, pre-tested, and come with 12-fiber MTP connectors on the back that break out to single connectors on the front. Cassettes are custom built to your specifications. Select from a variety of connectors including LC, SC, ST, and MU to meet your specific application needs

b. For the rack in the MDF, a 4-Rack Unit, Enclosure that holds 12 SDX Cassettes and associated adapters and connectors shall be used LEVITON 5R4UM-F15 : 4RU ENCLOSURE
c. Fiber will directly terminate on the patch panel couplings without additional splicing. Sufficient cable slack to allow for movement and rack relocation will be required (no less than 10 feet).

4. Data Racks and Cable Management

a. MDF and IDF Racks/Cabinets shall be Belden XDR8419-310 or Equal. MDF Rack shall be 84” in height and shall be capable of accepting 19” wide EIA equipment. IDF cabinets equipment mounting rails shall be tapped #10-32 and be adjusted to 4 ½” back from the front of the cabinet. The equipment mounting rails will include printed rack unit numbering from top to bottom in ascending order.
b. All data racks / cabinets are to be grounded. Rack / cabinet construction method shall ensure an electrically bonded structure for ease of grounding.
c. Coordinate placement of MDF racks with District Technology Consultant prior to installation.

Type	Vendor Product Number	Description
Floor Mounted Data Cabinet (MDF)	Belden XDR8419-3102836	19” X 7’ Floor Mounted Data Enclosure – Black (4 post racks)
Wall Mounted Data Cabinet.	Belden XWM-2320-SD	24”W X 39”H X 27”D Wall Mounted Data Enclosure – Black with built in ventilation fan kit 120VAC, 100 CFM and Power Strip surge protected, NEMA 5-30R (non-locking type), Horizontal

		and Vertical cable manager and mounting bracket.
Vertical Cable Manager	Belden BHVL006	84” H x 6” W Front/Rear Manager
Horizontal Manager	Belden BHH192UC	19” x 2U Horizontal Cable Manager
UPS	Coordinate with District for Specific type of UPS provided at each IDF/MDF. Receptacle type/size and NEMA configuration shall match installed UPS.	

5. Cable Runway

   a. All cable runways shall be installed according to MDF elevation or plan views.
   b. Required connectors, butt-splices, junction-splice, j-hooks and other attachment fittings shall be used to complete the assembly.
   c. Protective end caps shall be installed on all exposed cable runway ends.
   d. Wall angles shall be attached to 1 ½” uni-strut bars that have been securely bolted to the wall framing with lag with minimum 3’ embedment into the wood framing member. See attachment detail drawing.
   e. Where vertical all-thread rods are used to support ladder sections, a protective covering shall be installed over the all-thread rod.
   f. Cable runway shall bond to the TMGB, TGB or CBN with a #6 GREEN Stranded conductor.
   g. All cable runway sections shall be bonded to each other using the manufacturer’s kit.

Type	Vendor Product Number	Description
Cable Runway (Ladder Rack)	Cooper B –Line SB-17U	12” Cable Runway, Black
-Butt Splice Kit	Cooper B-Line SB-2107-BZN	Butt Splice Kit
Junction Splice Kit	Cooper B-Line SB-2101-A-BZN	Junction Splice Kit
Rack-to-Runway Mounting Plate	Cooper B-Line SB-2133-12-KFB	Channel Rack-to-Runway Mounting Plate with Hat Bracket
Support Bracket	Cooper B-Line SB-213-12 KFB	Triangular Support Bracket
J-Bolts	Chatsworth 11431-001	J-Bolts
Wall Angle Support Kit	Cooper B-Line SB-2113-FB	Wall Angle Support Kit
Protective End Caps	Cooper B-Line SB-21-B	Protective End Caps, Cable Runway
End Closing Kit	Chatsworth 11700-712	End Closing Kit
J-Hooks	Cooper B-Line BCH Series	BCH12-W2
J-Hooks	Cooper B-Line BCH Series	BCH21-W2
J-Hooks	Cooper B-Line BCH Series	BCH32-W2
J-Hooks		BCH 64

C. Provide all keys and special tools provided for each equipment to District prior to acceptance

by district as part of close out documents.

D. Provide labeling for all interior Loudspeaker/clocks and Exterior Horn/speakers. Labels shall be visible from outside for easy identification of installed cabling.

PART 3 - EXECUTION

3.01 INSTALLATION

A. The installation shall be accomplished by and under the direction of skilled electronic craftsmen, factory trained by the equipment manufacturer, and experienced in the installation of systems of this type in the State of California. Workmanship shall be of the highest quality.

B. Note that the general installation requirements of Division 16, “Basic Materials and Methods” apply to work performed under this Section.

C. All wiring shall be neat and orderly. Disorganized installation of wire and cable will not be allowed. No splicing allowed. Absolutely no connections are to be made in wet locations or below grade.

D. Punch list items and contractor corrections shall be completed no more than 30 days following issuance to the contractor or unless agreed to otherwise by the district.

E. Label outside of IDF cabinets with appropriate names per plan with non-removable stencils. Get prior approval from district before installation of stencil

F. Label all cables at 12 inches from each end with Brady "Omni-Grip" devices or the equivalent.

G. The conduit, outlet boxes, terminal cabinets, etc., which form a part of the rough-in work shall be furnished and installed complete as described and otherwise required in other sections of this Division 16 Specification.

H. Size all wires and cables as required specifically for each installation. The requirements of this specification and the Drawings indicate minimum requirements. Coordinate box, terminal cabinet, and conduit sizes required with other trades as needed.

I. For all copper cabling inside permanent buildings and relocatable with IDF’s, Category 6 UTP cabling is required. For relocatable buildings where station cabling will route underground to an IDF in another building, Category 6 OSP Mohawk cabling is required.

J. Category 6A UTP Jack Modules at station jack locations shall be color coded as follows:

1. Teacher Workstation – Ivory Jack/blue Cable. Length 1 meter at jack and 3 meters at IDF/MDF. (All patch cords shall be provided by Contractor).
2. Student Workstation – (2)-Ivory Length 1 meter at jack and 3 meters at IDF/MDF. (All patch cords shall be provided by Contractor).
3. Clock/Speaker – (1)-Red jack/red cable/red patch cord, with 1’-0” patch cords. (All patch cords shall be provided by Contractor).
4. Wireless Access Point – (1)-Blue, with meters (10’-0”) patch cords coiled above ceiling. (All patch cords shall be provided by Contractor).
5. Video – (1)-Gray with 1’0” patch cords.(All patch cords shall be provided by Contractor).
6. Fax/Red Phones POTS lines-RED jack/red cable. Length 1 meter at Jack and 3 meters at IDF/MDF/MPOE. (All patch cords shall be provided by Contractor).
7. IDF -2’X2’36”: Preliminary 3’0” Patch cords (All patch cords shall be provided by Contractor).
8. IDF Slim Line Box (Hubbell Rebox): Preliminary 3’0” patch cords (All patch cords shall be provided by Contractor).
9. MDF Room Rack: TBD (All patch cords shall be provided by Contractor).

a. Workstations: 3 meters (10’-0”).

b. Wireless: 3 meters (10’-0”).

K. Provide identification labeling of all communication conduits and cables at IDF/MDF/Vaults/pull boxes.

(Color Scheme and patch cords shall be confirmed and provided as directed by the School IT Director)

3.02 TESTS, INSTRUCTION AND DOCUMENTATION

A. The entire system shall be tested and adjusted under the supervision of the Contractor's electronics engineer.

1. Provide all instruments for testing and demonstrate in the presence of the District's Representative that all audio, video, telephone, and signal circuits and wiring are free of shorts and grounds and that the installation performs as required and is as specified herein.

2. Any defects or abnormalities shall be corrected at once and the test re-conducted to demonstrate proper operation at no additional cost to the District.

3. A complete report of all these tests shall be prepared by the testing personnel and signed by them. The report shall include the date the testing was conducted a narrative describing each test and the results of all testing upon correction of all defects. The site inspector shall be informed of the testing schedule and his signature shall appear on the report attesting to the fact that these tests were conducted. The original copy of the final signed report shall be submitted to the Architect; and following his review, copies of the report shall be included in the operations and maintenance manuals provided to the District.

B. Cable Testing- NO FAIL OR MARGINAL PASS RESULTS WILL BE ACCEPTED

1. The contractor shall perform all pretests and adjustments. All final testing shall be performed with the District Technology Consultant present for 100% of the project testing. The contractor will furnish all test equipment necessary and perform all work required to determine or modify performance of the system in accordance with these specifications. Valid copper test tools may include a field tester level III or equal.

2. The contractor will submit a complete test plan for Copper Station Wiring/Information outlet and Fiber Optic Cable systems to be used for this contract. At minimum, the plan should show test configurations, calibration procedures, impedances, and measurement equipment. This plan must be approved prior to the start of testing. The test plan is a one-time requirement and will remain in effect for the duration of this contract unless specifications change requiring a re-submittal. The scope of this work includes, but is not limited to, the following:

a. Check all system(s) for compliance with the Performance Standards and Specifications
b. Maintain a check-off list for reference by the District during tests.
c. The result of the measurements outlined shall be recorded and submitted as final proof of system performance.
d. All systems must pass specifications and be accepted before the work will be considered complete.

3. Station Wiring/Information Outlet

a. All jacks should be tested with a Fluke Networks DSX tester and assigned its appropriate circuit id number with auto test. All outlets will be tested in accordance with The Belden Partner Alliance Networking System Warranty requirements.
b. Category 6A UTP:
c. Station wiring/information outlets (100%) will be tested to proposed Category 6A standards (ANSI/TIA- 568-C) and must adhere to The Belden Partner Alliance CSV 25 Network Systems Warranty parameters for Category 6A. Test MUST be 100% pass

(with no marginal results) and will be reviewed by telecom engineers and District for approval.

d. Category 6A outside Plant Cabling:
e. All station wiring/information outlets (100%) will be tested to proposed Category 6A standards (ANSI/TIA -568-C). These locations will be tested and must adhere to The Belden Partner Alliance CSV 25 Networks Systems Warranty. for Category 6A.

C. Fiber Optic Cable Testing

1. All fiber supplied to the District must be tested before installation, while still on the shipping reel, using an optical time domain reflectometer (OTDR). A discrepancy of more than 1 dB on any fiber in either window indicates possible shipping damage and the fiber must be returned to the supplier. The test results must be maintained in a file for future reference. The contractor is responsible for insuring fiber integrity and performance specifications.

2. All fiber must be tested after installation according to the procedures and acceptability criteria described in EIA/TIA 568-C.3 and all applicable addenda after installation and termination using a Fluke Networks CertiFiber Pro OLTS. All fiber Cables shall be tested to TIA 568-C.3 standards for Optical Loss. The results of these tests (printed OLTS PASS results) must be provided by the installer as documentation of the quality of installation and as a baseline for future troubleshooting. All optical test equipment must have current, traceable manufacturer approved calibration certification.

3.03 OPERATION AND MAINTENANCE MANUALS

A. Three complete sets of maintenance instructions, system/component data sheets and operating instructions shall be bound into three ring binders permanently labeled "Data Network Systems" and delivered to the District Technology Consultant.

1. Preface the manuals with a typewritten sheet in a plastic protector identifying the system installer by business name, address and telephone number.

2. The manuals shall include all approved submittal information, product data sheets, spare parts list, troubleshooting guides, complete "as- built" and one line diagrams, circuit diagrams and wiring destination schedules necessary for the proper operation and servicing of the system. Separate manuals may be prepared for each major system group or logical group dividers shall be provided. Provide an index to all material and indexing dividers for easy location of information.

a. As-built should consist of and will be the responsibility of the Contractor:

1) Laminated site of MDF
2) Laminated site of IDF(s)
3) AutoCAD for future A/E
4) Visio version for District use

3. All original equipment documentation and manuals provided by the equipment manufacturers shall be safeguarded and turned over to the District at the completion of the project.

END OF SECTION

SECTION 27 10 10
CLASSROOM TECHNOLGY
(Designer to coordinate with District for preferences)

PART 1 - GENERAL

1.01 SMART MEDIA CLASSROOM

A. The following are some objectives for a Smart Classroom application:

1. To help teachers to meet new challenges and developing students' abilities and performance.
2. To enables teachers to access multimedia content and information that can be used for teaching students more effectively. Pedagogically sound and visually rich curriculum resources.
3. To enables teachers to express their views and ensures that every child is understanding the undertaken concept which ultimately affects his achievement.
4. To make possible for the concepts to be understood clearly. To makes abstract concept real.
5. To have interactive and live teaching to elaborate and compare different objects and perceptions towards the concepts
6. To design a module of smart class which allows a student to visualize the concept much better than static images. Visuals and animations that students will never forget.
7. To move a step towards development where students' achievement is highlighted.
8. To makes learning an enjoyable experience for students. Activities and games to make learning process easy.
9. To make effective blending of technology with the classroom, and to Inform the teachers of classroom events
10. To instruct simultaneously remote and local students.
11. To improve creative thinking in learning process to visualize the concepts and practices with model and demonstrations.
12. To optimize the use of e-resources wise e-books, e-journals, protocols, lecture notes, documentaries and so on.
13. To customized content as per the school's scheme of work and to provide facility to update the content.

1.02 Principles inherent in Smart classroom

A. The following are the principles for smart classrooms in terms of arrangement and pedagogical configuration which we have established as widely generalizable and which should be considered in order to transform any formal learning space in smart classroom.

1.03 Principle of Adaptability

A. From the idea that every teacher and every class is different, and that space can be adapted to their needs, the concept of smart classrooms includes the principle of adaptability to the type and needs of teacher and of each student.

1.04 Principle of Connectivity

A. The concept of connectivity has a twofold character. On one hand it is required that the learning space has a good network connectivity, both local and global, to use to the most the potential of mobile devices. Connectivity should be wireless, and this is fundamental to maximize physical mobility around the space and comfort in using technology. On the other hand, beyond digital connectivity there exists social and informational connectivity. Through networks, students live connected to teachers, friends, family, professionals and to a large number of information sources, both in their immediate surrounding and from distant places.

1.05 Principle of Comfort

A. Under this principle, elements which enable this well-being should be included in the learning space for the various tasks to be done for learning, such as couches, pillows, rugs and carpets, comfortable chairs. A smart classroom is a place arranged to comfortably do various activities –reading, watching videos, playing, listening to music and audios, writing, talking, debating, experimentation, and so on.

1.06 Principle of Flexibility of physical arrangement

A. The arrangement of a smart classroom and its elements is such that it allows agile and easy variations in activities, that is, make it possible to change student grouping, the type of resources being used, use of various types of resources at the same time, ICT and non-ICT, for different students to carry out different tasks, e.g. searching information, discussing, watching a video, etc. The classrooms are supplied with varied furniture elements to achieve flexibility of space arrangement.

1.07 Principle of Multiplicity

A. This principle refers to smart classrooms having features which enable the use of various types of resources and stimuli. While teaching and learning, the arrangement enables possibilities for creativity, reasoning, logical thinking, etc., and be adapted as close as possible to learners' various needs and learning styles.

1.08 Principle of Order / Organization

A. This is an important principle, even though it is not easy to design, and attain, sustainable placing, storing, arrangement and rules of use of spaces and resources available. For this reason, teachers carefully consider the order and arrangement of spaces and resources so that these are the most adequate for the learning activities that will take place in their smart classroom.

1.09 Principle of Openness

A. This principle relates to the false and rooted belief that learning takes place only in the formal space in the traditional classroom, where the teacher presents information and gives a lesson in a transmissive way. Learning takes place beyond the classroom space, both physically and virtually, and therefore activities put forward for smart classrooms should consider these extended learning places and learning times in order to learn beyond the classroom and the class times traditionally assigned.

1.10 Principle of Personalization

A. Smart classrooms allow students and teachers to personalize their environment according to their likes and needs. A space which progressively teacher and students should make their own, personalizing it by means of activities which support and reinforce learning.

1.11 Principle of Safety / Security

A. Smart classrooms have an arrangement which prevents users from having physical accidents and will also be safe in terms of access to information and communication on the Internet from the classroom. Therefore, security systems will be taken into account when conceptualizing and designing smart classrooms.
B. In sum, the arrangement, structure, methodologies and principles of smart classrooms intend that learning experience be as likely as people's learning ways, preferences and styles, in a natural way and in a personal space; all this through active participation, experimentation, collaboration, solidarity, rapport, creativity, leadership, and so on.

PART 2 - CONCEPT

2.01 Main themes in the Smart Classroom concept

A. Smart Classroom aims at combining entrepreneurial pedagogy, collaborative teaching and the latest technological teaching tools to create a modern and effective education service environment in education setting. There are three main themes in the SMART Classroom concept:

1. Smart Pedagogy,
2. Smart Teaching Solutions.
3. Smart Learning Space

B. SMART Pedagogy is based on entrepreneurial pedagogy and methodologies. Smart Classroom project aims at fostering the application of these methodologies in institution setting and hereby provide more interactive alternatives to traditional teaching. This theme of the project results a handbook for teachers on applying fresh teaching methods into practice, tools for teachers' self-reflection and evaluation and training program for teachers.

C. The second theme of the Smart Classroom concept is called Smart Teaching Solutions and it deals with variety of practical teaching tools and materials for teachers including teaching games and simulations. Smart Teaching Materials include for example exercises and examples that teachers can apply to their courses.

D. Smart Teaching Spaces cover both physical and virtual teaching spaces in the institution setting. The Smart Teaching Spaces concept defines the essential furniture and technical specifications of ideal physical classrooms and the most important features of virtual learning platforms. Also, facilities and functions for lecture halls and collaborative teaching spaces will be defined in this package. The Smart Teaching Spaces brings flexibility to learning and makes the learning ubiquitous.

2.02 The Layout of Smart Classroom

A. The Smart Classroom is physically built in a separate room of Pervasive Computing Lab in which several video cameras, microphone arrays are installed in it to sense human's gesture, motion and utterance. According to the characteristic of invisibility in pervasive computing environment, it deliberately removed all the computers out of sight. Two wall-sized projector displays are mounted on two vertically crossed walls. According to their purposes, they are called "Media Board" and "Student Board" separately. The Media Board is used for lecturer's use as a blackboard, on which prepared electronic courseware and lecturers' annotation are displayed. The Student Board is used for displaying the status and information of remote students, who are part of the class via Internet.

B. The classroom is divided into two areas, complying with the classroom's model. One is the teaching area, where is close to the two boards and usually dominated by lecturer. The other is the audience area, where is the place for local students. Complying with the philosophy of Natural and Augmented. Natural means obeying real-world model of classroom as much as possible to provide lecturer and students the feeling of reality and familiarity, which leads to the existence of local students. Augmented means trying to extend is the reason for remote student.

2.03 Suggested features for Smart Classroom

A. Smart Classroom must have some of the following features:

1. • Redecorated interiors
2. • Enhanced lighting controls
3. • A gyro wireless mouse to control the computer and projector from anywhere in the classroom
4. • Switching controls to easily change projector output between the PC, laptop,
5. document camera, and DVD/VCR
6. • New projectors

7. • Laptop plugs so you can bring your own computer and hook it up instantly
8. • A document camera to show transparencies, papers, or small objects on the projector and even take

B. Snap shots of them

1. • A SMART Symposium that allows you to make electronic notes and images appear
2. • The Classroom Performance System (CPS) to get real-time answers from your students in class by means of wireless multiple-choice response devices.

PART 3 - PRODUCTS

3.01 Components of Smart Classroom

A. • Smart Board
B. • Smart LED TV
C. • Short throw Projector
D. • Video Conferencing Equipment
E. • Laptop with Internet connection
F. • Document Camera/ Visualizer
G. • Podium with amplifier in-built.
H. • Video Conferencing – High Definition and Screen
I. Architecture of Smart Classroom at Library

3.02 Affordable Components of technology for Smart classroom

A. Document cameras

1. A budget-friendly device that can help to more actively engage students, document cameras allow teachers to display worksheets on a screen or to individual devices much like an old-school lamination projector. Group exercises and quizzes can be displayed with the camera instead of on individual sheets of paper, helping classrooms become more environmentally friendly as well as technologically savvy.

B. SMART boards

1. Interactive whiteboards, or SMART boards, offer a benefit like that of a document camera, but taken up a notch. Presentations are made more robust and given more depth. When a picture or document is displayed on the board, teachers can write on them with an Internet-connected stylus that provides a trove of additional information to the lesson, such as definitions, extra images or accompanying video. Instructors are also able to archive and share any lesson that has used the board, and past lessons can be revisited to reinforce new topics being covered.

C. Cloud-based communication systems

1. One of the most beneficial aspects of adding technology into a classroom environment is its ability to broaden the scope of what students are exposed to on a daily basis. With Internet communication services like voice-over-IP and Web conferencing, teachers can arrange for virtual field trips to places they wouldn't be able to take their classes otherwise. Experts in specific topics can give a talk through Skype and students can collaborate with one another on projects online.

D. Tablets and eBooks

1. Like laptops and smartphones, tablets and e-readers are becoming increasingly popular with students outside of school. Harnessing familiar technology inside the classroom can help to engage students and help them feel more comfortable with the material since it is being presented in a format they are used to. Providing electronic copies of textbooks also allows students to go into the lesson more in depth, as links to additional material can be provided inside the text. Key concept summaries can also be provided at the end of a

section, as well as digital flashcards that cover the lesson plan.

2. All these devices can help teachers and schools greatly improve learning experiences for their students, but all of the benefits offered by the technology would be for nothing if it can't be managed effectively and kept secure.

3.03 Functionality of Smart Classroom Applications

A. The functionalities of Smart Classroom Applications are listed below:

1. For a single student

a. The application suite reminds the student of his/her homework and class schedule based on current time and current location.
b. The application module will synchronize the lecture notes between a student's smart phone and desktop computer before and after class.

2. For instructor/Teaching Assistant

a. The application suite synchronizes the lecture notes between instructor or teaching assistant smart phone and desktop computer before and after class, since desktop computers have the original lecture notes.

3. For student-to-student communication

a. The application suite enables students to exchange and share their documents in drawing.
b. It also enables students synchronize drawing document among their smart phone.

4. For instructor/ Teaching Assistant-to-students communication

a. The application suite distributes teaching material (lecture notes/survey forms/grade sheet/course schedule) from instructor or teaching assistant to all students at proper situations.
b. The instructor can create exams for students and groups by using the application suite.
c. The instructor can also send exams to the students and groups and collect answers; grade and send the grade back to the students by using the application suite.

5. For student-to-instructor/Teaching Assistant communication

a. The application suite facilitates students to store their questions or concerns in text format in their smart phone. When the instructor is available (in classroom), the questions are automatically transferred to the instructor smart phone.
b. Students submit their progress report in a similar way by using the application suite. At the end of a class, their reports are submitted to the instructor automatically.
c. Students make appointments with the instructor using their smart phone to send the request to the instructor's smart phone and get a confirmation using the application suite.
d. Students write answers of the exams and send answers to the instructor using the application suite.
e. Students run and display their homework on the smart phone and project it on the screen with the help of the application suite.

3.04 A typical User Experience Scenario in Smart Classroom

A. ~~**The following is a typical user-experience scenario happened within the Smart Classroom. Multiple persons enter the room through the door. At the door, there is an audiovisual identification module identifying the entering person's identity through facial and voice identification. If the person is identified as lecturer, he is granted the control right of the Smart Classroom. Besides, he takes a badge embedded with location sensor. The visual motion-track module tracks the lecturer's motion in the room. Once he steps into the teaching area, he will be able to use gesture and voice command to**~~

~~exploit the Smart Classroom to give lessons.~~

B. Persons in the Smart Classroom other than lecturer are deemed as local students. When the lecturer is in the teaching area, he can start the class by just saying, “Now let’s start our class.”
C. The Smart Classroom starts Microphone Array Agent to capture and recognize his voice command, and then launches necessary modules such as Virtual Mouse agent, Same View agent. Lecturer loads prepared electronic courseware by utterance like, “Go to Chapter 1 of Multimedia course”. In the meanwhile, The Smart Cameraman Agent was activated to focus on the lecturer Location Receiver Microphone.

3.05 Advantages of Smart classroom

A. **Access to online information:** Technology tools allow learners to easily access a rich database of online resources. Teachers can use the wide variety of online information sources such as knowledge databases, online video and news items to reinforce their lessons. Learners can also quickly access the wide range of powerful tools and resources to conduct.
B. **Allow for connectivity in different location:** Interactive technology tools allow for connectivity in different locations; making ideal collaboration and distance learning environments. When using technology tools, student show to increase student-to-student collaboration and increase overall participation in the lesson.
C. **Better understanding:** It shifts the classroom experience from the sage-on-a-stage approach to a more collaborative environment. With classrooms turning into smart classrooms, students are also getting smarter! Big chunks of paragraphs are being replaced with pie charts, bar graphs and images and the theory “A picture is worth a thousand words” is coming to life.
D. **Countless resources for making learning more fun and effective:** From apps to organizational platforms to e-textbooks and more, there are many amazing tools that can help .Tools will help both students and professors alike collaborate, share ideas, stay organized, and more to get the most out of learning.
E. **Can automate a lot of teaches tedious task:** There are engagement tools like that can automate grading for you and keep track of student performance. Similarly, tools can help him streamline grading for writing assignments, discussions, and participation, and answering common student questions, which otherwise can seem daunting due to their objective nature. The class has instant access to information that can supplement their learning experience.
F. **Change the way of imparting knowledge:** Overall, incorporating technology tools to the classroom environment is likely to change the way teachers impart knowledge to students and at the same time simplify the learning process for students. Students will find it easy to engage with lessons and gain a better understanding of the overall subject concept. It is an ideal tool for any classroom setting. The education field needs technology like this for students, learners, and educators to continue to grow in their field.
G. **Environmentally friendly**: Interactive technology tools are also environmentally friendly. They offer teachers an entirely different way of presenting information to students, which eliminates the need for writing, printing or photocopying. Which contribute to eliminate wastage from over-utilization of paper and ink.
H. **Enhanced teaching/learning experience:** Technology tools provide new ways for teachers to teach, and for student to learn. These tools support a wide variety of learning styles. For instance, visual learners can watch as their tutors use the technology tools to project visual elements, whereas audio learners can listen and have discussions. On the other hand, the Boards come with touch screen capabilities that allow tactile learners to touch and interact with the board.
I. **Increased exposure and wider access to information:** With internet access, students are provided with great exposure as they are given a chance to think and feel outside their bubble. They come in terms with what is happening in the world and perhaps even try to change the wrong. Technology nowadays is not only widely available but also affordable. From apps to e-textbooks to Wikipedia, no matter how far you go, all you need is the internet and information will be available to you and all other potential readers and learners.
J. **Improved student engagement:** Students who hardly raise their hands in class or the back

benchers who are usually sleeping, now look forward to learning something new as these modern age tools are more relatable to them. By fostering discussions and surfacing new and out of the box ideas, technology also helps improve the student- teacher bond.

K. **Interact and share:** The interactive nature of technology tools offers learners an opportunity to share and participate in the instructional process. Interactivity provides a platform for students to demonstrate their grasp of the subject through touching, drawing, and writing. Every learner has an opportunity to participate or contribute to the presentation and discussion.
L. **Low-Maintenance:** Technology tools are neat and easy to use. There are no hassles cleaning or maintaining whiteboards. The data on the screen can be modified using a specialized highlighting tool or pen. There is no need for using unhygienic chalk or marker pens.
M. **Provide rapid assessment:** In addition, the technology tools provide for rapid assessment whereby learners can receive immediate feedback. Teachers and students are able to identify individual strengths and weaknesses in various subject areas and isolate areas/topics that need more focus or review. Thus, smart board helps to increase the involvement of the students in learning.
N. **Provides Flexibility:** Interactive technology tools allow many different forms of media – including photos, illustrations, maps, graphs, games, and video, to be displayed. These tools help to expand the nature of content that can be used in learning. In addition, technology tools make learning to be more dynamic as the different forms of presenting information are readily available.
O. **Students can learn life skills through technology:** Creating presentations, learning to differentiate reliable from unreliable sources on the Internet, maintaining proper online etiquette, and writing emails; these are all vital skills that your students can learn in the classroom and master before graduation.
P. **Technology Integration:** Technology tools allows for integration of various technologies in order to improve the learning experience. For instance, it is possible to attach tools such as microscopes, document cameras, cameras or video cameras to a whiteboard to aid in instruction. It is also possible to integrate the interactive learning tools with a wide range of software applications.
Q. **Teachers can do more experiment in Teaching:** As an academic professional, teachers learn more about how to effectively design and execute a class guided with technology. Whether it's a dramatic change such as teaching with a flipped-classroom, or just adopting a single tool for a specific project or term, he will learn something new in modern academia! Being well-versed in technology can also help build his credibility with students, and even with fellow colleagues.

3.06 Active Teaching Classroom

A. An Active Teaching Classroom supports both traditional teaching pedagogies as well as group breakout learning workstations for students to work together and collaborate in small groups. Features include:

1. Main display to provide focus for the class
2. Smaller breakout displays or mobile video carts for students to share desktops and work together
3. Instructor system to control room systems and display work from breakout sessions on main room display

3.07 Maker Spaces and Special Program Spaces

A. Maker Spaces and Special Program Spaces support STEAM (science, technology, engineering, art and math) programs with both focused and flexible spaces including science labs, music and video production and editing, situational learning and computer programming.
B. In makerspaces, usually set up in schools or libraries, students work collaboratively on projects that encourage using creative solutions to explore areas in **science, technology, engineering, art and math**.
C. "One of the goals of any makerspace should be to instill the maker mindset in students through

a series of creative experiences while simultaneously building 21st-century skills".

D. Makerspaces have revolutionized what school libraries can do. Everything from craft supplies to microcontroller kits to 3D printers have been added to library spaces to allow students to think outside the box and innovate.

3.08 How Makerspace Tools Teach Students Coding Concepts

A. While computer science is usually associated with computer screens and coding programs, makerspaces offer students a chance to **visualize core computer science concepts** through hands-on learning.
B. For example, students can take advantage of Little Bits code kits to practice creating simple programs through Arduino to control Little Bits light sensors and motors.

3.09 Community Areas

A. Community areas in educational designs are an important feature that can inspire team collaboration while giving students a place to recharge and relax.
B. Typical features for community areas include:

1. Flexible and movable furniture and tables which allows the space to be used for multiple purposes
2. Creating unique collaboration spaces such as on or under stairwells, window seats and conversation pits
3. Plenty of electrical outlets and data plugs to accommodate different needs
4. Ceiling-mounted projectors to project presentations and other content when the space is used larger meetings.

3.10 Technology Trends in K12 Education

A. The technologies and products fall into the following categories:

1. Interactive applications and tools
2. Bi-directional team screen sharing
3. Team collaboration tools
4. Wireless presentation mirroring
5. Large-scale digital annotation
6. Multi-touch interaction
7. Immersive technologies and virtual reality
8. Web-based distance education
9. Instructor Tools

3.11 Interactive applications and educator tools

1. Some of resources and interactive applications for educators to use in their classrooms:

a. **Microsoft Educator Community** (https://education.microsoft.com/) – a community for educators to connect and collaborate with others, and find training and lessons
b. **Google** (https://edu.google.com/) – collaborative products and ideas for students and teachers
c. **OpenBoard** (http://openboard.ch/index.en.html) – a free open source interactive whiteboard software
d. **Poll Everywhere** (https://pollev.com/) – a tool to create interactive polling and quick quizzes to see if students are understanding the lesson
e. **WeaveSilk** (http://weavesilk.com/) – more of a fun interactive generative art program for students to try out and creatively explore
f. **Krita** (https://krita.org) – a free digital painting program

3.12 Bi-directional team screen sharing

A. There are new tools available now to leverage and simplify the bi-directional viewing and

sharing of materials in the (active) classroom including network-based streaming appliances such as Crestron's NVX solution. This uses the building's structured data cabling as the signal pathway to facilitate content being viewed at an endpoint. With this concept in mind, it makes re-configuring a classroom to accommodate a different format and team positioning fairly easy as you are working with the data network connections (granted this required a bit more coordination for the institution's IT/network support staff).

3.13 Team collaboration tools

A. Under the team collaboration category, wireless microphone devices for group audio support for both the presenter and students alike. Examples of Assisted Listening System equipment for voice and audio support for the hearing impaired were provided including the Listen Technologies Listen TALK and iDSP solutions and discussed the option for using the student's own personal device supported by ListenWiFi.
B. One of the products was the VoiceLift microphone system from Extron which enable both instructors and students to be heard equally throughout any education space. Wireless microphones can also be used for recording and web collaboration.

3.14 Wireless presentation mirroring

A. For classrooms, the more robust wePresent product from Barco that makes it easy for users to connect and present from any device without any software installation making it ideal for bring-your-own-device environments.

3.15 Large-scale digital annotation

A. Large scale digital annotation is the ability to uses a short throw projector to facilitate interactive sessions displayed on a whiteboard. These whiteboards allow teachers and students to project, illustrate and share their work.

3.16 Multi-touch interaction

A. The Samsung Flip is a portable digital flipchart that can drive more productive and efficient collaboration in a classroom without minimal hassle or setup.
B. Flipcharts have been a staple in classrooms for decades because they enable quick and easy collaboration. While traditional flipcharts can get the job done, they are a clunky and inefficient way to capture and collaborate with information. The Flip is different because any work is captured and digitally stored. Documents can be saved to the cloud, emailed directly from the Flip or printed. Since the Flip is portable, it can be rolled around a classroom and unlike paper flipcharts, it can integrate with PCs, tablets or smartphones using HDMI, USB, screen mirroring, wireless or NFC.

3.17 Immersive technologies and virtual reality

A. Immersive technologies provide enhanced learning environments, augmented physical experiences and virtual field trips using virtual reality (VR). Virtual reality is the umbrella term for anything that has uses immersive multimedia or computer-simulated reality. Other terms used include:

1. Augmented reality (AR) or live direct or indirect views of a physical, real-world environment
2. 360 degree or immersive videos that let users experience real world scenes
3. Virtual reality (VF) is content that is computer-generated content that can either rendered in real-time to make it reactive (like an interactive video game)

B. These technologies are ideally suited to STEAM classes where the technology allows students to experience science in person instead of just reading about it in a book or listening to a lecture.
C. While VR headsets have been coming down in price, there are less expensive ways to go on a "virtual field trip" using a smartphone and cardboard headset, like Google Cardboard. A smartphone and the free Cardboard app (as well as many others that are similar including free

stereoscopic videos and YouTube content) provide many interesting ideas for educators to introduce into the classroom. Information on how to leverage VR tools can be found in this article from the International Society for Technology in Education (ISTE) titled "25 Resources for Bringing AR and VR to the Classroom".

3.18 Web-based distance education

A. There are many different tools on the market for web conferencing and team screen sharing, Zoom which is one of the more popular choices in education. In fact, more than 88% of the top US universities use Zoom for virtual classrooms, online courses and group projects.
B. Beyond providing interaction and collaboration tools for team use, other benefits of web collaboration programs include:

1. Ability to expand the classroom to bring in special presenters or distant classrooms
2. Ability to create "virtual classrooms" or video webinars
3. Facilitating virtual "field trips"
4. Ability to record sessions and support for distance education

3.19 Instructor Tools

A. To make all technology easier to use, the final category provides ways for teachers to manage the equipment and technologies in their classrooms.
B. Controls to connect external devices, switch settings and manage volume

1. Software for proctoring exams and managing classrooms
2. Devices for assistive listening to support requirements under the Americans with Disabilities Act (ADA) including WiFi ALS support using the student's own personal device instead of distinguishing headphone equipment
3. Wall and mobile charging stations for Chromebook, tablets and other computing devices

3.20 Best Practices for Technology Adoption

A. Look for opportunities for integration between technologies, systems and applications
B. Avoid "technology for technology's sake" by looking at the value the technology can provide
C. For learning technologies, we take this view a step further by emphasizing the importance of teacher training and understanding that wide-spread adoption must be managed.
D. From a teacher training standpoint, best practices include:

1. Encourage trials and the use new tools with classes to keep
2. Create a learning classroom concept or "digital sandbox"
3. Develop train-the-trainer programs
4. Give teachers time to learn
5. Measure effectiveness of new tools to ensure that they are producing positive results

E. To maximize instructor adoption, ease of use and operation are key. Other best practices include:

1. Allow instructors to fully understand a technology and help them build it into their teaching methodology
2. Find and nurture technology "champions" who are passionate about actively working with new tools once they have been proven effective.

3.21 Preferred Items:

A. Lighting and Electrical

1. Lighting Zones As a rule, all classroom spaces shall have lighting organized into several zones. These zones can be combined and dimmed to create any number of different lighting scenarios. Classroom lighting should include day lighting, multi-modal lighting, controllability, and optimize energy performance. A room can be zoned based on the amount of day lighting available, with each fixture responding to the amount of light at any

time and location.
Note: Dimensional AV coordination required for any pendant mount solutions in classrooms.

2. Instruction area (front of classroom and lectern area). Design whiteboard and demonstration table lighting to provide visibility when the room lights are at full intensity. The foot candles in this area should be consistent with the overall lighting of the room.
3. Non-projection white board (board that is not obscured by a lowered projection screen). Lighting of white boards during concurrent AV presentations allows instructor to write on the board while in projection, without light bleeding over onto the projected image. Projection white board (board that is obscured by a lowered projection screen) Use the same requirements above during non-projection mode.
4. Instructor workstation. The instructor should be able to read notes and use an-board AV equipment with low-light conditions of projection mode.
5. Isolate emergency light away from the projection screen.
6. The color temperature for all light fixtures should be the same. The color temperature goal is 4000-degree Kelvin.
7. Motion Sensors: Motion sensors are required in all rooms. When installing motion sensors, be sure to set timer to maximum to avoid light shut off during low-motion activities such as test taking.
8. Place wall outlets receptacles on walls of the classrooms at 6’ intervals or as necessary to allow for 30% student utilization.
9. Wall outlet intervals in the lecture halls are not as critical. Follow code to determine the appropriate number.
10. Install one phone jack, two data port and one electrical outlet adjacent to the instructor’s workstation.
11. Install one 2-gang AV wall box (min 2 ½” D) at least 18 inches above the finished floor. Install two 1 ¼” conduit stub-outs above the ceiling Install one AC power quad outlet attached by flexible conduit to a J-box located above the suspended ceiling to allow for the future installation of a data projector. This quad should be sited 12’-15’ from the screen.
12. Provide one single-gang data outlet above the ceiling 12’-15’ from the screen.
13. Provide 120V power capped at a J-box located above the suspended ceiling to allow for the future installation of a low voltage motorized screen controller.
14. Provide floor outlets for every classroom to ensure optimum flexibility. Floor boxes are to accommodate AV, AC power, data. The number of floor outlets is determined by the size of the room, the capacity, and the function.

B. HVAC & Fire Prevention

1. Diffuser Location Diffusers should be located as to avoid any movement of the screens which would be caused by air flow.
2. Location of Above-Ceiling Mechanical Equipment Access to mechanical equipment for the building should not be located within a classroom. Noise Excessive background noise or reverberation in classrooms interferes with speech communication and thus presents an acoustical barrier to learning. In all phases of the classroom design and construction process, careful attention must be paid to acoustics. Locate all mechanical equipment as far from the classroom as possible. If adjacency is unavoidable, provide for sound attenuation methods at doors, light fixtures, and all other ceiling or wall breaches. System components (fans, ductwork & diffusers) shall be selected to meet sound criteria of NC20 to NC25.Fire alarm speaker/Strobes shall be Located away from projection screen to prevent sightline obstructions when screen/flat panel display is extended.

END OF SECTION

SECTION 27 53 00
IP ADDRESSABLE CLOCK AND SPEAKER SYSTEM

PART 1 - GENERAL

1.01 Introduction

A. When safety is a top priority, making sure emergency messages can be heard clearly is a critical component of any mass notification plan. IP speakers help organizations around the world broadcast these messages through live and recorded audio. Additional visual assets that accompany these speakers make messages even more noticeable. However, with such a large variety of speakers to choose from, it can be difficult to know which is the best fit.

B. Singlewire Software has compiled this IP speaker guide to help organizations find the right tools for a variety of use cases. Whether you work in manufacturing, K12 or somewhere in be- tween, this guide will help direct you in the right direction for your environment and needs.

C. Each section also includes a speaker Singlewire has deemed the best for that particular use case. Winners were selected based on information provided by the vendor, feedback from InformaCast customers, and the expertise of members of the Singlewire team.

Note: Pricing is listed as provided by the vendor and is subject to change.

PART 2 - CONNECTING IP SPEAKERS WITH INFORMACAST

2.01 PRODUCTS

A. Every speaker listed in this guide is compatible with InformaCast emergency notification software. InformaCast Advanced and InformaCast Fusuion reach on-premises devices with emergency messages that can help keep people out of harm's way in the case of severe weather, active shooters, and other crisis scenarios. Learn how InformaCast can help your organization build a robust notification ecosystem that delivers the speed and reach necessary to keep everyone safe and informed at www.singlewire.com/informacast.

B. The IP speakers from our ecosystem partners best suited for manufacturing facilities are listed below. Consult the chart to see how each compares, and read through for more details on each speaker's capabilities.

	Advanced Network Devices	AtlasIED	CyberData	Digital Acoustics	2N	Valcom	Wahsega Labs
Withstand a hose hit?	Yes	No	No	Yes	Yes	Yes	No
Produce loud audio to be heard over machinery?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Include strobes for visual alerting?	Yes	Yes	No	No	No	No	No
Include lights for visual alerting?	Yes	Yes	No	No	No	No	No
Include scrolling text for visual alerting?	Yes	Yes	No	No	No	No	No
Operate at extreme temperatures?	Yes	Yes	Yes	Yes	Yes	Yes	Yes

2.02 ADVANCED NETWORK DEVICES

A. Recommended Models: IPSWS-SM-O (speaker only) or IPSWD-RWB (for display).

Withstand a hose hit?	Yes
Produce loud audio to be heard over machinery?	Yes

Include strobes for visual alerting?	Yes
Include lights for visual alerting?	Yes
Include scrolling text for visual alerting?	Yes
Operate at extreme temperatures?	Yes



B. Additional Details/Notes: IPSWS-SM-O has an IP54 rating for “hose hit,” and the AND-STROBE-KIT-1 can be added to support “strobes for visual alerting.” The IPSWD-RWB includes a red, white and blue LED flashers for “lights for visual alerting.” These speakers support an operating temperature range of -10 to 55 C. They also include GPIO which enables connection to manufacturing sensors/peripherals.

C. It can be difficult to get a message across outdoors. IP speakers need to be able to withstand the elements and broadcast loudly, so messages are heard by everyone. The IP speakers from our ecosystem partners best suited for outdoor use are listed below. Consult the chart to see how each compare and read through for more details on each speaker’s capabilities.

	Advanced Network Devices	AtlasIED	Cyber Data	Digital Acoustics	2N	Valcom	Wahsega Labs
Can this speaker withstand harsh weather conditions, including extreme cold and heavy rain?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Produce loud audio to be heard in loud conditions, such as thunderstorms or high winds?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Withstand tampering and potential vandalism?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Provide visual alerts, as well as audio?	Yes	No	No	Yes	No	No	No

2.03 ADVANCED NETWORK DEVICES

A. Recommended Models: IPSWS-SM-O (speaker only) or IPSIGN-O (display only)

Can this speaker withstand harsh weather conditions, including extreme cold and heavy rain?	Yes
Produce loud audio to be heard in loud conditions, such as thunderstorms or high winds?	Yes
Withstand tampering and potential vandalism?	Yes
Provide visual alerts, as well as audio?	Yes



B. Additional Details/Notes: IPSWS-SM-O is IP54 and IPSIGN-O is also designed for outdoor use; IPSWS-SM-O can produce loud audio. IPSWS-SM-O can withstand vandalism if equipped with tamper-proof screws. IP- SIGN-O provides visual alerts with to 400 feet; IPSWS-SM-O provides audible alerts.

2.04 ATLAS IED

A. Recommended Models: IHVP+

Can this speaker withstand harsh weather	Yes

conditions, including extreme cold and heavy rain?	
Produce loud audio to be heard in loud conditions, such as thunderstorms or high winds?	Yes
Withstand tampering and potential vandalism?	Yes
Provide visual alerts, as well as audio?	Yes



B. Additional Details/Notes: This IP endpoint comes with a horn instead of speaker driver. It is waterproof, weatherproof, and vandal proof.

2.05 CYBERDATA

A. Recommended Models: 011407 or 011406 with attached horns 011068

Can this speaker withstand harsh weather conditions, including extreme cold and heavy rain?	Yes
Produce loud audio to be heard in loud conditions, such as thunderstorms or high winds?	Yes
Withstand tampering and potential vandalism?	Yes
Provide visual alerts, as well as audio?	No



B. Additional Details/Notes:The 011407 can handle two horns capable of covering 10,000 square feet. The horns can be mounted in any direction. The speaker software does not reside in the horns, so if a horn becomes damaged, it can be easily replaced for $60. Visual alerting is also available with the addition of the IP Strobe Kit 011288 which is sold separately.

2.06 DIGITAL ACOUSTICS

A. Recommended Models: SPKR-IPSystem-1-VP-HD-IC

Can this speaker withstand harsh weather conditions, including extreme cold and heavy rain?	Yes
Produce loud audio to be heard in loud conditions, such as thunderstorms or high winds?	Yes
Withstand tampering and potential vandalism?	Yes
Provide visual alerts, as well as audio?	Yes



B. Additional Details/Notes: More information is available at https://www.digitalacoustics.com/product/wall-mount-ip-speaker/.

C. Price Range: See the “Purchasing” section for more information

2.07 2N

A. Recommended Models: 2N IP Verso

Can this speaker withstand harsh weather conditions, including extreme cold and heavy rain?	Yes
Produce loud audio to be heard in loud conditions, such as thunderstorms or high winds?	Yes
Withstand tampering and potential vandalism?	Yes
Provide visual alerts, as well as audio?	No



B. Additional Details/Notes: SIP speaker - IP67, SPLmax 124dB, relay for connection of strobe, -30°C ~ +60°C IP Force - IP69, 10W (94dB) speaker, outputs for strobes and lights, -40°C – 70°C. The same for Horn and Force, IP Verso - IP54, modular system, HD cam, -40°C – 70°C, IK8 ... IP Force - IK10

2.08 VALCOM

A. Recommended Models: SPKR-IPSystem-1-VP-HD-IC

Can this speaker withstand harsh weather conditions, including extreme cold and heavy rain?	Yes
Produce loud audio to be heard in loud conditions, such as thunderstorms or high winds?	Yes
Withstand tampering and potential vandalism?	Yes
Provide visual alerts, as well as audio?	No





B. Additional Details/Notes: Add V-WG-Horn-2 for vandal resistant housing. Optional visual alerts available with VIP-999.

2.09 WAHSEGA LAB

A. Recommended Models:

Can this speaker withstand harsh weather conditions, including extreme cold and heavy rain?	Yes
Produce loud audio to be heard in loud conditions, such as thunderstorms or high winds?	Yes
Withstand tampering and potential vandalism?	Yes
Provide visual alerts, as well as audio?	No



B. Additional Details/Notes: Industrial temp range -40°C to +85°C, IP65 rating, can use analog horn speaker for increased decibel levels, superior talk-back capability, call button and built-in

microphone.

PART 3 - CLASSROOM IP SPEAKERS

3.01 PRODUCTS

A. Overcoming classroom noise can be a challenge but having the right IP speaker can make all the difference. The IP speakers from our ecosystem partners best suited for classroom use are listed below. Consult the chart to see how each compares and read through for more details on each speaker's capabilities.

	Advanced Network Devices	AtlasIED	CyberData	Digital Acoustics	2N	Valcom	Wahsega Labs
Can this speaker be heard in noisy classrooms?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Be used for hands-free inter-com?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Include scrolling text?	Yes	Yes	No	No	No	No	No
Provide the time?	Yes	Yes	Yes	No	No	Yes	No

3.02 ADVANCED NETWORK DEVICES

A. Recommended Models: IPSWD-RWB

Can this speaker be heard in noisy classrooms?	Yes
Be used for hands-free intercom?	Yes
Include scrolling text?	Yes
Provide the time?	Yes



B. Additional Details/Notes: This speaker can act as master clock for an analog clock array and has a built-in microphone for two-way communication. It also includes line in for voice reinforcement.

3.03 ATLAS IED

A. Recommended Models: I8SCMF+

Can this speaker be heard in noisy classrooms?	Yes
Be used for hands-free intercom?	Yes
Include scrolling text?	Yes
Provide the time?	Yes



B. Additional Details/Notes: Additional information is available at https://www.atlasied.com/i8scmfplus. Price Range: $700-$1,300 (contact Atlas IED for more information)

3.04 CYBERDATA

A. Recommended Models: 011399 (or 011400) with 011153 (or 011154) and 011185. Visual: 011288

Can this speaker be heard in noisy classrooms?	Yes

Be used for hands-free intercom?	Yes
Include scrolling text?	No
Provide the time?	Yes



3.05 DIGITAL ACOUSTICS

A. Recommended Models: SPKR-IP-CS-IC

Can this speaker be heard in noisy classrooms?	Yes
Be used for hands-free intercom?	Yes
Include scrolling text?	No
Provide the time?	No



B. Additional Details/Notes: This speaker also accommodates easy ceiling tile lay-in.

3.06 2N

A. Recommended Models: SIP speaker Horn, SIP speaker, any IP intercom



Can this speaker be heard in noisy classrooms?	Yes
Be used for hands-free intercom?	Yes
Include scrolling text?	No
Provide the time?	No

B. Additional Details/Notes: This speaker can be used in combination with 2N Audio manager to make announcements to specific zones.

3.07 VALCOM

A. Recommended Models: VIP-431A-DS-IC Surface Mount Wall Speaker with Digital Clock

Can this speaker be heard in noisy classrooms?	Yes
Be used for hands-free intercom?	Yes
Include scrolling text?	No
Provide the time?	Yes

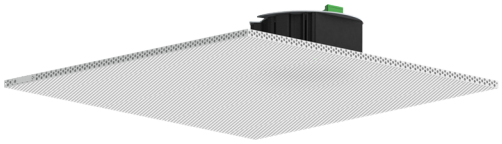


B. Additional Details/Notes: For visual scrolling text with this speaker, add the optional VL530A-IC.

3.08 WAHSEGA LABS

A. Recommended Models: Wahsega 2x2 Ceiling IP Speaker with InformaCast

Can this speaker be heard in noisy classrooms?	Yes
Be used for hands-free intercom?	Yes
Include scrolling text?	No
Provide the time?	No



B. Additional Details/Notes: This speaker supports two independent speakers using one PoE run, Call/Panic button, sound reinforcement panel, and two relays for classroom lockdown.

PART 4 - TWO SIDED SPEAKERS

4.01 PRODUCTS

A. Two sided speakers can help amplify a message and help communicate in areas with excess noise, like school hallways. The best two-sided IP speakers are listed below. CyberData, 2N and Wahsega did not submit speakers for consideration in this category. Consult the chart to see how each compares, and read through for more details on each speaker's capabilities.

	Advanced Network Devices	AtlasIED	CyberData	Digital Acoustics	2N	Valcom	Wahsega Labs
Can this speaker provide the time?	Yes	Yes	N/A	No	N/A	No	N/A
Include scrolling text on each side?	Yes	Yes	N/A	No	N/A	No	N/A
Be heard in noisy environments?	Yes	Yes	N/A	Yes	N/A	Yes	N/A

4.02 ADVANCED NETWORK DEVICES

A. Recommended Models: IPCDS-RWB

Can this speaker provide the time?	Yes
Include scrolling text on each side?	Yes
Be heard in noisy environments?	Yes



B. Additional Details/Notes: This speaker provides time with "digital" clocks, and includes an integrated wall mount bracket.

4.03 ATLAS IED

A. Recommended Models: IPDSC-DSE+

Can this speaker provide the time?	Yes
Include scrolling text on each side?	Yes
Be heard in noisy environments?	Yes



B. Additional Details/Notes: More information is available at https://www.atlasied.com/ipdsc-dseplus.

4.04 DIGITAL ACOUSTICS

A. Recommended Models: SPKR-IP11-BD-P



Can this speaker provide the time?	No
Include scrolling text on each side?	No
Be heard in noisy environments?	Yes

B. Additional Details/Notes: This speaker includes a powerful 8-watt integrated amplifier and dual 4" speaker cones.

4.05 VALCOM

A. Recommended Models: VIP-9815AL-IC



Can this speaker provide the time?	No
Include scrolling text on each side?	No
Be heard in noisy environments?	Yes

B. Additional Details/Notes: Scrolling text and digital analog clocks are optional add-ons.

PART 5 - SPEAKERS WITH DISPLAY

5.01 PRODUCTS

A. Visual elements can help communicate messages and provide additional details. The IP speakers from our ecosystem partners that include large sign boards are listed below. CyberData, Digital Acoustics and Wahsega Labs did not submit speakers for consideration in this category. Consult the chart to see how each compares, and read through for more details on each speaker's capabilities.

	Advanced Network Devices	AtlasIED	CyberData	Digital Acoustics	2N	Valcom	Wahsega Labs
Can this speaker provide the time?	Yes	Yes	N/A	N/A	No	Yes	N/A
Include text that can be seen from a distance?	Yes	Yes	N/A	N/A	No	Yes	N/A
Be heard in noisy environments?	Yes	Yes	N/A	N/A	Yes	Yes	N/A

5.02 ADVANCED NETWORK DEVICES

A. Recommended Models: IPSIGNL-RWB

Can this speaker provide the time?	Yes
Include text that can be seen from a distance?	Yes
Be heard in noisy environments?	Yes



B. Additional Details/Notes: Text can be seen from up to 150 feet away. This speaker includes high quality stainless steel front baffle, multi-color display and high visibility LED flashers.

5.03 ATLAS IED

A. Recommended Models: I8SCMF+



Can this speaker provide the time?	Yes
Include text that can be seen from a distance?	Yes
Be heard in noisy environments?	Yes

B. Additional Details/Notes: This speaker has the largest display available from Atlas IED.

5.04 2N

A. Recommended Models: SIP speaker horn



Can this speaker provide the time?	No
Include scrolling text on each side?	No
Be heard in noisy environments?	Yes

B. Additional Details/Notes: 2N claims this is the most powerful speaker on the market.

5.05 VALCOM

A. Recommended Models: VL550AF-IC



Can this speaker provide the time?	Yes
Include scrolling text on each side?	Yes
Be heard in noisy environments?	Yes

B. Additional Details/Notes: More information is available at http://www.valcom.com/products/enhance- ments_ts/digital-signage.htm.

PART 6 - IP SPEAKERS

6.01 PRODUCTS

A. Visual elements can help communicate messages and provide additional details. The IP speakers from our ecosystem partners that include large sign boards are listed below. CyberData, Digital Acoustics and Wahsega Labs did not submit speakers for consideration in this category. Read through for more details on each speaker's capabilities.

6.02 ADVANCED NETWORK DEVICES

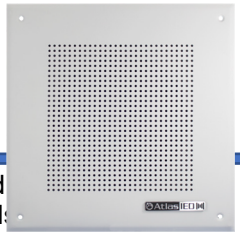
A. Recommended Models: IPSCM-RM

B. Additional Details/Notes: IPSCM-RM ships with two speakers and IP speaker, and a non-IP speaker that connects to the IP speaker.



6.03 ATLAS IED

A. Recommended Models: I8S+



B. Additional Details/Notes: More information is available at https://www.atlasied.com/i8splus.

C. Price Range: $390

6.04 CYBERDATA

A. Recommended Models: 11395 (IP) or 011120 (analog)

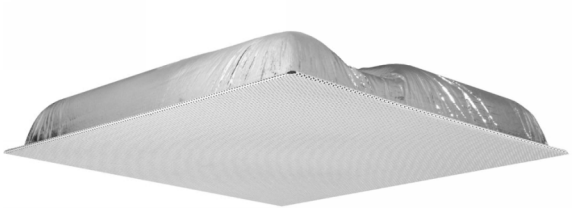


B. Additional Details/Notes: The analog speaker can double the sound output for only $50 more.

PART 7 - DIGITAL ACOUSTICS

7.01 Lower Cost IP Speakers

A. Recommended Models: SPKR-IP-CS-IC



B. Additional Details/Notes: Tile lay in cuts down on installation time.

C. Price Range: $389 for the speaker, add $25 for InformaCast

7.02 2N

A. Recommended Models: 2N SIP audio converter Additional Details/Notes: This is only a converter



B. Price Range: See the “Purchasing” section for more information

7.03 VALCOM

A. Recommended Models: VIP-120A-IC 8” Round Ceiling Speaker



B. Additional Details/Notes: More information is available at http://www.valcom.com/products/speaker_ts/ceilspkr.htm.

7.04 WAHSEGA LABS

A. Recommended Models: SIP Alerter IP Speaker



B. Additional Details/Notes: Easy mounting, call button, mic, relay for classroom lockdown, small form factor, supports external analog horn speaker for increased decibel levels.

PART 8 - COMBINING SOUND AND VISUAL

8.01 PRODUCTS

A. Combining sound and visual elements help make alerts more effective. The IP speakers from our ecosystem partners that include visual alerting are listed below. Digital Acoustics, Wahsega Labs and 2N did not submit speakers for consideration in this category. Consult the chart to see how each compares and read through for more details on each speaker's capabilities.

	Advanced Network Devices	AtlasIED	CyberData	Digital Acoustics	2N	Valcom	Wahsega Labs
Can this speaker alert people with strobes and/or lights?	Yes	Yes	Yes	N/A	N/A	Yes	N/A
Includes scrolling or static text?	Yes	Yes	No	N/A	N/A	No	N/A

8.02 ADVANCED NETWORK DEVICES

A. Recommended Models: IPCSL-W-RWB

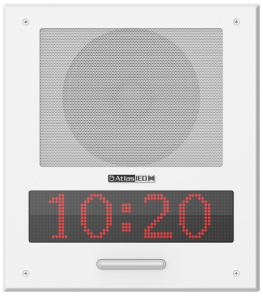


Can this speaker alert people with strobes and/or lights?	Yes
Includes scrolling or static text?	Yes

B. Additional Details/Notes: White display visible up to 300 feet...

8.03 ATLAS IED

A. Recommended Models: I8SCMF+



Can this speaker alert people with strobes and/or lights?	Yes
Includes scrolling or static text?	Yes

B. Additional Details/Notes: More information is available at https://www.atlasied.com/i8scmfplus.

8.04 CYBERDATA

A. Recommended Models: 011288 Auxiliary RGB Strobe Kit

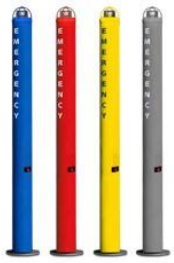


Can this speaker alert people with strobes and/or lights?	Yes
Includes scrolling or static text?	No

B. Additional Details/Notes: Powerful 8-watt integrated amplifier, dual 4” speaker cones

8.05 VALCOM

A. Recommended Models: VE9811-IC



Can this speaker alert people with strobes and/or lights?	Yes
Includes scrolling or static text?	No

B. Additional Details/Notes: Scrolling text and digital analog clocks are optional add-ons.

PART 9 - INFORMACAST SUPPORT

9.01 PRODUCTS

A. Any type of device installation can pose it’s challenges, so it’s important to choose a vendor that offers sufficient support resources to help troubleshoot and resolve issues. Support resources provided by each of the vendors are listed below.

9.02 ADVANCED NETWORK DEVICES

A. Timely support is offered via phone, email and web conference. A Singlewire support page and downloadable app notes are available on the Advanced Network Devices website. For issues regarding multicast and SLP, users can expect friendly support via phone, email and web conference through issue resolution.



B. Visit: http://www.anetdsupport.com

9.03 ATLAS IED

A. Full time support staff is available for remote help to configure IP endpoints and is very familiar with In- formacast. They can help troubleshoot hardware and software and connect to

call manager platforms. Support documentation for configuring AtlasIED speakers for InformaCast is available from their customer service staff and the AtlasIED website.

B. Visit: https://www.atlasied.com/support

9.04 CYBERDATA

A. Free tech support is available for CyberData customers. All product pages have a “downloads” tab that house the Operations Guide for each product. Customers can interact with a staff that offers more than ten years of industry expertise.

B. Visit: http://support.cyberdata.net/

9.05 DIGITAL ACOUSTICS

A. Speakers come with a two-year warranty, and tech support is available via phone or email from 8 a.m.–4 p.m. CST via phone or email. Support for InformaCast integration is available here. Their knowledgeable network professionals will be able to directly assist or point customers in the right direction.

B. Visit: https://www.digitalacoustics.com/support/

9.06 2N

A. Direct support is available via email and phone for signed partners, and any customer has access to LiveChat on the company website. Support for InformaCast is described in the configuration manual. Evaluation and support is offered for issues dealing with multicast and SLP.

B. Visit: wiki.2n.cz

9.07 VALCOM

A. U.S.-based technical support is offered 24/7 every day of the year. Free CAD speaker layout is available, and InformaCast configuration details are included with each speaker’s packaging or on the Valcom website.

B. Direct support for issues regarding multicast of SLP is available from the technical support group at 1-540- 563-2000.

C. Visit: http://www.valcom.com/InformaCast/default.htm

9.08 WAHSEGA

A. Direct U.S.-based technical support is by phone, email and Webex. InformaCast configuration details are listed under “Documentation” on the company website. For issues regarding multicast and SLP, Valcom will run through a series of troubleshooting steps to diagnose where the problem originates, analyze packet captures and syslogs, screen share to help solve issue and include Wahsega networking experts on staff to find a resolution.

B. Contact: support@wahsega.com

PART 10 - PURCHASING INFORMATION

Organizations interested in purchasing any of the IP speakers listed in this guide can visit the links listed below for details and contact information.

10.01 ADVANCED NETWORK DEVICES

A. Visit https://www.anetd.com/where-to-purchase/ for information on where to purchase AND speakers.

10.02 ATLAS IED

A. Visit https://www.atlasied.com/RepMap to contact your local sales rep for a quote.

10.03 CYBERDATA

A. Visit http://www.cyberdata.net/where-to-buy-distributors/ for information on where to purchase CyberData speakers.

10.04 DIGITAL ACOUSTICS

A. Visit https://www.digitalacoustics.com/where-to-buy/ for information on where to purchase Digital Acoustics speakers.

10.05 2N

A. Visit https://www.2nusa.com/en_US/how-to-buy for information on how to purchase 2N speakers.

10.06 VALCOM

A. Visit https://www.valcom.com/about_us/distributors.html for information on where to purchase Valcom speakers.

10.07 WAHSEGA

A. Visit https://www.wahsega.com/ to buy speakers direct from Wahsega Labs.

END OF SECTION

SECTION 28 01 00

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. As many school administrators struggle to learn about drug trafficking trends, gang identification, stranger danger, climates of bullying and the prevention of aggressive and the prevalence of violent behavior, even newer challenges have arrived at the schoolhouse doorway. Concealed weapons, homemade bombs, anthrax scares and other "new crimes for new times" now present school administrators with the formidable task of developing security and crisis preparedness guidelines at both building and district levels.

B. In addition to these "traditional" security threats, recent shifts in school violence in even the safest of schools and communities, school administrators, educators, and officials realize that "it could happen here." The community (including staff members, students, parents, politicians, lawyers, and the media) will want to know what has done to prevent these things from happening.

C. Compton Unified School District is located in in the south-central region of Los Angeles County, California. CUSD encompasses the city of Compton and portions of the cities of Carson and Los Angeles. The district currently serves nearly 26,000 students at 36 sites and is in the midst of a dramatic turnaround, marked by increases in student achievement rates, a graduation rate nearing 90%, dramatic facilities improvements, and a focus on STEAM throughout all schools.

D. System Integrator/Contractor shall include all licensing fees for Cameras and access control system’s Hardware and Software requirements. The Hardware and software upgrades, licensing fees and system maintenance shall be included for a 3-year period after substantial completion and acceptance by district. Provide annual licensing fees and software upgrades after the expiration of initial contract period to district as part of closeout documentation.

1.02 CUSD MISSION STATEMENT

A. The mission of the Compton Unified School District is to empower leaders to lead, teachers to teach and students to learn by fostering an environment that encourages leaders and teachers to be visionary, innovative and accountable for the achievement of all students.

1.03 CUSD GOALS

A. Promote a safe and healthy environment in every school.

B. Provide equal education for every child.

C. Ensure that every child has access to technological opportunities.

D. Continue to maintain high expectations and high student achievement and hold personnel accountable for student success.

E. Improve team efforts by enhancing employee communications and collaboration.

F. Embrace and celebrate the diversity of our district.

G. Build, foster and promote partnerships with parents and the community.

H. Maintain facilities; plan and promote capital improvements.

1.04 CUSD CORE BELIEFS

A. CUSD believes all children will learn at higher levels.

B. CUSD believes schools have an enormous impact on children's lives.

C. CUSD believes that all children shall be educated in a safe and orderly environment.

D. CUSD believes all children will reach their learning potential and that the achievement gap can be eliminated.

E. CUSD believes the District will become a high performing organization.

1.05 OVERVIEW PROPOSED SAFETY TECHNOLOGY STANDARDS

A. CUSD has committed to designing and deploying an integrated, enterprise class,

B. IT Centric Security System district wide. This document will provide definition and engineering standards/requirements for the requested solution platform. From a high level, the features and benefits of the proposed system incorporate the following:

Understanding the Requirements	**Threat Vectors:** What are the general and specific threats? For example, if a shooter is present on the site, the physical security system provides real-time situational awareness and containment. **Vulnerabilities:** What are the vulnerabilities against the threat? Vulnerabilities are driven by the value and the nature of the protected subject. **Value of Asset(s):** What is the value of the thing that needs protection? The value of life is impossible to determine but the gold in Fort Knox has a set value. **Impact of Failure:** If the physical security system fails, how does this impact mission success, preservation of life or property, and so on?
Manageable Costs	**For the Decision Maker:** The most important cost is proven/expected security – what will the security system keep out and what undesired intrusions may slip through? **For the Workers Staff:** (those inside the building) They prefer a combination of what is least cumbersome in operation and what degrades their work efficiency the least – how much will these extra security measures and reviews slow down, interrupt, or obstruct my work?

	For the Security Officer: He or she is likely focused on efficiency – how can we succeed without adding too many additional staff members, which drives up cost? **For Visitors:** (such as vendors delivering products to the compound)
Ease of Installation and Maintenance	Installing and maintaining an integrated physical security system can introduce multiple layers of complexity and hidden costs for an organization. Network centric technologies for automatic management, optimization, and operational status reporting are critical components to assure availability of these critical systems. A critical factor is ongoing maintenance and support that is provided directly by the manufacturer to protect the interest of customer.
Flexibility and Scalability	CUSD's diverse environment is continually evolving, expanding, and adapting to the needs of the community. This means the security system must also be capable of extensibility, repositioning, and resizing. As you add areas – or even areas within areas – of protection, the redesign and rebuild of the control system can be extremely time consuming and difficult. All systems considered support planning and accommodating growth, giving customers room to grow in size and specificity.

C. Cisco Systems connected safety and security suite addresses the above criteria and offers the benefit of the comprehensive solution from end to end, for both product and maintenance and support.

D. Following are further details on the recommendations:

1.06 Access Control – Cisco Identiv Connected Physical Access Manager (IICPAM)

A. Identiv and Cisco have joined forces to deliver a low-cost, intelligent access control solution, leveraging existing Cisco networks to allow monitoring and information exchange between devices. IICPAM tightly integrates with Cisco's suite of Connected Safety and Security products and features support for our award-winning Hirsch Mx Controllers. It can configure controllers and readers, monitor activity, enroll users, create identification badges, and integrate with security and IT applications and data stores.

1.07 CCTV / Video Management System - Cisco Video Surveillance Manager

A. Traditionally, video surveillance cameras were connected to a separate network, increasing costs and restricting viewing of video feeds to consoles connected to the same network. More recently, organizations have begun connecting their cameras to their existing IP network. This is part of a global trend called the Internet of Everything, referring to burgeoning connections between people, process, data, and things, including video surveillance cameras and physical access controllers.

B. The Internet of Everything is transforming safety and security operations. For example, situational awareness improves because mobile personnel can receive alerts and view video from anywhere, on any device, including tablets and smartphones. In addition, you can automate response to events by integrating different safety and security systems connected to the same network—for example, by capturing video in response to gunshots or an opening

door.

C. To capitalize on the potential of the Internet of Everything for video surveillance, the district will need:

D. A secure architecture that can adapt to evolving business needs. This might include adding many more cameras, capturing high-resolution video to enable facial recognition, or storing video from vehicle mounted cameras on the cameras themselves when the vehicle loses connectivity. Today, supporting requirements like these typically requires costly efforts such as rebuilding the infrastructure or replacing cameras.

E. Automated processes to minimize management overhead. The challenge is not simply making the deployment work, but making it work with your existing resources. Adding ten times more cameras is not economically feasible if it requires ten times more staff

F. Simplified troubleshooting and remediation. To maintain high video quality, the IT team needs to find out about quality issues without having to wait for user reports and needs easy-to-use tools to quickly pinpoint and remediate the source of the issue. Cisco Video Surveillance Manager meets these requirements. It works with analog and digital cameras from any vendor and provides even more advantages when used with Cisco Video Surveillance IP Cameras.

1.08 Network Video Storage

A. **Cisco Unified Compute Servers (UCS)** The Cisco UCS C220 and C240 M5 Rack Servers deliver superior performance for deploying and managing Cisco Video Surveillance Manager. The Connected Safety and Security Unified Computing System combines performance and density for deploying and managing Cisco Video Surveillance Manager.

B. Cisco Connected Safety and Security Cisco UCS includes a suite of two server models and a wide array of features in a single, easy-to-use, and easy-to-deploy configuration.

C. The Cisco Connected Safety and Security Cisco UCS C220 model (KIN-UCSM5-1RU-K9) is an enterprise-class server in a one-rack unit (1RU) form factor with a single Intel Xeon 4114 processor that delivers significant performance and efficiency. It supports 16 GB of memory and four 3.5-inch drives for up to 40TB storage capacity in a compact 1RU package. The KIN-UCSM5-1RU-K9 delivers a total Media Server throughput of 200Mbps.

D. The Cisco Connected Safety and Security Cisco UCS C240 model (KIN-UCSM5-2RU-K9) is an enterprise-class server in a 2RU form factor with dual Intel Xeon 4114 processors that delivers significant performance and efficiency. It supports up to 64 GB of memory and a maximum of 120 TB with twelve 3.5-inch drives for security video storage. The KIN-UCSM5-2RU-K9 delivers a total Media Server throughput of 385Mbps.

PART 2 - ADDITIONAL INTEGRATED TECHNOLOGY FEATURES

2.01 The technology selection criteria for the chosen systems are briefly outlined as follows:

2.02 Access Control – (Cisco)

A. Universal open source operating system solution

B. Leverages existing door wiring and locking hardware (all systems may require additional cabling)

C. Components and endpoints are PoE addressable network nodes and are incorporated into IT infrastructure visibility and management.

D. No additional licensing or integration costs for Video Management System

E. COTS support for VMS integration

F. Utilizes all Wiegand standard existing readers, locking hardware, and other low voltage components

G. VM or Appliance Based Server Application can be integrated

H. Robust client (mobile) support available

I. Robust customer support from well-established company with many reference able accounts

J. Direct support from Manufacturer

2.03 Video Management System (Cisco):

A. Universal open source solution & the only true Network solution

B. Direct to end-user warranty support and service

C. Media Net enabled auto configuration and advanced administration

D. Simplified deployment – appliance-based server (no Microsoft OS with 3rd party application)

E. Single Manufacturer

F. Reduced licensing costs

G. Compatible with proposed storage area network as well as internal storage options

2.04 Video Recording Storage Solution (Cisco):

1. Unified Compute Servers (UCS) with internal storage (up to 48TB raw) to support distributed and secure access with fail-over capabilities surveillance video data.
2. UCS servers offer performance and density for deploying and managing Cisco Video Surveillance Manager Installations and are fully warranted and covered by technical assistance and SmartNet.
3. For this project we recommend the CSS UCS C240. It is an enterprise-class server in a two-rack unit (2-RU) form factor with dual Intel Xeon E5-2600 series processors.
4. Each server supports up to twelve 3.5-inch drives for storage expandability and performance.

PART 3 - STANDARDIZED CUSD PRODUCTS LIST

NOTE – MUST REVIEW WITH MANUFACTURER FOR ALL PRODUCT SKUs AS THEY ARE SUBJECT TO CHANGE ANNUALLY

3.01 VIDEO SURVEILLANCE ITEMS	
Cisco Video Surveillance Manager & Media Servers	
CIVS-IPC-8020=	Interior Cisco Video Surveillance IP Camera, Indoor 5MP H.265 Dome Body with IR plus clear dome.
CON-SSSNT-CIVS8020	SOLN SUPP 8X5XNBD 5MP H265 Indoor Dome Camera
CIVS-IPC-8020-S	Interior Cisco Video Surveillance IP Camera, Indoor 5MP H.265 Dome Body with IR plus smoke dome.
CON-SSSNT-CIVS802S	SOLN SUPP 8X5XNBD Cisco Video Surveillance IP Camera, 5 MP
CIVS-IPC-8030=	Exterior Video Surveillance IP Camera, 5MP H.265 Dome Body with IR plus clear vandal resistant dome.
CON-SSSNT-CIVS8IPC	SOLN SUPP 8X5XNBD Cisco Video Surveillance IP Camera, 5MP
CIVS-IPC-8030-S	Exterior Video Surveillance IP Camera, 5MP H.265 Dome Body with IR plus smoke vandal resistant dome.
CON-SSSNT-CIVPC803	SOLN SUPP 8X5XNBD Cisco Video Surveillance IP Camera, 5MP
CIVS-IPC-8620=	Interior Cisco Video Surveillance IP Camera, Indoor HD H.265 WDR Dome Body with IR plus clear dome.
CON-SSSNT-CIVSIP86	SOLN SUPP 8X5XNBD Cisco Dome IP Camera, Indoor, 1080p, Dom
CIVS-IPC-8620-S	Interior Cisco Video Surveillance IP Camera, Indoor HD H.265 WDR Dome Body with IR plus smoke dome.
CON-SSSNT-CIVSI862	SOLN SUPP 8X5XNBD Cisco Dome IP Camera, Indoor, HD, H.265
CIVS-IPC-8630=	Exterior Cisco Video Surveillance IP Camera, HD H.265 WDR Dome Body with IR plus clear vandal resistant dome.
CON-SSSNT-CIVSIPV0	SOLN SUPP 8X5XNBD Cisco Dome IP Camera, Outdoor, 1080p Dom
CIVS-IPC-8630-S	Exterior Cisco Video Surveillance IP Camera, HD H.265 WDR Dome Body with IR plus smoke vandal resistant dome.
CON-SSSNT-CIVIP863	SOLN SUPP 8X5XNBD Cisco Video Surveillance Camera, Outdoor
CIVS-IPC-8000P	Box Style camera with 4.1-9 mm lens. 5MP H.265
CON-SSSNT-CIVS8000	SOLN SUPP 8X5XNBD 5MP H265 Box Camera
CIVS-IPCA-VCM4.1-9	LENS,DV2.2x4.1SR4A-SA2L,FUJINON

CON-SSSNT-CIVSIPC9	SOLN SUPP 8X5XNBD LENS,DV2.2x4.1SR4A-SA2L,FUJINON
CIVS-IPC-8400=	Bullet Style camera with IR 5MP H.265, IK10
CON-SSSNT-CIVS4IPC	SOLN SUPP 8X5XNBD Cisco Video Surveillance IP Camera, 5MP
CIVS-IPC-8070=	Indoor/Outdoor 360 degree camera, 12MP H.265, with IR
CON-SSSNT-CIVSI807	SOLN SUPP 8X5XNBD Cisco 12MP Fisheye Camera
CIVS-IPC-8930=	PTZ camera with 30X optical zoom, 250 meter IR, IK10 Includes wall mount arm, no power supply
CON-SSSNT-CIVSI930	SOLN SUPP 8X5XNBD Cisco Video Surveillance HD Outdoor IP P
Additional Cisco Camera Accessories	As required per plans & specifications, must be Cisco SKU
CIVS-8KA-MOUNT	Mount for 8000 series cameras
CIVS-8KA-EXT=	Pendant Pipe (40cm)
CIVS-8KA-POLEMNT	Pole Mount for 8000 series cameras
CIVS-8KA-CORMNT	Corner Mount for 8000 series cameras
CIVS-8KA-JBOX	Junction box
CIVS-8KA-CONBOX=	Outdoor Conduit Box for 8630 Cisco IP camera
CIVS-6KA-GNECK=	Goose Neck Mount for 35xx, 6k, and 7030 IP Domes
CIVS-8KA-ADPPLT=	Adapting Plate for 8070 Cisco IP camera
CIVS-6KA-PENHEAD=	Ceiling mount for 35xx, 6k, and 7030 IP Domes
CIVS-9KA-MOUNT	Mounting adapter for SD9361
CIVS-8KA-CTMSURF	Surface Mount Adapter for 8000 Series Cameras
CIVS-8KA-CTMFLSH	New Flush mount for 8000 series
L-CPS-SASD-7=	EDelivery License for 1 VSM Safety Security Desktop

CON-SAS-LCPSSASD	SW APP SUPP EDel Lic for 1 Safety and Security Deskt
L-CPS-VSM7-1CAM=	EDelivery License for 1 camera connection with VSM7
CON-SAS-LCPSVSM7	SW APP SUPP EDel Lic for 1 camera Conn with VSM7
L-CPS-VSOM7-C-VM=	EDelivery License for one Operations Manager on C Series
CON-SAS-LCPSVSOC	SW APP SUPP EDel Lic for one Ops Manager on C Series
	Media Server licenses for 3260 configuration (Qty 4)
L-CPS-VSMS7-C-VM=	EDelivery License for one Media Server on C Series
L-CPS-	
CON-SAS-LCPSVCOMPTON USD	SW APP SUPP EDel Lic for one Media Srv on C Series
UCS-C3260-SA-D	UCSC C3260 for Video Surveillance Solutions
CON-SNT-C3260SAD	SNTC 8X5XNBD, Colusa Bundle TBD
CAB-N5K6A-NA	Power Cord, 200/240V 6A North America
UCS-C3X60-G2SD48	UCSC C3X60 480GB Boot SSD (Gen 2)
UCSC-C3X60-RAIL	UCS C3X60 Rack Rails Kit
UCSC-PSU1-1050W	Cisco UCS 1050W AC Power Supply for Rack Server
UCSC-C3X60-BLKP	Cisco UCS C3X60 Server Node blanking plate
UCSC-C3160-BEZEL	Cisco UCS C3160 System Bezel
UCSC-C3260-SIOC	Cisco UCS C3260 System IO Controller with VIC 1300 incl.
N20-BBLKD-7MM	UCS 7MM SSD Blank Filler
UCSC-C3X60-SBLKP	UCS C3x60 SIOC blanking plate
UCS-S3260-M5SVR3	C3000 M5 Server Node 2x5118 CPU, Memory, RAID Controller

UCS-CPU-5118	2.3 GHz 5118/105W 12C/16.50MB Cache/DDR4 2400MHz
UCS-MR-X32G2RS-H	32GB DDR4-2666-MHz RDIMM/PC4-21300/dual rank/x4/1.2v
UCS-S3260-DRAID	UCS S3260 Dual Raid based on LSI 3316
UCS-S3260-M5HS	UCS S3260 M5 Server Node HeatSink
UCS-C3K-56HD10E	UCS C3X60 4row of 56x 10TB 512e NL-SAS drives (56Total)560TB
UCS-C3K-10TEM	Cisco UCS C3000 10TB (512e) Top Load
VMW-VSP-STD-1A=	VMware vSphere 6 Standard (1 CPU), 1-yr, Support Required
CON-ISV1-VSXSTD1A	VSphere Standard for 1 CPU; ANNUAL List 1-YR Reqd
UCS-VMW-TERMS	Acceptance of Terms, Standalone VMW License for UCS Servers
USB Joystick	HFX-45S00-U-MJ4S
PTZ Camera	SONY – HD Interior, Sony SNCWR630, HD Exterior Cameras, SNCER585

3.02 ACCESS CONTROL & ALARM ITEMS

Cisco IDENTIV Velocity Software (ICPAM)

Server Software & Licenses	VEL-SERVER	Velocity Server License - up to 64 (10 thick Clients)	
	MOD-ADD-16	Special 16 Add-On License	
	MOD-ADD-128	128 Module Add-On License	
	MOD-ADD-512	512 Module Add-On License	
	MOD-ADD-1024	1024 Module Add-On License	
	CLIENT-ADD-5	Additional Client License (5)	
	VEL-VCCS	Velocity Cert Checking Service	
	Mx-1-W	Wireless Lock license (8)	
Identiv Cisco Integration Software Plug-In.	Cisco VSM plugin (VEL-VSM-PLUGIN) for the integration to the Cisco video.		

Single Door Controller	**Hirsch Mx-1 Controller - 1 Door PoE+ Edge** Controls 1 Fully Supervised Door. 4000 Users, 1 door relay, 1 auxiliary relay (both relays support optional wet power setting), 2 Alarm Inputs (requires Line Modules), plastic enclosure, requires PoE+ power supply, tamper switch, integrated SNIB3 and RREB (one port, 2 readers). 2 Built in software configurable Wiegand interfaces for direct reader connection. Provides 10/100/1000 encrypted Ethernet to Host PC and downstream controllers, SNIB2 or SNIB3 (Mx and DIGI*TRAC). Requires ICPAM 3.0.1 Velocity 3.6 SP2.1 or later for full functionality. ***Options: Expansion Boards and Line Modules***
2 Door Controller	**Hirsch Mx-2 Controller - 2 Door with SNIB3** Controls 2 Fully Supervised Doors. 4000 Users, 2 door relays, 2 Alarm Inputs (requires Line Modules), enclosure, pwr supply, batt (1.3Ah), tamper switch, lock and SNIB3. Built in software configurable Wiegand interface for direct reader connection. Supports Expansion Boards. Provides 10/100/1000 encrypted Ethernet to Host PC and downstream controllers (Mx and DIGI*TRAC). Requires Velocity 3.6 SP1 or later for full functionality. Switching power supply (110/230). *upgradeable to 4 or 8 doors. SNIB3 uses 1 expansion slot, so 4 expansion slots available for other expansion boards **Options: Expansion Boards and Line Modules**
4 Door Controller	**Hirsch Mx-4 Controller - 4 Door with SNIB3** Controls 4 Fully Supervised Doors. 4000 Users, 4 door relays, 4 Alarm Inputs (requires Line Modules), enclosure, pwr supply, batt (7Ah), tamper switch, lock and SNIB3. Built in software configurable Wiegand interface for direct reader connection. Supports Expansion Boards. Provides 10/100/1000 encrypted Ethernet to Host PC and downstream controllers (Mx and DIGI*TRAC). Requires Velocity 3.6 SP1 or later for full functionality. Switching power supply (110/230). *upgradeable to 8 doors. SNIB3 uses 1 expansion slot, so 4 expansion slots available for other expansion boards **Options: Expansion Boards and Line Modules**

8 Door Controller	**Hirsch Mx-8 Controller - 8 Door with SNIB3** Controls 8 Fully Supervised Doors. 4000 Users, 8 door relays, 8 Alarm Inputs (requires Line Modules), enclosure, power supply, batt (7Ah), tamper switch, lock and SNIB3. Built in software configurable Wiegand interface for direct reader connection. Supports Expansion Boards. Provides 10/100/1000 encrypted Ethernet to Host PC and downstream controllers (Mx and DIGI*TRAC). Requires Velocity 3.6 SP1 or later for full functionality. Switching power supply (110/230). SNIB3 uses 1 expansion slot, so 4 expansion slots available for other expansion boards. **Options: Expansion Boards and Line Modules**		
Service & Support Warranty	SSA-VEL-SERVER-3YR	Velocity Server SSA 3YR	
	SSA-VEL-SERVER-5YR	Velocity Server SSA 5YR	
	SSA-MOD-16-3YR	Special 16 Add-On SSA 3YR	
	SSA-MOD-128-3YR	128 Module Add-On SSA 3YR	
	SSA-MOD-512-3YR	512 Module Add-On SSA 3YR	
	SSA-MOD-1024-3YR	1024 Module Add-On SSA 3YR	
	SSA-MOD-1024-5YR	1024 Module Add-On SSA 5YR	
	SSA-CLIENT-5-3YR	Additional Client SSA (5) 3YR	
	SSA-Mx-1-W-3YR	Wireless lock SSA (8) 3YR	
	VEL-VCCS-M-3YR	Velocity Cert Checking Service 3YR	
L-CIAC-PAME-BD=	Cisco PAM Badge Designer and Enroller License		
CON-SAS-PAMBD	SW APP SUPP Cisco PAM Badge Designer		
L-CIAC-PAME-EDI=	Cisco PAM Enterprise Data Integration License		
CON-SAS-PAMEDI	SW APP SUPP Cisco PAM Enterprise		
L-CIAC-PAME-M64=	Cisco PAM 64 Module License		
CON-SAS-PAMM64	SW APP SUPP Cisco PAM 64 Module		
UCSC-C220-M3L	UCS C220 M3 LFF w/o CPU, mem, HDD, PCIe, PSU, w/ rail kit		
CAB-9K12A-NA	Power Cord, 125VAC 13A NEMA 5-15 Plug, North America		
CON-SNT-C220M3LF	SMARTNET 8X5XNBD UCS C220 M3 Server - LFF		
UCS-CPU-E5-2620	2.00 GHz E5-2620/95W 6C/15MB Cache/DDR3 1333MHz		

UCS-HDD3TI2F214	3TB SAS 7.2K RPM 3.5-inch HDD/hot plug/drive sled mounted
UCS-MR-1X082RY-A	8GB DDR3-1600-MHz RDIMM/PC3-12800/dual rank/1.35v
UCS-RAID9271CV-8I	MegaRAID 9271CV with 8 internal SAS/SATA ports with Supercap
R2XX-RAID6	Enable RAID 6 Setting
UCSC-CMA1	Reversible Cable Management Arm for C220,C22,C24 servers
UCSC-HS-C220M3	Heat Sink for UCS C220 M3 Rack Server
UCSC-PSU-650W	650W power supply for C-series rack servers
UCSC-RAIL1	Rail Kit for C220, C22, C24 rack servers
VMW-VS5-STD-1A	VMware vSphere 5 Standard (1 CPU), 1yr, Support Required
CON-ISV1-VS5STD1A	ISV 24X7 VMware vSphere Standard, List Price is ANNUAL
Enclosures	M5 Series Enclosures, United Technologies
Delayed Egress	Schlage (See Locking Hardware details)
Mini Prox Reader	HID Mullion Reader miniprox 5365
Thinline Prox Reader	HID ThinLine Reader model 5395
Glass Break Detector	Honeywell FG-730
Motion Detector	Bosch TriTech 360 Dome Motion Detector
Ceiling Mount PIR Detector	Bosch ISN-CC1
Panic Switch	GE Panic Switch - Pull Type 3050
Piezo Sounder	Sentrol-Moose MPI-47E
Door Contact Switch	1078 & 1076 Series PTF Door Contacts
Surface Mount Contact	GE 1045

Overhead Door Contact	Potter Series ODC-59
R40 Card Reader(s)	HID-910PTNNEK00000 HID-920PTNNEK00000
SMARTCARDS	HID-2022BGGMVM (*QTY 5000)
ID Card Printer	Fargo 555100 DTC4500e ID Card Printer, Dual-Sided Configurable, with extended warranty (EXTWarranty-55000, cleaning kit, (2)3,000k black ribbon, (3) color ribbon YMCKOK refills.
Power Supply Units	
Rack Mount Power Supply Unit	Altronix ALT-MAXIMAL3RD and standby battery source
Electrical AC outlet Wall Mount Power Supply Unit Single device power supply	Altronix TP2450
Wall Mount Power Supply Unit 8 door controller	Altronix AL600ULACM and standby battery source
INTERCOM STATIONS	
2N Helios IP Vario	
Cisco 9971 VOIP Desktop Phone (base station/master)	
Ethernet over Coax with POE+ Adapters	
Ethernet over Coax Components	Altronix 16 channel eBridge16PCRX
Multichannel receivers are to be used with single channel transmitters	Altronix 8 channel eBridge8PCRX
	Altronix 4 channel eBridge4PCRX
	Altronix eBridge 1PCRT (single cam kit)
EMERGENCY CALL TOWERS	
Talk-A-Phone	Emergency Mini Tower ETP-MT-72
	Emergency Call Tower WEBS-MT-R
	Emergency Tower WEBS-MT-R OP4 – CAM

	Emergency Call Station Unit VOIP-500
	Emergency Mini-Tower Mounting Bracket
	Emergency Tower Mounting Bracket
	Wall Mount Emergency Station - WEBS-WM
MASS NOTIFICATION INFORMACAST SYSTEM	
	SINGLEWIRE INFORMACAST Version 12.7.1
STRUCTURED CABLING	
Data (Cat6)	Cat6 – Berk-Tek Leviton or 8 Conductor plenum rated, must carry manufacturer's 25-year warranty for all cable, patch cables, jacks, and components. CX6500 or CS6700 depending on application environment
18-2 communications cable	Berk-Tek Leviton AV6400
Fiber Cable	Berk-Tek Leviton OM1 or OM2, 49990-MDL, 449990-MSC, 6-144 fiber counts for PDP/PDR Indoor only, 6-432 fiber counts for Plenum or riser applications Indoor-Outdoor
Communications cable	Berk-Tek Leviton 10170931 23 AWG 4 Pair Solid Red LANmark-6 Riser UTP
Patch Panels and jacks	Must be Berk-Tek Leviton
Patch Cords	All must be Plenum rated.
Cable Management/Accessories	Berk-Tek Leviton
SECURITY OPERATIONS (DISPATCH) EQUIPMENT	
50" Monitors	HDMI, 1080p, 50" Diagonal with articulating wall mounts
Operators Console & Storage Systems	WINSTED – See proposed design reference for components required
3.03 ALLEGION LOCKING HARDWARE DETAIL	
Key System	Schlage 1456 Keyway, IC (Interchangeable Core) – Keys to be stamped, "Do Not Duplicate". Consult with District Locksmith, Jim Galligan 310-434-4481 for additional and other specific keying information and instructions. <u>All Substitutions must be approved by Facilities Dept.</u>

Locksets	Mortise: Schlage L9000 Series, 06A Design – IC (Office lock L9050T**, Vestibule L9060T**, Passage and Classroom lock L9071T**, Storeroom lock, L9080T**, Faculty Restroom L9486T** x L583-375) Cylindrical: Schlage "ND" Series Vandlgard function, RHO Design - IC (Office lock ND92TD**, Classroom & Passage Lock ND95TD**, Vestibule lock ND93TD**, Storeroom lock, ND96TD**, Faculty Restroom ND85TD**)
Electrified Locksets	Mortise: Schlage L9000T** EL/EU Series, 06A design for all construction. (Same function as non-electrical spec.) FAIL-SECURE ON EXTERIOR DOORS, FAIL-RELEASE ON INTERIOR DOORS Cylindrical: Schlage "ND" EL/EU Series. Interior/exterior – IC (Same function as non-electrical spec.) FAIL-SECURE ON EXTERIOR DOORS, FAIL-RELEASE ON INTERIOR DOORS
Rim Cyls	Schlage Rim series, 1456 Keyway – IC (Interchangeable Core)
Restroom Locksets	Public – Schlage mortise L9071T**, Cylindrical ND95TD**, 1456 Keyway – IC Faculty/staff – Schlage mortise - L9486T** x L583-375 - IC (Hotel lock, Occupied Indicator) Schlage lever – ND85TD** – IC (Hotel/Motel lock with indicating cylinder)
Padlocks	Schlage Kryptonite PL Series, 1456 Keyway
Exit Devices	Von Duprin 98 series. Use Von Duprin 992L-F (06 Lever trim at rated openings), 990NL at Non Rated openings. – IC and CD (Cylinder Dogging)
Electrified Exit Devices	Von Duprin QEL98 series. (Power Supply PS873-2Q) Use Von Duprin 992L-F (06 lever trim at rated openings), 990NL at Non Rated openings. IC and CD
Mullions	Von Duprin KR4954 Series IC
Electric Door Operators	LCN Senior Swing 9500 series, single door and double doors All receivers, interior and exterior must be hard wired, low voltage (no batteries)
Surface Door Closers	Inswinging & Outswinging: LCN 4041-EDA-DA series (Wood doors to be through bolted, consult with Facilities Management on use of Hold Open Arms @ Non Rated opening)
Floor Closers	Not recommended for new construction. Replace existing floor closers with mfr.'s best logical replacement unit. Drop plates maybe necessary.
Pivots	Not recommended for new construction.
Hinges	Conventional: Ives 3CB1HW Series, McKinney (4 hinges required on doors wider than 36in. or over 7ft. tall) Continuous: Markar FM111 Type (stainless steel, pin & barrel) Electrified: Hager AB700/800 x ETW/ETM
Floor Stops	Interior: Ives FB436/438 Exterior: Ives FS18S

Door Seals	Pemko, Zero or Reese. Use “intumescent” at “S” labeled openings
CLOUD BASED INTERNET SECURITY	
	Cisco DNA Security Suite
BROCADE/RUCKUS Wireless Networking	
	MODEL DESCRIPTION Ruckus R720 Smart Wi-Fi 802.11ac Access Point 901-R720-XX005 R720 dual-band (5GHz and 2.4GHz concurrent) Wave 2 802.11ac wireless access point, 4x4:4 streams, adaptive antennas, dual ports, PoE support. Includes adjustable acoustic drop ceiling bracket. One Ethernet port is 2.5GbE. Does not include power adaptor. Optional Accessories 902-0180-XX00 PoE injector (90 – 264 VAC 47-63 Hz) 902-1170-XX00 AC/DC Power supply - 48V - 36W 1 902-0120-0000 Secure Mounting Bracket
Interactive Classroom Display	
	Clear Touch Interactive 6000K Series 65” Flat Panel Display Manufacturer Item Number: CTI-6065K-UH20 Manufacturer Item Description: 65” 6000K Series Interactive Panel with USB HID / AGG / 20 Points of Touch – Ultra HD
Building Management Systems	
	Tridium Honeywell Niagara Edge Controllers Edge 10 Niagara 4.3 or higher https://www.tridium.com/en/products-services/niagara4/compare-niagara

PART 4 - ABBREVIATIONS AND ACRONYMS

AABC - Associated Air Balance Council; www.aabc.com.
AASHTO - American Association of State Highway and Transportation Officials; www.transportation.org.
ACI - American Concrete Institute; (Formerly: ACI International); www.abma.com.
AEIC - Association of Edison Illuminating Companies, Inc. (The); www.aeic.org.
AIA - American Institute of Architects (The); www.aia.org.

AISC - American Institute of Steel Construction; www.aisc.org.
ANSI - American National Standards Institute; www.ansi.org.
ASCE/SEI - American Society of Civil Engineers/Structural Engineering Institute; (See ASCE).
ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers; www.ashrae.org.
ASME - ASME International; (American Society of Mechanical Engineers); www.asme.org.
ASSE - American Society of Safety Engineers (The); www.asse.org.
ASTM - ASTM International; www.astm.org.
ATIS - Alliance for Telecommunications Industry Solutions; www.atis.org.
BICSI - BICSI, Inc.; www.bicsi.org.
CSI - Construction Specifications Institute (The); www.csinet.org.
ECA - Electronic Components Association; (See ECIA).
FM Approvals - FM Approvals LLC; www.fmglobal.com.
FM Global - FM Global; (Formerly: FMG - FM Global); www.fmglobal.com.
ICBO - International Conference of Building Officials; (See ICC).
ICC - International Code Council; www.iccsafe.org.
ICEA - Insulated Cable Engineers Association, Inc.; www.icea.net.
IEC - International Electrotechnical Commission; www.iec.ch.
IEEE - Institute of Electrical and Electronics Engineers, Inc. (The); www.ieee.org.
IES - Illuminating Engineering Society; (Formerly: Illuminating Engineering Society of North America); www.ies.org.
IESNA - Illuminating Engineering Society of North America; (See IES).
Intertek - Intertek Group; (Formerly: ETL SEMCO; Intertek Testing Service NA); www.intertek.com.
ISA - International Society of Automation (The); (Formerly: Instrumentation, Systems, and Automation Society); www.isa.org.
ISO - International Organization for Standardization; www.iso.org.
NECA - National Electrical Contractors Association; www.necanet.org.
NEMA - National Electrical Manufacturers Association; www.nema.org.
NETA - InterNational Electrical Testing Association; www.netaworld.org.
NFPA - National Fire Protection Association; www.nfpa.org.
NFPA - NFPA International; (See NFPA).
SMACNA - Sheet Metal and Air Conditioning Contractors' National Association; www.smacna.org.
TIA - Telecommunications Industry Association (The); (Formerly: TIA/EIA - Telecommunications Industry Association/Electronic Industries Alliance); www.tiaonline.org.
TIA/EIA - Telecommunications Industry Association/Electronic Industries Alliance; (See TIA).
USGBC - U.S. Green Building Council; www.usgbc.org.

4.01 Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list.

IAPMO - International Association of Plumbing and Mechanical Officials; www.iapmo.org.
ICC - International Code Council; www.iccsafe.org.
ICC-ES - ICC Evaluation Service, LLC; www.icc-es.org.

4.02 Federal Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list.

EPA - Environmental Protection Agency; www.epa.gov.
FG - Federal Government Publications; www.gpo.gov.
GSA - General Services Administration; www.gsa.gov.
OSHA - Occupational Safety & Health Administration; www.osha.gov.

4.03 State Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list.

CBHF; State of California; Department of Consumer Affairs; Bureau of Electronic and Appliance Repair, Home Furnishings and Thermal Insulation; www.bearhfti.ca.gov.
CCR; California Code of Regulations; Office of Administrative Law; California Title 24 Energy Code; www.calregs.com.
SCAQMD; South Coast Air Quality Management The District; www.aqmd.gov.

Note control equipment that is not dually UL 864 and 2572 listed are not acceptable.

4.04 Latest Codes Adopted by Division of State Architect (DSA)

END OF SECTION

SECTION 28 02 00
SECURITY CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 MANUFACTURERS

A. Berk-Tek Leviton

1.02 CONNECTORS AND SPLICES

A. Berk-Tek Leviton

B. Hubbell Power Systems, Inc.

C. O-Z/Gedney; EGS Electrical Group LLC.

D. 3M; Electrical Products Division.

E. Tyco Electronics Corp.

1.03 SLEEVES FOR CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Consider retaining first paragraph below if cables penetrate exterior walls below grade.

C. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral water stop, unless otherwise indicated.

D. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum **0.052- or 0.138-inch** thickness as indicated and of length to suit application.

E. Coordinate sleeve selection and application with selection and application of firestopping specified in "Penetration Firestopping."

1.04 SLEEVE SEALS

A. Retain this Article if annular space between pipe sleeves and cables must be sealed against hydrostatic pressure. Sleeve seals are usually furnished with EPDM sealing elements, plastic pressure plates, and carbon-steel bolts. NBR and silicone sealing elements, carbon- and stainless-steel pressure plates, and stainless-steel bolts are available for special applications.

B. See Editing Instruction No. 1 in the Evaluations for cautions about naming manufacturers and products. Retain one of first three paragraphs and list of manufacturers below. See Division 01 Section "Product Requirements. “Division 1 Section "Product Requirements."

1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Metraflex Co.
4. Pipeline Seal and Insulator, Inc.

5. 3M
6. Hilti

1.05 CONDUCTOR MATERIALS & APPLICATIONS

A. Solid Conductors: ASTM B 3.

B. Stranded Conductors: ASTM B 8.

C. Tinned Conductors: ASTM B 33.

D. Bonding Cable: 28 kc mil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.

E. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.

F. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

G. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

1.06 METAL CONDUIT AND TUBING

A. AFC Cable Systems, Inc.

B. Alflex Inc.

C. Allied Tube & Conduit; a Tyco International Ltd. Co.

D. Anamet Electrical, Inc.; Anaconda Metal Hose.

E. Electri-Flex Co.

F. Manhattan/CDT/Cole-Flex.

G. Maverick Tube Corporation.

H. O-Z Gedney; a unit of General Signal.

I. Wheatland Tube Company.

1.07 OPTICAL FIBER/COMMUNICATIONS CABLE RACEWAY AND FITTINGS

A. Berk-Tek Leviton

1.08 METAL WIREWAYS

A. Cooper B-Line, Inc.

B. Hoffman.

C. Square D; Schneider Electric

D. Panduit.

1.09 SURFACE RACEWAYS

A. Thomas & Betts Corporation.

B. Walker Systems, Inc.; Wiremold Company (The).

C. Wiremold Company (The); Electrical Sales Division.

D. Panduit

1.10 BOXES, ENCLOSURES, AND CABINETS

A. RACO; a Hubbell Company.

B. Robroy Industries, Inc.; Enclosure Division.

C. Scott Fetzer Co.; Adalet Division.

D. Spring City Electrical Manufacturing Compan

E. Thomas & Betts Corporation.

F. Walker Systems, Inc.; Wiremold Company (The).

G. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.

H. Fire Alarm device boxes as recommended by Fire Alarm manufacturer in compliance with CFC.

I. EGS/Appleton Electric.

END OF SECTION

SECTION 28 10 00
ELECTRONIC ACCESS CONTROL AND INTRUSION DETECTION SYSTEMS (EACIDS)

PART 1 - GENERAL

1.01 PRODUCT ACCEPTABILITY

A. The Products section contains lists of acceptable products. If product substitutions are proposed, they must be made based upon a comparison of equivalence to the product specified. Considerations may include but shall not be limited to functional, physical, aesthetic and/or interface aspects. CLIENT shall be the sole judge of whether or not a submitted substitution is deemed to be "equivalent" to that specified.

1.02 ELECTRONIC ACCESS CONTROL EQUIPMENT

A. System: Identiv Velocity Security Management System.

B. Software:

1. Software: Identiv Velocity Version 3.6. or latest supported version

2. Contractor shall provide a minimum of two (2) reprogramming sessions within twelve (12) months of the final acceptance of the system to modify the user programming.

3. The server software shall support Cold Redundant, Warm Redundant, Hot Redundant, and clustered server environments.

4. System shall be compatible with Virtual Machine environment such as VMWare or HyperV

5. During installation support for split SQL Server Database server and Application/Communication server shall be available.

C. Servers and Workstations: Provide Servers and Client Workstations as noted herein and as shown on the plans. The following describes the minimum guideline configuration for servers and workstations. The Contractor shall be responsible for insuring the acceptable performance of the system based on the EACIDS manufacturers' hardware requirements, the performance criteria specified herein for the access control system, and Client's server standards.

1. EACIDS Server: The Primary EACIDS server shall be located in the {Identify Location} data center [and the redundant EACIDS server shall be located in {Identify Location}]. The primary and redundant server shall have the same hardware configuration.

a. The Server computer shall be a Dell Power Edge R710 or equal by IBM, or Hewlett Packard, 100% compatible Xeon E3-1220, 3.10 GHz Turbo Quad Core/4T or faster processor, configured as required by the manufacturer, with the following minimum attributes:
b. Rack-Mount Configuration (2 RU)
c. 8 GB 1333MHz UDIMMS, Advanced ECC DDR3 RAM.
d. 8 MB Cache
e. Raid Controller (Supports RAID 0, 1, 5, and 10): Embedded 6GB/s SAS, w/512MB cache

f. 300.0 GB 15K RPM SAS Disk Drive (Provide number required for selected RAID configurat
g. DVD +/-RW, SATA Optical Drive
h. Computer Monitor/Keyboard/Mouse, 17” Flat Panel w/keyboard and mouse: Provide Dell Keyboard/Mouse/Monitor unit in 2 RU pull out rack drawer.
i. Video controller with 1GB of memory.
j. Sound Card and Speakers
k. 1 eSATA Port
l. System compatible Bus Mouse and Hardware.
m. 2 Parallel Ports LPT1 and LPT2.
n. 2 Serial Ports, COM1 and COM2.
o. Software and hardware as recommended by Honeywell to provide hot redundant back-up services.
p. Microsoft Windows Server 2008 R2 64-bit Standard or Enterprise edition multi-tasking operating system platform with graphical user interface as required by system software.
q. Security Network: The Server shall be capable of providing Network communications between Client Workstations subservient to the Server and to other Server or Administrative Workstations. Data, alarms, and information shall be shared between Server and Client Workstations at the discretion of the network administrator.
r. Network Interface Board: 1000BaseT Ethernet Communications Board, compatible with existing customer LAN network

1.03 DATABASE PLATFORM

A. Server: SQL Server 2012 R2 64-bit Standard, Workgroup, or Enterprise edition with SP1

B. Workstation: SQL Server 2012 R2 Express (Included with EACIDS software)

C. Client: Database connection to Server

1. Client Workstations: Provide Client Workstation as shown on the plans. The following describes the minimum guideline configuration for the EACIDS workstation. The Security Contractor shall be responsible for insuring the acceptable performance of the system based on the EACIDS manufacturers' hardware requirements and the performance criteria specified herein for the EACIDS.

a. The Workstation shall be a Dell T5500, HP Z400, or equal by IBM 100% compatible i7 Quad Core, 3.4 GHz or faster computer, configured as required by the manufacturer, with the following minimum attributes:
b. Rack-Mount, tower or desk top Configuration as required by location
c. 8GB, DDR3 RDIMM,1333 MHz, ECC
d. 12 MB L3 Cache
e. SATA Drive Adapter
f. 250 GB SATA 3.0 GB/s Hard Disk Drive w/integrated controller
g. Recordable Optical DVD+R/+RW Drive with backup software, 24X write: The recordable DVD drive shall be used for system backups and to record stored video clips for archival and off site use.
h. Standard Monitor (24”): Provide Computer Monitor, 24" Flat Panel Color LCD Display Monitor. Monitor shall utilize TFT Active Matrix LCD technology, minimum 1000:1 contrast ratio and 250 cd/m2 brightness, resolution of 1920 x 1080, and a minimum

viewing angle of 160 vertical x 170 horizontal. Provide Dell Professional P2210 22" HAS wide monitor or equal.

i. DVI Color Graphics Display Board: nVidia QuadroFX 4800, 1.5GB, dual monitor DVI board, or equal with cable compatible with selected monitor.
j. Sound Card: High Definition Integrated Realtek ALC262 Audio or Soundblaster Audigy II with on board 1394
k. System compatible Bus Mouse and Hardware
l. 4 USB 2.0 ports
m. 2 Serial Ports, COM1 and COM2
n. Microsoft Windows 7 SP1 32-bit or 64-bit Professional, Ultimate, or Enterprise edition multi-tasking operating system platform with graphical user interface and any additional software programs required to meet specifications
o. Network Card: 1 GB Ethernet Communications Board, compatible with WBMWD's existing LAN network

D. [Fault-Tolerant Server: Provide redundant fault-tolerant Windows server 2012 R2 operating system, SQL Server 2012 database, with flat panel monitor.]

E. System Controller Panels: Provide sufficient controllers and input/output boards to meet all requirements of specifications.

1. EACIDS Controller: Where new controllers are required provide the following;

a. Identiv MX Controller, compatible with the EACIDS application software, with a flash ROM module, power supply, battery standby, and Communications Module, as described herein.
b. Contractor shall review drawings and specifications with the Project Representative and may propose changes to the topology of the system based on device layout, where such changes improve performance or functionality of the system. CLIENT has final authority as to the final approach for system topology.
c. Reader Support: Controller shall be configurable for 2, 4, or 8 readers. Enclosure, controller board, and accessories shall be the same for 2, 4, or 8 reader configurations for consistency in system hardware layout. Controllers shall be field upgradeable from 2 to 4 to 8 doors through firmware upgrade.
d. Provides Boolean logic functions for input/output points for primary and downstream controllers without need for host server
e. Dedicated encryption processor to enable PKI based certificate level encryption between controllers and host server. Encryption shall also include encrypted communication to readers with imbedded encryption processor.
f. The controller shall have integrated network communications with onboard Ethernet port.
g. High security supervised alarm points.
h. Configurable output relays.
i. Expansion capability within standard controller enclosure footprint:

1) Memory up to 132,000 users
2) 8-imput Alarm Expansion Boards – up to 4
3) 8-output Relay expansion boards – up to 5

j. Controllers shall be capable of upgrading the firmware through the EACIDS head-end without requiring the need to access each controller to upgrade the firmware.
k. The controller shall support a MATCH reader interface board for entry/exit readers for a single door utilizing a single reader port on the controller.

l. The MATCH reader interface board shall enable enhanced cable distance from reader to controller up to 1,800 feet using 18 gauge wires.
m. CODE/Buffer: The controller shall be capable of expanding the CODE database up to a maximum of 132,000 Users with the addition of a memory expansion board. The board shall be mounted in the controller cabinet and connect to the controller board via an expansion bus cable. The CODE/Buffer expansion board shall be Identiv Model MEB\CB64 (64,000 Users) or the MEB\CB128 (128,000 Users). Both Expansion Boards shall expand the Buffer capacity as well as the Code record capacity. The Model M1N shall not accept any CODE/Buffer Expansion board.
n. Event Transaction Buffer: The controller shall be capable of expanding the event transaction buffer up to a maximum of 20,000 events and 2,000 alarms with the addition of a memory expansion board. The board shall be mounted in the controller cabinet and connect to the controller board via an expansion bus cable. The event transaction buffer expansion board shall be Identiv Model MEB\BE. The Model M1N shall not accept a Buffer Expansion board.
o. Controllers shall utilize Version 7.5.37 or later flash downloadable CCM (Command and Control Module) firmware.

2. Controller General Features: The software for the controller shall reside in Flash ROM (firmware) and be located on a plug removable module on the controller board to facilitate easy field upgradeability of the features. All of the necessary software for a fully functional System is located in the controller. The controller firmware shall be fully supported by the EACIDS head-end, and include the following general features at a minimum:

a. 3 - 15 digit keypad Codes.
b. Duress digit for keypad Codes.
c. 150 Time Zones for access restriction and automatic event control.
d. 128 Access Zones for access management.
e. 256 Control Zones for alarm and relay management.
f. 366 programmable holidays this year, 366 days next year. Each Holiday may be assigned to 1 - 4 Holiday Schedules.
g. Automatic daylight savings time clock adjustment.
h. 27 different functions for Codes and cards, such as access, unlock, re-lock, alarm mask, and relay control.
i. Add user records.
j. Tag users for annunciation at host computer.
k. 4,000 Users.
l. 1500 event, 1500 alarm transaction buffer

F. Access Control Features: The controller shall include the following access control features at a minimum

1. Restrict access by: time of day; day of week; door; holiday.

2. Momentary Access of door up to 8100 seconds.

3. Extended Access for User Definable Momentary Access duration (requires ScramblePad). ScramblePad will display time remaining on the minute and annunciate at the defined “Warning Time”.

4. Special Needs Time Extension to provide additional time for Momentary Access and Door Open Too Long for selected people.

5. Unlock/Re-lock of door by CODE, card, or Time Zone.

6. Door status monitoring shall allow for: door forced monitoring; door-open-too-long monitoring; door-open-too-long while door is unlocked; and auto-re-lock of door when opened or closed.

7. Request-to-exit masks alarm and/or unlocks door.

8. 2-person requirement by door. A user can be defined as Normal, A/B Rule A, A/B Rule B, or Executive Override. Can be disabled by Time Zone.

9. 63 Pass-back Zones. Can be disabled by Time Zone. A User can be designated with Pass-back Executive Override.

10. Use Count limits on users.

11. Absentee Rule limits on users.

12. Temporary Day limits on users.

13. Occupancy Counting / Minimum & Maximum limits per Pass-back Zone.

14. Deadman CODE / Timer.

15. Threat Levels – 99 Levels may be defined. Based on the Level in effect for the facility, selected readers may be disabled, dual readers in Card/Code Only During Time Zone can require dual, and selected User's Credentials can be disabled.

16. Timed Anti-Pass-back

G. Alarm Management Features: The controller shall include the following alarm management features at a minimum:

1. Momentarily mask alarm by CODE and/or card.

2. Mask/unmask alarm by CODE and/or card or by Time Zone.

3. Alarm device supervised while masked.

4. Tamper switch on alarm device monitored while masked.

5. Tamper Input may be configured to operate as a "Latch Monitor" with the appropriate door lock hardware.

6. Entry/Exit delay per alarm input.

7. Alarm input triggers relays

H. Relay Control Features: The controller shall include the following relay control features at a minimum:

1. CODE and/or card, input, or other relay triggers relays.

2. Trigger relays by time zone.

3. Relay may be normally de-energized or energized.

4. Disable relays during time zone.

5. Clear relay at end of time zone

I. Controller Connectivity

1. Controllers shall support connection to the security LAN/WAN using TCP/IP protocol, and shall also support connection to the manufacturer's standard data communications protocol (RS-232, RS-485, or RS-422).

2. TCP/IP-connected controllers may act as a network "gateway", to re-transmit controller data via the manufacturers standard data communications protocol (RS-232, RS-485, or RS-422), to other EACIDS controllers located within the same site. Provide controllers which support the manufacturer's standard data communications protocol, RS-232/RS-485, as required.

3. LAN/WAN Interface Board: Model SNIB2 10/100 Mbps interface with 128-bit AES encryption.

J. Intelligent Reader Interface: The control panels shall utilize an intelligent reader interface (Model: MRIA or MRIB) to communicate with card readers of various types. The interface shall be microprocessor based and allow data formats including ABA magnetic stripe, Wiegand (26 to 55 bit), Proximity, Bar Code, Touch Memory, RF, and Biometric. The interface shall utilize a digitizing algorithm, which will convert the card data to a unique number, thus eliminating the need for facility codes. A single interface shall support both entrance and exit readers with keypads associated with each door. The interface shall be U.L. Listed to U.L.294. The reader interface shall be included as standard in all Scramble Pads.

K. Alarm Inputs: The controller shall be capable of accepting up to 32 additional supervised alarm inputs, in increments of eight (8). The sensitivity of the line supervision shall be 2% AA Standard. The alarm expansion boards shall be mounted in the controller cabinet and connect to the controller board via an expansion bus cable. This option shall be limited to 16 additional supervised alarm inputs for the 16-zone alarm input controller (Model M16N), and none for the Model M1N. The alarm expansion board shall be Identiv Model AEB8.

L. Relay Output: The access control (Model M2N, Model M8N, and Mx) and alarm monitoring (Model M16N) controllers shall be capable of accepting up to 32 additional Form C, 2 Amp rated relay outputs in increments of 8. The 1 - 32 relay controller (Model MSPN-8R) shall accept up to a maximum of 24 additional Form C, 2 Amp rated relay outputs in increments of 8. The 1 - 64 relay controller (Model M64N) and the Model M1N shall not accept any additional relay outputs. These outputs shall be used for control applications other than standard door access, such as elevator floor control, local door annunciators, HVAC interface, etc. The relay expansion boards shall be mounted in the controller cabinet and connect to the controller board via an expansion bus cable. The relay expansion board shall be Identiv Model REB8.

M. Controller Power Supply: Provide Identiv Model PSH5A power supply based on panel configuration.

N. Battery Back-up: Provide Identiv Model SB7AH batteries to provide battery back-up on 120 VAC power failure.

O. Multi-Frequency, Multi-Technology, contactless card reader: The multi-frequency contactless card reader(s) shall be designed to securely read, decipher, and authenticate user card data from 13.56 MHz and 125 kHz proximity cards

1. Shall be able to securely authenticate with cards that support a PLAID applet, extract and process the employee format data for building access

2. Support all three modulations of 125 KHz proximity card technologies (ASK, PSK, FSK) within the same standard reader and output card data from all three modulations in succession.

3. Supports programming and re-flashing through RS-485 data protocol

4. Through the use of a device certificate the reader shall support Strong Identity Verification when authenticated with identity cards that carry an employee certificate.

5. Reader connectivity shall include Wiegand and RS-485 protocols

6. The reader shall support enhanced security technology features including:

a. Optical sensor that detects physical tampering of the reader by the removal of the reader from its mounting plate
b. The multi-frequency contactless card reader shall utilize Secure Access Module to protect keys and cryptographic functions to the international standard Evaluation Assurance Level (EAL) 5+.

P. The multi-frequency contactless card reader shall provide enhanced usability features including

1. The reader shall support a Near Field Communication for reading NFC tokens

2. The multi-frequency contactless card reader shall provide enhanced user feedback options through the use of tri-colored LEDs configurable to support any three color combinations (RGB - Red, Green, and Blue).

3. Multi-frequency contactless card reader shall allow for secure installation mounting by utilizing tamper resistant screws

4. Multi-frequency contactless card reader shall provide the following configurable audio/visual feedback:

a. An audible device shall provide various tone sequences to signify: access granted, access denied, power up, and diagnostics.
b. A high-intensity red/green/blue (RGB) light ring shall provide clear visual status. The light ring shall provide uniform distribution of light eliminating individual bright spots

5. The multi-frequency contactless card reader shall provide the ability to upgrade its application code through the use of a cloud based application library.

6. Multi-frequency contactless card reader shall provide the ability for mounting to standard

electrical boxes through the use of universal international mounting holes.

Q. Multi-frequency contactless card readers shall provide the following compatibility features including:

1. The multi-frequency contactless card reader shall provide simultaneous support for 125 kHz proximity FSK (HID, AWID), PSK (Indala), and ASK (Casi Rusco) 125 kHz.

2. 13.56MHz including MIFARE, DESFire EV1 and SmartMX applets including PIV and PLAID

3. ISO14443A/B & ISO15693 UID support

4. Sony FeliCa CSN

5. PIV and CIV compatibility

6. CAK validation

7. TWIC compatibility

R. Multi-frequency contactless card reader shall provide enhanced environmental and sustainability features including:

1. Multi-frequency contactless card reader shall be fully compliant with Restriction of Hazardous Substances directive (RoHS) restricting the use of specific hazardous materials found in electrical and electronic products. The substances banned under RoHS are lead (Pb), mercury (Hg), cadmium (Cd), hexavalent chromium (CrVI), polybrominated biphenyls (PBB) and polybrominated diphenyl ethers (PBDE).

S. Multi-frequency contactless card reader shall comply with the following standards to ensure product compatibility and predictability of performance

T. Technical Standards

1. ISO 15693

2. ISO 14443A

3. ISO 14443B

4. Global Platform 2.1.1

5. Open Platform Java card 2.2.2

6. Certifications

U. FCC: reader shall comply with Part 15 of the FCC Rules

1. IC: reader shall comply with Industry Canada license-exempt RSS standard(s).

2. CE: reader shall follow essential requirements and other relevant portions of Directive

R&TEE 1999/5/EC

3. The reader shall be compliant with RoHS requirements

4. IP65

5. UL294

V. Multi-frequency contactless card reader shall be provided with a full potted assembly.

W. Multi-frequency contactless card reader shall provide the following typical contactless read ranges:

1. SmartMX: Up to 3 cm

2. MIFARE: Up to 5 cm

3. Proximity: Up to 6 cm

X. Multi-frequency contactless card reader shall be designed for low current operation. Power requirements shall be:

1. Operating voltage: 5 – 16 VDC, reverse voltage protected. Linear power supply recommended

2. Peak power consumption: 100mA or less (nominal)

Y. Multi-frequency contactless card reader shall meet the following physical specifications:

1. Dimensions: 11.8cm x 4.3cm x 2.8cm

2. Weight: 235g Terminal Strip

3. Material: UL94 Polycarbonate

4. Plastics: Consist of two-piece design with mounting plate and separate front bezel / reader body with built in circular LED diffuser.

5. Color: Black

Z. Multi-frequency contactless card reader shall meet the following environmental specifications:

1. Operating temperature: -35 to 65 degrees C

2. Operating humidity: 5% to 95% relative humidity non-condensing

AA. Multi-frequency contactless card reader cabling requirements shall be:

1. Cable distance: (Wiegand): 150m

2. Cable type: 8-conductor #22 AWG (Shielded cable not required)

3. Reader termination: Terminal strip or pigtail

BB. The multi-frequency contactless card reader shall provide a lifetime warranty against defects in materials and workmanship.

CC. Multi-frequency contactless card reader [Select from options below for each specific project]

1. Identiv Model 8000: Mullion Mount, 13.56 MHz only, Pigtail or Terminal Connection

2. Identiv Model 8010: Mullion Mount, 125 kHz / 13.56 MHz, Pigtail or Terminal Connection

3. Identiv Model 8030: Mullion Mount, 125 kHz / 13.56 MHz, 6-pin Connector, RJ-45 PoE option

4. Identiv Model 8100: Wall Mount, 13.56 MHz only, Pigtail or Terminal Connection

5. Identiv Model 8110: Wall Mount, 125 kHz / 13.56 MHz, Pigtail or Terminal Connection

6. Identiv Model 8210: Wall Mount, 125 kHz/ 13.56 MHz, With Keypad, Terminal Connection

7. Identiv Model 8130: Wall Mount, 125 kHz / 13.56 MHz, 6-pin connector, RJ-45 PoE option.

DD. Scramble Pad Digital Keypad: The controller shall be capable of using scrambling keypad readers. The keypad shall incorporate the following features:

1. Scrambling display of numbers 0 - 9 (numbers appear in different location every time it is used); +/- 4 degrees horizontal and +/- 26 degrees vertical viewing restriction; accept 3 - 15 digit CODEs simultaneously; be disabled for 1 minute and report CODE Tamper violation (guessing CODEs); be disabled and report Physical Tamper violation (attempt to remove keypad from mounting box); silent CODE duress; status LEDs for reporting granted, denied, and overridden transactions, AC Fail, Programming Mode active, responses to Status Request of Alarm Inputs and Relay Outputs; weather-resistant; supervised by controller; and built-in diagnostics. The Scramble Pad shall include the MATCH Reader Interface functionality for connection of up to two (2) card readers. The scrambling keypad shall be the Identiv Scramble Pad Model DS47L.

2. A version of the scrambling keypad shall be available for use in high ambient lighting conditions, or where the front is subject to direct sunlight. This version shall have a

3. +/- 12 degrees horizontal and +/- 26 degrees vertical viewing restriction. The high intensity display scrambling keypad shall be the Identiv ScramblePad Model DS47L-HI.

4. A version of the scrambling keypad shall be available with an integrated HID compatible proximity card reader. Presentation of the card shall automatically auto-start the scrambling display. The scrambling keypad with integrated proximity card reader shall be the Identiv ScrambleProx Model DS47L-SPX. High Intensity (DS47L-SPX-HI)

5. A version of the scrambling keypad with high intensity display shall be available with an integrated Indala compatible proximity card reader. Presentation of the card shall automatically auto-start the scrambling display. The scrambling keypad with integrated proximity card reader shall be the Identiv ScrambleProx Model DS47L-SPX-I. High Intensity (DS47L-SPX-I-HI)

6. A version of the scrambling keypad shall be available with an integrated smart card reader and HID proximity reader. Presentation of the card shall automatically auto-start the scrambling display. The scrambling keypad with integrated smart card reader and HID Proximity Reader shall be the Identiv ScrambleSmartProx Model DS47L-SSP-HID.

7. A version of the scrambling keypad with high intensity display shall be available with an integrated smart card reader and HID proximity reader. Presentation of the card shall automatically auto-start the scrambling display. The scrambling keypad with integrated smart card reader and HID proximity reader shall be the Identiv Scramble Smart Prox Model DS47L-SSP-HID-HI.

8. A version of the scrambling keypad with high intensity display shall be available with an integrated smart card reader and HID proximity reader. Presentation of the card shall automatically auto-start the scrambling display. The scrambling keypad with integrated smart card reader and HID proximity reader shall be the Identiv Scramble Smart Prox Model DS47L-SS-HID-HI.

EE. Access Control Readers: Provide Smart Card Proximity (RFID) type card readers as shown on the drawings. Card readers shall be "single-package" type, combining controller, electronics and antenna in one package, in the following configurations:

1. Card Reader, (Standard)

   a. Provide “single-gang” mounting style smart card proximity readers for wall mounting, Vehicle Stanchions and Pedestals, and where shown on plans.
   b. The reader shall have an approximate read range of 4”-5” when used with the compatible access card.
   c. The reader shall be of potted, polycarbonate material, sealed to a NEMA rating of 4X.
   d. The reader shall be UL 294 listed and shall be FCC certified.
   e. The reader shall have a lifetime warranty.
   f. The reader shall have separate terminal control points for the tri-color LED and for the audible indicator.
   g. Color shall be black.
   h. {Manufacturer Model Number}.

2. Card Reader, Special Mounting (applications with a minimum of mounting space)

   a. Provide “surface” mounting style proximity readers for door mullions, special minimum-space mounting configurations, and where shown on plans.
   b. The reader shall have an approximate read range of 2.5” when used with the compatible access card.
   c. The reader shall be of potted, polycarbonate material, sealed to a NEMA rating of 4X.
   d. The reader shall be UL 294 listed and shall be FCC certified.
   e. The reader shall have a lifetime warranty.
   f. The reader shall have separate terminal control points for the tri-color LED, and for the audible indicator.
      a. Color shall be black
   g. {Manufacturer Model Number}

3. Credentials (Access Cards):

   a. Access cards shall be used with access readers to gain entry to access controlled

portals. The card shall be made of durable material and shall be in a form suitable for direct one-sided dye-sublimation printing on the specified badge printer. Presentation to the access control reader at any angle within a minimum of two (2) inches shall result in an accurate reading of the card.

b. Provide [quantity] access cards compatible with the specified card readers.
c. The card shall not carry any identification showing the location of the property unless otherwise specified herein.
d. Provide [quantity] badge protectors, with clips, of a type acceptable to the Engineer.
e. Provide {Manufacturer} Model {Model Name} card or equal. Card shall be configured for compatibility with selected reader and controller

4. Controller Tamper Switch: Provide a tamper switch on the Controller enclosure. Connect to the system as an individual alarm point.

5. Terminations: Provide all connections to labeled screw barrier terminal blocks.

FF. Secure all devices within the Controller enclosure. Dress all wiring in a neat and competent manner. Label all conductors to match documentation.

END OF SECTION

SECTION 28 20 00
VIDEO SURVEILLANCE MANAGEMENT & CAMERA SYSTEMS

PART 1 - GENERAL

1.01 GENERAL INFORMATION ON CAMERA SYSTEMS

A. All equipment and materials used shall be standard components that are regularly manufactured and utilized in the manufacturer's system.

B. All systems and components shall have been thoroughly tested and proven in actual use.

C. All systems and components shall be provided with the availability of a toll-free (U.S. and Canada), 24-hour, technical assistance center (TAC) from the manufacturer. The TAC shall allow for immediate technical assistance for either the dealer/installer or the end-user at no charge.

D. All systems and components shall be provided with a one-day turnaround repair express and 24- hour parts relocation. The repair and parts express shall be guaranteed by the manufacturer on warranty and non-warranty items.

E. All cameras will be IP network capable.

F. All cameras will be vandal resistant.

G. All fixed-view camera locations shall be in 1080p HD resolution units. Selected manufacturer is Cisco Latest Model Series, IP rugged fixed dome for interior and exterior applications. This will be the standard unless otherwise noted on the system layout and blueprints.

H. All PTZ camera locations shall be installed with the appropriate mount for the location. Preferred manufacturer is Sony, Latest Model Series. Provide the model with the best zoom and picture rating.

I. All cameras shall have clear domes unless otherwise specified.

J. All fixed-view cameras, at time of installation, shall include auto-iris with vary-focal lens, with a minimum adjustable range of 3.5mm to 8mm.

K. All PTZ Cameras shall have heater/blower components integrated into their environmental housings.

L. All PTZ Cameras shall be powered by a dedicated power supply unit installed within close proximity and in a serviceable location. (See Power Supply Part/Section for details.)

M. All Fixed-view Cameras shall be powered by a PoE enabled network switch located within close proximity and in a serviceable location. (See Power Supply Part/Section for details.)

1.02 SYSTEMS, NETWORK INFRASTRUCTURE & INSTALLATION CONSIDERATIONS

A. NETWORK DISTRIBUTION

1. Device cable runs, and any IP transmission shall be of CAT 6 with matching jack and patch cable.
2. All video signals from cameras in the system shall be home run to the closest respective IP Security Video System switch secured in an electrical room or in a separate secured rack and connected to the IP Network and recorded on the network storage manager.

B. VIDEO CABLING TESTING

1. The following tests will be performed to ensure that the cable is installed correctly:

   a. Wire Map
   b. Length
   c. Insertion loss (Attenuation)
   d. NEXT loss (Near-End Crosstalk)
   e. PSNEXT loss (Power Sum Near-End Crosstalk)
   f. PSELFEXT loss (Power Sum Equal Level Far-End Crosstalk)
   g. Return loss
   h. ACR (Attenuation to Crosstalk Ratio)
   i. PSACR (Power Sum Version of ACR)
   j. Propagation Delay
   k. Delay Skew

2. Model Number: Fluke Networks DTX-1800 Cable Analyzer

C. VIDEO SIGNAL NETWORK TRAFFIC

1. Security integrator shall work closely with the IT department to maintain proper system architecture for proper reliability and functionality of video signal traffic across the network. The Network Administrator shall be kept updated and advised of all additions, changes and issues that will require attention and planning that may affect normal network operations.
2. This system involves continued expansion and upgrades involving multiple buildings and multiple sites across a wide area. It is important that the network backbone will accommodate the added security signal device traffic on the network, without disrupting other standard site network traffic and communication.

D. ENVIRONMENTAL REQUIREMENTS

1. Contractor to provide The District with the correct HVAC sizing requirements.
2. The operating environment must comply with the environmental specifications (Ambient Temperature, Storage Temperature, Operating Humidity, Maximum Humidity Gradient, Operating Altitude and Operating Vibration) as detailed by the manufacturer in the product documentation.

PART 2 - VIDEO SURVEILLANCE MANAGEMENT, A&E SPECIFICATIONS

The intent of this section is to specify the minimum criteria for the design, configuration, installation, and administration of the Cisco Video Surveillance Manager and its modules.

2.01 SUMMARY

A. The Video Surveillance Manager is a platform solution optimized for applications to view, store, and manage real-time and recorded video in a networked environment. The system uses an

open suite of URL-based programmatic interfaces to communicate with applications. Cisco Video Surveillance Manager provides a highly scalable and reliable platform to enable customized, network-based surveillance applications.

2.02 SECTION INCLUDES

1. Video Surveillance Media Server
2. Video Surveillance Operations Manager
3. Cisco Video Surveillance Safety and Security Desktop
4. Client Viewing Software

2.03 REFERENCES

1. Conformity for Europe (CE)
2. Consultative Committee for International Radio (CCIR)
3. Electronic Industry Association (EIA)
4. Federal Communications Commission (FCC)
5. Institute of Electronic and Electrical Engineers (IEEE)
6. International Electrotechnical Commission (IEC)
7. International Organization for Standardization (ISO)
8. National Television System Committee (NTSC)
9. Phase Alternation by Line (PAL)
10. Underwriters Laboratories Inc. (UL)
11. Underwriters Laboratory Canada (ULC)
12. Factory Mutual (FM)
13. NEMA TS2-1998
14. CALTRANS

2.04 DEFINITIONS

A. No Substitutes: The exact make and model number identified in this specification shall be provided without exception.

B. Or Equal: Any item may be substituted for the specified item provided that in every technical sense, the substituted item provides the same or better capability and functionality

C. Or Approved Equal: A substitute for the specified item may be offered for approval by the Owner. The proposed substitution must, in every technical sense, provide the same or better capability and functionality as the specified item. Such requests for approval shall be submitted in accordance with the provisions of PART 1.06 – SUBMITTALS and must be obtained within the time frames outlined.

2.05 SYSTEM DESCRIPTION

A. Performance Requirements:

1. Provide low latency video with high quality images
2. Display any combination of live and recorded CCTV camera feeds on multiple workstations simultaneously using a TCP/IP Ethernet network.
3. Support thousands of simultaneous video feeds across multiple locations for centralized and decentralized storage, display, and distribution of video.
4. Support multiple camera and encoder manufacturers within the same system.
5. Support redundancy configurations including failover and complex high-availability

scenarios
6. Support web application and installed application options

2.06 SUBMITTALS

A. General: Submittals shall be made in accordance with the Conditions of the Contract and Submittal Procedures Section.

B. Product Data: The following shall be provided:

1. Technical data sheets
2. A complete set of instruction manuals.

2.07 DELIVERY, STORAGE AND HANDLING

A. General: Delivery, storage, and handling of any hardware shall be in accordance with the manufacturer's recommendations.

B. Ordering: The manufacturer's ordering instructions and lead-time requirements must be followed in order to avoid installation delays.

C. Delivery: Hardware components shall be delivered in the manufacturer's original, unopened, undamaged container with identification labels intact.

D. Storage and Protection: Hardware components shall be stored and protected from exposure to harmful weather conditions and at the environmental conditions recommended by the manufacturer.

2.08 PROJECT/SITE CONDITIONS

A. Temperature Requirements: Hardware shall operate in an environment with an ambient temperature range of 5˚ C to 35˚ C without the assistance of fan-forced cooling.

B. Humidity Requirements: Hardware shall operate in an environment with relative humidity of 10% to 90% (non-condensing).

2.09 CISCO VSM PRODUCTS ACCEPTABLE MANUFACTURER

A. Cisco Systems, Inc., 170 West Tasman Dr., San Jose, CA 95134USA
Telephone: 408.527.2764, Fax: 603.710.5539
Email: CiscoCLP@cisco.com, Internet: www.cisco.com

B. Substitutions: Not Permitted

2.10 VMS SYSTEM PERFORMANCE

A. Video Media Management
The video media management module shall enable the distribution, archiving, and management of video feeds from IP cameras, video encoders, media servers, and storage devices.

1. The system shall display any combination of live and recorded CCTV camera feeds on multiple workstations simultaneously using a TCP/IP Ethernet network.

2. The system shall provide low latency video with high quality images and support MPEG-4, H.264, H.265, and Motion-JPEG (MJPEG) compression schemes simultaneously.
3. The system shall provide replication of individual video feeds at different frame rates for multiple users and other system processes.
4. The system shall support simultaneous video feeds across multiple locations for centralized and decentralized storage, display, and distribution of video.
5. The system shall be capable of streaming and recording video at different bit rates and variable frame rates up to full motion 60 fps video and support QCIF, CIF, 4CIF, 720P (1280x760) and 1080P (1920x1080), 5MP (2560 x 1920), Ultra HD 2160P (4K), 11MP (3840 x 2880), 20MP (5472 x 3648) camera resolutions, as well as 360 degree camera special resolutions up to 1920 x 1920.
6. The system shall support configuration of two streams per camera at different resolution, bit rate, and encoding with different recording options for each.
7. The system shall support multiple camera and encoder manufacturers.
8. The system shall support cameras via drivers from the following manufacturers: Arecont, Axis, Bosch, Cisco, IQInvision, Mobotix, Panasonic, Pelco, Sony, Vivotek
9. The system shall support ONVIF 2.0 or greater
10. The system shall support the creation of a Custom Model associated with its ONVIF device streaming characteristics.
11. The system shall allow common camera setup characteristics be defined and called upon as defaults during the setup of cameras. These include:

    a. Motion Configuration – Default Full Motion Window, Sensitivity, Persistence, Detection Threshold, Stop Trigger Time
    b. Camera Tamper – Trigger duration, Clear duration
    c. Text Overlay – Placement, Enable Date/Time, Text, Alignment
    d. Time Settings – Automatic, User Configured

12. The system shall allow custom port assignment for HTTP, HTTPS, and RTSP on a per-camera basis.

B. Pan Tilt Zoom

1. The system shall provide the ability to remotely control (pan, tilt, zoom) the CCTV cameras and support priority for PTZ control based on user privileges and scheduling, recurring or one-time, for PTZ camera movements.
2. The system shall support the return of the PTZ camera to HOME preset after a number of idle seconds configurable on a per camera basis. A text warning overlay shall appear in the operator page with a countdown timer indicating number of seconds before the camera is moved to HOME preset.
3. The system shall support PTZ tours and an operator shall be able to interrupt the tour. The camera shall return to tour mode after a predefined operator idle time.
4. The system shall support digital pan-tilt-zoom on live or archived video.

C. Discovery, Configuration, and Provisioning

1. The system shall provide the ability to remotely configure the CCTV cameras and shall allow configuration data to be imported from a spreadsheet.
2. The system shall support discovery and provisioning of cameras without user intervention
3. The system shall have auto-provisioning profiles to allow automatic assignment of discovered cameras by make and model to templates, recording servers, and camera settings.

D. Recording and Storage

1. The system shall allow instant replay of video and will permit pausing of live video, forward and backward review of recorded video, and return to live viewing.
2. The system shall support the ability to disable display of live video to a certain category of operators, and similarly be able to also disable either the entire camera recording or time-based segments of camera recordings (Covert feature).
3. The system shall manage storage of real-time video at any specified frame rate, duration, and physical location on the network.
4. The system shall provide flexible archiving capability in terms of frame rate, duration, and location. It shall support access to the archived video, to seek to any point in the archive, to set the pre and post time, and to loop that segment of the archive.

E. Bulk Administration Functions

1. The system shall provide the means to perform bulk actions on cameras for the following actions:

    a. Backup Now
    b. Delete
    c. Enable
    d. Disable
    e. Repair Configurations
    f. Replace Configurations
    g. Change Template
    h. Change Location
    i. Change Pointed to Location
    j. Change Media Server
    k. Changer Password
    l. Camera Settings
    m. Camera Covert
    n. Set Custom Fields
    o. Format SD Card
    p. Reboot camera

2. The system shall allow the following filters be applied in the selection of the bulk cameras:

    a. Name
    b. Tags
    c. Make/Model
    d. Encoder Filters
    e. Server
    f. Install Location
    g. Template
    h. Overall Status

        1) Enabled: OK
        2) Enabled: Warning
        3) Enabled: Critical
        4) Disabled
        5) Pre-provisioned
        6) Soft Deleted
        7) Enabled: Unknown

i. Issue Type

1) Configuration Mismatch
2) Capability Mismatch
3) Identity Collision
4) Motion Unconfigured
5) Requires Formatting
6) Unknown Device State

j. By Category

1) Configuration
2) Reachability
3) Hardware
4) Software
5) Streaming
6) Recording

k. By Custom Field

F. Map Feature

1. The system shall allow the selection of an active map provider, and the ability to add new map providers for use.
2. The system shall support user import of raster format images in JPEG, and PNG format for use as map layers
3. The system shall support user import of vector format shapefiles for use as map layers.
4. The system shall support the assignment of a map view or layer to a location
5. The system shall support the placement of cameras with orientation indictors on the map.

G. Location and Camera Configuration

1. The system shall support the creation of location hierarchy for simplified operator navigation as well as a framework to support permission or partition based access and management of video assets by lower categories of administrators
2. The system shall support the import of a location hierarchy via a comma-delimited file (CSV)
3. The system shall support creation of user-defined schedules that can be applied to variable recording rules or event triggers assigned to cameras.
4. The system shall use templates to manage the common settings across cameras instead of requiring cameras to be individually configured
5. The system shall provide the following template general parameters:

a. Template Name
b. Description
c. Associated Location
d. Template Type

1) Generic
2) Model Specific

e. Camera App association with template

6. The system templates shall define the following camera configuration parameters:

    a. Video Format: NTSC, PAL
    b. Recording Schedule, Basic or Custom defined by user
    c. Stream A and Stream B definition with different streaming and recording rules
    d. Recording rules: No recording, Motion Only, Continuous, Continuous & Motion
    e. Retention periods for Continuous and event recordings
    f. Alert notification
    g. Advanced Events Configuration
    h. Advanced Storage
    i. Analytics Settings
    j. Audio options: Off, Live Only, Live and Recorded
    k. Event padding for pre and post events
    l. Verify recording space
    m. On-Demand Recording option

7. The system templates shall provide two stream setup definitions with the following features:

    a. Shortcut settings to OFF, LO, MED, HI stream settings
    b. Custom settings including the following parameters:

        1) Field of View
        2) Codec
        3) Transport
        4) Bit rate mode
        5) Resolution
        6) Framerate
        7) Bit rate
        8) Quality
        9) Predicted Bitrate

8. The system camera template shall provide point and click resiliency setup options for:

    a. Stream redundancy – All stream to all servers
    b. Stream Redundancy – Stream A to Primary and Stream B to secondary
    c. Failover
    d. Long Term Storage for all or event video recordings and daily schedule

9. The system shall support recording on camera SD card, including the following options:

    a. Operator-initiated copy of recordings
    b. Auto-merge camera recordings to server
    c. Scheduled copy to server with adjustable copy range
    d. Event-based recording to both SD and server
    e. On-Camera continuous recording
    f. On-Camera recording in case of network connectivity failure

10. The system shall provide streaming bandwidth management via the following options:

    a. Dual stream options with high and low streaming profiles
    b. Views with low stream profiles
    c. Economical streaming
    d. iFrame streaming

e. Video buffering
f. Dynamic proxy configuration
g. Site-based (login) stream setup

11. The system shall provide camera recording and archiving options as follows:

    a. Continuous recording
    b. Motion recording
    c. Continuous and motion blended grooming rules
    d. Smart stream recording – Using Stream A (event) and stream B (non-event)
    e. On-demand (operator initiated) recording
    f. Trigger initiated recording
    g. Long Term Storage: iFrame Only for H.264/MJPEG
    h. Long Term Storage: Motion events
    i. On-Camera recording
    j. Lower Frame rate for MJPEG
    k. Separate (3) retention levels for Continuous, Motion/events, and Long Term Storage

12. The system shall support 17 VIEW formats from single pane up to 5x5 grid templates.
13. The system VIEW shall support Camera Rotation (display sequence) in any video pane with a user-defined delay.
14. The system VIEW shall support display of Stream A or Stream B by default.
15. The system VIEW shall support display dewarp modes of Original, Panoramic, Quad View, Single Region, for the 360 degree camera
16. The system shall support Video Wall definitions that support switching from their default VIEW to display of live and/or recorded video on events that can roll back to original VIEW after a predefined period
17. The system shall support Site definitions that enable bandwidth management rules to apply depending on operator login location
18. The system Site definition shall allow streaming reduction via Dynamic Proxy feature. The system shall have an Active User monitor screen that provides the administrator the option to terminate a session.

H. Clipping and Review Player

1. The system shall support a license free video player (thick client) capable of video monitoring and video wall operations.
2. The system shall support a Review Player client for playback of incident clips.
3. The system Review Player shall support multi-pane synchronized playback of exported incident clips, including audio.
4. The system Review Player shall support all forensic playback modes of the regular client, including; Digital zoom, Single frame review, and playback speed options.
5. The system Review Player shall have the option to be digitally signed with a password that protects the integrity of the exported clip from the system.

I. **Administrative Functions**

1. The system shall provide a Management Console web interface for recording servers that can provide alternate access to video streams and recordings in the event the primary Operations Manager is not reachable.
2. The system shall provide a troubleshoot interface for running and pending jobs on the system as well as the cameras and encoders.
3. The system shall provide access to Audit logs via a browser interface

4. The system shall provide pruning options for Alerts, Events, and Audit logs
5. The system shall provide email notification means for:

    a. System health issues based on location
    b. Security alerts by location or device and by alert characteristics
    c. Option to provide camera snapshot with email notification

6. The system shall provide the following downloadable reports:

    a. Audit Report
    b. Streaming Report
    c. Active Users
    d. All Users
    e. Camera Report
    f. Encoder Report
    g. Server Report
    h. Template Report

7. The system shall be able to playback recorded video from system alarm and event logs by simply clicking on the event entry in the client. The recording pre-event playback time should be user adjustable and have an option to display live video side by side.
8. The system shall support event recording analysis where timeline indicators based on user-selectable event filters are placed on the recording timeline of one or more synchronized video panes to allow quick navigation through events via skip-to-event buttons.
9. The system shall allow a custom User Timeout setting for logout due to inactivity, configurable for up to a maximum of 7 days (10,080 minutes).
10. The system shall have a Fixed Duration Timeout after which an operator is logged out automatically and shall be configurable to a maximum of 24 hours
11. The system shall allow Low, Medium, and High QOS value assignment for video between media server and client.
12. The system shall allow duplicate IP addresses for cameras to be supported
13. The system shall allow custom port configuration to be defined
14. The system shall have a Privacy Mask Timer option to block the video when activated from the client and this timer shall have an administrative defined expiration time in minutes to remove the privacy mask.
15. The system shall allow the following configuration parameters for password:

    a. Password Expiry Duration
    b. Minimum password length
    c. Maximum password length
    d. Identical Password/Username Allowed
    e. Three-character types requirement for passwords
    f. Repeat Characters allowed
    g. Six customizable questions for password recovery

16. The system shall allow language setting and custom formats for date and time and selection for first day of week to be specified
17. The system shall allow severity level of system errors to be changed between INFO, WARNING, or CRITICAL.
18. The system shall allow email alerts be sent based on system reaching user defined thresholds on storage utilization variance between configured and actual storage consumption.
19. The system shall display a history of system administration jobs and their status, including

jobs that are still in queue and in pending mode.

20. The system shall allow camera firmware to be uploaded once into the Operations Manager and from their get installed to cameras across the deployment
21. The system shall allow camera driver packs to be uploaded once and distributed and installed throughout the deployment.
22. The system shall allow software upgrades to be loaded once into Operations Manager and from their get copied to rest of deployment and applied.
23. The system shall, prior to committing to an upgrade, perform a system-wide check to make sure the deployment is capable of supporting the upgrade.
24. The system shall provide a means to review Jobs running in the background.
25. The system shall support the addition of custom event types and event subtypes that can be assigned to cameras as custom event triggers and notifications.
26. The system shall provide means to add custom fields of the following types to server, camera, and encoders:

    a. Text field, Max/Min Characters, Mandatory, Initial Value
    b. Number field, Min/Max values, Mandatory, Initial Value
    c. List of choices
    d. Checkbox field, Initial value CHECKED/UNCHECKED
    e. Appear in Bulk Action
    f. For User Access Filter
    g. Appears in SASD and Maps (Text only)

27. The system shall support the Assignment of a SIP number to a camera confirming to any of the following protocols: SIP, CiscoTel, TEL
28. The system shall support the distribution of ONVIF Model profiles across the deployment.

J. Analytics and Camera Apps

1. The system shall support management and assignment of camera applications for audio, video, and other custom functions for edge deployment in cameras that provide the following functionality:

    a. Audio Detection App
    b. Audio Analytics – Aggression
    c. Audio Detection – Car Alarm
    d. Audio Analytics – Gunshot
    e. Audio Analytics – Glass Break
    f. Video App – Line Crossing
    g. Video App – Zone Intrusion
    h. Video App – Activity Detection
    i. Video App – Wrong Way
    j. Video App - Speed
    k. SIP client app
    l. SIP video app
    m. LUA Scripting App
    n. Digi Zigbee sensor app
    o. Video Summarizer App
    p. Video Tag App

2. The system application management shall manage large number of camera applications from a single Operations Manager with the ability to push application to thousands of cameras.

3. The system shall manage the pool of licenses for camera applications for easy re-provisioning from camera to camera.
4. The system shall support the addition of custom sub-event types for camera apps to create granular event history and alerts in the operators page

K. Recording Server

1. The system shall provide a Management Console that shows the status of CPU, Memory, Disk Usage, and traffic analysis.
2. The system shall provide ability to create users, control their capabilities and integrate with LDAP for both authentication and authorization of user rights
3. The system shall provide for integration with other software applications through an open and published Application Programming Interface (API).Such applications shall include, but not be limited to, access control, video analytics, and other alarm and sensor inputs.
4. System shall have capability for up to 250 cameras per server application instance
5. System shall support virtualized environments
6. The system provide for or have the capability of interoperating with the following functional modules:

   a. Video Surveillance Operations Manager
   b. Video Surveillance Redundant Media Server
   c. Video Surveillance Failover Media Server
   d. Video Surveillance Dynamic Proxy Server
   e. Video Surveillance LTS Storage System
   f. Client Viewing Software, including:

      1) Web Browser
      2) Thick Client, e.g. SASD(Safety & Security Desktop)
      3) Mobile client, e.g. VSMVIEWER

2.11 VMS HARDWARE REQUIREMENTS

A. The Video Surveillance Manager System (Media Server and/or Operations Manager) shall run on the directly on the Cisco Physical Security Appliance Platforms or virtualized on the Cisco Unified Computing System including Cisco UCS B series, C series, E series, and the 3X60 series Platforms.

B. Virtual Resources shall meet the following minimum requirements on Cisco UCS B-Series:

VMWare ESX or ESXi 5.0 or greater
VCPU: 2.66GHz or greater with 4 vCPUs
vRAM: 12GB

C. Virtual Resources shall meet the following minimum requirements on Cisco UCS C-Series

VMWare ESX or ESXi 5.0 or greater
VCPU: 2.4GHz or greater with 4 vCPUs
vRAM: 12GB

D. Virtual Resources shall meet the following minimum requirements on Cisco UCS E-Series

VMWare ESX or ESXi 5.0 or greater
VCPU: 2 or 4 vCPUs on E140 or E160 models
vRAM: 4 - 12GB

E. Virtual Resources shall meet the following minimum requirements on Cisco UCS 3260 Series 60 drives of 4TB or 10TB capacity mapped to 4 recording VMs for up to 1000 cameras System RAM of 256GB

VMWare ESX or ESXi 6.5
VCPU: 2.4GHz or greater with 4 vCPUs, per VM
vRAM: 16GB, per VM

2.12 ACCEPTABLE PRODUCT

A. The Video Surveillance System shall be the Cisco Video Surveillance Manager Suite of products including

1. Cisco Video Surveillance Operations Manager
2. Cisco Video Surveillance Media Server
3. Cisco Safety & Security Desktop Client

2.13 OPTIONAL MODULES

A. Video Surveillance Operations Manager - The Video Surveillance Operations Manager shall provide the capability for multiple web-based display consoles to configure, manage, display, and control video throughout the IP network and include, as a minimum, the administrator and operator features/functions/specifications listed below.

1. Administrator functionalities:

a. Server, encoder, and camera administration
b. Scheduled and event-based video recording
c. User and role management locally and/or through LDAP/AD
d. Bulk edit the camera streams
e. Fine-grained system audit reports
f. Ability to push pre-defined cameras to any number of monitors with a Safety and Security Desktop application
g. Mass import capability allowing configuration data to be imported from a spreadsheet
h. Consolidated configuration of all camera operational parameter through templates
i. Automated discovery of endpoints without requiring user/administrator intervention
j. Automated configuration of endpoints without user/administrator intervention required

2. Operator functionalities:

a. Secure login
b. Flexible video displays
c. PTZ controls and presets
d. Digital zoom and instant replay
e. On-demand recording
f. Video enhancements (adjusting brightness, color, transparency, etc.)
g. Instantly swap between live and archive video of the same camera feed
h. Archive review and playback

i. Event notifications
j. Mapping interface through which video may be accessed directly
k. Picture in Picture display of cameras within a group of displayed cameras
l. Display of constant timeline showing gaps in recorded video

3. Software Requirements - The Video Surveillance Operations Manager module shall include the following software:

   a. Cisco Video Surveillance Operations Manager

4. Acceptable Product – The Video Surveillance Operations Manager shall be the Cisco Video Surveillance Operations Manager.

B. Cisco Video Surveillance Safety and Security Desktop - The Video Surveillance Safety and Security Desktop shall be an intelligent digital video management system that allows any operator or integrated application to control the video being displayed on any number of monitors, both local and remote. The video surveillance Safety and Security Desktop shall allow a user to control the delivery of video to any number of viewing stations running the Safety and Security Desktop client software. Operators shall be able to choose from available cameras to be displayed on any system monitors with varying video display patterns. The video surveillance Safety and Security Desktop shall be integrated with other systems to automatically display video in response to input triggers including access control systems, fire systems, motion sensors, and contact closures.

1. Hardware Requirements - The Video Surveillance Safety and Security Desktop shall run on standard commercial off-the-shelf computer / server equipment based on Intel processors and meeting the following recommended requirements:

   a. Intel Core i7, 3.07 GHz
   b. 6 GB DDR3 (12GB for optimal performance)
   c. 200 GB HDD
   d. Gigabit Ethernet Interface.
   e. Graphics: Nvidia GeForce GT630, GTX 660, GTX760, GTX960 with latest drivers
   f. Microsoft .Net 4.5 framework
   g. Windows 7 SP1, 8.1, 10: Internet Explorer 11 (32 bit or 64 bit)

2. Acceptable Product – The Video Surveillance Virtual Matrix shall be the Cisco Video Surveillance Safety and Security Desktop.

C. Client Viewing Software – Client Viewing Software shall allow an individual operator’s PC to access and view video streams.

1. The Client Viewing Software shall be a stand-alone Windows program that plays video archive files without a browser or connection to the video surveillance system host.
2. The software shall have Archive Control functions integrated seamlessly with Live video play back for play back of JPEG, MPEG-4, H.264, and H.265 archive files to include:

   a. play forward
   b. play backward
   c. pause
   d. step one frame forward
   e. step one frame backward

3. This software shall have the ability to take a snapshot, set playing frame rate, skip frame, and search by time.
4. Supported file format types shall include:

    a. MP4 -A standard file format for storing audio/video data on a PC
    b. CVA Cisco format: multi-camera and secure clipping format
    c. BMP, JPEG, PNG, and TIFF formats, savable as snapshots.

5. The viewing PC shall meet the following recommended requirements:

    a. Intel Core i7, 3.07 GHz
    b. 6 GB DDR3 (12GB for optimal performance)
    c. 200 GB HDD
    d. Gigabit Ethernet Interface.
    e. Graphics: Nvidia GeForce GT630, GTX 660, GTX760, GTX960 with latest drivers
    f. Microsoft .Net 4.5 framework
    g. Windows 7 SP1, 8.1, 10: Internet Explorer 11 (32 bit or 64 bit)

PART 3 - BRIEF SPECIFICATION

3.01 The Video Surveillance Media Server shall include, as a minimum, the following features/functions/specifications:

A. The system shall display any combination of live and recorded CCTV camera feeds on multiple workstations simultaneously using a TCP/IP Ethernet network. The system shall provide low latency video with high quality images and support H.264, MPEG-4, and Motion-JPEG compression schemes simultaneously. The system shall provide replication of individual video feeds at different frame rates for multiple users and other system processes. The system shall support simultaneous video feeds across multiple locations for centralized and decentralized storage, display, and distribution of video without limitation, but shall minimize load on video servers by streaming only the active video channels. The system shall be capable of streaming and recording video at different bit rates and variable frame rates up to full motion 60 fps video on all CCTV camera feeds and support QCIF, CIF and 4CIF, 720P, 1080P and Multi-Megapixel camera resolution. The system shall support multiple camera and encoder manufacturers. The system shall provide the ability to remotely control (pan, tilt, zoom) the CCTV cameras and support priority for PTZ control based on user privileges and scheduling, recurring or one-time, for PTZ camera movements. The system shall support digital pan-tilt-zoom on live or archived video. The system shall provide the ability to remotely configure the CCTV cameras and shall allow configuration data to be imported from a spreadsheet. The system shall allow instant replay of video and will permit pausing of live video, forward and backward review of recorded video, and return to live viewing. The system shall manage storage of real-time video at any specified frame rate, duration, and physical location on the network. The system shall provide flexible archiving capability in terms of frame rate, duration, and location and shall utilize dynamic file allocation to ensure that the full duration of the selected video stream will be recorded, regardless of lighting condition, motion, or scene detail. It shall support access to the archived video, to seek to any point in the archive, to set the pre and post time, and to loop that segment of the archive. The system will allow for redundant multi-site video storage. The system shall provide a Management Console that shows the status of CPU, Memory, Disk Usage, and traffic analysis. The system shall provide for automated discovery and configuration of endpoints. The system shall provide for integration with other software applications through an open and published Application Programming Interface (API). Such applications shall include, but not be limited to, access control, video analytics, and other alarms and sensor inputs. The system shall be capable of running on a single physical server

or distributed across the network, scaling to handle thousands of cameras and users. The system shall provide for or have the capability of interoperating with the functional modules providing the capability for multiple web-based display consoles to configure, manage, display, and control video throughout the IP network; multiple options to store video and audio; virtual matrix switching; client PC viewing; and, remote encoding and storage.

3.02 SUMMARY – Cisco Video Surveillance Manager Specified

A. The VSM shall be a platform solution optimized for applications to view, store, and manage real-time and recorded video in a networked environment. The system shall use an open suite of URL-based programmatic interfaces to communicate with applications. The VSM will provide a highly scalable and reliable platform to enable customized, network-based surveillance applications.

B. Performance Requirements:

1. Provide low latency video with high quality images
2. Display live and recorded IP VIDEO camera feeds on multiple workstations simultaneously using a TCP/IP Ethernet network.
3. Support thousands of simultaneous video feeds across multiple locations for centralized and decentralized storage, display, and distribution of video.
4. Support multiple camera and encoder manufacturers within the same system.
5. Support redundancy configurations including failover and complex high-availability scenarios
6. The system must support Cisco Medianet.

3.03 SYSTEM PERFORMANCE

A. The VSM Server shall include, as a minimum, the following features/functions/specifications:

1. The system shall display live and recorded IP VIDEO camera feeds on multiple workstations simultaneously using a TCP/IP Ethernet network.
2. The system shall provide low latency video with high quality images and support MPEG-4, H.264, and Motion-JPEG (MJPEG) compression schemes simultaneously.
3. The system shall provide replication of individual video feeds at different frame rates for multiple users and other system processes.
4. The system shall support simultaneous video feeds across multiple locations for centralized and decentralized storage, display, and distribution of video without limitation, but shall minimize load on video servers by streaming only the active video channels.
5. The system shall be capable of streaming and recording video at different bit rates and variable frame rates up to full motion 30 fps video on all IP VIDEO camera feeds and support QCIF, CIF,4CIF,720P (1280x760) and 1080P (1920x1080) camera resolution.
6. The system shall provide diagnostic tools that support Simple Network Management Protocol (SNMP). Version 2.0 or higher and shall further provide notification & API support for failure of encoders, archives and proxies.
7. The system shall provide for integration with other software applications through an open and published Application Programming Interface (API). Such applications shall include, but not be limited to, access control, video analytics, and other alarm and sensor inputs.
8. The system shall support multiple camera and encoder manufacturers.
9. The system shall provide the ability to remotely control (pan, tilt, zoom) the IP VIDEO cameras and support priority for PTZ control based on user privileges and scheduling, recurring or one-time, for PTZ camera movements.
10. The system shall support digital pan-tilt-zoom on live or archived video.

11. The system shall provide the ability to remotely configure the IP VIDEO cameras and shall allow configuration data to be imported from a spreadsheet.
12. The system shall allow instant replay of video and will permit pausing of live video, forward and backward review of recorded video, and return to live viewing.
13. The system shall manage storage of real-time video at any specified frame rate, duration, and physical location on the network.
14. The system shall provide flexible archiving capability in terms of frame rate, duration, and location and shall utilize dynamic file allocation to ensure that the full duration of the selected video stream will be recorded, regardless of lighting condition, motion, or scene detail. It shall support access to the archived video, to seek to any point in the archive, to set the pre and post time, and to loop that segment of the archive.
15. The system shall provide a Management Console that shows the status of CPU, Memory, Disk Usage, and traffic analysis.
16. The system shall provide / creates reports on user activity, device configuration, run-time, and application log and event history.
17. The system shall provide ability to create users, control their capabilities and integrate with LDAP
18. The system provide for or have the capability of interoperating with the following functional modules (see Para. 2.0.5):

    a. Video Surveillance Operations Management
    b. Video Surveillance Storage System
    c. Video Surveillance Video Display
    d. Client Viewing Software
    e. Access Control Systems
    f. Interoperability and Emergency Response Systems

3.04 HARDWARE REQUIREMENTS

A. The VMS Server shall run on standard commercial off-the-shelf computer server equipment based on Intel processors. The system shall be capable of running on a single physical server or distributed across the network, scaling to handle thousands of cameras and users. Servers shall meet the following minimum requirements:

    1. Intel Core 2 Duo Processor E4300 1.80 GHZ or greater
    2. Rack Mount Unit (4RU maximum)
    3. 8 GB DDR2 SD RAM
    4. Capability for up to 36 Internal Storage (3 TB disk and RAID 5)
    5. Dual Gigabit Ethernet Interface\
    6. RedHat Enterprise Server version 6.x Operating System

B. Video Surveillance Storage System – The video surveillance storage system shall provide multiple options to store video. VMS Server internal storage may be augmented by Direct Attached, SAN, or NAS storage. The video surveillance storage system shall store video in loops, one-time archives, or event clips triggered by alarm systems. It shall provide for redundant storage and remote long-term archival. The video surveillance storage system shall have the following capabilities:

    1. Direct Attached configurations
    2. Provide internal storage of over 19 TB Redundant archives
    3. RAID 5 configuration
    4. Clustering for failover protection
    5. Redundant power supplies and RAID controllers

C. Video Surveillance Matrix Server Software shall be an intelligent digital video system that allows any operator or integrated application to control the video being displayed on any number of monitors, whether local and remote. Must include an API to allow a web application to control the delivery of video to any number of viewing stations running the matrix client software. A command server must be able to connect to and display video streams from any media server. Operators shall be able to choose any number of available cameras to be displayed on any system monitors within any custom video display patterns. The video surveillance matrix server software shall be integrated with other systems to automatically display video in response to input triggers including access control systems, fire systems, motion sensors, and contact closures.

D. D. Operations Management - The Operations Management module shall provide the capability for multiple web-based display consoles to configure, manage, display, and control video throughout the IP network and include, as a minimum, health monitoring, support for the same interface for Administrative and Operations usage, ability to bulk import camera configurations, and Forensic Search. It must provide the ability to remotely create/burn/archive video

E. It must also provide the administrator and operator features/functions/specifications listed below.

1. Administrator functionalities:

    a. Server, encoder, and camera administration
    b. Scheduled and event-based video recording
    c. User and role management
    d. Bulk edit the camera streams
    e. Detailed activity reports and system audit
    f. Ability to push pre-defined views to any number of monitors with a command server
    g. Ability to schedule to operator shifts, event filters, temporary views
    h. Mass import capability allowing configuration data to be imported from a spreadsheet

2. Operator functionalities:

    a. Secure login
    b. Flexible video displays
    c. PTZ controls and presets
    d. Digital zoom and instant replay
    e. On-demand recording
    f. Video enhancements (adjusting brightness, color, transparency, etc.)
    g. Instantly swap between live and archive video of the same camera feed
    h. Archive review and clipping
    i. Event notifications
    j. Ability to search archived video based on motion within a predefined window within the video frame

3. Hardware Requirements - The Operations Management module shall have the option of being run on router hardware so no additional hardware needs to be deployed at remote site, or run on the same server as the VMS or on standard commercial off-the-shelf computer / server equipment based on Intel processors and meeting the following minimum requirements:

    a. Intel Core 2 Duo Processor E4300 1.80Ghz

b. 2 GB DDR2 SDRAM
c. 200 GB HDD
d. 100/1000 Ethernet Interface.
e. RedHat Linux Enterprise Server version 6.x

F. Client Viewing Software – Client Viewing Software shall allow an individual operator's PC to access and view video streams.

1. The Client Viewing Software shall be a stand-alone Windows program that plays video archive files without a browser or connection to the video surveillance system host.
2. The software shall have basic Archive Control functions for play back of JPEG, MPEG-2, and MPEG-4 archive files to include:

a. play forward
b. play backward
c. pause
d. step one frame forward
e. step one frame backward

3. This software shall have the ability to take a snapshot, set playing frame rate, skip frame, and search by time.
4. Supported file format types shall include:

a. WMV - A standard file format for downloading and playing audio/video data or to stream data on a PC.
b. AVI / MP2 -A standard file format for storing audio/video data on a PC.MP2
c. Clip (BWM) - An instance or single event in time.
d. Secure Clip (BWX) - A secured instance or single event in time.
e. CVA Cisco format
f. Streamable - Compressed real time video or audio downloaded over the Internet.
g. BMP, GIF, JPEG, PNG, and TIFF formats, savable as snapshots.

5. The viewing PC shall meet the following requirements:

a. Intel 950i7 Core -3.07 Ghz
b. 4GB RAM DDR3
c. Gigabit Ethernet (GigE) Network connection required
d. Windows XP or Windows Vista (32 bit) and Internet Explorer 6 or 7
e. DirectX 9.0c
f. NVIDIA Get Force GTX260 896MB PCIe

3.05 COMMAND AND CONTROL OPERATIONS CONSOLE

A. A scalable Command and Control style Security Operations Console (SecOps System) that unifies disparate, 3rd party video management systems, and access control systems, and supports the operation of the video surveillance management system, the physical access control system, and the IP-based dispatch and incidence response solution. The SecOps System must come in an appliance form factor and provide the following benefits – (1) Improved scalability for large and geographically distributed environments. (2) Complete view of facilities, sensors, and alarms in an easy-to-use and intuitive map-enabled graphical interface and (3) a comprehensive security alarms/events management system with a powerful workflow and business logic engine.

B. Performance Requirements

1. Collect and correlate events and alarms from single or multiple VSM and PAM solutions
2. Collect and correlate events and alarms from video management systems, access control systems and other intrusion detection systems
3. Allow security incidents, complete with details and video from both server based management systems and endpoints/cameras, to be dispatched into IPICS dispatcher application
4. Display sensors and alarms on GIS enabled or regular maps
5. Allow user to navigate maps in a hierarchical list or tree based security zones or logical groups
6. Display live and archive videos, take snapshots and create video clips
7. Control PTZ cameras
8. Control common operations such as lock and unlock on access doors
9. Video display in single windows or video matrix
10. Capability to trace a suspect across multiple camera views using video EZ track
11. Alarm display and alarm handling capability
12. Capability to automate alarm correlation and actions
13. Role based controls
14. Password management and strong authentication
15. Auditing and reporting
16. Trend analysis

C. General SecOps System Display Functionality

The SecOps System solution shall have the following general display functionality:

1. View and handle multiple alarms at one time
2. View multiple video windows at one time. Operators shall be able to resize and move video windows.
3. View windows in a single monitor or across multiple monitors
4. Access, display and manage events/alarms and related security data and information from subsystem based on priority and authority level.
5. View and manage detailed response procedures and tasks
6. Enable a single operator or multiple operators to monitor and control commands from connected subsystems, including all operational capabilities for detection, assessment, notification, entry control, and communications
7. Provide the rapid annunciation and display of alarms to facilitate evaluation and assessment

D. MAP DISPLAY

1. The SecOps System solution shall have the following map display functionality
2. View security environment through geospatial or fixed composite computer generated (JPEG, BMP, AutoCAD, etc.) map
3. Allow user to interactively drill down to specified security zones and sub-zones
4. Allow user to view sensor and related name from map console
5. Allow all resources, objects, sensors and elements on the map to be geo-referenced such that they have a real world coordinate.
6. Visually display a camera sensor with related camera orientation, camera range and camera field of view angle.
7. Visually display an alarming sensor on map
8. Visually differentiate sensor alarm severities on map through different color and icon

identifiers
9. Immediately view alarm details (including description, video, etc.) and investigate the alarm from the map
10. Allow user to choose camera from map to view live video
11. Allow user to choose camera and take live video image snapshot and save to file from any camera
12. Allow user to choose camera from map to move PTZ cameras
13. Allow user to choose camera icon from map to view recorded video from console
14. Allow user to choose camera to play, pause, stop, fast-forward, rewind, and play recorded video from preset time
15. Allow user to choose camera and take recorded video image snapshot and save to file or print from any live or recorded video
16. Allow user to take action on Access Control door from console to open unlock door, relock door, allow momentary access for door, lock down door, release lock down
17. Allow user to take query Access Control door from console to get last 5 activities for door, get activities for door in the last 5 minutes, get door activities for last hour, get door activities for the last day, etc.
18. Allow user to view badge photo ID from door activity results
19. Allow user to jump from one map to the next with a single click of a mouse with map links
20. Allow map information “layers” to be displayed/hidden on items such as,
21. Sensor names
22. Sensors
23. Sensor range (camera – orientation, range, field of view angle)
24. Security areas and zones
25. Perimeter ranges
26. Resource tracks
27. Allow user to zoom in/out on different regions of map graphic

E. Navigation

The SecOps System solution shall have the following navigational display functionality:

1. Allow user to navigate maps in a hierarchical list or tree based security zones or logical groups
2. Allow user to navigate to a map or security zone through the map interface and through a graphical hierarchical tree view
3. Allow user to quickly navigate to an open alarm through a hierarchical tree and related map.
4. Allow user to navigate to search by sensor name and be directed to related graphical map
5. Allow user to sort hierarchical tree by name of zone or area
6. Visually indicate in the hierarchical tree/list if a sensor in a security zone is in an alarm state.
7. Visually display the number of open alarms in a security zone or area in the hierarchical tree
8. “Bubble up” the visual indication of the highest severity alarm to the next higher level in hierarchical tree.

F. Search and Trace Capabilities

1. Allow user to search and find sensor(s) names with text “wildcards”
2. Allow user to search and find security zones and areas names with text “wildcards”
3. Allow user to search and find alert ID to quickly find alert and alert details
4. Allow user to search and trace all user activity related to a specific badge ID or user name
5. Allow user to search and trace all user activity related to a specific user name

G. Video Display

The SecOps System solution shall have the following video display functionality:

1. View live or recorded video from resizable and movable windows
2. Ability to perform video controls for video systems from PSOM workstation:

    a. Play, fast-forward, rewind, pause, and specify time to play recorded video
    b. Take a video still image (snapshot) from live or recorded video
    c. Export video for user specified time and duration
    d. Move PTZ cameras (if available)

3. View Video in Video Matrix

    a. Display in 1x1, 2x2, 3x3 and 4x4 window formats
    b. Enable predefined video windows to be displayed in matrix
    c. Enable operator to specify video windows to be displayed in matrix
    d. Enable matrix settings to be saved per user
    e. View either live or recorded video can be displayed in the video matrix window.
    f. Enable video snapshot to be taken and saved from any window pane in the matrix view

4. Rotate video in “virtual” video guard tour

    a. Rotate through multiple video views based on predefined video camera sequence and duration.
    b. Enable the user to pause the rotation of video and resume the video rotation again
    c. Enable times between new video to be adjusted
    d. Enable both live video and recorded video to be played through the video guard tour.
    e. Enable alarms to be generated from any video pane

5. Enable user to only view and control video for which they have been assigned permissions by the administrator
6. Manually create an alarm from the live or recorded video with specified severity and description

H. Summary Dashboard

1. Provide alarm summary of each monitoring zone or monitoring area in graphical chart format
2. Display the following charts per global area, monitoring zone or monitoring area

    a. Open Alert Count by Monitoring Zone/Monitoring Area
    b. New vs. Viewed (Opened Alerts)
    c. Open Alert Count by Alert Severity
    d. Highest Severity Alert

3. Enable Monitoring Zone or Monitoring area default to Summary view dashboard or to a map when the zone or area is selected.

I. Sensor List View

1. Provide a tabular list of sensors in each monitoring area
2. Enable each column in the table to be sorted

3. Enable each column to be filtered based on criteria
4. Enable actions to be taken on each sensor similar to the icon on the map

    a. For video cameras, choose the camera to view live video, recorded video, launch tracking capability, generate alert
    b. For access control door choose the door to unlock door, relock door, allow momentary access for door, lock down door, release lock down, get last 5 activities for door, get activities for door in the last 5 minutes, get door activities for last hour, get door activities for the last day, etc.

J. Alarm Display

The SecOps System solution shall have the following alarm display functionality:

1. Display real time, dynamic, iconic status of alarm point indications, overlaid onto a computer generated or GIS graphic map of the detection area and zone
2. Display textual alarm description alarm status, severity, activity, operator actions, tasks and procedures, and time/date status.
3. Allow users to view digital video scenes, automatically or manually, related to alarm for both live and recorded video
4. Allow users to handle alarms based on priority
5. Allow users to handle and view multiple alarms in individual windows or in a list
6. Allow users to view alarm notification in system tray
7. Allow users to view alarm notification and alarm summary in alert list window pane
8. Allow users to view alarm notification in the hierarchical tree view
9. Allow users to view alarm in a specific security zone and associated with specific sensor on the map
10. Allow users to view a list of alarms associated to a sensor on the map
11. Sort alarms list status by time/date
12. Sort alarm list by severity (i.e. highest severity on top)
13. Sort alarm list by alarm type
14. Sort alarm list by location
15. Allow users to choose which columns (details) are shown in the alarm list
16. Allow users to scroll through multiple queued alarms
17. Display associated queued video with each alarm
18. Filter alarms by severity, status, sensor name, alert types
19. Group alarms by type, location, sensor, etc.
20. Subgroup alarms by type, location, sensor, etc.
21. Have the same “look and feel” for different alarms generated or alarms generated from different systems

    a. All alarm details are displayed in the same places and information is consistent
    b. Video windows and controls are in the same place and can be displayed with the same controls
    c. Notes are in the same location for different alarm types
    d. Acknowledgement of alarms can be performed in the same way for different alarms types
    e. Vendor specific information is displayed in the same portion of the user interface

K. Alarm Handling

The SecOps System solution shall have the following alarm handling functionality:

1. Ability to display alarm condition through visual display and audible tone
2. Ability to simultaneously handle multiple alarms from multiple workstations
3. Ability to prioritize and display multiple alarms and status conditions according to pre-defined parameters such as alarm type, location, sensor, severity, etc.

    a. Display the highest priority alarm and associated video in the queue as default, regardless of the arrival sequence
    b. Place subsequent alarm in a queue according to predefined priorities without covering up or higher priority alarm

4. Ability to automatically present an integrated window of the incident and access to the following incident related information and actions with a single mouse click or less

    a. Related queued recorded video
    b. Related live video from related camera
    c. Related video PTZ controls (if camera is PTZ)
    d. Related local map image with location of alarm
    e. Related door activity
    f. Related alarm notes
    g. Acknowledge/close alarm
    h. Take a visual image snapshots of live or recorded video to be printed, saved to disk or saved as a part of the alarm
    i. Vendor specific sensor information (i.e. video analytics alarms may generate marked up images, etc.)

5. Ability to automatically display related response instructions and tasks for each alarm

    a. Tasks in checklist format
    b. When tasks have been updated
    c. Completion progress
    d. Provide option to require operator to complete specific task(s) before alarm can be acknowledged or closed

6. Ability to acknowledge or close alarms from central console and updates to be synchronized with related alarming security subsystems
7. Ability to enter notes during the alarm and notes information to be shared with other users of the system
8. Ability to view historical alarms that have been closed or acknowledged in the system to view activity, video, etc. (for duration of video being captured in the system)
9. Ability to automatically stamp note entries with time/date and operator user name
10. Enable new alerts to automatically open alert details window when alerts are received or for alerts to remain in the alerts list until a user clicks on the alert.
11. Ability to generate comprehensive alarm report within 30 seconds of alarm occurrence including alarm description, time/date, severity, location, maps, door activity (if available), video image snapshots (if taken), and response instructions (if available)
12. Ability to print comprehensive alarm report within 30 seconds of alarm occurrence including alarm description, time/date, severity, location, maps, door activity (if available), video image snapshots (if taken), and response instructions (if available)
13. Ability to email comprehensive alarm report within 30 seconds of alarm occurrence including alarm description, time/date, severity, location, maps, door activity (if available), video image snapshots (if taken), and response instructions (if available)
14. Ability for operator to quickly export associated video upon alarm occurrence.
15. Ability to automatically and manually escalate alarms

a. Automatically escalate alarms if alarm is not addressed within a predefined time frame. Enable alarm to be escalated to new group or user and actions to be taken.
b. Operator can escalate and redirect alarm directly from the PSOM workstation while working on the alarm
c. Alarms can be redirected or escalated to pre-configured user group or user.

16. Enable operator to generate a new alarm from map

    a. Automatically capture the alarm time and date
    b. Automatically capture the location of the alarm on the map
    c. Enable operator to specify severity, alarm type, and alarm description
    d. Enable appropriate response tasks to be associated with the alarms
    e. Enable other operators to see and handle alarm similar to other alarm types

17. Enable operator to generate a new video alarm while watching live or recorded video

    a. Automatically capture the alarm time and date
    b. Automatically capture the location of the alarm
    c. Automatically capture video image snapshot and link to related video
    d. Enable operator to specify severity and alarm description
    e. Enable other operators to see and handle alarm similar to other alarm types
    f. Enable appropriate response tasks to be associated with the alarms

18. Provide multiple alarm details display types based on operator experience

    a. Simple view which defaults to alarm details and response tasks where operator chooses icons to view additional information such as video, notes, etc
    b. All-in-one detailed views to provide operator with all relevant information at one time

19. Enable administrator to configure pop-up message if response tasks have not been completed for alarms before they are acknowledged or closed
20. Enable different sound types and sound files to be associated with different alarm types
21. Enable electronic voice playback of alarm and alarm description

L. Historical Alarm Handling

The SecOps System solution shall have the following historical alarm handling functionality:

1. Ability to view historical alarms details even after the alarm has been acknowledged or closed.
2. Ability to sort alarms according to date/time, severity, type, and sensor ID or location.
3. Ability to group alarms according to date/time, severity, type, and sensor ID or location.
4. Ability to view associated alarm description, time/date, severity, location, maps, door activity (if available), video image snapshots (if taken), and response instructions (if available) and related queued video from time of alarm.

M. Auditing

The SecOps System solution shall have the following auditing capabilities:

1. Ability to store and log all activities related to alarm

    a. When alarm is created in PSOM system

b. When alarm is viewed by operator
c. When alarm is acknowledged, closed, or deleted
d. Actions taken on related sensor resources
e. Video snapshot images taken by operator
f. Notes entered by operator for alarm
g. Reports generated

2. Ability to display all activities while alarm is open
3. Ability to display all activities after alarm is acknowledged or closed
4. Ability to display activities on monitor and print report
5. Ability to export alarm report in various formats including pdf, jpeg, html, txt, and mht formats

N. Alarm Reporting

The SecOps System solution shall have the following alarm reporting capabilities:

1. Ability to generate a full incident report within 30 seconds of the alarm being generated.
2. Ability to display report on monitor and print report
3. Ability to select information to be included in report at time of report generation.

a. Details of alarm including severity, time/date, description and location
b. Map of surrounding area associated with alarm
c. Associated door activity and badge holder information if access control alarm
d. Captured video image snapshots
e. Response instructions
f. Alarm activities (audit trail)

4. Ability to export alarm report in various formats including pdf, jpeg, html, txt, and mht formats
5. Ability to generate an alarm incident package including the full incident report and exported video from the incident in a specific folder location.

O. Trend Reporting

The SecOps System solution shall have the following trend reporting capabilities:

1. The PSOM system shall allow generation of security trend reports to provide insight for proactive in resource planning and pinpoint specific problem areas and sensors.

a. Alarm Count Daily Report
b. Alarm Count Hourly Report
c. Alarm Detail Report
d. Alarm Response Time by Alarm Type Report
e. Operator Alarm Count Report
f. Operator Alarm Response Time Report
g. Operator End of Shift Report
h. Top X Alarm Response Time Report
i. Top X Alarms by Alarm Type Report
j. Top X Alarms by Area Report
k. Top X Alarms by Sensor Report
l. Top X False Alarms by Sensor Report
m. Top X Simulated Alarms By Sensor Report

2. Ability to display report on monitor and print report
3. Allow reports to be generated and filtered based on different criteria including

    a. Time
    b. Date
    c. Area/Location(s)
    d. Sensor(s)
    e. Alarm type and source
    f. Alarm severity
    g. Simulated alarms

4. Create predefined report templates based on different criteria
5. Ability to customize the look and feel of the report

    a. Chart Type
    b. Enable/Disable Chart
    c. X-Axis and Y-Axis labels
    d. Color Scheme

6. Ability to save report templates to be reused at a later time
7. Ability to export report in various formats including pdf, jpeg, html, txt, and mht formats

P. Video Tracking

The SecOps System solution shall have the following video tracking capabilities:

1. When operator is viewing video from an existing camera, automatically display video from adjacent cameras

    a. Select the direction of movement to show adjacent video
    b. Follow a suspect/object moving from one camera view to the next camera view by selecting one of the next camera views
    c. Simultaneously watch current field of view while also viewing video from adjacent cameras
    d. Should not require operator to memorize or enter in camera names/IDs or times.
    e. Support live or recorded video
    f. Fast-forward, rewind, pause or stop recorded video
    g. Ability to track suspect/object forwards and backwards (if supported by video management system)

2. Ability to automatically build a track report when the operator moves from one camera to the next camera

    a. Record camera ID and name
    b. Record time and date
    c. Record and update video still image

3. Ability to replay the path of the object suspect including

    a. Camera ID and name
    b. Time and date
    c. Video still image
    d. Animated map with associated camera location on map

e. Breadcrumb trail showing the path of the object/suspect from camera to camera
f. Recorded video for each video track

4. Ability to generate 'track' report including camera IDs, video snapshots, times/dates, and map locations
5. Ability to export report in various formats including pdf, jpeg, html, txt, and mht formats

3.06 USERS

A. The SecOps System solution shall have the following user capabilities:

1. Enable multiple users to access system simultaneously
2. Enable multiple users to handle the same alarm at one time
3. Enable single or multiple users to view and manage alarms in defined areas
4. Enable changes (acknowledge/close/escalate/add comment) by one user to be seen by other users

3.07 PERMISSIONS AND GROUPS

A. The SecOps System solution shall have the following user and group permission capabilities:

1. Ability to utilize Windows security and Microsoft SQL Server security (Windows Authentication or SQL Server Authentication)
2. Ability to provide multiple security groups and roles:

a. Operators – to access operational functionality in the user interface.
b. Administrators – to access both the operational functionality and administrative and system related configuration functionality in the user interface.
c. Power Users – to access operational functionality and some limited administrative functionality
d. Video Viewer – to access video console only, and granted scope of hierarchy only
e. Mobile Operator – to access alarms via PDA or Smartphone

3. Ability to create new users with login and passwords and assign users to the appropriate security groups
4. Ability to search and auto-filter user lists to find specific users
5. Ability to assign security groups/roles to

a. View individual security zones and maps
b. View alarms in specific security zones and locations
c. View and control sensors in specific security zones and locations
d. Configure system including maps, sensors, policies, permissions, users

6. Ability to grant or revoke the permission of the following functionalities to each security group/role

a. Access Administration Console
b. Access Operation Console
c. Access Video Console
d. Access Business Logic Console
e. Access Alert Manager
f. Access Video Tracking
g. Access Report Wizard

h. Acknowledge Alert
i. Close Alert
j. Delete Alert
k. View Alert Details
l. View Deleted Alerts
m. Print Alert Details
n. Export Alert Details
o. Email Alert Details
p. Add Notes to Alert Details
q. Export Video
r. Video Snapshot
s. Create Video Alert
t. Run a Report
u. Save a Report
v. Save a Report as a New Report
w. Print a Report
x. Export a Report
y. Access Preferences
z. Identify a person via badge ID or image
aa. Limit access to recorded video to customizable timeframe

3.08 VMS SYSTEM ADMINISTRATION

A. The SecOps System solution shall have the following system administration capabilities:

1. Allow systems administration functionality to be configured through a graphical user interface
2. Ability to configure alarm policies and properties through user interface
3. Ability to configure maps through user interface
4. Ability to configure sensor locations through user interface
5. Ability to configure sensor properties through user interface
6. Ability to establish user access and permission levels through user interface
7. Ability to create new users, logins and passwords specific for each user through user interface
8. Ability to configure security zones through user interface
9. Ability to easily add/remove/edit sensors as a part of a security zone through user interface
10. Ability to configure all alarm priorities, text and graphics information, locate display alarm points, video displays/video recording and playback characteristics, password management, report generation and configuration and other related information
11. Ability to archive, retrieve database via database tools

3.09 CONFIGURATION WIZARD AND SETUP

A. The SecOps System solution to be able to be configured through a GUI based configuration wizard.

1. Ability to have entire PSOM solution configured and functional through the configuration wizard
2. Ability to have a checklist of items that need to be completed for each step
3. Ability to have a progress meter to view progress of installation
4. Ability to stop and resume the configuration at a later time
5. Ability to view configuration tips and tricks
6. Ability to link to the specific PSOM configuration screen for setup if required

3.10 MAP ADMINISTRATION

A. The SecOps System solution shall have the following map administration capabilities:

1. Ability to import map images from AutoCAD, BMP, JPEG and other standard image files
2. Ability to geospatially reference maps and sensors on maps to real-world coordinates
3. Ability to logically group maps and organize hierarchically
4. Ability to add sensors to map, such as cameras and ACS doors, etc,
5. Ability to display camera properties on map such as camera orientation, camera field of view angle, and camera range.
6. Ability to represent different sensors types with different icons
7. Ability to create security zones on map represented by polygon shapes to allow the operator to visually distinguish the different regions
8. Ability to apply permissions to maps such that different groups and authority levels can only see the maps for which they have privileges to view
9. Ability to display only security maps, sensors and alerts associated with security zone
10. Ability to create links on the map to move back to the previous map views, move to another map, adjacent map (left, right, up, down, custom link), or go to the top level map with a single click of a button
11. Ability to search and auto-filter security zones and areas to find specific zones/areas in large environments

3.11 VMS SENSOR ADMINISTRATION

A. The SecOps System solution shall have the following sensor administration capabilities:

1. Ability to sustain frequent additions/removal/changes to sensors and sensor properties
2. Ability to easily accommodate new sensor types such as access control alarms, intrusion alarms, video systems, etc. which may be added at a later date
3. Ability to browse sensor subsystem for related sensor name or ID to add the sensor to the PSOM system
4. Ability to update maps and graphical elements through graphical user interface
5. Ability to define properties and details of sensors

    a. Name
    b. Description
    c. Location
    d. Position
    e. Camera Specific - Field of view angle, distance, direction, type
    f. Mapping to subsystem

6. Ability to create sensor groups such that related sensors such as access control sensor and camera sensor can be in a sensor group to display appropriate video when alarm occurs or to correlate multiple alarms together in the group
7. Allow more than one of the same type of sensor (camera, access control, intrusion alarm, etc.) to be added to the same group such that multiple cameras can be displayed per alarm or multiple alarms from similar devices can be correlated.
8. Ability to search and auto-filter sensor lists to find specific sensor(s) in large sensor lists
9. Ability to bulk import sensors and sensor configuration from xml, excel, or CSV file
10. Ability to bulk monitoring area names with members from xml, excel, or CSV file
11. Ability to bulk export sensor configurations for any sensor types

3.12 ALARM POLICIES AND BUSINESS LOGIC ADMINISTRATION

A. The SecOps System shall have the following ability to handle the workflow alarms through Visio-like graphical user interface:

1. Ability to be create an alarm policy to raise alarm in the PSOM system by defining conditions through configurable GUI-based business logic designer

    a. Ability to match keywords or text from the alarming subsystem's event description to raise an alarm using criteria including exact match, exact NOT match, contains match, wildcard match and regularly expression match (such as forced door alarm, denied access, door open too long, etc.)
    b. Ability to optionally match alarming subsystem's event status, event severity, and sensor type
    c. Ability to customize the alarm description the PSOM system to use the exact description from the Event Source, a predefined Alert Description, or any customer description.
    d. Ability to customize the alarm severity in the PSOM system based on the type of alarm subsystem event

2. Ability to apply the alarm policy across all alarm subsystems or only selected alarm subsystems with a single alarm policy
3. Ability to apply any alarm policy to one or more monitoring area(s) or zone(s) without having to reapplying the policy multiple times.
4. Ability to apply any alarm policy to one or more sensors without having to reapply the policy multiple times.
5. Ability to assign specific actions for each alarm

    a. Email
    b. Command line action
    c. Correlation and fusion of additional incident related information
    d. Alarm escalation

6. Ability to automatically correlate related data and information to be displayed in real-time for each alarm and related rule

    a. Correlate data or information from any security subsystem such as related live video, related recorded video, door activity, door commands, operator response instructions, map location, badge images, etc.
    b. Automatically display information in real-time when an alarm is generated.
    c. Display all correlated information together in attached windows when an alarm is generated.
    d. Automatically display related response instructions and tasks for each alarm and related rule

7. Ability to assign and apply business logic policy to specific sensors and or security zones
8. Ability to create business logic policy to support multi-decision, multi-action workflow for any alarm through a drag and drop GUI-based designer
9. Enable the following activities to be included in the business logic policy:

    a. Enable business logic activity to display live video
    b. Enable business logic activity to display recorded video based on a relative time offset from the alarm time

c. Enable business logic activity to display door activity based on configurable amount of time and/or events
d. Enable business logic decisions based on time of day
e. Enable business logic decisions based on severity
f. Enable business logic decisions based on location
g. Enable business logic decisions based on regular expression text matches
h. Enable business logic decisions based on security threat level
i. Enable business logic activity to escalate alarm after predefined time
j. Enable business logic activity to generate a new alarm
k. Enable business logic activity to make a call
l. Enable business logic activity to send email
m. Enable business logic activity to take action on sensor subsystem (ACS, camera commands, etc.)
n. Enable a custom Microsoft Power shell activity to be created and included in the business logic flow
o. Enable business logic to correlate multiple alarms together and take follow on action such as auto-acknowledging/closing prior alarms, creating new alarms, etc.
p. Enable business logic to activity to generate a report
q. Enable business logic to escalate an alert to notification service
r. Enable business logic to execute a web services call
s. Enable business logic to execute ODBC database call
t. Enable business logic to invoke an external method call
u. Enable business logic to generate a report on an incident in multiple report formats and with different customizable information
v. Enable business logic to automatically send report to a predefined email
w. Enable business logic to take a HTTP SEND or GET action on predefined URL with or without authentication
x. Enable business logic to take a HTTPS SEND or GET action on predefined URL with or without authentication
y. Enable business logic to determine whether the current location of an alarm is within a specific geographic boundary/area
z. Simulate an alert and follow the step-by-step execution of the business logic prior to application of business logic in production environment
aa. Enable business logic to call another child business logic policy as a part of the main business logic activity
bb. Enable business logic activity to aggregate RSS or ATOM feeds, filter the feeds and create corresponding alert in the PSOM system
cc. Enable business logic to change the alarm context to that of another alarm
dd. Enable business logic to lock a specified door, relative door defined in an area or sensor group, or multiple doors defined in an area or group
ee. Enable business logic to open a specified door, relative door defined in an area or sensor group, or multiple doors defined in an area or group
ff. Enable business logic to open momentarily a specified door, relative door defined in an area or sensor group, or multiple doors defined in an area or group

10. Enable business logic policies to be saved, loaded and reused as necessary as business logic templates
11. Ability for simulate alarms through business logic designer
12. Enable multiple business logic policies to be deployed and to be processing at any one time
13. Ability to schedule business logic policies to run at specified times of the day, days of the week, monthly, or yearly within a specified or endless time range.
14. Ability to collapse multiple duplicate alarms to reduce alarm clutter

a. Ability for administrator to apply collapsing policies through PSOM administrative user interface
b. Ability to assign different collapsing policies to be assigned to different security zones and locations
c. Ability for alarms to be collapsed based on time duration, matches to sensor name, severity, and alert description regular expression
d. Allow user to view number of collapsed alerts through the operational user interface
e. Allow user to view the collapsed alerts and collapsed alerts details through the operational interface if required

15. Ability to set up automated escalation policies for different areas and locations

a. Escalate alarm if no activity is taken on alarm within predefined time period
b. Escalate alarm to predefined groups or users
c. Take actions on escalated alarms
d. Re-escalate alarm if no activity is taken on escalated alarm with new groups or users and actions.

3.13 AUTOMATED SENSOR UPDATES

A. The SecOps System solution shall have the following automated sensor update capabilities:

1. Ability to automatically add newly found subsystem sensors as a new sensor PSOM system
2. Ability to automatically add the newly found sensor to a corresponding monitoring area
3. Ability to automatically apply a business logic policy to the newly found sensor

3.14 PERMISSION ADMINISTRATION

A. The SecOps System solution shall have the following permission administration capabilities:

1. Ability to assign the following permissions to maps and security areas
2. Operator’s permission to perform all functions within that client software. These users cannot access the Administrator Console.
3. Administrator permission to access both the Operator Console and the Administration Console. This allows them to perform the same actions as Operators, as well as create, configure, modify and view the entire PSOM system.

3.15 COMMUNICATIONS WITH SECURITY SUBSYSTEMS

A. The SecOps System solution shall have the following communication capabilities with security subsystems:

1. Ability to view alarms and events in PSOM system from subsystems such as access control, video analytics, video management system, intrusion systems, etc.
2. Ability to send alarm status updates (acknowledgements, closing, deletion, etc.) from PSOM systems to each underlying subsystem
3. Ability to send action commands to underlying subsystems to take action such as move PTZ cameras, unlock/lock ACS doors, etc.
4. Ability to receive other alarms through an open web services interface.
5. Support multiple NVR/DVR vendors/models simultaneously
6. Support multiple Physical Access Control Systems simultaneously
7. Support multiple Video analytics Systems simultaneously

8. Support multiple Intercom Systems simultaneously
9. Support multiple other subsystems simultaneously
10. Integrate with News Feed via RSS
11. Integrate SNMP traps in to PSOM solution
12. Integrate WMI alerts in to PSOM
13. Integrate Syslog alerts in to PSOM

3.16 SECURITY FUNCTIONALITY

A. The SecOps System solution shall have the following security capabilities:

1. Ability to secure system through password and privilege protection provided by the operating system(s) using Windows authentication and by Microsoft SQL Server using SQL Server authentication.
2. Ability to communicate among major components utilizing SOAP (Simple Object Access Protocol). SOAP is a protocol for exchanging XML-based messages over a computer network, and the communication can be configured as HTTP or HTTPS for a more secure environment.
3. Ability to communicate over Secure Sockets Layer (SSL)

3.17 SYSTEM OPERATIONS

A. The SecOps System solution shall have the following system operations capabilities:

1. Ability to support unattended Operation

    a. SecOps System server services run even if a user is not logged in
    b. SecOps System server to return to normal activity after reboot without administrator intervention

2. Ability for administrator without database administration skills to configure and set up system
3. Ability for system to be easy to use and administer

3.18 PERFORMANCE

A. The SecOps System solution shall have the following system performance capabilities:

1. Ability to support thousands of configured sensors in the SecOps System console
2. Ability to support over 10,000 open alarms in the console
3. Ability to support over 100 PSOM operations consoles from a single PSOM server
4. Ability to support alert bursts of over 52 alarms per second

3.19 INSTALLATION

A. The SecOps System solution shall meet the following installation requirements:

1. The SecOps System server software comes preinstalled and is sold as an appliance
2. Ability for new subsystem integrations to be installed without having to reinstall the base SecOps System solution
3. SecOps System shall have a GUI-based integration manager that allows

    a. One or more integration with subsystem to be configured

b. Multiple instances of subsystem to be configured
c. Parameters for integrated subsystem to be specified
d. Connectivity and calls to subsystems to be automatically checked
e. Integration with subsystem to be removed

4. SecOps System shall have a GUI-based services configuration wizard that allows each of the SecOps System services and components to be configured.
5. Ability for SecOps System to be upgraded to the SecOps System version while maintaining all previously configured components - the maps, policies, sensors, and response workflow.

PART 4 - IP CAMERAS

4.01 SUMMARY

A. The Video Surveillance IP Camera (IP Camera) should be able utilize multiple compression formats and must support wide dynamic range, embedded security and monitoring, event notification, provision for Power over Ethernet (PoE), and various mounting options. The camera shall provide outputs to support both an NTSC or PAL analog video signal and an Internet Protocol (IP) packeted digital signal, for transmission via wireless or copper.

B. The IP camera will contain a digital signal processor-based (DSP) unit, whereby embedded firmware determines its characteristics and performance and for which firmware can be upgraded over the network to correct, enhance or change its characteristics.

C. Performance Requirements: The IP Camera shall include, as a minimum, the following features/functions/specifications:

1. The system shall provide high-resolution, real-time video images, encapsulated in Internet Protocol (IP) packets and presented through a 10/100BASE-T RJ-45 Ethernet network connection. The system shall provide full D1 video, 30 fps at 720 x 480 (NTSC) or 25 fps at 720 x 576 (PAL) and be scalable to D1, 4CIF, and CIF.
2. Optionally, the system shall provide IEEE 802.11 b/g wireless transmission, capable of data rates of 1 - 11 Mbps for 802.11b and 6 - 54 Mbps for 802.11g and shall support wireless security as provided by Wired Equivalent Privacy (WEP), Temporal Key Integrity Protocol (TKIP), Wi-Fi Protected Access (WPA), and Wi-Fi Protected Access Pre-shared key (WPA-PSK).
3. Wide dynamic range (102 dB typical) using 1/3” CMOS imager.
4. Ability to control image parameters, including automatic white balance, automatic back lighting, automatic gain control, DC auto/manual iris, sharpness, image quality, time stamp, and camera ID.
5. Daytime (color) and night (black and white) modes.
6. Dual IP video streams, each capable of operating in unicast or multicast mode with quality of service (QoS) tagging.
7. IP and analog video outputs.
8. Resolution at 1080p, D1, 4CIF, and CIF settings with operation at discrete settings to 30 frames per second.
9. Two-way audio and contact closure capability.
10. Optional 802.11 b/g transmission capability.
11. IEEE 802.1x Port-based security authentication and AES encryption.
12. Activity detection and event notification.
13. Ability to be upgraded over the IP network.
14. Must support Cisco Medianet

15. The system shall provide dual unicast or multicast MPEG-4 video data streams for simultaneous live viewing and archiving at different resolutions and frame rates. When dual streaming, one stream shall provide up to 4 CIF capability at 25/20 (NTSC/PAL) frames per second, and the other stream shall provide CIF capability at 25/20 (NTSC/PAL) frames per second. The system shall allow for switched, multicast network architectures.
16. The system shall provide options for constant bit rate (CBR) or variable bit rate (VBR) with ceiling.
17. The system shall be capable of detecting activity within a pre-defined area of the image and issuing notifications as a result.
18. The system shall be compatible with the Cisco Video Surveillance network software.
19. The system shall have an embedded Linux™ operating system to provide distributed video processing and support true open network standards.
20. The system shall support the following protocols: Internet Protocol (IP), User Datagram Protocol (UDP), Transmission Control Protocol (TCP), Dynamic Host Control Protocol (DHCP), Address Resolution Protocol (ARP), Interior Gateway Management Protocol (IGMP) 3.0, Domain Naming System (DNS), File Transfer Protocol (FTP), Hypertext Transfer Protocol (HTTP and HTTPS), Real-Time Transport Protocol (RTP), Real-Time Streaming Protocol (RTSP), Simple Mail Transfer Protocol (SMTP), Secure Socket Layer/Transport Layer Security (SSL/TLS), Network Time Protocol (NTP), Secure Shell (SSH), and Simple Network Management Protocol (SNMP) 2.0.
21. The system shall provide quality of service (QoS) tagging based on IEEE 802.1p and DiffServ standards.
22. The system shall support 802.1x port-based security and AES encryption.
23. The system shall contain 64 MB flash and 128 MB SDRAM memory.
24. The system shall contain an imager chip of 1/3” CMOS, which shall be capable of providing up to 120 dB dynamic range. A progressive scan image sensor with global electronic shuttering shall provide natural color rendition, zero blooming and smear, and minimal motion blurring. Image control features shall include color level, brightness, contrast, automatic white balance, automatic back lighting, automatic gain control, DC auto/manual iris, sharpness, image quality, exposure control, time stamp, and camera ID. The system shall operate satisfactorily at light levels .4 lux in daytime color mode and .04 lux in black and white night mode (F1.4). The system shall provide a minimum signal-to-noise ratio (SNR) of 48 dB.
25. The system shall be capable of receiving firmware upgrades over the IP network.
26. The system shall provide a standard analog video output signal via BNC connector.
27. The system provide a built-in microphone and bi-directional audio channel, based on G.726 compression with 8 KHz sampling, with capability for full duplex, half-duplex, or simplex transmission.
28. The system shall provide an RS-485 bi-directional data channel, capable of supporting Cisco-D protocol.
29. The system shall provide two (2) bi-directional alarm inputs and outputs, logic level programmable.
30. System software shall allow configuration support for:

    a. 1 or 3 user definable detection areas
    b. NTSC or PAL
    c. Image settings: color level, brightness, sharpness, contrast, white balance, exposure control
    d. Time, date, and camera ID overlay
    e. Selection of bit rate (constant or variable)
    f. IP filtering: allowed or blocked addresses
    g. IE 5.x or later browser configuration

31. The camera shall create and maintain log files. One log file shall contain information about

the operating status of the camera and its connection to the network; the other shall contain an event log that includes each the method by which each alarm was triggered and the date and time that each alarm ends.

32. The camera shall be able to be configured to synchronize its internal date and time to a designated NTP server.
33. Access to the camera through the network shall be controlled by two user levels of protection. Each level shall have its own configurable login credentials and provide configurable privileges, which control access to camera features.
34. The camera shall be able to capture individual JPEG snapshots from the video stream, and shall provide the capability to save each JPEG image on a designated computer hard drive.
35. The camera shall provide a monochrome night mode operation. This mode shall use the removable IR filter, which shall activate automatically under low light conditions.
36. The camera shall support event-based scheduling for handling motion- or alarm-triggered streaming video. The functionality shall include options for daily, weekly, and weekend, and holiday scheduling.
37. The IP camera must stream 30 frames per second (fps) at D1 (720 x 480, NTSC) resolution or 25 fps at D1 (720 x 576, PAL) utilizing IP Protocol over an Ethernet network.
38. The system shall be capable of being powered by a 12 VDC power supply or Power over Ethernet (PoE, 802.3af), 48 VDC @.3A.
39. The system shall have an operating temperature of 0°C to 50°C, ambient, a storage temperature of -40°C to +85°C, ambient, a relative humidity ability of 0% to 95% (non-condensing) at 50°C, and a MTBF of > 100,000 hours.
40. The system radiated emissions shall be compliant with FCC Part 15, Class A, and EN55022 specifications.

4.02 USB JOYSTICK CONTROLLER

A. The U S B Joystick can be used in conjunction with a complete network-based video system product, and it shall be the point from which all user functions can be accessed. The keyboard shall be compatible with all Cisco VSM distributed, network-based video products. One keyboard can control all system cameras through either a PC or video console display.

B. Operator can use standard Windows PC Compatible Keyboard and Mouse concurrently.

Product Specification

Product Configuration Breakdown

HFX-4	HFX joystick model 1400, 3 axes with pushbuttons
5	3 axes with 2 pushbuttons
S	square limiter plate
0	flush mounting
0	0V to +5V Rail to Rail
-U	USB
MJ4S	Housing

Extension Number:

Log update	
Date	Initials

Extension Number Description:

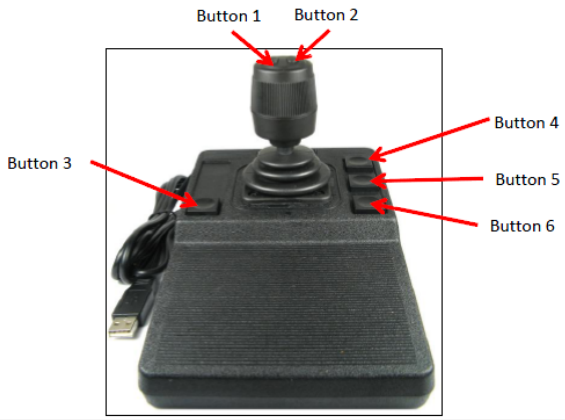
USB = Invert "Y" axis

MJ4S Housing

Use Loctite 4204 Glue on Sensor Holders

Use Super lube Grease on Bell, Spring, Shaft

Firmware # 520-127 **oem3_6_rev-A.hex**



Product Picture:



CH Products
970 Park Center Drive
Vista, CA 92081
760.598.2518

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Product Number:		
HFX-45S00-U-MJ4S		
Size:	(A) 11in x 8.5in	
Date:	2/15/2013	
Creator:	VS	Page 1 of 1
Product Revision:		**A**

4.03 PAN, TILT & ZOOM IP DOME CAMERA, HIGH-DEFINITION

The following are the minimum requirements for the Pan, Tilt, Zoom dome cameras, to be utilized throughout the project. Exterior locations and interior locations shall utilize the appropriate apparatuses, specific to that location, and for optimal viewing capabilities.

The manufacturer and model shall be Sony SNCER585, for all PTZ camera locations, unless otherwise specified on the system layout.

A. Indoor Locations – flush-mounted, clear dome, highest zoom capability and image quality currently available from manufacture, vandal-resistant dome and enclosure.

B. Outdoor Locations -– clear dome, highest zoom capability and image quality currently available from manufacture, environmental housing with heater blower, vandal-resistant dome and enclosure, parapet mount for rooftops or wall-mount bracket as appropriate.

4.04 INDOOR / OUTDOOR CAMERA DOME POSITIONING SYSTEM

A. The indoor/outdoor camera dome system shall provide a 100Base-TX network interface for live streaming to a standard Web browser.

A. The indoor/outdoor camera dome system shall be a discreet camera dome system consisting

of a dome drive with a variable speed/high speed pan/tilt drive unit with continuous 360° rotation; 1/4-inch high resolution color, monochrome, or color/black-white CCD camera; motorized zoom lens with optical and digital zoom; auto focus; and an enclosure consisting of a back box, lower dome, and a quick-install mounting.

B. The indoor/outdoor network positioning camera shall support standard IT protocols.

C. The indoor/outdoor network positioning camera shall use a standard Web browser interface for remote administration and configuration of camera parameters. The browser interface shall provide PTZ control including preset and pattern and on-screen display (OSD) for access to camera programming.

D. The indoor/outdoor network positioning camera shall have a window blanking feature to conceal user-defined privacy areas that cannot be viewed by an operator. The indoor/outdoor camera dome system shall support up to eight blanked windows. A blanked area shall appear on the screen as a solid gray window.

E. The indoor/outdoor network positioning camera shall feature open architecture connectivity for third-party software recording solutions allowing integration into virtually any IP-based system. It is also compatible with Cisco VSM and Digital Sentry® video management systems. As with all Cisco IP camera solutions, Spectra® IV IP is Cisco VSM Enabled™ to record, manage, configure, and view multiple live streams.

F. The network camera shall provide an additional processor for running Cisco Video analytics.

1. Cisco Analytic Suites shall be configured and enabled using a standard Web browser.
2. Cisco Analytic Suites shall allow remote operation and alarm notification when used with an Cisco VSM system or a third-party system that supports Cisco's Analytics API.
3. Cisco Analytics for EP High Definition Digital Network Cameras including:

    a. Abandoned Object: Detects objects placed in a defined zone and triggers an alarm if the object remains in the zone longer than the user-defined time allows. An airport terminal is a typical installation for this behavior. This behavior can also detect objects left behind at an ATM, signaling possible card skimming.
    b. Adaptive Motion: Detects and tracks objects that enter a scene and then triggers an alarm when the objects enter a user-defined zone. This behavior is primarily used in outdoor environments with light traffic to reduce the number of false alarms caused by environmental changes.
    c. Camera Sabotage: Detects contrast changes in the field of view. An alarm is triggered if the lens is obstructed with spray paint, a cloth, or a lens cap. Any unauthorized repositioning of the camera also triggers an alarm.
    d. Directional Motion: Generates an alarm in a high traffic area when a person or object moves in a specified direction. Typical installations for this behavior include an airport gate or tunnel where cameras can detect objects moving in the opposite direction of the normal flow of traffic or an individual entering through an exit door.
    e. Loitering Detection: Identifies when people or vehicles remain in a defined zone longer than the user-defined time allows. This behavior is effective in real-time notification of suspicious behavior around ATMs, stairwells, and school grounds.
    f. Object Counting: Counts the number of objects that enter a defined zone or cross a tripwire. This behavior might be used to count the number of people at a store entrance/exit or inside a store where the traffic is light. This behavior is based on tracking and does not count people in a crowded setting.
    g. Object Removal: Triggers an alarm if an object is removed from a defined zone. This

behavior is ideal for customers who want to detect the removal of high value objects, such as a painting from a wall or a statue from a pedestal.

h. Stopped Vehicle: Detects vehicles stopped near a sensitive area longer than the user-defined time allows. This behavior is ideal for airport curbside drop-offs, parking enforcement, suspicious parking, traffic lane breakdowns, and vehicles waiting at gates.

4. Cisco Analytic Suites shall be preloaded or configuration and alarm notification when used with a Cisco VSM® system or a third-party system that supports Cisco's Analytics API. Multiple Cisco behaviors can be scheduled to work during a certain time or condition.

4.05 Additional Cisco Safety & Security Component SKUs and Warranty Data

Cisco Safety K& Security component Part Number	Description	Service Duration (Months)
CIVS-IPC-8020=	5MP H265 Indoor Dome Camera	---
CON-SSSNT-CIVS8020	SOLN SUPP 8X5XNBD 5MP H265 Indoor Dome Camera	12
CIVS-IPC-8020-S	Cisco Video Surveillance IP Camera, 5 MP Indoor Smoked Dome	---
CON-SSSNT-CIVS802S	SOLN SUPP 8X5XNBD Cisco Video Surveillance IP Camera, 5 MP	12
CIVS-IPC-8030=	Cisco Video Surveillance IP Camera, 5MP H265 Outdoor Dome	---
CON-SSSNT-CIVS8IPC	SOLN SUPP 8X5XNBD Cisco Video Surveillance IP Camera, 5MP	12
CIVS-IPC-8030-S	Cisco Video Surveillance IP Camera, 5MP H265 Outdoor Smoked	---
CON-SSSNT-CIVPC803	SOLN SUPP 8X5XNBD Cisco Video Surveillance IP Camera, 5MP	12
CIVS-IPC-8620=	Cisco Dome IP Camera, Indoor, 1080p Dome, WDR PRO	---
CON-SSSNT-CIVSIP86	SOLN SUPP 8X5XNBD Cisco Dome IP Camera, Indoor, 1080p, Dom	12
CIVS-IPC-8620-S	Cisco Dome IP Camera, Indoor, HD, H.265 WDR Camera	---
CON-SSSNT-CIVSI862	SOLN SUPP 8X5XNBD Cisco Dome IP Camera, Indoor, HD, H.265	12
CIVS-IPC-8630=	Cisco Dome IP Camera, Outdoor, 1080p Dome, WDR Pro	---
CON-SSSNT-CIVSIPV0	SOLN SUPP 8X5XNBD Cisco Dome IP Camera, Outdoor, 1080p Dom	12
CIVS-IPC-8630-S	Cisco Video Surveillance Camera, Outdoor HD H265, WDR Smoked	---
CON-SSSNT-CIVIP863	SOLN SUPP 8X5XNBD Cisco Video Surveillance Camera, Outdoor	12

CIVS-IPC-8000P	5MP H265 Box Camera	---
CON-SSSNT-CIVS8000	SOLN SUPP 8X5XNBD 5MP H265 Box Camera	12
CIVS-IPCA-VCM4.1-9	LENS,DV2.2x4.1SR4A-SA2L,FUJINON	---
CON-SSSNT-CIVSIPC9	SOLN SUPP 8X5XNBD LENS,DV2.2x4.1SR4A-SA2L,FUJINON	12
CIVS-IPC-8400=	Cisco Video Surveillance IP Camera, 5MP H265 Outdoor Bullet	---
CON-SSSNT-CIVS4IPC	SOLN SUPP 8X5XNBD Cisco Video Surveillance IP Camera, 5MP	12
CIVS-IPC-8070=	Cisco 12MP Fisheye Camera	---
CON-SSSNT-CIVSI807	SOLN SUPP 8X5XNBD Cisco 12MP Fisheye Camera	12
CIVS-IPC-8930=	Cisco Video Surveillance HD Outdoor IP PTZ Camera	---
CON-SSSNT-CIVSI930	SOLN SUPP 8X5XNBD Cisco Video Surveillance HD Outdoor IP P	12
CIVS-8KA-MOUNT	Mount for 8000 series cameras	---
CIVS-8KA-EXT=	Pendant Pipe (40cm)	---
CIVS-8KA-POLEMNT	Pole Mount for 8000 series cameras	---
CIVS-8KA-CORMNT	Corner Mount for 8000 series cameras	---
CIVS-8KA-JBOX	Junction box	---
CIVS-8KA-CONBOX=	Outdoor Conduit Box for 8630 Cisco IP camera	---
CIVS-6KA-GNECK=	Goose Neck Mount for 35xx, 6k, and 7030 IP Domes	---
CIVS-8KA-ADPPLT=	Adapting Plate for 8070 Cisco IP camera	---
CIVS-6KA-PENHEAD=	Ceiling mount for 35xx, 6k, and 7030 IP Domes	---
CIVS-9KA-MOUNT	Mounting adapter for SD9361	---
CIVS-8KA-CTMSURF	Surface Mount Adapter for 8000 Series Cameras	---
CIVS-8KA-CTMFLSH	New Flush mount for 8000 series	---
L-CPS-SASD-7=	EDelivery License for 1 VSM Safety Security Desktop	---
CON-SAS-LCPSSASD	SW APP SUPP EDel Lic for 1 Safety and Security Deskt	12
L-CPS-VSM7-1CAM=	EDelivery License for 1 camera connection with VSM7	---
CON-SAS-LCPSVSM7	SW APP SUPP EDel Lic for 1 camera Conn with VSM7	12
L-CPS-VSOM7-C-VM=	EDelivery License for one Operations Manager on C Series	---
CON-SAS-LCPSVSOC	SW APP SUPP EDel Lic for one Ops Manager on C Series	12

4.06 Representative Cisco Media Server for 3260 Configuration		
L-CPS-VSMS7-C-VM=	EDelivery License for one Media Server on C Series	---
CON-SAS-LCPSVCOMPTON USD	SW APP SUPP EDel Lic for one Media Srv on C Series	12
UCS-C3260-SA-D	UCSC C3260 for Video Surveillance Solutions	---
CON-SNT-C3260SAD	SNTC 8X5XNBD, Colusa Bundle TBD	12
CAB-N5K6A-NA	Power Cord, 200/240V 6A North America	---
UCS-C3X60-G2SD48	UCSC C3X60 480GB Boot SSD (Gen 2)	---
UCSC-C3X60-RAIL	UCS C3X60 Rack Rails Kit	---
UCSC-PSU1-1050W	Cisco UCS 1050W AC Power Supply for Rack Server	---
UCSC-C3X60-BLKP	Cisco UCS C3X60 Server Node blanking plate	---
UCSC-C3160-BEZEL	Cisco UCS C3160 System Bezel	---
UCSC-C3260-SIOC	Cisco UCS C3260 System IO Controller with VIC 1300 incl.	---
N20-BBLKD-7MM	UCS 7MM SSD Blank Filler	---
UCSC-C3X60-SBLKP	UCS C3x60 SIOC blanking plate	---
UCS-S3260-M5SVR3	C3000 M5 ServerNode 2x5118 CPU, Memory, RAID Controller	---
UCS-CPU-5118	2.3 GHz 5118/105W 12C/16.50MB Cache/DDR4 2400MHz	---
UCS-MR-X32G2RS-H	32GB DDR4-2666-MHz RDIMM/PC4-21300/dual rank/x4/1.2v	---
UCS-S3260-DRAID	UCS S3260 Dual Raid based on LSI 3316	---
UCS-S3260-M5HS	UCS S3260 M5 Server Node HeatSink	---
UCS-C3K-56HD10E	UCS C3X60 4row of 56x 10TB 512e NL-SAS drives (56Total)560TB	---
UCS-C3K-10TEM	Cisco UCS C3000 10TB (512e) Top Load	---
VMW-VSP-STD-1A=	VMware vSphere 6 Standard (1 CPU), 1-yr, Support Required	---
CON-ISV1-VSXSTD1A	VSphere Standard for 1 CPU; ANNUAL List 1-YR Reqd	12
UCS-VMW-TERMS	Acceptance of Terms, Standalone VMW License for UCS Servers	---
Cisco Safety K& Security component Part Number	Description	Service Duration (Months)
CIVS-IPC-8020=	5MP H265 Indoor Dome Camera	---

CON-SSSNT-CIVS8020	SOLN SUPP 8X5XNBD 5MP H265 Indoor Dome Camera	12
CIVS-IPC-8020-S	Cisco Video Surveillance IP Camera, 5 MP Indoor Smoked Dome	---
CON-SSSNT-CIVS802S	SOLN SUPP 8X5XNBD Cisco Video Surveillance IP Camera, 5 MP	12
CIVS-IPC-8030=	Cisco Video Surveillance IP Camera, 5MP H265 Outdoor Dome	---
CON-SSSNT-CIVS8IPC	SOLN SUPP 8X5XNBD Cisco Video Surveillance IP Camera, 5MP	12
CIVS-IPC-8030-S	Cisco Video Surveillance IP Camera, 5MP H265 Outdoor Smoked	---
CON-SSSNT-CIVPC803	SOLN SUPP 8X5XNBD Cisco Video Surveillance IP Camera, 5MP	12
CIVS-IPC-8620=	Cisco Dome IP Camera, Indoor, 1080p Dome, WDR PRO	---
CON-SSSNT-CIVSIP86	SOLN SUPP 8X5XNBD Cisco Dome IP Camera, Indoor, 1080p, Dom	12
CIVS-IPC-8620-S	Cisco Dome IP Camera, Indoor, HD, H.265 WDR Camera	---
CON-SSSNT-CIVSI862	SOLN SUPP 8X5XNBD Cisco Dome IP Camera, Indoor, HD, H.265	12
CIVS-IPC-8630=	Cisco Dome IP Camera, Outdoor, 1080p Dome, WDR Pro	---
CON-SSSNT-CIVSIPV0	SOLN SUPP 8X5XNBD Cisco Dome IP Camera, Outdoor, 1080p Dom	12
CIVS-IPC-8630-S	Cisco Video Surveillance Camera, Outdoor HD H265, WDR Smoked	---
CON-SSSNT-CIVIP863	SOLN SUPP 8X5XNBD Cisco Video Surveillance Camera, Outdoor	12
CIVS-IPC-8000P	5MP H265 Box Camera	---
CON-SSSNT-CIVS8000	SOLN SUPP 8X5XNBD 5MP H265 Box Camera	12
CIVS-IPCA-VCM4.1-9	LENS, DV2.2x4.1SR4A-SA2L,FUJINON	---
CON-SSSNT-CIVSIPC9	SOLN SUPP 8X5XNBD LENS, DV2.2x4.1SR4A-SA2L, FUJINON	12
CIVS-IPC-8400=	Cisco Video Surveillance IP Camera, 5MP H265 Outdoor Bullet	---
CON-SSSNT-CIVS4IPC	SOLN SUPP 8X5XNBD Cisco Video Surveillance IP Camera, 5MP	12
CIVS-IPC-8070=	Cisco 12MP Fisheye Camera	---
CON-SSSNT-CIVSI807	SOLN SUPP 8X5XNBD Cisco 12MP Fisheye Camera	12

CIVS-IPC-8930=	Cisco Video Surveillance HD Outdoor IP PTZ Camera	---
CON-SSSNT-CIVSI930	SOLN SUPP 8X5XNBD Cisco Video Surveillance HD Outdoor IP P	12
CIVS-8KA-MOUNT	Mount for 8000 series cameras	---
CIVS-8KA-EXT=	Pendant Pipe (40cm)	---
CIVS-8KA-POLEMNT	Pole Mount for 8000 series cameras	---
CIVS-8KA-CORMNT	Corner Mount for 8000 series cameras	---
CIVS-8KA-JBOX	Junction box	---
CIVS-8KA-CONBOX=	Outdoor Conduit Box for 8630 Cisco IP camera	---
CIVS-6KA-GNECK=	Goose Neck Mount for 35xx, 6k, and 7030 IP Domes	---
CIVS-8KA-ADPPLT=	Adapting Plate for 8070 Cisco IP camera	---
CIVS-6KA-PENHEAD=	Ceiling mount for 35xx, 6k, and 7030 IP Domes	---
CIVS-9KA-MOUNT	Mounting adapter for SD9361	---
CIVS-8KA-CTMSURF	Surface Mount Adapter for 8000 Series Cameras	---
CIVS-8KA-CTMFLSH	New Flush mount for 8000 series	---
L-CPS-SASD-7=	EDelivery License for 1 VSM Safety Security Desktop	---
CON-SAS-LCPSSASD	SW APP SUPP EDel Lic for 1 Safety and Security Deskt	12
L-CPS-VSM7-1CAM=	EDelivery License for 1 camera connection with VSM7	---
CON-SAS-LCPSVSM7	SW APP SUPP EDel Lic for 1 camera Conn with VSM7	12
L-CPS-VSOM7-C-VM=	EDelivery License for one Operations Manager on C Series	---
CON-SAS-LCPSVSOC	SW APP SUPP EDel Lic for one Ops Manager on C Series	12
Media Server for 3260 Configuration		
L-CPS-VSMS7-C-VM=	EDelivery License for one Media Server on C Series	---
CON-SAS-LCPSVCOMPTON USD	SW APP SUPP EDel Lic for one Media Srv on C Series	12

UCS-C3260-SA-D	UCSC C3260 for Video Surveillance Solutions	---
CON-SNT-C3260SAD	SNTC 8X5XNBD, Colusa Bundle TBD	12
CAB-N5K6A-NA	Power Cord, 200/240V 6A North America	---
UCS-C3X60-G2SD48	UCSC C3X60 480GB Boot SSD (Gen 2)	---
UCSC-C3X60-RAIL	UCS C3X60 Rack Rails Kit	---
UCSC-PSU1-1050W	Cisco UCS 1050W AC Power Supply for Rack Server	---
UCSC-C3X60-BLKP	Cisco UCS C3X60 Server Node blanking plate	---
UCSC-C3160-BEZEL	Cisco UCS C3160 System Bezel	---
UCSC-C3260-SIOC	Cisco UCS C3260 System IO Controller with VIC 1300 incl.	---
N20-BBLKD-7MM	UCS 7MM SSD Blank Filler	---
UCSC-C3X60-SBLKP	UCS C3x60 SIOC blanking plate	---
UCS-S3260-M5SVR3	C3000 M5 ServerNode 2x5118 CPU, Memory, RAID Controller	---
UCS-CPU-5118	2.3 GHz 5118/105W 12C/16.50MB Cache/DDR4 2400MHz	---
UCS-MR-X32G2RS-H	32GB DDR4-2666-MHz RDIMM/PC4-21300/dual rank/x4/1.2v	---
UCS-S3260-DRAID	UCS S3260 Dual Raid based on LSI 3316	---
UCS-S3260-M5HS	UCS S3260 M5 Server Node HeatSink	---
UCS-C3K-56HD10E	UCS C3X60 4row of 56x 10TB 512e NL-SAS drives (56Total)560TB	---
UCS-C3K-10TEM	Cisco UCS C3000 10TB (512e) Top Load	---
VMW-VSP-STD-1A=	VMware vSphere 6 Standard (1 CPU), 1-yr, Support Required	---
CON-ISV1-VSXSTD1A	VSphere Standard for 1 CPU; ANNUAL List 1-YR Reqd	12
UCS-VMW-TERMS	Acceptance of Terms, Standalone VMW License for UCS Servers	---

END OF SECTION

SECTION 28 21 10
INTEGRATION & CONFIGURATION OF EQUIPMENT & DEVICES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. As many school administrators struggle to learn about drug trafficking trends, gang identification, stranger danger, climates of bullying and the prevention of aggressive and the prevalence of violent behavior, even newer challenges have arrived at the schoolhouse doorway. Concealed weapons, homemade bombs, anthrax scares and other "new crimes for new times" now present school administrators with the formidable task of developing security and crisis preparedness guidelines at both building and district levels.

B. In addition to these "traditional" security threats, recent shifts in school violence in even the safest of schools and communities, school administrators, educators, and officials realize that "it could happen here." The community (including staff members, students, parents, politicians, lawyers, and the media) will want to know what has done to prevent these things from happening.

C. Compton Unified School District is located in in the south-central region of Los Angeles County, California. CUSD encompasses the city of Compton and portions of the cities of Carson and Los Angeles. The district currently serves nearly 26,000 students at 36 sites and is in the midst of a dramatic turnaround, marked by increases in student achievement rates, a graduation rate nearing 90%, dramatic facilities improvements, and a focus on STEAM throughout all schools.

1.02 CUSD MISSION STATEMENT

A. The mission of the Compton Unified School District is to empower leaders to lead, teachers to teach and students to learn by fostering an environment that encourages leaders and teachers to be visionary, innovative and accountable for the achievement of all students.

1.03 CUSD GOALS

A. Promote a safe and healthy environment in every school.

B. Provide equal education for every child.

C. Ensure that every child has access to technological opportunities.

D. Continue to maintain high expectations and high student achievement and hold personnel accountable for student success.

E. Improve team efforts by enhancing employee communications and collaboration.

F. Embrace and celebrate the diversity of our district.

G. Build, foster and promote partnerships with parents and the community.

H. Maintain facilities; plan and promote capital improvements.

1.04 CUSD CORE BELIEFS

A. CUSD believes all children will learn at higher levels.

B. CUSD believes schools have an enormous impact on children's lives.

C. CUSD believes that all children shall be educated in a safe and orderly environment.

D. CUSD believes all children will reach their learning potential and that the achievement gap INTEGRATION & CONFIGURATION OF EQUIPMENT & DEVICES

1.05 ELECTRIFIED LOCKING HARDWARE

A. All door locations requiring Electrified Locking Hardware shall have their requirements identified in the Door Hardware Schedule Section. Each door will be identified as having either a mortise style electrified lock, a cylindrical style electrified lock or other based on the door type and style.

B. AOR, District locksmith and IT shall coordinate for the required electronic door hardware requirement compatible to the access control system specified. A detail door hardware schedule prepared by AOR shall be provided to the system integrator for proper coordination of door hardware, door power supplies and cabling.

C. It shall be the responsibility of the Security integrator/Integrator to review the Door Hardware Schedule and to identify the door requirements and coordinate will all responsible parties to successfully complete the Electrified Door Hardware and Locking System at each door location.

D. All security integrators responsible for the installation of the Electrified Locking Hardware shall be properly trained and licensed to perform the intended work and also be able to provide door certification, or re-certification where and when applicable.

E. The quantity and location of electrified locking devices shall be as specified in contract documents or drawings.

F. All Electrified Locking Hardware shall be powered by 24VDC. The Power Supply Unit, use in conjunction with the lock, shall be as specified by the manufacturer as to not violate any provided warranty on the electrified lock components and be the appropriately unit for proper functionality and longevity of the locking system.

G. All door locations requiring Electrified Locking Hardware shall provide 'No-prior- Knowledge Free and Unobstructed Egress' from the secure side/area of the controlled door. Whether a door lever handle is being used, or a crash-bar is used as the form of egress out of the door, all applications shall meet current ADA and State Fire Marshall codes and requirements for that particular door installation location as it pertains to the type of area, such as an office, classroom, a lobby, general assembly area, fire-rated hallway, etc.

H. All locks shall be fail-secure unless otherwise specified by the Security Consultant/Designer. Locks specified, as being fail-safe shall be installed in accordance to Section 5-2.1.6.2 of NFPA Life Safety Code 101.

I. Door locations the require Electrified Locking Hardware shall have integrated into the lock hardware chassis a micro-switch or frame mounted DPS used for the purpose of detecting an

egress event. This micro-switch shall be wired back to the Card Reader Controller board's REX/RTE input.

J. Preferred method for cabling for the Electrified Lock shall be secured within the door hollow or within a cored path through the door interior. No exposed cables will be permitted. All lock cables will transition between the door and the door frame via a heavy-duty wire-pass-thru hinge with sufficient cables to manage lock power and REX/RTE functions. When crash-bars are used, a heavy-duty armored cable can be used for the wire transition between the door and door frame. Designer may choose an option to utilize electronic open gate strikes, which could eliminate the need for the electronic kit for the panics and electric door hinges.

K. Electronic locking devices shall have a separate power supply to support the locks specified below. The unit shall incorporate integral battery charging capabilities and a fused line voltage input for a minimum of eight (8) individual locks. All power supplies shall be equipped with optional battery pack for up to 12 hours. The unit shall be equipped with a module to accommodate fire alarm NC contacts when a fire alarm activates.

L. The SECURITY INTEGRATOR shall coordinate with THE DISTRICT approved Fire Alarm and Sprinkler Security integrators for the interconnection of the specified ICPAM.

1.06 REQUEST-TO-EXIT DEVICES

A. In all normal cases, when door locking hardware is electrified and is used to control access and egress through the controlled door by means of an access card, keypad, biometrics or other external interfaced means, the egress portion of the total control and locking mechanism shall be integrated into the door hardware. A person shall be able to exit by means of turning or pushing on a door handle or by pushing on a crash-bar. The process of egress shall be of a 'No Prior Knowledge' basis requiring a person to have no special knowledge or perform any uncommon act in order to exit through a door and vacate an area in the event of an emergency. The egress monitoring mechanism shall be an embedded micro-switch inside the locking hardware and part of the normal manufacturer's hardware options for that type of door and associated locking hardware. The micro-switch shall be wired back to the main control board of the access control system that monitors and records door position and usage activity. If for any reason the type of door and hardware does not lend itself to this type of scenario, then the following will be required:

B. Request-to-Exit device is to be Detection System DS150i or equal, if not provided through the electronic door hardware provider. (If applicable and/or unless otherwise directed per other dedicated equipment / device section specific to REX/RTE detectors, or as indicated in the Electrified Locking Hardware Section.)

C. Quantity and location of Request-to-Exit devices shall be as specified in contract documents or drawings.

1.07 ALARM SOUNDERS / HORNS & STROBE LIGHTS

A. Some locations may require sounders and/or sounders with integrated strobe light. These units will provide audible (at minimum) and visual indication of a local alarm condition. These units will be connecting to the access control system and be monitored by the Customer's on-site police division.

B. Audible Horn/Siren

1. Mini horn shall be capable of operating at nominal 12 or 24VDC (includes fire alarm panels with built in sync) and shall mount to a single gang back box. Mini horn shall operate between 32°F and 120°F. Shall have 12-volt rated notification appliance circuit outputs shall operate between 8.5 and 17.5 volts; 24-volt rated notification appliance circuit outputs shall operate between 16.5 and 33 volts. If the notification appliances are not UL 9th edition listed with the corresponding panel or power supply being used, then refer to the compatibility listing of the panel to determine maximum devices on a circuit.
2. All notification appliances shall be backward compatible.

C. Audible Horn/Siren/Strobe

1. The horn strobe shall be wired as a primary-signaling notification appliance and comply with the Americans with Disabilities Act requirements for visible signaling appliances, flashing at 1Hz over the strobe's entire operating voltage range. The strobe shall have field-selectable candela settings including 15, 15/75, 30, 75, 95, 110, 115, 135, 150, 177, 185. The strobe light shall consist of a xenon flash tube and associated lens/reflector system. The horn shall have three audibility options and an option to switch between a temporal three-pattern and a non-temporal (continuous) pattern. These options are set by a multiple position switch. On four-wire products, the strobe shall be powered independently of the sounder. The horn on horn/strobe models shall operate on a coded or non-coded power supply. The horn strobe shall operate between 32°F and 120°F.
2. The horn strobe shall mount to a standard 4 × 4 × 1½-inch back box, 4-inch octagon back box, double-gang back box or for two wire products a single-gang 2 × 4 × 17⁄8-inch back box. A universal mounting plate shall be used for mounting ceiling and wall products. The notification appliance circuit wiring shall terminate at the universal mounting plate.
3. Shall be powered from a non-coded notification appliance circuit output and shall operate on a nominal 12 or 24 volts (includes fire alarm panels with built in sync). Shall have 12-volt rated notification appliance circuit outputs shall operate between 8.5 and 17.5 volts; 24-volt rated notification appliance circuit outputs shall operate between 16.5 to 33 volts. If the notification appliances are not UL 9th edition listed with the corresponding panel or power supply being used, then refer to the compatibility listing of the panel to determine maximum devices on a circuit.
4. The horn strobe shall be plug-in and shall have the ability to check wiring continuity via a shorting spring on the universal mounting plate. The shorting spring shall also provide tamper resistance via an open circuit if the device is removed.
5. All notification appliances shall be backward compatible.

1.08 EMERGENCY DOOR SOUNDER – DELAYED EGRESS

A. Some door locations in the stairwells require emergency door sounders and door holding devices that will retard the egress through the door for a short programmable period of time. These units will provide audible indication of a local alarm condition. The units will utilize magnetic door holders that secure the door while the count-down is in progress. These units will be connecting to the access control system and be monitored by the Customer's on-site police division.

B. The units shall have an integral verbal message, digital countdown display and sign provide comprehensive and clear instructions of the door operation for persons without prior knowledge of the exit delay, including the sight and hearing impaired. The digital keypad eliminates the need to carry and locate keys for reset and bypass functions.

C. Egress Delay

1. 15 or 30 second exit delay
2. 1 or 2 second nuisance delay

D. Built-In 3 Function Keypad

1. Alarm and lock reset
2. 1 to 30 second bypass
3. Sustained bypass
4. Additional key switch optional

E. Control Inputs

1. 1 to 30 second request-to-exit and access
2. bypass with anti-tailgate
3. Alarm reset

F. Built-in Annunciation

1. Armed mode
2. Nuisance mode
3. Irreversible egress mode
4. Release mode
5. Digital countdown display
6. Field selectable voice notification or tone
7. Field selectable male voice with security message
8. Or Field selectable female voice with safety message

G. Monitoring Outputs

1. Armed status
2. Egress initiation status
3. Released status

H. Optional EMLock Outputs

1. Door position sensor - indicates door
2. Open and door closed, commonly used to verify egress after release
3. Magnetic bond sensor - indicates locked with full holing force, low holding force,
4. Unlocked and tampering

I. Choice of Mounting

1. Recessed mounted (3 gang plaster ring included)
2. Surface mounted with optional gang box (DEC-J)

J. Trigger Modes

1. Egress alarm triggered by door movement when used with EmLocks.
2. Trigger input from external device field selectable (n/o or n/c)

K. Power-Up Modes

1. Field selectable automatic or manual power up after emergency release or power loss.

2. Use of manual power up complies with California Building Code (OSHPD) requirements
3. Code Compliance

    a. IFC International Fire Code
    b. IBC International Building Code
    c. NFPA 101 Life Safety Code
    d. NFPA 1 Uniform Fire Code
    e. California Building Code

1.09 ACCESS CONTROL – STANDARD HID WIEGAND CARD READERS

A. Different card technologies and different style card readers may be used on this project and are also currently in use throughout the District. Standard HID proximity card readers will be used in the following areas:

    1. Exterior locations: HID 5365 Mullion mount proximity card reader
    2. Interior locations: HID 5395 ThinLine proximity card reader
    3. Interior locations: HID WP644 Magstripe card reader (only in those locations where specified as they are being phased out.)
    4. The units shall support the current and newly issued card populations being managed in the card access control database. There shall be no substitutions.

B. Card readers shall be interfaced to the Cisco ICPAM Gateway via integrated reader electronics or through the use of Remote Reader Electronics (ICPAM Gateway) modules.

C. Each remote reader electronics interface shall also provide four (4) supervised alarm inputs for the monitoring of door contact switch, request-to-exit devices and any other local sensor devices, as well as two (2) relay outputs to be used for electric lock control and any other device that may be required.

D. Each card reader and/or reader electronics shall be powered directly from the Cisco ICPAM Gateway. External or local power supplies shall not be required unless the reader electronics is located more than 1,000 feet from the controller.

E. The card reader shall have the following minimal features:

    1. Rugged, weatherized enclosures rated for indoor and outdoor mounting.
    2. Rated for mounting on metal and non-metal surfaces.
    3. Provide audible and visual indicators for reader status and validation of granted and denied access.

F. Outdoor Card Reader

    1. The card reader shall meet the follow features, standards and specifications:

        a. Mounting: Unobtrusive design mounts directly onto metal including door mullions.

        b. Hazardous Location MiniProx® Reader Mounting: Designed to mount onto junction box included with each reader. The junction box is attached to an appropriate surface location utilizing four holes.

        c. Audiovisual Indication: When a proximity card is presented to the reader, the red LED flashes green and the beeper sounds. The multicolor

		LED and beeper can also be controlled individually by the host system.
d.	Diagnostics:	On reader power-up, an internal self-test routine checks and verifies the setup configuration, determines the internal or external control of the LED and beeper, and initializes reader operation. An additional external loop-back test allows for the reader outputs and inputs to be verified without the use of additional test equipment.
e.	Indoor/outdoor Design:	Sealed in a rugged, weatherized polycarbonate enclosure designed to withstand harsh environments, providing reliable performance and a high degree of vandal resistance.
f.	Easily Interfaced:	Wiegand output model interfaces with all existing Wiegand protocol access control systems. Clock-and-Data (magnetic stripe) model interfaces with most systems that accept magnetic stripe readers.
g.	Security:	Recognizes card formats up to 85 bits, with over 137 billion unique codes.
h.	Warrant:	Lifetime warranty against defects in materials and workmanship (see complete sales policy for details).
i.	Part Numbers:	
j.	Base Part No.:	5365 Wiegand interface
Base Part No.:		5368 Clock-and-Data interface
Description:		Tri-State LED, Internal beeper on Options:
k.	Typical Maximum* Read Range	
		ProxCard® II card - up to 5.5” (14 cm) ISOProx® II card - up to 5” (12.7 cm) DuoProx® II card – up to 5” (12.7 cm) Smart ISOProx®/DuoProx® cards – up to 5” (12.7 cm) Proximity & MIFARE® card - up to 5” (12.7 cm) ProxCard® Plus card - up to 2” (5.1 cm) ProxKey® II keyfob - up to 2” (5.1 cm) MicroProx® Tag - up to 2.5” (6.4 cm) *Depending on local installation conditions.
l.	Dimensions:	6.0” x 1.7” x 1.0” (15.2 x 4.3 x 2.54 cm)
m.	Material:	Polycarbonate UL 94
n.	Power supply:	Standard MiniProx: 5-16 VDC Haz. Loc. MiniProx: 5-16 VDC Linear power supplies are recommended.
o.	Current requirements:	Max Average 30 mA Typ Peak: 75 mA
p.	Operating temperature:	-22° to 150° F (-30° to 65° C)
q.	Operating humidity:	0-95% relative humidity non-condensing
r.	Weight:	With terminal strip: 3.5 oz. (99 g) With pigtail: 3.8 oz. (108 GHz. Loc. MiniProx: 3.8 oz. (108 g)
s.	Transmit frequency:	125 kHz
t.	Excite frequency:	125 kHz
u.	Cable distance:	Wiegand interface: 500 feet (150 m) Clock-and-Data interface: 50 feet (15 m) Recommended cable is ALPHA 1295 (22 AWG) 5 conductor minimum stranded with overall shield or equivalent. Additional conductors may be required for

LED or beeper control.

v. Environmental: IP55

w. Certifications: UL294/cUL (US), FCC Certification (US), IC (Canada), CE (EU), C-tick (Australia, New Zealand),

x. SRRC (China), MIC (Korea), NCC (Taiwan), MIC (Japan), iDA (Singapore), RoHS

G. Indoor Card Reader

1. The card reader shall meet the follow features, standards and specifications:

a. Mounting: Mounts on a single-gang electrical box for easy installation.
Mounts directly on metal with minimal impact on read range performance.

b. Audiovisual Indication: A red LED flashes green and the beeper sounds when reader is presented with a proximity card. The multicolor LED and beeper can also be controlled individually by the host system.

c . Diagnostics: On reader power-up, an internal self-test routine checks and verifies the setup configuration, determines the internal or external control of the LED and beeper and initializes reader operation.
An additional external loop-back test allows for the reader outputs and inputs to be verified without the use of additional test equipment.

d. Indoor/outdoor Design: Sealed in a rugged, weatherized polycarbonate enclosure designed to withstand harsh environments, providing reliable performance and a high degree of vandal resistance.

e. Easily Interfaced: Wiegand output model interfaces with all existing Wiegand protocol access control systems. Clock-and-Data (magnetic stripe) model interfaces with most systems that accept magnetic stripe readers.
Recognizes card formats up to 85 bits, with over 137 billion unique codes.

f. Warranty: Lifetime warranty against defects in materials and workmanship (see complete sales policy for details).

g. Base Part No.: 5395 Wiegand interface
Base Part No.: 5398 Clock-and-Data interface
Description: Tri-State LED, internal beeper on

h. Options: CLASSIC series cover in white, beige, charcoal gray or black (or) Designer series cover in white, wave blue, charcoal gray or black LED and beeper operation

i. Typical Maximum* Read Range

ProxCard® II card - up to 5.5” (14 cm)
ISOProx® II card - up to 5” (12.7 cm)
DuoProx® II card - up to 5” (12.7 cm)
Smart ISO®/DuoProx® cards - up to 5” (12.7 cm)
Proximity & MIFARE® card - up to 5” (12.7 cm)
ProxCard® Plus card - up to 1.5” (3.8 cm)
ProxKey® II keyfob - up to 2” (5.1 cm)
MicroProx® Tag - up to 3” (7.6 cm)
*Depending on local installation conditions.

j.	Dimensions:	4.70” x 3.00” x 0.68”(11.9 x 7.6 x 1.7 cm)
k.	Material:	Polycarbonate UL 94
l.	Power supply:	5-16 VDC, Linear power supplies are recommended.
m.	Current requirements:	Average: 30 mA (5 VDC); 20 mA (12 VDC) Peak: 110 mA (5 VDC); 115 mA (12 VDC)
n.	Operating temperature:	-22° to 150° F (-30° to 65° C)
o.	Operating humidity:	0-95% relative humidity non-condensing
p.	Weight:	3.3 oz. (94 gm)
q.	Transmit frequency:	125 kHz
r.	Excite frequency:	125 kHz
s.	Cable distance:	Wiegand interface: 500 feet (150 m) Clock-and-data interface: 50 feet (15 m) Recommended cable is ALPHA 1295 (22 AWG) 5 conductor minimum stranded with overall shield or equivalent. Additional conductors may be required for LED or beeper control.
t.	Environmental:	IP55
u.	Certifications:	UL294/cUL (US), FCC Certification (US), RoHS

H. Indoor Card Reader – Magstripe

The card reader shall meet the follow features, standards and specifications:

1. Data Tracks:	Track 1 or 2; high or low coercivity
2. Card Size:	2.125”H x 3.375” L x 0.03” +/- .003” thick (54mm H x 86mm L x .76mm +/- .07mm thick)
3. Card Speed:	8 to 50 inches (203 to 1270mm) per second
4. Data Rate:	1 ms per bit
5. Approvals:	UL 294; FCC Part 15, CE
6. Outline:	6.00” x 1.75” x 1.49”; 152 x 38 x 43 mm
7. w/Adapter Plate:	7.00” x 2.75” x 1.69”; 178 x 70 x 43 mm
8. Connections:	Pigtail or Plug-in Connector
9. Cable:	200’ (60m) on five #22 unshielded wires 500’ (150m) on five #18 unshielded wires
10. Output Formats:	Wiegand 26-bit, Wiegand 34-bit, all bits Wiegand, and Clock-and-Data
11. Power:	EMPI, ABA/ISO,4.75 to 5.25 VDC @ 35mA
12. Mounting:	Single-gang electrical box, door mullion, or directly on vertical surface
13. Lifetime:	250,000 wear cycles. MTBF 22,000 hours
14. Error Rate:	5% false reject 2x10-6 false accept
15. Static Discharge:	Withstands 20,000 volts
16. LED:	Red, Green
17. Material:	GE Lexan (polycarbonate) in white or black
18. Temperature:	-31º to 150º F (-35º to 66º C) operating
19. Humidity:	5 to 95%, non-condensing
20. Environment:	Indoor or outdoor
21. Card Format:	Output Format

EMPI	26 or 34-bit Wiegand
10 Digit	ANSI/ISO* 26 or 34-bit Wiegand
ABA/ANSI/ISO	All bits Wiegand or Clock-and- Data up to 37 characters

* First five digits are site code, last five are card number

22. Product Compatibility:

The Dorado WP644 reader is compatible with mainstream access controllers that accept a Wiegand or Clock-and-Data input from a card reader. The reader accepts cards encoded on track 1 or 2 and are encoded with either ABA/ANSI/ISO or EMPI encoding. EMPI is HID's own encoding format that provides a higher level of security than standard ABA/ANSI/ISO encoding. ABA/ANSI/ISO encoding format refers to the industry standard

75 BPI, 5 bits per character encoding (ISO 7810 Track 2).

23. Warranty: 36 -month limited warranty covering parts and labor. (Magnetic stripe reader heads are not covered under this warranty; for complete details, please see HID's Sales Policy.) Installer will provide additional 6 months of coverage.

1.10 INTRUSION DETECTION DEVICES:

A. When the following intrusion detection devices are deployed in the field and incorporated into the site security scheme, they shall be interfaced directly into the Access Control System. Monitoring of the intrusion detection devices shall be performed by District Security through the Access Control Software Application.

1.11 DOOR SENSOR CONTACTS / SWITCHES:

A. Switches shall be Sentrol series 1078 or 1085 or equal. (Unless otherwise directed per other dedicated equipment / device section specific to door contacts).

B. Recessed (concealed) magnetic door contacts shall be provided for all card access doors and doors requiring intrusion detection. Surface mount contacts will only be permitted when recessed contacts are not feasible. Door contacts shall be provided on single doors and both sides of double doors at locations indicated on drawings.

C. Where building structure makes it impossible to install conduit within the wall or doorframe, the SECURITY INTEGRATOR shall substitute surface-mount contacts with armored cable for the specified contacts.

D. Heavy-duty door contacts with armored cable shall be provided for all Roll-Up Doors where indicated on the drawing.

E. All devices shall be wired point to point and to the nearest ICPAM physical access gateway module interface.

F. Quantity and location of door contact switches shall be as specified in contract documents or drawings.

1.12 MOTION DETECTORS:

A. All motion detectors shall have the appropriate sensing pattern feature for the area that it will be located and monitoring. Ceiling mount is preferable to wall mount, where possible. The project blueprints/drawings will indicate field pattern necessary for the appropriate selection of the motion detector model.

B. Motion detectors shall be Bosch DS9360, ISN-CC1-50W or ISN-CC1-100N or equal.

C. [WALL MOUNTED] [CEILING MOUNTED] passive infrared (PIR) motion detectors shall be provided where indicated on drawings. Motion detectors shall be masked or oriented to minimize the likelihood of nuisance alarms caused by environmental conditions.

D. All devices shall be wired point to point and to the nearest ICPAM physical access gateway module interface.

E. A 12VDC centralized power supply shall be utilized to power motion detectors.

F. Quantity and location of Motion detectors shall be as specified in contract documents or drawings.

1.13 GLASS-BREAK DETECTORS:

A. Glass-break detectors shall be Honeywell FG-730.

B. These acoustic glass-break detectors with latching LED shall be provided where indicated on drawings.

C. The devices shall be surface mounted onto a flush mounted single-gang electrical junction box with a mud-ring. The ideal mounting location shall be on the ceiling at approximately 18” to 24” inches out from the wall where possible for rooms and large spaces or centered on ceiling when in a hallway location with a bank of windows. Wall-mounting above the top (at approx 6”) of the window is only permissible if no other location is suitable.

D. The device shall have a 30', 360-degree range measured to the furthest point on all type of glass.

E. All devices shall be wired point to point and to the nearest ICPAM physical access gateway module interface.

F. A 12VDC centralized power supply shall be utilized to power glass break detectors.

G. Quantity and location of glass-break detectors shall be as specified in contract documents or drawings.

1.14 PANIC / DURESS BUTTONS:

A. Shall be a Sentrol 3040 or equal. All panic buttons will be wired using no less than an 18- gauge conductor wire pair back to the physical access gateway module. Panic buttons shall not be paired together on the same zone input. Panic buttons shall have a latching circuit and a red LED indicator displaying that the unit has been triggered and needs to be re-set.

1.15 ACCESS CONTROL - INTERCOM STATIONS:

A. The Intercom System shall be used to identify a person before access is granted to a specific area or room. The Intercom System shall consist of a Door Intercom Station with SIP capabilities that can communicate directly with the District Cisco VOIP system, including all manufacturer recommended supporting devices/components such as power supply units, controllers, software, etc., to complete the intended application. Proposed model is the 2NUSA Helios Vario matched with a Cisco 9971 Color Display desktop phone for the “base” station.

1. All equipment and materials used shall be standard components that are regularly manufactured and utilized in the manufacturer's system.
2. All systems and components shall have been tested and proven actual use.
3. The system shall have IP addressable devices (Door Station) and connect directly to a network switch via a Cat6 cable.
4. The system shall provide a live color video image, on a compatible Cisco IP Phone, of the person that has initiated communication at the Door Station.
5. The Cisco 9971 VOIP Desk phone shall have the ability to release the Electrified Door Lock allowing a person to gain access to the room or area.
6.

B. IMPORTANT – The mechanism and method for unlocking the door SHALL NOT be solely controlled by the Intercom System but shall be interfaced with the Access Control System in order to provide an event and history log of access granted via the Cisco 9971 VOIP Desk phone System at any given Intercom Door Station location. This will also allow for over-ride controls (emergency, scheduled, etc.) via the Access Control System. An acceptable interface scenario would be for the Door Intercom Station's lock relay to connect to an input on the Access Control system rather than directly to the lock power at the door location or at the door power supply unit. The Access Control System's input would then be programmed to trigger the release of the door lock. The Access Control input shall be identified in the system as an 'Intercom Release Command' event from the Cisco 9971 VOIP Desk phone Unit. The intercom interface shall not be paralleled directly into the REX/RTE input for door lock release as it is important to identify between a normal REX event, a normal access granted event, and an intercom request for door release event.

C. If a Hard-wired Release Button is to be used in conjunction with the Cisco 9971 VOIP Desk Phone door release feature as a secondary means of granting access, then that button shall be connected to a dedicated input on the Access Control System and be identified separately from all other door unlock command events.

D. The Door Intercom Station shall be vandal resistant, weather-proof, and the faceplate shall be constructed out of heavy-duty stainless steel. The Door Station shall be a flush- mount style unit and have a manufacturer's provided junction back-box.

1. The Cisco 9971 VOIP Desk phone shall have the option for wall-mounting or desk locations.
2. The Intercom System shall be expandable allow for multiple Master Stations and Door Stations.
3. The Intercom System shall have software accessibility for set-up and programming purposes.
4. The Intercom System shall have a software application that mimics the Cisco 9971 VOIP Desk phone providing all the same feature-sets as the field device (Master Station).

E. The recommended intercom components are as follows:

1.	Door Station –	Manufacturer:	Helios	Model	IP Vario
2.	Master Station –	Manufacturer:	Cisco	Model:	9971
3.	Power Supply –	Manufacturer:	Aiphone	Model:	24v or equal

1.16 EMERGENCY COMMUNICATION TOWERS AND STATIONS

A. District Locations may include tower stations and/or wall mount stations. All locations shall be integrated into and be part of the existing WEBS® Contact & MASS Notification platform on

District. All Emergency Call Stations involving tall or standard towers and wall-mounted units shall be outfitted to accommodate the MASS Notification feature. For locations involving Mini-Towers, the MASS Notification feature shall not be required provided there is adequate sound distribution from neighboring Emergency Call Stations within the coverage area.

1.17 WALL MOUNT STATION HOUSING

A. ITEM DESCRIPTION

1. The wall mount station will meet the following dimensions and features and accept the communication module/plate as described below.

Dimensions (W x D x H): 10.7 x 8.2 x 31.9 in. (273 x 209 x 810 mm)

Weight:	50 lbs. (22.5 kg)
Construction:	12GA (.105 in.) brushed stainless steel with impact-resistant polycarbonate lens and resistance to UV-fade
Colors:	Brushed stainless steel is standard. Available painted in custom colors.
Signage:	1.25 in. high reflective red “EMERGENCY” lettering with wide-angle visibility is standard. Available as “ASSISTANCE”, “INFORMATION”, or custom colors, lettering and graphics.
Audio Broadcast:	Two 40 watt speakers, 118 dBA @ 1 meter
Lighting:	[LED Blue Light] 209 lumens peak, 78 flashes per minute, 70% of initial lumens after 50,000 hours of operation [LED Panel Light] Ultra bright LEDs, 50,000 hour lifetime
Power:	Maximum total 65 watts, 120 VAC
Mounting:	Mounts to a wall or straps to a pole or a kiosk
Warranty:	3-year warranty

1.18 FACE PLATE, COMMUNICATION UNIT / MODULE

A. GENERAL DESCRIPTION

1. The Emergency Phone shall consist of an outdoor-rated, vandal resistant and ADA-compliant hands-free speakerphone communications device with a stainless steel faceplate and metal buttons.
2. The Emergency Phone shall be Talk-A-Phone model VOIP-500, no substitutions, and have one 1.7" diameter metal button with UV-resistant finish labeled "EMERGENCY" and three 5 mm diameter red light emitting diodes (LED) labeled "CALL PLACED", "CALL RECEIVED", and "HELP ON THE WAY."
3. The unit shall be programmable from a remote location and have a six number dialing capability, reverting to the subsequent number if the first is busy or does not respond. The unit shall be full duplex in operation. The unit shall utilize Power over Ethernet (PoE, 802.3af) for power, or a dedicated, line regulated 12VDC or 24VDC/AC power supply. DIP switch programming and push to talk devices are not acceptable.

B. Construction

1. Faceplate shall be constructed of stainless steel.

2. Faceplate shall be 12 gauge (2.8mm) #4 brushed stainless steel measuring 9.5" W x 11.75" H.
3. Wall opening shall measure approximately 6.4" W x 9.75" H x 2.71" D. d. Unit shall weigh approximately 8 lbs.
4. Signage shall be constructed of a cast metal zinc dichromate with lettering and Braille raised approximately 3/32" for ADA compliance.
5. Word "EMERGENCY" and its associated button shall be red.
6. Push button and switch shall be a single assembly rated for mechanical life of 1,000,000 cycles and provide tactile response. Piezo switches not permitted.
7. Speaker and microphone shall be protected by non-ferrous perforated metal screen to provide a barrier against vandalism, rain, snow and insects.

C. Features

1. Unit shall feature one Layer 2 switch 10/100 BaseT Ethernet port and one 10/100 BaseT WAN Ethernet port; Cat5e cabling or better is required.
2. Output sound level shall be greater than 90dBC at one meter for normal conversation and greater than 100dBC at one meter for paging mode.
3. All programming shall be stored in non-volatile flash memory.
4. Unit shall be programmable remotely from a Web GUI.
5. Unit shall be compatible with Ethernet standard (IEEE 802.3) and TCP/IP (RFC 1122) protocol suite.
6. Unit shall support standard VoIP protocol SIP (RFC3261).
7. Unit shall support G.711 PCM a-Law @ 64kbps, G.711 PCM u-Law @ 64kbps, G.729a, and G.723.1a audio codecs.
8. Call conversation timer shall be programmable from 1 to 4270 minutes.
9. LED for the hearing impaired shall illuminate to indicate when calling party has placed the call and when the call was received. A manually activated/deactivated LED indicating "help is on a way" shall be provided.
10. Unit shall be programmable with six different telephone numbers of up to 30 digits each including pauses for each of six telephone number lists that can be assigned to different buttons. If the first number does not answer or is busy, unit shall automatically call the second number. If the second number is busy or does not answer, unit shall call the third number. Unit shall continue dialing round robin until call is answered or call conversation timer limit is reached.
11. Unit shall include three auxiliary outputs (rated at 120mA@120VAC/DC) and three auxiliary inputs (rated at 10mA@8VDC) that are opto-isolated and rated for up to 1,000 volts. Auxiliary outputs shall be activated, providing a dry contact closure, either automatically when Emergency Phone is activated, manually by guard keypad operation, or by local phone events. Auxiliary input shall allow unit to be activated by any device or switch that provides a contact closure.
12. Unit shall be capable of automatically notifying attendant of emergency phone location via recorded message that plays at the beginning of the phone conversation.
13. Unit shall be programmable with up to five unique voice messages. These messages can be assigned to be played back upon specific events (e.g. auxiliary input activation plays message on local speaker; activation of an info button call plays a message to a called party).
14. Unit shall be capable of silent monitoring.
15. When call is finished, unit shall automatically terminate the call.
16. Unit shall be capable of auto answering any call placed to it from another telephone.
17. Unit shall be arrestor lightening suppressed and full wave polarity guarded.
18. Unit shall comply with FCC Title 47, Part 15 (47 CFR 15).

D. Environmental

1. Speaker: The unit shall be a 3.5” square, RoHS compliant, outdoor rated speaker with an ambient operating temperature range of -67°F (-55°C) to +185°F (+85°C). The speaker shall be capable of withstanding a total immersion for 96 hours and operating without any deterioration of sound quality. The speaker cone shall be constructed of a corrosion resistant material. The speaker shall be constructed of a neodymium magnet and a solid aluminum voice coil and shall be adequately protected from ferrous and non-ferrous particles via a special sealed design.
2. Microphone: The unit shall be 6mm in diameter, aluminum construction, RoHS compliant, with an IP57 type enclosure to protect from dust and water. The microphone shall have an operating temperature range of -40°F (-40°C) to + 158°F (+70°C). The microphone shall operate within ±3db of initial sensitivity, (after 6 hours of conditioning at +25°C) after being placed in a chamber at +40°C and 90±5% relative humidity for 240 hours.
3. Push Button/Switch: The push button and the switch shall be a single assembly unit with an operating temperature range of -67°F (-55°C) to +185°F (+85°C). The push button and the switch shall be constructed of an aluminum alloy. The enclosure design shall be watertight as per IP68S, 1m rating. The push button and the switch shall provide tactile feedback.
4. Faceplate (Phone): The faceplate shall be constructed of 12-gauge, 304 grade stainless steel with enhanced corrosion resistance.
5. Keypad: The unit shall have a heavy die cast zinc construction with a marine quality chrome plating on the bezel and buttons. The keypad shall have an operating temperature range of -22° F (- 30°C) to +212°F (+100°C) and 95% humidity (non-condensing). The keypad shall be highly resistant to SO2, O3 and oxidation. Silicone pad gasket shall seal out dust and other foreign contaminants.

E. Electrical

1. Unit shall operate on Power over Ethernet (PoE, 802.11af), a 12VDC power supply, or 24VDC/AC power supply.
2. Unit shall require a dedicated line regulated power supply when operating on 12VDC or 24VDC/AC.
3. Unit nominal draw shall be 500mA@12VDC, 300mA@24VDC/AC, and 150mA@+36-57 VDC (PoE).
4. Unit maximum draw shall be 800mA@12VDC, 500mA@24VDC/AC, and 250mA@+36-57 VDC (PoE).

F. Mounting

1. Unit shall include six vandal-resistant, oval-head spanner mounting screws to mount flush into any of the following mounts:
2. Flush Mounting Sleeve, model MS-400, shall mount into a wall.
3. Surface mount accessories shall be available to allow for the surface mounting of the Emergency Phone. They shall be outdoor rated, constructed of stainless steel and available in brushed finish or painted in one of three colors (bright "caution yellow", "emergency red" or "hospital blue"). "EMERGENCY" lettering,
4. Options: Other lettering, or no lettering on the side is available:
5. Surface Mount Accessory, model ETP-SM.
6. Hooded Surface Mount, model ETP-SMH, includes a weather-protective hood.
7. Lighted Surface Mount, model ETP-SML, includes a weather-protective hood with lighted faceplate and translucent, lighted "EMERGENCY" sign.
8. Dual Surface Mount, model ETP-SMD, includes a second opening for a directory or other faceplate.
9. Boxed Surface Mount, model ETP-SMB, includes a door to enclose the Phone.
10. Surface Mount for Wireless and Switched Power, model ETP-SMW, includes extra storage

space for Power Charging System and/or wireless interface.

11. Stainless steel wall mount stations shall be available with integrated LED Blue
12. Light. When the Emergency Phone is not in use, the LED Blue Light shall remain lit and visible from a distance. When the button is pressed, the LED Blue Light shall start flashing and shall continue flashing until a deactivation event (e.g. termination call, auxiliary input activation, etc.). Stations shall be available with optional integrated fixed CCTV camera:
13. Wall Mount Station, model ETP-WM, includes radius corners and a recessed lighted faceplate.
14. Economy Wall Mount Station shall be model ETP-WM/E.
15. Wall Mount Station with WEBS, model WEBS-WM, includes radius corners, a recessed lighted faceplate and paging speakers for mass notification.
16. Free standing, rectangular, steel pedestal mount with 0.25" thick walls shall be available. Pedestal mounts shall be available with optional integrated fixed CCTV camera:
17. Pedestal Mount, model ETP-PM, shall measure 12" W x 8" D x 48" H with a sloped top.
18. Stainless Steel Pedestal Mount, model ETP-PM-SS, shall measure 12" W x 8" D x 48" H with a sloped top.
19. Dual Faceplate Pedestal Mount, model ETP-PMD, shall be 12" W x 8" D x 60.1" H with a sloped top and include a second opening for a directory or other faceplate.
20. Dual Faceplate Stainless Steel Pedestal Mount model ETP-PMD-SS shall be
21. 12"W x 8"D x 60.1"H with a sloped top and include a second opening for a directory or other faceplate.
22. Steel Tower Mounts shall be available with 0.25" thick walls, integrated LED Blue Light and lighted faceplate. When the Emergency Phone is not in use, the LED Blue Light shall remain lit and visible from a distance. The faceplate shall also remain lit. When the EMERGENCY button is pressed, the LED Blue Light shall start flashing for the duration of the communication. Tower mounts shall be available with optional integrated fixed or PTZ CCTV camera:
23. Tower Mount, model ETP-MT, measures 114.2" H x 10" W x 8" D.
24. Radius Tower Mount, model ETP-MT/R, measures 108" H x 12" W x 10" D with radius corners and a protective acrylic housing for the LED Blue Light. Radius Tower Mount shall be available with fixed or PTZ CCTV camera.
25. Radius Tower Mount with WEBS, model WEBS-MT/R, measures 124" H x 12.75" D x 11" W with radius corners, a protective acrylic housing for the LED Blue Light, and paging speakers for mass notification. Radius Tower Mount shall be available with fixed or PTZ CCTV camera.
26. Unit shall be available with a second button as model VOIP-500D.
27. There shall be a primary 1.7" diameter red metal button with UV-resistant finish labeled "EMERGENCY" on bottom and a secondary 1.25" diameter black metal button with UV-resistant finish labeled "INFO" above it.
28. Each button shall be capable of dialing six unique phone numbers.
29. If a call has been initiated by pressing the "INFO" button, the unit shall be capable of seizing the line when the primary "EMERGENCY" button is pressed.
30. Unit shall be available with a keypad as model VOIP-500K.
31. There shall be a primary 1.7" diameter red metal button with UV-resistant finish labeled "EMERGENCY" on bottom and a secondary 1.25" diameter black metal button with UV-resistant finish labeled "CALL" above it with a 12-button keypad.
32. The primary button shall be capable of dialing six unique phone numbers in round robin.
33. The secondary button shall take the phone off-hook in order to dial using the keypad.
34. If a call has been initiated by pressing the secondary button and dialing a number on the keypad, the unit shall be capable of seizing the line when the primary emergency button is pressed.
35. All units shall be available with a primary casting that reads "TO CALL" instead of
36. "EMERGENCY" (add "C" to model number, e.g. VOIP-500C).
37. Unit shall be available with built-in pinhole camera (add "OP 3" to model number for color

camera, "OP 3BW" for black and white camera, e.g. VOIP-500 OP 3). For full specifications of faceplate cameras, contact Talk-A-Phone Co.

38. Unit shall be compatible with a 2.4GHz Radio Frequency Interface, model VOIP-RF, to create a radio frequency emergency phone system.

1.19 EMERGENCY CALL STATION MINI TOWERS

A. General Description

1. The unit shall be a highly vandal-resistant free-standing steel emergency phone tower mount, model ETP-MT-72, no substitutions, with built-in combination blue light/strobe and lighted faceplate. The tower shall house an ADA-compliant; line-powered communication device manufactured by Talk-A-Phone Co.

B. Construction

1. The unit shall be constructed of steel and weigh approximately 190 lbs. b. The unit shall measure 10" W x 8" D x 72" H with 0.25" thick walls.
2. A multi-coat, rust-inhibitive coating shall be applied to withstand prolonged exposure to harsh environments.
3. An internal base plate shall be fully welded within the tower 2" above the tower base.
4. The base plate shall be fabricated of 0.75" A-36 steel. There shall be a 4" diameter center hole for wiring access and four 1" diameter holes for anchor bolt clearance.
5. Tower shall have a wiring access opening measuring 11" H x 8" W, located 15" above the base of the tower. The opening shall have a flush cover plate with a wall thickness of
6. 0.25", held in place by two 10-24 countersunk, tamper-resistant spanner screws.
7. An opening shall be cut in the face of the column for mounting any flush-mounting, 400-Series emergency phone models. The lower edge of the opening shall slope down 30º from rear to front, making the edge difficult to use as a shelf yet convenient as a writing surface.
8. Reflective letters shall be emblazoned on all four sides of the unit (custom lettering, sizes& colors available).

C. Lighting

1. Atop the tower shall be a combination blue light and strobe.

   a. The blue light shall be a watt high efficiency, compact fluorescent light with a 10,000-hour lifetime. It shall be lit at all times.
   b. The strobe shall provide 1.5 million candlepower and flash 70 times per minute when the emergency phone is activated and continue flashing until the call has been completed.

2. The tower shall have a concealed 7-watt high efficiency, long life compact fluorescent light illuminating the emergency phone face plate at all times.
3. Optional area lighting shall be available (see Options below).

D. Electrical

1. The communication device shall require no external power. It shall be powered by the phone line, PBX extension, or a wireless communication interface.
2. Standard 120VAC power shall be required for the blue light/strobe and face plate light.
3. Tower shall be available in alternate power versions including: 24VDC, 12VDC, solar powered, and powered by a switched high-voltage power source (see Options below).

4. All lamps and fixtures shall be UL and C.S.A. listed. All electrical components shall be hard wired and concealed within the tower. All wiring and electrical fixtures comply with the standards of the National Electrical Code, UL and C.S.A.

E. Mounting

1. The tower shall include 24 inch J-bolts for mounting into a 24" x 24" concrete foundation, depth to vary according to local regulations and other site-specific considerations. J-bolts shall protrude approximately 5 inches from surface of foundation.
2. An optional mounting kit shall be available for mounting into above ground locations such as parking decks, where access to concrete base is available from both above and below.

F. Options

1. Power

a. Tower shall be available in 24VDC version, model ETP-MT-72 24V. Blue light/strobe shall include ultra-bright, long-lasting LEDs instead of compact fluorescent. Face plate light shall be 24VDC LED bulb.
b. Tower shall be available in 12VDC version, model ETP-MT-72 12V. Blue light/strobe shall include ultra-bright long-lasting LEDs instead of compact fluorescent. Face plate light shall be a 12VDC LED board.
c. Power Charging System, model PCS-1, shall be available to provide continuous
d. power to towers when a switched power supply is available to provide power at least 6 hours per day.

2. Communications

a. Tower shall accept any 400-Series flush mounting emergency phone.
b. Communication device shall accept fiber optic line instead of standard copper wire. 400-Series flush mounting emergency phone and fiber interface shall be required.
c. Cellular Interface shall be available when phone line is not available.
d. Transmission shall be tri mode 800MHz TDMA/1900 MHz PCS/800 MHz AMPS, model ETP-CI.
e. Transmission shall be 1900Mhz GSM, model ETP-CI/GSM.
f. Radio Frequency Interface, model ETP-WTR/2, shall be available when phone lines are not available. Radio Frequency Interface functions as part of a complete proprietary radio frequency system.

3. Integrated CCTV

a. Model ETP-MT-72 OPT 2 shall include an integrated fixed camera, supplied by others, mounted above the faceplate.
b. Model ETP-MT-72 OPT 3 shall include an integrated Silent Witness fixed camera mounted above the faceplate. For full specifications of Silent Witness camera,

G. Compliance

1. CSA Certified to UL Standard 60950

H. Warranty

1. Equipment shall be warrantied against any defects in material and workmanship, under normal use, for a period of 3 years from date of installation. In the event system is found by manufacturer to be defective within the warranty period, manufacturer shall repair and/or replace any defective parts, provided the equipment is returned to manufacturer.

I. Manufacturer

1. The Manufacturer shall be Talk-A-Phone Co. (773) 539-1100, 7530 N. Natchez Ave, Niles, Illinois 60714-3804, www.talkaphone.com. THERE ARE NO EQUIVALENTS.

1.20 DOOR POWER SUPPLIES

A. For door locations that involve only an electrified cylindrical lock, or mortise lock, power can be provided by the access control system, provided there is sufficient amperage and back- up battery to accommodate the locking mechanism. Each lock shall be connected to its own dedicated, fused output terminal on the access control power supply unit.

B. Door locations that involve crash bars and heavy-duty locking mechanisms, requiring extra amperage, shall have dedicated power supplies as recommended by the manufacturer of the electrified locking mechanism. This is for the purpose of promoting proper lock function and extension of life and longevity of the lock mechanism, and to maintain the manufacturer's warranty.

C. The following are minimum requirements:

1. UL listed burglar and access control power supply (UL603, UL294)

a. Input 115VAC 50/60Hz, 1.9 amps.
b. amps continuous supply current at 12VDC
c. amps continuous supply current at 24VDC
d. Field selectable 12VDC or 24VDC operation
e. Power supply input options:

1) common power input for ACM8CB and lock power (factory installed).
2) isolated power inputs (external power supply is required). (For this option, output current is determined by the power supply connected, not to exceed a maximum of 10-amp total).

2. Access Control System trigger inputs.

a. Input options:

1) 8 normally open (NO) inputs.
2) 8 open collector inputs.
3) Any combination of the above.

i) 8 independently controlled Fail-Safe and/or Fail-Secure.
ii) 8 auxiliary outputs (unswitched).
iii) (all outputs are class 2 power limited, circuit breaker protected, rated @ 2.5amp)
iv) Main fuse is rated at 10 amps.
v) Red LEDs indicate outputs are triggered (relays energized).

vi) Fire Alarm disconnect (latching or non-latching).

3. Fire Alarm disconnect input options:

   a. Normally open (NO) or normally closed (NC) dry contact input.
   b. Polarity reversal from FACP signal circuit.

4. Fire Alarm disconnect options:

   a. 8 outputs affected.
   b. outputs affected, 4 outputs unaffected (50/50 mode).
   c. Alarm output relay indicates that FACP input is triggered (form "C" contact rated
   d. @ 1 amp 28VDC not evaluated by UL). Green LED indicates when FACP disconnect is triggered.

5. Built-in charger for sealed lead acid or gel type batteries.

   a. Maximum charge current .7 amps.
   b. Automatic switch over to stand-by battery when AC fails.
   c. Zero voltage drop when unit switches over to battery backup (AC failure condition)
   d. Thermal and short circuit protection with auto reset. m. AC input and DC output LED indicators.
   e. AC fail supervision (form "C" contact).
   f. Battery fail and battery presence supervision (form "C" contact). p. Enclosure accommodates up to 2 12AH batteries.
   g. Removable terminal blocks facilitate ease of installation.
   h. Unit is complete with enclosure, cam lock, transformer and battery leads.

1.21 FIXED POSITION CAMERA AND PTZ CAMERA POWER SUPPLIES

A. All fixed-view cameras shall be powered by a PoE-capable network switch that is mounted in the security rack system, in an identified security equipment room location, as per blueprints. The PoE switches will be provided by the District. In the event that they must be provided by the Security Integrator, they shall be specified by the District and quoted separately. The Security integrator will coordinate with the District IT Department with regard to required make and model, and with regard to switch configuration.

B. All PTZ camera units shall be powered by a dedicated 24VAC power supply unit, as recommended by the manufacturer for that camera model. Location and distance between the power supply unit and the PTZ camera shall not exceed the recommended maximum distance, as set forth by the manufacturer. The gauge of the power wire will also adhere to the requirements of the manufacturer. Power supplies will be located in fully-accessible and serviceable locations. The Installing Security integrator shall provide a location map for all power supply units. This map should be provided in the form of an as-built/drawing blueprint. The recommended manufacturer for the power supply unit is Cisco.

1.22 UPS FOR SWITCH AND CONTROLLER / SERVER POWER

A. One uninterruptible power supply (UPS) shall be provided to sustain the operation on the IP video system equipment for a minimum period of twenty (20) minutes.

B. The UPS shall provide continuous, no-break power during complete or momentary loss of supply power. In the normal operating mode the UPS shall condition line power protecting

against environmental conditions, power surge, power sag, under-voltage, over-voltage, line noise, frequency (variation of the waveform), transients and harmonic distortion.

C. The uninterruptible power supply (UPS) shall be manufactured by American Power Conversion (APC) / or approved equal. The AC input for the UPS is provided by the District.

D. Communication Power and Grounding to be provided by The District.

END OF SECTION

SECTION 28 21 20
COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. UTP cabling.
2. Multiuser telecommunications outlet assemblies.
3. Cable connecting hardware, patch panels, and cross-connects.
4. Telecommunications outlet/connectors.
5. Cabling system identification products.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Coordinate layout and installation of telecommunications cabling with District's telecommunications and LAN equipment and service suppliers.
B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
2. Wiring diagrams to show typical wiring schematics, including the following:

a. Cross-connects.
b. Patch panels.
c. Patch cords.

3. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.

1.04 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.
B. Source quality-control reports.
C. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings Cabling Administration Drawings,

and field-testing program development by an RCDD.

2. Installation Supervision: Installation shall be under the direct supervision of Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site. Test each pair of UTP cable for open and short circuits.

1.08 DISTRICT STANDARDS

A. The installation contractors shall have telecommunications installer certification (BICSI and Berk-Tek Leviton).
B. All projects shall be certified with full manufacturer's warranty. Minimum 20-year warranty on cabling system.
C. In addition to wired connectivity all District classrooms, labs and offices as well as indoor and outdoor student lounge and study areas should be provided with wireless connectivity.
D. Wiring Standard: ANSI EIA/TIA 568B.2-1 UL Verified Category 6 and ANSI EIA/TIA 568-C Category 6A
E. Wiring System Used: BERK-TEK LEVITON Giga SPEED XL Structured Cabling, Giga SPEED X10D CAT 6A for Media and Technology Facilities. Note: Installation Contractors must be Certified for District required 20-year warranty.
F. Minimum jacks per office: Minimum of (2) RJ 45 jacks in 6 port plate in single gang outlet box, Blank off unused ports.
G. Standard Copper Cable: GigaSPEED XL 1071A, Cat 6, UTP, 24AWG, twisted pair, solid conductors, 4 pair.
H. Use X10D Cat 6A for Media and Technology Facilities. Use multiple colors to identify zones, rooms or functions. Any color EXCEPT Grey, Ivory or Beige – those colors for voice only. Purple/Violet for CCTV Camera. Use type 2081 for areas requiring PLENUM cable.
I. Standard information outlet: GigaSPEED XL MGS400. Use X10D MGS600 for Media and Technology Facilities
J. Standard Patch Panel: 48 port GigaSPEED XL PATCHMAX Evolve Panels. Use X10D PATCHMAX GS5 for Media and Technology Facilities
K. Patch Cords: GigaSPEED XL GS8E Modular Patch Cords. Use X10D GS10E for Media and Technology Facilities.
L. Copper Patch Cords:
M. In addition to the specification above, the contractor will provide the following patch cords for the project:

1. The number of color patch cords provided shall equal 75% of all data ports on the patch panels.
2. The contractor shall provide a variety of lengths of patch cords calculated on the distances from the patch panel to the proposed locations of data equipment in the rack. Patch cords provided shall be no shorter than 3 feet and no longer than 8 feet unless there are unusually long distances.
3. The contractor shall provide a variety of colors to match colors used in building wiring.
4. Fiber Cable Specification for Voice, Data and Video
5. Standard Fiber Cable: OptiSPEED Optical Fiber, Multimode, 62.5/125
6. Premium Fiber Cable: LasrSPEED 300 Optical Fiber, Multimode
7. Data Grade Fiber Connector: ST on patch panels, SC on equipment end
8. Fiber Cross Connect: 360 Series, 100/200A LIU, LST, Patchmax Evolve
9. Fiber Patch Cords: Number of patch cords provided to be specified

N. Racks

a. All open relay, enclosed racks and cable ladder rack specify CHATSWORTH PRODUCTS Inc. (CPI). Provide the two/four post CPI Rack and accessories for installation as required.

O. Color Coding of Termination Fields

TIA/EIA-606 Standard
Orange Demarcation Point (Central Office Termination)
Green Termination of Network Connections on the Customer Side of Demarcation Point
Purple Termination of Cables Originating from Common Equipment (PBX, Computers, LAN)
White First Level Backbone Telecommunications Media - Main Cross-Connect
Gray Second Level Backbone Telecommunications Media - Main Cross-Connect
Blue Termination of Station Telecommunications Media
Yellow Termination of Auxiliary Circuits, Alarms, Maintenance, Security and other Miscellaneous Circuits
Red Termination of Key Telephone Systems

P. Jack and Patch Panel Labeling

Outlet and Jack labeling (difference between voice and data jacks and cables will be via color code only):
Closet-Room Number - Outlet Box - Jack Position
9X-999-99-99
2A-204-12-01 (2nd Floor Closet A, Room 204-Outet Box 12-Jack 1)
Cable label is the same as this number on room end.
Closet number can be left off if only one closet per floor.
Patch Panel Labeling
Room Number - Outlet Box - Jack Position
204-12-01
Cable label is the same as this number on wiring closet end.
Building, floor or wiring closet can be left off when system is totally administered from a single building/closet and/or there is not enough space on label.

Q. Minimum Conduit Sizes: Refer to Division 26 05 33 for conduit types & Permitted uses.

Between building wiring closets: 2-4" Conduits (PVC Underground)
Wiring closet to individual data outlet location: 3/4" Conduits (EMT in walls and gyp board ceilings, free air with J -hooks above T- Bar grid ceilings) minimum and conduit sized for fill @40% maximum and pull boxes as required to maintain bending radius.

1.09 SECURITY SYSTEMS

A. Security is custom designed for each building, conduit required to sensor and camera locations
B. Intrusion Detection and Access Control: GE Interlogix - Info Graphics Systems
C. Video Surveillance: Pelco Systems, Endura Recording and Control. All Voice/Data, Video and security system wiring shall terminate at Telecom Closet as directed by District IT.

1.10 HORIZONTAL CABLING DESCRIPTION

A. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called a "permanent link," a term that is used in the testing protocols.

1. TIA/EIA-568-B.1 requires that a minimum of two telecommunications outlet/connectors be installed for each work area,
2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.
3. Bridged taps and splices shall not be installed in the horizontal cabling.

1.11 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA/EIA-568-B.1 when tested according to test procedures of this standard.
B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 450 or less.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
D. Grounding: Comply with J-STD-607-A.

1.12 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches or size as indicated on plans.

1.13 UTP CABLE (see District Standards 2.1)

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Solutions; a Berk-Tek Leviton Inc. brand. (District Standard)

B. Description: 100-ohm, four-pair UTP, formed into 25-pair, binder groups covered with a blue thermoplastic jacket.

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA/EIA-568-B.1 for performance specifications.
3. Comply with TIA/EIA-568-B.2, Category 6.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

a. Communications, General Purpose: Type CM or CMG.
b. Communications Plenum Rated: Type CMP complying with NFPA 262.
c. Communications Riser Rated: Type CMR, complying with UL 1666.
d. Communications, Limited Purpose: Type CMX.
e. Multipurpose: Type MP or MPG
f. Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.
g. Multipurpose, Riser Rated: Type MPR or MPP, complying with UL 1666.

1.14 UTP CABLE HARDWARE

A. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.
B. Connecting Blocks: 110-style IDC for Category 6A. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs

and jacks where indicated.

C. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

1. Number of Terminals per Field: One for each conductor in assigned cables.

D. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.
E. Number of Jacks per Field: One for each four-pair UTP cable indicated.
F. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.
G. Patch Cords: Factory-made, four-pair cables in 48-inch lengths; terminated with eight-position modular plug at each end.

1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6A performance. Patch cords shall have latch guards to protect against snagging.
2. Patch cords shall have color-coded boots for circuit identification.

1.15 CONSOLIDATION POINTS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
B. Chatsworth Products, Inc.
C. Description: Consolidation points shall comply with requirements for cable connecting hardware.

1. Number of Terminals per Field: One for each conductor in assigned cables.
2. Number of Connectors per Field:

D. One for each four-pair UTP cable indicated.
E. One for each four-pair conductor group of indicated cables, plus 25percent spare positions.
F. Mounting: Furniture.
G. NRTL listed as complying with UL 50 and UL 1863.
H. When installed in plenums used for environmental air, NRTL listed as complying with UL 2043.

1.16 MULTIUSER TELECOMMUNICATIONS OUTLET ASSEMBLY (MUTOA)

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
B. Chatsworth Products, Inc.
C. Description: MUTOAs shall meet the requirements for cable connecting hardware.
D. Number of Terminals per Field: One for each conductor in assigned cables.
E. Number of Connectors per Field:

1. One for each four-pair UTP cable indicated.
2. One for each four-pair conductor group of indicated cables, plus 25 percent spare positions.

F. Mounting: Furniture.
G. NRTL listed as complying with UL 50 and UL 1863.
H. Label shall include maximum length of work area cords, based on TIA/EIA-568-B.1.
I. When installed in plenums used for environmental air, NRTL listed as complying with UL 2043.

1.17 TELECOMMUNICATIONS OUTLET/CONNECTORS

A. Jacks: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply

with TIA/EIA-568-B.1.

B. Workstation Outlets: Two-port-connector assemblies mounted in single or multi-gang faceplate.

1. Plastic Faceplate: High-impact plastic. Coordinate color with Section 262726 "Wiring Devices."

C. For use with snap-in jacks accommodating any combination of UTP work area cords.

1. Flush mounting jacks, positioning the cord at a 45-degree angle.

D. Legend: Factory labeled by silk-screening or engraving for stainless steel faceplates.
E. Legend: Machine printed, in the field, using adhesive-tape label.
F. Legend: Snap-in, clear-label covers and machine-printed paper inserts.

1.18 GROUNDING

A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.
B. Comply with J-STD-607-A.

1.19 IDENTIFICATION PRODUCTS

A. Comply with TIA/EIA-606-A and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
B. Comply with requirements in Section 260553 "Identification for Electrical Systems."

1.20 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.
B. Factory test UTP cables on reels according to TIA/EIA-568-B.1.
C. Factory test UTP cables according to TIA/EIA-568-B.2.
D. Cable will be considered defective if it does not pass tests and inspections.
E. Prepare test and inspection reports.

PART 2 - EXECUTION

2.01 WIRING METHODS

A. Install cables in pathways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used in cable tray. Conceal pathways and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements in Section 270528 "Pathways for Communications Systems."
3. Comply with requirements in Section 270536 "Cable Trays for Communications Systems."

B. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
C. Wiring within Enclosures:

1. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
2. Install lacing bars and distribution spools.
3. Install conductors parallel with or at right angles to sides and back of enclosure.

2.02 INSTALLATION OF CABLES

A. Comply with NECA 1.
B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-B.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. MUTOA shall not be used as a cross-connect point.
5. Consolidation points may be used only for making a direct connection to telecommunications outlet/connectors:

    a. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.
    b. Locate consolidation points for UTP at least 49 feet from communications equipment room.

6. Terminate conductors; no cable shall contain un terminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
7. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
8. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
9. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
10. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
11. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.
12. In the communications equipment room, install a 10-foot- long service loop on each end of cable.
13. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:

1. Comply with TIA/EIA-568-B.2.
2. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.

D. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

E. Group connecting hardware for cables into separate logical fields.
F. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-B for separating unshielded copper voice and data

communication cable from potential EMI sources, including electrical power lines and equipment.

2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

2.03 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."
B. Comply with TIA-569-B, Annex A, "Firestopping."
C. Comply with BICSI TDMM, "Firestopping Systems" Article.

2.04 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
B. Comply with J-STD-607-A.
C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.
D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

2.05 IDENTIFICATION (see District Standards for labeling)

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

    1. Administration Class: 2.
    2. Color-code cross-connect fields. Apply colors to voice and data service backboards,

connections, covers, and labels.

B. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 2 level of administration, including optional identification requirements of this standard.
C. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
D. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of TIA/EIA-606-A. Furnish electronic record of all drawings, in software and format selected by Owner.
E. Cable and Wire Identification:

1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

    a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.
    b. Label each unit and field within distribution racks and frames.

5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
6. Uniquely identify and label work area cables extending from the MUTOA to the work area. These cables may not exceed the length stated on the MUTOA label.

F. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA-606-A.

1. Cables use flexible vinyl or polyester that flex as cables are bent.

2.06 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Visually inspect UTP jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments and inspect cabling connections for compliance with TIA/EIA-568-B.1.
2. Visually confirm Category 6A, marking of outlets, cover plates, outlet/connectors, and patch panels.
3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
4. Test UTP backbone copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection

blocks. Test cables after termination but not cross-connection.

a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

5. UTP Performance Tests:

a. Test for each outlet and MUTOA. Perform the following tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.2:

1) Wire map.
2) Length (physical vs. electrical, and length requirements).
3) Insertion loss.
4) Near-end crosstalk (NEXT) loss.
5) Power sum near-end crosstalk (PSNEXT) loss.
6) Equal-level far-end crosstalk (ELFEXT).
7) Power sum equal-level far-end crosstalk (PSELFEXT).
8) Return loss.
9) Propagation delay.
10) Delay skew.

6. Final Verification Tests: Perform verification tests for UTP systems after the complete communications cabling and workstation outlet/connectors are installed.

a. Voice Tests: These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and digital subscription line telephone call.
b. Data Tests: These tests assume the Information Technology Staff has a network installed and is available to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.
c. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.
d. End-to-end cabling will be considered defective if it does not pass tests and inspections.
e. Prepare test and inspection reports.

2.07 DEMONSTRATION

A. Train Owner's maintenance personnel in cable-plant management operations, including changing signal pathways for different workstations, rerouting signals in failed cables, and keeping records of cabling assignments and revisions when extending wiring to establish new workstation outlets

END OF SECTION

SECTION 28 21 30
GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Grounding conductors.
2. Grounding connectors.
3. Grounding bus bars.
4. Grounding labeling.

1.02 DEFINITIONS

A. BCT: Bonding conductor for telecommunications.
B. EMT: Electrical metallic tubing.
C. TGB: Telecommunications grounding bus bar.
D. TMGB: Telecommunications main grounding bus bar.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.04 INFORMATIONAL SUBMITTALS

A. As-Built Data: Plans showing as-built locations of grounding and bonding infrastructure, including the following:
   a. Ground and roof rings.
   b. BCT, TMGB, TGBs, and routing of their bonding conductors.
B. Qualification Data: For Installer.
C. Qualification Data: For testing agency and testing agency's field supervisor.
D. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Installation Supervision: Installation shall be under the direct supervision of ITS Technician, who shall be present at all times when Work of this Section is performed at Project site.
2. Field Inspector: Currently registered by BICSI as ITS Installer 2 to perform the on-site inspection.

PART 2 - PRODUCTS

2.01 SYSTEM COMPONENTS

A. Comply with J-STD-607-A.

2.02 CONDUCTORS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Harger Lightning & Grounding.
2. Panduit Corp.
3. Tyco Electronics Corp.

B. Comply with UL 486A-486B.
C. Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.

1. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.
2. Cable Tray Equipment Grounding Wire: No. 6 AWG.

D. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmils 14 strands of No. 17 AWG conductor, and 1/4 inch in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Tinned-copper tape, braided conductors terminated with two-hole copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.03 CONNECTORS

A. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.
B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Burndy; Part of Hubbell Electrical Systems.
2. Chatsworth Products, Inc.

C. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.

1. Electroplated tinned copper, C and H shaped.

D. Busbar Connectors: Cast silicon bronze, solderless compression or exothermic-type, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch centers for a two-bolt connection to the busbar.
E. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.04 GROUNDING BUSBARS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Chatsworth Products, Inc.
2. Harger Lightning & Grounding.

B. TGB: Predrilled rectangular bars of hard-drawn solid copper, 1/4 by 2 inches x 12" in cross section, length as indicated on Drawings. The busbar shall be for wall mounting, shall be NRTL listed as complying with UL 467, and shall comply with J-STD-607-A.

1. Predrilling shall be with holes for use with lugs specified in this Section.
2. Mounting Hardware: Stand-off brackets that provide at least a 2-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.)
3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

C. Rack and Cabinet Grounding Busbars: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with J-STD-607-A. Predrilling shall be with holes for use with lugs specified in this Section.

1. Cabinet-Mounted Busbar: Terminal block, with stainless-steel or copper-plated hardware for attachment to the cabinet.
2. Rack-Mounted Horizontal Busbar: Designed for mounting in 19- or 23-inch equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.
3. Rack-Mounted Vertical Busbar: 72 or 36 inches long, with stainless-steel or copper-plated hardware for attachment to the rack.

2.05 LABELING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Brother International Corporation.
2. Hellermann Tyton.
3. Panduit Corp.

B. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
C. Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine the ac grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of the electrical system.
B. Inspect the test results of the ac grounding system measured at the point of BCT connection.
C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
D. Proceed with connection of the BCT only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Bonding shall include the ac utility power service entrance, the communications cable entrance, and the grounding electrode system. The bonding of these elements shall form a loop so that each element is connected to at least two others.
B. Comply with NECA 1.

C. Comply with J-STD-607-A.

3.03 APPLICATION

A. Conductors: Install solid conductor for No. 8 AWG and smaller and stranded conductors for No. 6AWG and larger unless otherwise indicated.

1. The bonding conductors between the TGB and structural steel of steel-frame buildings shall not be smaller than No. 6AWG.
2. The bonding conductors between the TMGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.

B. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

C. Conductor Support:

1. Secure grounding and bonding conductors at intervals of not less than 36 inches.

D. Grounding and Bonding Conductors:

1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.
2. Install without splices.
3. Support at not more than 36-inch intervals.
4. Install grounding and bonding conductors in 3/4-inch EMT conduit until conduit enters a telecommunications room and cable tray. Conductors shall not be installed in EMT unless otherwise indicated.

    a. If grounding and bonding conductor is installed in ferrous metallic conduit, bond the conductor to the conduit using a grounding bushing and bond both ends of the conduit to a TGB.

E. Install busbars horizontally, on insulated spacers 2 inches minimum from wall, 12 inches above finished floor unless otherwise indicated.
F. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

3.04 CONNECTIONS

A. Bond metallic equipment in a telecommunications equipment room to the grounding busbar in that room, using equipment grounding conductors not smaller than No. 6 AWG.
B. Stacking of conductors under a single bolt is not permitted when connecting to busbars.
C. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:

1. Use crimping tool and the die specific to the connector.
2. Pre twist the conductor.
3. Apply an antioxidant compound to all bolted and compression connections.

D. Primary Protector: Bond to the TMGB with insulated bonding conductor.
E. Telecommunications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install vertically mounted rack grounding busbar unless the enclosure and rack are manufactured with the busbar. Bond the equipment grounding busbar to the TGB No. 2 AWG bonding conductors.
F. Structural Steel: Where the structural steel of a steel frame building is readily accessible within the room or space, bond each TGB and TMGB to the vertical steel of the building frame.
G. Electrical Power Panelboards: Where an electrical panelboard for telecommunications equipment is located in the same room or space, bond each TGB to the ground bar of the panelboard.
H. Shielded Cable: Bond the shield of shielded cable to the TGB in communications rooms and spaces. Comply with TIA/EIA-568-B.1 and TIA/EIA-568-B.2 when grounding screened, balanced, twisted-pair cables.
I. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.

3.05 IDENTIFICATION

A. Labels shall be preprinted or computer-printed type.

1. Label TMGB(s) with "fs-TMGB," where "fs" is the telecommunications space identifier for the space containing the TMGB.
2. Label TGB(s) with "fs-TGB," where "fs" is the telecommunications space identifier for the space containing the TGB.
3. Label the BCT and each telecommunications backbone conductor at its attachment point: "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

3.06 FIELD QUALITY CONTROL

A. Perform tests and inspections.
B. Tests and Inspections:

1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
2. Test the bonding connections of the system using an ac earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing a TMGB and a TGB and using the process recommended by BICSI TDMM. Conduct tests with the facility in operation.

    a. Measure the resistance between the busbar and the nearest available grounding electrode. The maximum acceptable value of this bonding resistance is 100 milliohms.

3. Test for ground loop currents using a digital clamp-on ammeter, with a full-scale of not more than 10 A, displaying current in increments of 0.01 A at an accuracy of plus/minus 2.0 percent.

    a. With the grounding infrastructure completed and the communications system electronics operating, measure the current in every conductor connected to the TMGB[and in each TGB]. Maximum acceptable ac current level is 1 A.

C. Excessive Ground Resistance: If resistance to ground at the BCT exceeds [5] <Insert value>

ohms, notify Architect promptly and include recommendations to reduce ground resistance.

D. Grounding system will be considered defective if it does not pass tests and inspections.
E. Prepare test and inspection reports.

END OF SECTION

SECTION 28 21 40
PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Metal conduits and fittings.
   2. Optical-fiber-cable pathways and fittings.
   3. Boxes, enclosures, and cabinets.

B. Related Requirements:
   1. Section 26 0533 "Raceways and Boxes for Electrical Systems" for conduits, wire ways, surface raceways, boxes, enclosures, cabinets, hand holes, and faceplate adapters serving electrical systems.

1.02 ACTION SUBMITTALS

A. Product Data: For surface pathways, wire ways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

1.03 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For pathway racks, enclosures, cabinets, equipment racks and their mounting provisions, including those for internal components, from manufacturer.

PART 2 - PRODUCTS

2.01 METAL CONDUITS AND FITTINGS

A. General Requirements for Metal Conduits and Fittings:

   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with TIA-569-B.

B. GRC: Comply with ANSI C80.1 and UL 6.
C. EMT: Comply with ANSI C80.3 and UL 797.
D. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
E. Joint Compound for GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.02 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

A. Description: Comply with UL 2024; flexible-type pathway, approved for riser or general-use installation unless otherwise indicated.

   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with TIA-569-B.

2.03 SURFACE PATHWAYS

A. General Requirements for Surface Pathways:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-B.

2.04 BOXES, ENCLOSURES, AND CABINETS

A. General Requirements for Boxes, Enclosures, and Cabinets:

1. Comply with TIA-569-B.
2. Boxes, enclosures and cabinets installed in wet locations shall be listed for use in wet locations.

B. Sheet-Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, aluminum, Type FD, with gasketed cover.
D. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
F. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, [cast aluminum] [galvanized, cast iron] with gasketed cover.
G. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.
H. Gangable boxes are prohibited.
I. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

J. Cabinets:

1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.

2.05 PATHWAY APPLICATION

A. Indoors: Apply pathway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed, Not Subject to Severe Physical Damage: EMT.
3. Exposed and Subject to Severe Physical Damage: GRC.
4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
5. Damp or Wet Locations: GRC.
6. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: EMT.
7. Pathways for Concealed General-Purpose Distribution of Optical-Fiber or Communications Cable: EMT.
8. Boxes and Enclosures: NEMA 250 Type 1, except use NEMA 250 Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

B. Minimum Pathway Size: 3/4-inch trade size. Minimum size for optical-fiber cables is 1 inch.
C. Pathway Fittings: Compatible with pathways and suitable for use and location.

1. Rigid Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. EMT: Use compression fittings. Comply with NEMA FB 2.10.

D. Install surface pathways only where indicated on Drawings.

PART 3 - INSTALLATION

3.01 GENERAL INSTALLATION

A. Comply with NECA 1, NECA 101, and TIA-569-B for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum pathways. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.
B. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.
C. Arrange stub-ups so curved portions of bends are not visible above finished slab.
D. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches of changes in direction. Utilize long radius ells for all optical-fiber cables.
E. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

1. Stub-ups to Above Recessed Ceilings:

F. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
G. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.
H. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.
I. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
J. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
K. Pathways for Optical-Fiber and Communications Cable: Install pathways as follows:

1. 1-Inch Trade Size and Larger: Install pathways in maximum lengths of 75 feet.
2. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements.

L. Install pathway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound.
M. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:

1. Where otherwise required by NFPA 70.

a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.

d. Attics: 135 deg F temperature change.

N. Mount boxes at heights indicated on Drawings in accordance with ADA requirements. Install boxes with height measured to bottom of box unless otherwise indicated.
O. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

3.02 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.03 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.04 PROTECTION

A. Protect coatings, finishes, and cabinets from damage or deterioration.

END OF SECTION

SECTION 28 22 00
MASS NOTIFICATION SINGLEWIRE/INFORMACAST

PART 1 - GENERAL

1.01 SUMMARY

A. Singlewire's InformaCast IP broadcasting application provides a flexible platform where authenticated and authorized personnel can send an audio stream and text messages to any combination of Cisco IP phones, compliant IP speakers, and PCs. Either on a tablet, kiosk, smartphone or desktop phone or a single click from a PC, a user can send a live, recorded, or scheduled broadcast to one or more paging groups.
B. In the event of an emergency, sending notification to students, staff, and the public can be a complex task. There are multiple communications pathways including voice, text, messaging, video, audio, social media (web based) that are all part of a comprehensive, integrated Mass Notification system.
C. Some of the features associated with integrating InformaCast into the Security System are:

1. Send a lockdown message immediately when there's an intruder or other dangerous situation
2. Automatically monitor, record, and send an alert when an emergency number like 911 is dialed
3. Send automated weather alerts to staff and students
4. Get immediate notifications when an emergency pole or telephone is activated
5. Internal Communication
6. Send audio, text, and video notifications to phones, speakers, computers, and other devices
7. Have the flexibility to choose exactly who receives your message, from a single person to a specific department to the entire campus

D. The devices associated with supporting the Mass Notification InformaCast system are:

1. IP Phones. Send text and/or audio to phones' speakers and display screens (with "whisper" functionality used for anyone on a phone call).
2. IP Speakers. Send text and/or audio to speakers connected to the IP data network.
3. Overhead Paging Systems. Send audio to indoor and outdoor public address systems.
4. On and Off-network (Mobility) Email Systems. Send an email with text information and an audio file with instructions
5. SMS Text Messaging. Send text messages to cell phones.
6. Web/Social Media Sites. Publish text to the organization's website, Facebook, and Twitter accounts.
7. Digital Media Displays. Send text and/or audio to monitors located public areas of buildings.
8. Computer Desktops. Send text and/or audio that immediately "pops up" on staff's computer workstations.

1.02 INFORMACAST ADVANCED

A. InformaCast Advanced is a software solution that transforms devices on your network into a powerful system for IP paging and emergency alerting. It integrates easily with Cisco phones overhead speakers, strobes, panic buttons, and more to increase the speed, reach, and success rate of your emergency alerts.
B. InformaCast makes it easy to send an alert to many different devices at the same time. This layered approach increases the odds that people receive your alert and get important information they need during an emergency.

C. Cisco Phone Alerts

1. InformaCast can send audio and text alerts to groups of Cisco IP phones. You can send an alert through the InformaCast user interface or by picking up a phone, dialing the designated extension, and speaking.

D. IP Speaker Alerts

1. InformaCast can send audio and/or scrolling text alerts to IP speakers and clocks on your network. You can choose to send alerts to all the speakers on your network or just the ones located in specific buildings, wings, or floors.

E. Analog Speaker Alerts

1. InformaCast can integrate with your existing analog speakers so you don't have to replace them. When you configure your existing analog paging zones using InformaCast's Legacy Paging Interface, you can add these zones as recipients of InformaCast alerts.

F. Panic Button Alerts

1. InformaCast can integrate with panic buttons to make triggering emergency alerts fast and easy. You can place a panic button in any room or conceal it under a desk to serve as a discreet call button for your reception staff. When someone pushes the button, a pre-recorded InformaCast alert will go to designated devices.

1.03 COMPUTER POP-UP ALERTS

A. InformaCast can send text and audio alerts to computer workstations. The alerts appear in a pop-up window that you can customize with your company's logo and color(s). InformaCast also provides the option for people to respond.

B. Digital Signage Alerts

1. InformaCast can send alerts to digital signage displays to supplement other types of alerts. It's also a great way to make alerts accessible for people who are deaf or hard of hearing.

C. Alerts to Two-Way Police/Security Radios

1. InformaCast can send alerts to groups of police/security radios when you need to notify law enforcement or security officers of an emergency in your organization. Alerts are delivered as one-way audio broadcasts.

1.04 Which Types of Alerts Can You Send with InformaCast?

A. Live, Audio Alerts

1. Audio alerts that are delivered in real time as you speak. You can initiate this type of alert by pressing a button or dialing an extension on a Cisco IP phone. The alert is delivered to pre- configured groups of Cisco IP phones.

B. Adhoc Audio Alerts

1. Audio alerts that are recorded live, but not delivered until you're satisfied, and you trigger the alert to go out. You can re-record as many times as you'd like.

C. Pre-Recorded Audio and Text Alerts

1. Audio and text alerts that are created during a non-critical time. You can assign groups of

devices that you want to receive these alerts, set how you'd like someone to be able to trigger these alerts, and save them in the system. They'll then be available for quick and easy delivery during an emergency situation. Intelligent Emergency Alerting

1.05 Intelligent Emergency Alerting Features

A. Emergency Call Monitoring, Recording, and Alerting

1. InformaCast can detect when someone in your facility dials 911 or an internal emergency number. When this happens, InformaCast sends an alert to internal safety team members, managers, local first responders and other designated people. The alert includes information about when, where, and by whom the call was placed to facilitate a fast, organized response.

B. Weather Monitoring and Alerting

1. InformaCast monitors Common Alerting Protocol (CAP) feeds from Federal agencies like the National Weather Service and NOAA. You can configure it to forward only alerts that pertain to your geographic area. The alerts can go to facility speakers, specific phone numbers or email addresses, and more.

C. Conference Call Management

1. When an emergency alert goes out, InformaCast can bring key people together into a conference call to coordinate an emergency response. These people will receive a phone call with a recording of the initial alert and an invitation to join the conference call bridge. They can invite other people to join the call by providing them with a designated extension.

D. Website RSS Feed Monitoring

1. You can configure InformaCast to monitor RSS feeds from designated websites. Whenever those feeds are updated with new content, it will send an alert to a designated group of people.

E. Alerts to Third Party Applications

1. InformaCast can send alerts via third party applications such as social media accounts and instant messaging clients.

F. Alerts to Twitter

1. You can assign Twitter accounts to recipient groups in InformaCast and send text alerts to those accounts in the same way you would an IP phone or other device.

G. Alerts to WordPress

1. You can assign WordPress websites to recipient groups in InformaCast and send text alerts to those websites in the same way you would an IP phone or other device.

1.06 Alerts to Cisco® Jabber™ Instant Messaging Clients

A. You can send InformaCast alerts to people via the Cisco Jabber IM client. Alerts are delivered as instant messages and include the short text of the InformaCast alert and a link to play back audio. The Jabber IM plugin is compatible with Cisco's on-premises and off-premises solutions, Cisco Unified Communications Manager IM, Presence, and WebEx.
B. Inbound and Outbound Email Alerts

1. When InformaCast receives an email from a designated email account, it can automatically send out a text and/or audio alert. Alternatively, InformaCast can send text/audio alerts to groups of email accounts.

C. Simple Scheduling Interface

1. InformaCast has a built-in interface that allows you to schedule alerts and tones as far in advance as you'd like. You can use this for a variety of functions, but the most common are listed below.

D. School Bells, Passing Period Alerts, and Announcements

1. You can schedule bells in advance for the entire school year. You can also create alternate bell schedules for teacher in service days, early release days, exams, and more. Anyone who is authorized to use InformaCast can make day-of changes in the user interface, even after the schedule is set. You can use this same method to schedule a musical recording to play during passing periods or to schedule end-of-day announcements.

E. Shift Change Alerts

1. You can schedule a 5-minute warning towards the end of a shift so people know to wrap up their work, clean up, etc., and then an alert that marks the end of the shift. This is especially helpful for organizations that have different crews for first, second, and third shift.

F. Closing Announcements

1. You can schedule InformaCast alerts to let people know when your store or facility is closing, when visiting hours are over, or when it's the end of the workday.

G. Prayer Time Scheduling

1. InformaCast can calculate prayer times for your location (based on latitude and longitude) and send scheduled prayer alerts. You can create schedules for multiple locations, and you have the option to customize the message of the alert, bell or tone, and recipients. This feature is especially helpful if your organization accommodates the Islamic practice of scheduled prayer.

1.07 Custom Solutions

A. URL Triggers to Third Party Applications

1. InformaCast can reach a third-party application via a URL. This feature is typically used when the third-party application has an API that can accept an inbound HTTP trigger from InformaCast. For example, InformaCast activates an IP-enabled security system by making an API REST call via a URL.

1.08 Custom Java and JavaScript Integrations

A. You can build a custom Java/JavaScript integration by creating a script file containing code that can participate at various phases of the broadcast. The integration can be deep—relaying audio associated with the broadcast—or simple. This depends on how much code is written, and how much of the exposed interface is used.
B. Inbound and Outbound Application Programming Interface (API)

1. You can configure InformaCast to remotely monitor and/or trigger systems and devices on the network via InformaCast's open API.

C. Integration with Facility Systems and Devices

1. InformaCast can integrate with facility systems and devices via contact closure (machine-to-machine) configuration.
2. With this configuration, an outgoing InformaCast alert can trigger an action. For example, a school administrator sends a lockdown alert and InformaCast automatically triggers the electronic door lock system to lock all interior doors.
3. It can also work the other way around, with an event triggering an InformaCast alert. For example, there's a fire in your building and someone pulls the fire alarm. InformaCast sends an alert with evacuation procedures to all IP speakers in your facility.

1.09 Extra Paid Options

A. InformaCast Mobile

1. InformaCast Mobile is a cloud-based service that allows you to send images, text, and pre-recorded audio alerts to mobile devices. It can broadcast both pre-defined and dynamic alerts to iOS or Android devices via the push network (requires InformaCast Mobile app). It can reach Windows, Blackberry, and feature phones via SMS text. It can also place phone calls and send emails to any capable device.
2. Senders can request a response, access data reports, view a list of who read their message, and configure InformaCast Mobile to escalate based on responses.
3. InformaCast Mobile's bi-directional integration with InformaCast allows senders to reach both InformaCast Mobile distribution lists and InformaCast distribution lists. This means a sender can trigger an alert from InformaCast Mobile and reach people on-and-off-premises via mobile devices, Cisco IP phones, email, social media, speakers, strobes, digital signage, etc.

B. Paging Gateway Server

1. The Paging Gateway plugin and Paging Gateway server allow you to send InformaCast audio alerts across a network that otherwise wouldn't support multicast traffic.

C. Park and Page

1. Park and Page is a feature of InformaCast that provides automatic call routing, customized escalation, and centralized call management across several locations. InformaCast uses a Cisco Unified Communications Manager configuration along with a combination of recipient groups and InformaCast alerts to automatically park calls, direct them to the right department, and notify associates in that department.
2. If no one picks up, InformaCast can escalate by re-directing the call to the correct department at a different branch, the manager on duty, or a centralized call center.

D. School Messenger

1. You can configure InformaCast to treat School Messenger jobs as recipients of InformaCast alerts. This allows you to assign them to recipient groups and send InformaCast alerts to them in the same way you would an IP phone or other device.

1.10 Devices, Licensing, and Info

A. Cisco Compatibility

1. InformaCast is compatible with most versions of Cisco Unified Communications Manager

and most Cisco IP phone models. See full compatibility lists at www.singlewire.com/compatibility-matrix

B. Technology Partners

1. There are several technology vendors that produce InformaCast-compliant IP speakers, panic buttons, contact closures, zone controllers, digital displays, and third-party applications. Learn more about these companies at www.singlewire.com/ecosystem-partners

C. Technical Requirements*

1. VMware ESXi 4.0 or later
2. 4 Gb of memory
3. A dedicated virtual CPU (vCPU) is required
4. A single virtual NIC configured for bridging, not NAT; InformaCast will not work through NAT'd network connections
5. 80 Gb disk, which can be either local disk or SAN-attached disk (the SAN may be of any type supported by VMware)
6. CUCM 8.5 or newer with multicast-enabled network (unicast gateway is available for WAN if needed)

*Please see Hardware Requirements on www.singlewire.com/compatibility-matrix for updates

1.11 Licensing Model

A. We license InformaCast Advanced according to the number of devices you want to reach with InformaCast alerts. These could include: Cisco IP phones, InformaCast-compliant IP speakers, and networked Windows/ Mac machines running the InformaCast Desktop Notifier. Maintenance contracts are available for purchase in 1-5 year subscriptions and provide access to upgrades, patches, and the Singlewire Support Team. For pricing and ordering information, contact your authorized Cisco re-seller or a Singlewire representative.

PART 2 - MASS NOTIFICATION PROCESS WORK- FLOW SUMMARY

2.01 The integration of the InformaCast system is a district (each campus) requirement, extending to all structures and locations that are part of each campus.

2.02 In the election for Fire Alarm integration, the InformaCast system will receive an HTTP output from the fireworks system via the InformaCast M2M plugin. This will trigger sirens, strobes, and the announcement engine to utilize the Giant Voice speakers installed on the campus.

2.03 The integrator shall integrate the components associated with this project to the base main campus system that utilizes the main campus Singlewire InformaCast Paging Adapter, that is installed in the security operations sensor that generates line-level signaling required by the speakers associated with the EST FAS.

2.04 A secondary plugin triggers the Cisco VOIP system to page all phones (speaker phones) to incorporate them into the notification schema.

2.05 Machine-to-Machine (M2M) refers to technologies that allow both wireless and wired systems to communicate with other devices. M2M uses a device (such as a contact closure) to capture an event (a doorbell ringing), which is relayed through a network (wireless, wired, or hybrid) to an

application (InformaCast), that translates the captured event into meaningful information (for example, the doorbell ringing sends a broadcast to answer the back service door).

2.06 The M2M plugin allows you to send InformaCast broadcasts when a contact closure has been triggered or trigger a contact closure when a specific broadcast has been sent. Once you have configured your contact closures, you can add them to InformaCast: input ports will allow you to trigger InformaCast The integration of the Informacast system is a campus-wide requirement, extending to all structures and locations that are part of the expansion of the foundation systems.

2.07 The M2M plugin has the following prerequisites:

A. A successful installation of InformaCast
B. Fully configured contact closures; supported models include Perle IOLAN DS1 D2R2 with firmware 4.2 and above,
C. Perle IOLAN DS1 T4 with firmware 4.2 and above, and Barix Barionet 50 with firmware B1.09 and above

2.08 Additional Plug-In programming will be required including:

A. Inbound CAP Plugin

1. The Inbound CAP (Common Alerting Protocol) plugin allows you to poll various data sources (which are typically RSS feeds from public safety organizations) and match the messages received from these data sources with message rules (which are used to define what types of messages you are interested in rebroadcasting to InformaCast recipients). For example, you might define a message rule that notifies you of any weather-related warnings in the county in which you live. Or, you may want your facility's security department to receive any missing persons alerts.
2. Once you have configured the Inbound CAP plugin, it will periodically poll your data sources, compare their content with the message rules you've created, and send out your specified InformaCast broadcast when the message rules' parameters are met.
3. The following points should be taken into consideration when using the Inbound CAP plugin for InformaCast:

    a. Because CAP is an open standard, organizations can still take certain liberties with some of its populated values. CAP is a payload specification (i.e. it's concerned with the format and structure of what you are sending), but it doesn't have a transport specification (i.e. it's not concerned with how something is delivered, so you could specify HTTP, HTTPS, FTP, SMTP, UDP, etc.). While we have made every attempt to make the Inbound CAP plugin work with RSS and ATOM data feeds, it is possible that a vendor has implemented their solution in such a manner that we are unable to extract and process the CAP message.
    b. When you start or restart InformaCast, it will not go back and re-post any previously posted alerts retrieved from your data sources. It will only process new CAP messages received from data sources since the startup. However, some data sources will post the same information in multiple CAP alerts. It is possible to receive the same information from more than one CAP alert.
    c. It is possible to overwhelm a phone recipient with CAP messages. This is a limitation of the phones, not the plugin. You should not rely on the Inbound CAP plugin as the only means of sending emergency management/time-critical information (e.g., tornado warnings). The best practice is to use the Inbound CAP plugin in conjunction with other communication methods (e.g., weather radio).

4. The Inbound CAP plugin has the following prerequisites:

a. A successful installation of InformaCast
b. Network connectivity between InformaCast and any data sources with which your Inbound CAP plugin will be exchanging data (for data sources on the public Internet, this connectivity can be either direct or through a proxy server)
c. A valid Inbound CAP plugin license

B. CAP is an XML-based, open, non-proprietary digital message format for all types of alerts and notifications. CAP messages are typically generated by any organization involved with notifications regarding public safety.
C. CAP Header Section

1. The Header section provides the most basic information about a message. It includes:

a. An <identifier> tag that uniquely identifies each message
b. A <status> tag that indicates whether this is an actual alert or merely a test
c. A <msgType> tag that indicates whether this is a new alert, an update to an existing alert, or a cancellation

D. There are other tags present in the header section, but they generally aren't used for Inbound CAP plugin configuration.
E. CAP Information Section

1. The Information section provides the details of the alert, including all of the information typically important to the public:

a. A <headline> tag provides a short overview of the situation and is typically what you would want to populate the **Short Text** field of your InformaCast message.
b. A <description> tag tends to give more details about the situation. For example, if there is a tornado warning, this section would typically contain information regarding the sighting of the tornado and towards which towns it is heading. This text is often used to populate the **Long Text** field of your InformaCast message.
c. An <instruction> tag explains what type of action the public should take. Like the <description> tag, this might also be used to populate the **Long Text**field of your InformaCast message.
d. An <area> tag describes what part of the globe is impacted by this message. There are three primary structures CAP provides for defining a geographic location:

1) The <polygon> tag can define irregularly shaped areas of the globe with latitude/longitude pairs. You typically see this tag used when the affected area doesn't follow political boundaries, e.g. chemical spills or flash floods.
2) Similar to the <polygon> tag, the <circle> tag can define an area of interest with a single latitude/longitude point and a radius.
3) The <geocode> tag assigns spatial coordinates to a data record or object, which represents an address or other geographic data. It is well-known to both the generating organization and the receivers of CAP messages. For example, the U.S. National Weather Service often uses the Federal Information Processing Standards Publications 6-4 (FIPS6) values when identifying affected counties. Under certain circumstances, the National Weather Service may also use the Universal Geographic Code (UGC) to define affected areas.

2.09 INFORMACAST COMMAND CENTER



END OF SECTION

SECTION 28 23 10
INTERACTIVE DISPLAYS FOR EDUCATION

PART 1 - GENERAL

1.01 SUMMARY

A. Smart educational technology reflects the way that students learn in the real world. Our students are natural networkers—playing games and swapping stories between classes and sharing their lives over social media at home. Clear Touch® interactive panels encourage the same kind of collaboration and game-based learning that comes so easily to today's student.

PART 2 - PRODUCT

2.01 Standardized Classroom Interactive Display

A. Clear Touch Interactive 6000K Series 65" Flat Panel Display

1. Manufacturer Item Number: CTI-6065K-UH20
2. Manufacturer Item Description: 65" 6000K Series Interactive Panel with USB HID / AGG / 20 Points of Touch – Ultra HD

B. Panel Operating System

1. System Version: Android 8.0
2. CPU: Dual Core A73
3. GPU: Quad Core Mali G51
4. RAM: 3GB
5. ROM: 16GB

C. Panel Interactivity

1. Sensing Type: Infrared recognition
2. Compatibility: Windows, Android, Mac OS-X, Linux, Chrome
3. Touch Points: 10 Points Writing, 20 Points Touch
4. Minimum Object Size: 3mm
5. Touch Tool: Finger, Opaque Objects, Passive Infrared Pen
6. Response Time: <10 ms
7. Accuracy: 1.5 mm (over 90% Area)
8. Communication Mode: Full-speed USB (driver free)
9. Interface: USB
10. Glass: Smooth Low Friction
11. Surface Hardness: 7 mohs toughened glass
12. Output Coordinate: 32767 x 32767

D. Panel Ambient

1. Operation Temperature: 32° F – 104° F
2. Operation Humidity: 10% — 90%
3. Storage Temperature: -4° F — 140° F
4. Storage Humidity: 10% – 90%
5. Altitude: Below 16404.2'

E. Included Panel Accessories

1. 3 Pens
2. Remote Control
3. 2 AAA batteries
4. Power Cord
5. HDMI Cable
6. USB Touch Cable
7. Fixed Wall Mount Manufacturer Item Number: CTI-MOUNT-FIXW (1 per panel, upon request)

F. Panel Display

1. Size: 65”
2. Screen Type: LED
3. Aspect Ratio: 16:9
4. Resolution: 3840H x 2160V Ultra HD
5. Display Area: 56.24” x 31.63”
6. Pixel Pitch: .372mm x .372mm
7. Back Light Unit: Direct type LED
8. Response Time: 8 ms
9. Refreshing Frequency:60Hz
10. Display Color: 1.07B (10bit)
11. Brightness: 350 cd/m2
12. Contrast Ratio: 1200:1
13. Viewing Angle: 178°
14. Lifetime: 30,000 hours

G. Panel Audio

1. Speaker Type: Built-in speaker
2. Output Power: 12W x 2

H. Panel Connectors

1. HDMI Output 2.0: 1
2. USB 2.0: 3
3. USB 3.0: 3
4. Touch Input: 2
5. HDMI Input 2.0: 3
6. VGA Input: 1
7. Audio Input: 1
8. Audio Output: 1
9. RS232 Port: 1
10. RJ45 Port: 1
11. SPDIF: 1

I. Power

1. Power Requirements: 100-240V~ 50/60Hz
2. Standby Power: ≤0.5W
3. Overall Power (nominal): 350W

J. Physical Specification

1. Key Location: Front
2. Dimension L x W x D: 58.62” x 35.32” x 3.39”
3. Package Dimension L x W x H: 65.20” x 8.03” x 41.34”

4. Net Weight: 82.34 lbs.
5. Gross Weight: 102.29 lbs.
6. Machine + Wall Mount Thickness (CTI-MOUNT-FIXW): 5.20”
7. Wall-hanging Screw Spec: M8 x 25 mm
8. VESA: 600 x 400 mm

K. Panel Optional Modules

1. Wi-Fi Module

    a. The optional WiFi Module enables wireless connectivity by the Android Operating System and reduces wiring by eliminating the need for an Ethernet cable. Some schools find the wireless connection makes screen sharing using the Collage app easier as well.

2. PC Module

    a. Onboard computer designed for Windows 10
    b. Available without or with Windows 10 Professional preinstalled
    c. 6 USB 3.0 Ports
    d. 1 LAN (RJ45)
    e. 1 VGA Output
    f. 1 Display Port Output
    g. 1 HDMI Output
    h. 1 Earphone Output
    i. 1 Microphone Input

L. 5 options available without Windows Operating System

1. Manufacturer Item Number: CTI-PCMOD-PC25-ST

    a. PC Module - Intel i5 Quad Core / 8GB DDR4 / 128GB SSD / Ultra HD (No Operating System)

2. Manufacturer Item Number: CTI-PCMOD-PC25-IG

    a. PC Module - Intel i5 Quad Core / 8GB DDR4 / 128GB SSD / Ultra HD with Independent Graphics card (No Operating System)

3. Manufacturer Item Number: CTI-PCMOD-PC25-VP

    a. PC Module - Intel i5 Quad Core vPro / 8GB DDR4 / 128GB SSD / Ultra HD (No Operating System)

4. Manufacturer Item Number: CTI-PCMOD-PC27-IG

    a. PC Module - Intel i7 Quad Core / 16GB DDR4 / 256GB SSD / Ultra HD with Independent Graphics card (No Operating System)

5. Manufacturer Item Number: CTI-PCMOD-PC27-VP

    a. PC Module - Intel i7 Quad Core vPro / 16GB DDR4 / 256GB SSD / Ultra HD (No Operating System)

M. 5 Options available with Windows 10 Professional Preinstalled

1. Manufacturer Item Number: CTI-PCMOD-PC25-ST-W10P

a. PC Module - Intel i5 Quad Core / 8GB DDR4 / 128GB SSD / Ultra HD (with Microsoft Windows 10 Professional)

2. Manufacturer Item Number: CTI-PCMOD-PC25-IG-W10P

a. PC Module - Intel i5 Quad Core / 8GB DDR4 / 128GB SSD / Ultra HD with Independent Graphics card (with Microsoft Windows 10 Professional)

3. Manufacturer Item Number: CTI-PCMOD-PC25-VP-W10P

a. PC Module - Intel i5 Quad Core vPro / 8GB DDR4 / 128GB SSD / Ultra HD (with Microsoft Windows 10 Professional)

4. Manufacturer Item Number: CTI-PCMOD-PC27-IG-W10P

a. PC Module - Intel i7 Quad Core / 16GB DDR4 / 256GB SSD / Ultra HD with Independent Graphics card (with Microsoft Windows 10 Professional)

5. Manufacturer Item Number: CTI-PCMOD-PC27-VP-W10P

a. PC Module - Intel i7 Quad Core vPro / 16GB DDR4 / 256GB SSD / Ultra HD (with Microsoft Windows 10 Professional

2.02 Bundled Tools

A. Nuiteq Snowflake MultiTeach®

1. Snowflake software is a powerful suite of more than 30 applications designed specifically for use on a touchscreen panel. These applications give teachers a toolkit for creating compelling classroom experiences. Pre-built tools allow users to craft custom games and activities, such as drag-and-drop challenges, word scrambles, matching quizzes, spinner games, and more.

a. Open all media types—videos, pictures, flash games, notes, and more
b. Split the screen into “zones” for multiple apps running at the same time
c. Create your own content tailored to your curriculum or choose from pre-built lessons online
d. Record screen, audio, and video to an MP4 file for homework helps, lessons for absentees, etc.
e. Works on equally well on Windows and Mac OS-X PCs.
f. Includes Snowflake teacher community loaded with prebuilt lessons, and lesson content tailored to the California State Standards
g. Embed YouTube video clips into lessons to capture the attention of Digital Natives and differentiate learning

B. Clear Touch Canvas™

1. Canvas gives you an infinite whiteboard that allows you to open all media types directly from the whiteboard, or open unlimited browsers inside your lessons to explore deeper. No more need to hyperlink, save bookmarks, or jump out of your lesson into multiple third-party applications, losing students along the way. You can even incorporate YouTube videos but avoid unwanted ads, comments, and links to related videos.

a. Unlimited whiteboard space to annotate and write
b. Make lessons practical with powerful interactive math tools
c. Ability to save files to the cloud or email

d. Open unlimited live browsers or videos without leaving Canvas
e. View webcams and document cameras and import snapshots and lesson content

C. Clear Touch Collage™

1. Collage makes it simpler than ever for teachers to get the whole class involved by allowing users to project content wirelessly and connect up to four devices simultaneously. Simply enable Collage on your panel, enter the displayed access code, and you're ready to go.

a. Connect up to 64 devices wirelessly
b. Enable up to 4 devices to connect and share simultaneously
c. Optional permission control for teacher to allow or restrict devices from sharing
d. Compatible with iPads, Chromebooks, Macs, PCs, and Android device

D. Clear Touch Command™

1. Command gives IT departments and school administrators the ability to remotely troubleshoot their panels, monitor device usage statistics, and communicate announcements and messages across and entire school or district. With Command, your IT team can see and update all panels remotely from a centralized computer instead of disrupting classes by visiting individual classrooms.

a. Automatic event scheduling including power controls
b. Built in text message capabilities to individual or district-wide panels
c. Comprehensive panel usage statistics and monitoring

E. Android Annotation Tools

1. Annotate (write, draw) over any input and over any application or document and save screenshots to the internal drive, save to Google or MS One Drive, or share with students via QR Code.
2. Walk-up ready Canvas whiteboard requires no login
3. Access the Home screen from either side of the panel
4. Manage open application and clear the memory
5. Freeze and zoom the screen to keep images displayed
6. Guide student focus using the built-in spotlight
7. Time tests and lessons with the Stopwatch and Countdown tools
8. Do classroom polling using the AirClass tool

F. Clear Touch Store

1. The Clear Touch Store is a curated App store that is preloaded with educational and informational apps and tools for the Android OS. This safe environment prevents objectionable and unwanted games and applications from being installed, while giving teachers a safe environment to download from.

G. Visualizer

1. Connect USB web cameras and document cameras using the Visualizer tool to view live images on the panel. Easily capture images to view, annotate, and save or share.

H. Clear Touch Academy

1. Clear Touch Academy™ members get free, 24/7 access to all our training modules and to our technical support community. The online lessons include exclusive video content, web clinics, and written content. The topics covered include Clear Touch® basics, such as

powering on, connecting to external devices, and installing software, as well as more advanced topics, such as multi-user collaboration and more complicated lesson planning or presentation-building.

2.03 Optional Wall Mounts & Mobile Stands

A. Wall Mounts

1. Fixed Wall Mount Manufacturer Item Number: CTI-MOUNT-FIXW
2. Adjustable Wall Mount Manufacturer Item Number: CTI-MOUNT-ADJW-V3
3. Electrically controlled height adjustable mount requires no wall loadbearing and can be mounted in front of existing whiteboards and/or chalkboards.

B. Mobile Stands

1. Fixed Mobile Stand Manufacturer Item Number: CTI-MOUNT-FIXM

a. Rectangular base provides stable platform and center shelf for component storage with four lockable casters for safety.

2. Fixed Mobile Stand Manufacturer Item Number: CTI-MOUNT-FIXM-V3

a. C-Shaped base provides maximum stability and easy access to students and special needs users. Center shelf for component storage with two lockable casters for safety.

3. Adjustable Mobile Stand Manufacturer Item Number: CTI-STAND-ADJM-V3

a. Electrically controlled height adjustable stand with C-Shaped base provides maximum stability and easy access to students and special needs users. Center shelf for component storage with two lockable casters for safety.

4. Convertible Mobile Stand Manufacturer Item Number: CTI-STAND-CONM-V3

a. Electrically controlled height adjustable stand with C-Shaped base provides maximum stability and easy access to students and special needs users. Stand adjusts from 0° to 90° and can be adjusted to any angle in between the two. Optional control by Snowflake software moves the table when specific Zones are selected***. NOTE: Table mode supported only with Clear Touch 7000X Series panels.***

2.04 Professional Development and User Training

A. User Training

1. Every Clear Touch panel purchase includes a complimentary User Training. This training must be scheduled with Clear Touch in advance, and may be conducted on site or online, depending on the customer's preference and Clear Touch availability.

B. Professional Development

1. Clear Touch Academy is an online portal available to any teacher using a Clear Touch Interactive flat panel display upon request and provided at no charge to the user.

C. Professional Development (PD) is performed by teachers and is for teachers to learn to use the tools to support their own pedagogical approaches to the classroom.

1. PD can be performed on site or online.

a. Manufacturer Item Number: CTI-SRVCS-PROD

   1) Professional Development (per day - online or on-site) 6 Hours

b. Manufacturer Item Number: CTI-SRVCS-OTS

   1) Clear Touch Studio - Online Training Standard

c. Manufacturer Item Number: CTI-SRVCS-OCC

   1) Clear Touch Studio - Online Coaching Custom - 3 x 20 minute sessions, valid for 1 year from purchase

PART 3 - WARRANTY

A. Standard 3-year limited warranty included at no extra cost.
B. Optional extensions to 5- and 7-year warranty upon request (additional cost may apply)

END OF SECTION

SECTION 28 24 00
TRIDIUM NIAGRA (HONEYWELL) BUILDING MANAGEMENT SYSTEM

PART 1 - GENERAL

1.01 TRIDIUM NIAGRA (HONEYWELL) BUILDING MANAGEMENT SYSTEM

Acronym	Description
Tridium	**The Company**
Niagara Framework®	**The Framework Architecture for Edge to Cloud technology**
JACE	**JAVA Application Control Engine**
API	Application Programme Interface
BaaS	Backup as a Service
ES	Enterprise Services
FM	Facilities Management
Fox	Unencrypted Niagara Framework intra-JACE communications
Foxs	Encrypted Niagara Framework intra-JACE communications
GUI	Graphical User Interface
HTTPS	Hypertext Transfer Protocol Secure
I/O	Input Output
ICT	Information Communications Technologies
IoT	Internet of Things
IP	Internet Protocol
LDAP	Lightweight Directory Access Protocol
M&E	Mechanical & Electrical
NAS	Network Attached Storage
NICS	**Niagara** Information **Conformance Statement**
OEM	Original Equipment Manufacturer
OSA	Open Systems Architecture
PaaS	Platform as a Service
PICS	BACnet Protocol Implementation Conformance Statement
PKI	Public Key Infrastructure
RBAC	Role-Based Access Control
SaaS	Software as a Service
SI's	Systems Integrators
SCADA	Supervisory Control and Data Acquisition
SPoG	Single Pain of Glass
SSL	Secure Socket Layer
SVG	Scalable Vector Graphics
TCP	Tridium Certified Program
TLS	Transport Layer Security

UI	User Interface
UPS	Uninterruptable Power Supply
VLAN	Virtual Local Area Network
VRV	Variable Refrigerant Volume
VSD	Variable Speed Drive

A. This guide specification is aimed at Consultants, Developers and Interested Specifying parties such as:

1. Consultants
2. Design & Build Contractors
3. Developers
4. Direct End Client / Users
5. Middleware Specialists
6. System Integrators

B. This specification serves as a guide to defining project specific requirements and becomes an outline to the deployment of the Niagara Framework® Architecture, equipment and solutions.
C. The aim is for specifying parties to create their own Smart Buildings specification from the outline of this Guide specification which provides information and guidance on the Niagara Framework® components and how to deploy the Niagara Framework® over multi protocoled systems and IoT Edge devices.
D. The output specification will need to incorporate the client's specific requirements and systems to be integrated, the target of this output should be Niagara Framework® OEM, Resellers and SI's who have the capability to deploy the required solution(s).
E. This output specification should also be read in conjunction with other services system specifications and their requirements such as BMS, Electrical, Lighting, Mechanical, Fire, Security, FM Systems & Enterprise Systems.

1.02 BMS OVERVIEW

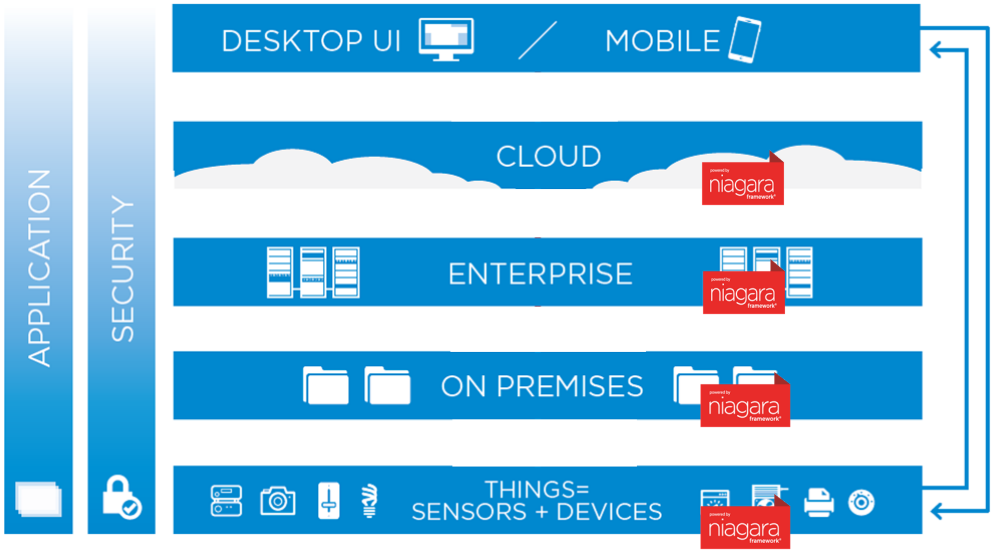
A. This Smart Buildings Guide specification outlines the Functions and Features of the Niagara Framework® which can be deployed across any network connected systems, locally and remotely and accessible via the Internet via WEB Browsers over the IoT(Internet of Things).
B. A Smart Building approach differs from a traditional building systems and services approach where each M&E, Facilities and Enterprise systems are connected via their own infrastructures, a Smart Building facilitates connectivity of any system over common communications Infrastructure (Cabling, Network Infrastructure) using industry standard open protocols and Application Programme Interfaces (API's) allowing data to be shared and manipulated to provide cause and effects between systems.
C. Communications infrastructures can include client's server environments (Server Farms) which are designed, supplied and installed by an Information and Communications Technology (ICT) and Cloud Specialist and includes/considers deployment of the following components parts which require separate scoping:

1. Data Centres and Cloud Infrastructure
2. Building Level Network Backbone Fibre/CAT6 cabling Infrastructure
3. Active Network / Switch Infrastructure
4. Direct Connectivity of Sub-Systems via IP
5. Connectivity of Building, Corporate or Internet Software Services (SaaS) on the same infrastructure Data via "Middleware" platforms to allow data connectivity
6. Logical Separation of Data Services (Building / Clients Services) via Firewalls / Virtual Local area Networks (VLAN's)

7. Implementation of common Network Security / Management in line with Client Policies
8. Virtualised Server \ Cloud Environments onto which all applications and services are deployed from
9. Common User Interfaces and Facilities Management Operation

1.03 Niagara Framework® IoT Data Stack

A. Building Services Technologies and Systems Data Integration can provide many possibilities and benefits for system data to be connected to allow inter-process control and interaction as well as providing common management level visualisation and operation via Desktops and Mobile devices.
B. There are different levels of integration available depending on the various systems, services and applications, the Niagara Framework® is architected around the IoT and takes the form of the following:



C. This is a representation of a typical IoT solution with the many layers required to get data from many disparate systems and IoT devices to either a Desktop User Interface (UI) I or Mobile device through the IoT Layer Stack.
D. The Niagara Framework® supports device and data connectivity across all layers of the Niagara Framework® Tridium are developing Niagara down to the Edge with Micro and Lite versions to facilitate applications at the Edge of the IoT layer stack.

1.04 Niagara FEATURES & Functions

A. The Niagara Framework® facilitates an Open, no lock-in framework architecture allowing multi-vendor systems and solutions to be connected and supported by a community of Systems Integrators and Developers, allowing clients freedom of choice to either retain existing systems and infrastructures or to upgrade in the future using the latest technologies and infrastructures. The Niagara Framework® was designed to allow integrators and developers to connect, manage, and control any device, regardless of manufacturer, using any protocol.
B. The Niagara Framework® s Architecture supports:

1. Cloud Deployment
2. Enterprise Systems & Services
3. Facilities & Asset Management Services

4. Visualisation, Alarming, History, Reporting Applications
5. On-Premises Deployment
6. IoT and Connectivity of Edge Devices
7. IoT Apps
8. Customizable Security Controls to meet Organization Security Policies

C. Niagara N4 Features

1. Structured / Relational Tagging
2. Templating
3. Analytics
4. User Interfaces
5. IT Compliance
6. Built-in Cyber Security Controls for Confidentiality, Integrity, Authentication, Authorization, Auditing, and Malware prevention.

1.05 Market Places

A. The Niagara Framework® is a flexible and extensible IoT framework that can support many business domains, it facilitates multi-disciplined Systems connectivity, and can provide solutions in the following sectors:

1. BMS / HVAC (Plant Level)
2. Security (CCTV/ACCESS)
3. Lighting / Blinds
4. AV
5. Fire
6. Elevators
7. Home Automation
8. Energy Management
9. Electrical Management
10. Building Performance and Monitoring
11.
12. Facilities Management
13. Data Centres (DCIM)
14. Renewables
15. Demand Side Response
16. Bureau Management
17. Smart Devices

1.06 Smart Building Benefits

A. Benefits when adopting a “Smart Building” approach on the Niagara Framework® could include any of the following value propositions:

1. Open, no lock in to a specific manufacturer, freedom of choice in future system upgrades
2. Backup as a Service (Baas) included.
3. Extensible and flexible – can be extended to support any device and protocol, allowing owners to adjust as technology changes
4. Browser Based User Interface and visualisation using HTML 5, no Browser Plugin required
5. All open protocols included as standard e.g. BACnet, KNX, LON, M-Bus, Modbus, oBiX, SNMP etc.
6. Can be used with Multiple Protocols on one platform, e.g. JACE or Server, either open and/or legacy types providing cost effective integration
7. JACE 8000 can be supplied with or without Wi-Fi on Board option.

8. Native built in Analytics at Platform and Supervisor Levels
9. Many different Protocol Drivers are available, refer to latest drivers list: https://www.tridium.com/~/media/tridium/common/documents/tridium%20and%203rd%20party%20drivers.ashx?la=en
10. One WEB Based Software engineering tool for Integration, Visualisation, Cyber Security, Enterprise data exchange and analytics.

1.07 On the Cloud Services

A. The Niagara Framework® also facilitates following:

1. Browser based engineering
2. Flexible secure access either locally and/or remotely
3. Cyber Security capabilities that provide strong authentication, role-based authorization, encrypted communications, encrypted sensitive information at rest, digitally-signed code validated at run-time, and auditing – customizable for meeting the Cyber Security policies of any organization
4. Real time Cloud Based information for better business decisions
5. Lower total cost of ownership
6. Opportunity to improve business processes
7. Savings in Operational management

B. Automation and Optimization of Systems and Processes

1.08 Niagara Platform Connectivity

A. Where systems and application require serial data and/or TCP/IP connectivity, these can be accommodated concurrently via the JACE Platform.

1. BACnet / RS485 / TCP/IP
2. Dali / RS485 / TCP/IP
3. LON / TCP/IP
4. KNX / RS485 / TCP/IP
5. M-Bus / RS232 / TCP/IP
6. Modbus / RS485 / TCP/IP
7. oBIX / TCP/IP
8. SNMP /TCP/IP

B. Niagara Integration

1. Building Services Systems Data can be “Integrated” at many levels:
2. Hardwired between different systems Input/Outputs to provide C&E functionality
3. High Level Integration at the Automation Level using Manufactures own developed Gateways and Protocols
4. High Level Integration at the Automation Level using 3rd Party Integration Platforms
5. High Level Integration between Automation and Management Levels using Gateways
6. Management Level via SQL / oBIX Data Exchange (Many Systems still use File Transfer)
7. Integrated Data may then be used to display data on the SPoG via Graphical User Interfaces and automated control interaction between Systems (Cause & Effect)
8. It should also be mentioned that the Niagara Framework® is a completely extensible open platform. Using our open APIs, any Niagara developer can write a software module to support any new protocol or device, providing flexibility in enterprise integration.

1.09 OPEN PROTOCOL & DATA Security

A. To facilitate secure deployment of Software Services (SaaS) utilizing Niagara Framework® during Smart Building deployment and as part of any future IoT deployment requirements, all connected systems and services shall comply with the following interfacing & security requirements:

1. Support of IT / Networking Industry Standard Open Protocols and IP Connectivity at all levels of each System / Product Architecture including Enterprise Level licensing and SQL / Enterprise interfacing.
2. Support of Windows / Linux RHEL Operating Systems
3. Support of Open Standard Services Protocols over Ethernet/IP or Serial Networks for Middleware deployment.
4. Support of Object data types over Niagara Framework® such as Analogue and Binary Input/Outputs, Internal Calculated Values, Set points, Alarms (Including Acknowledgements and Resets), Time Schedule Objects and Trend Log Objects which shall all be available for Middleware Platform data Integration and automation as well as Management Level Visualisation and Operation
5. Where BACnet Systems are deployed either at the Platform or Supervisor levels, the Protocol Implementation Conformance Statement (PICS) Statements for each connecting system shall be used to verify compliance.
6. Where other industry standard and Open protocols (Modbus, KNX, LON, SNMP) are utilised for integration with the Niagara Framework®, then each connecting party shall produce a generic interfacing compliance statement with a full list of all available data objects and supported functionality, including whether they are Read and/or Write, and a detail description of there addressing schemes.
7. All Niagara systems shall be configured in accordance to the Niagara 4 Hardening Guide. Niagara Framework® comes with a significant number of configurable Cyber Security capabilities, such as strong authentication, Role-Based Access Control, encrypted communications, encryption at rest, security auditing, and provides the ability for integrators to customize security based on their security policies. It is critical that all integrators use the Niagara Hardening Guide to protect Niagara systems. For more information, please see: https://www.tridium.com/~/media/tridium/library/documents/niagara%204%20hardening%20guide.ashx?la=en
8. Role-Based Access Control (RBAC) shall be deployed, making user permissions easy to configure and less error-prone. All user actions and security-related events shall be recorded in Niagara's audit log for traceability.
9. Any 3rd Party system to be connecting into the Niagara Framework® onto a Smart Building solution, must have an End of Life (EoL) statement outlining the long term life cycle plan, and ongoing product support plan.

1.10 Middleware Requirements

A. A physical Middleware comprising of Niagara Framework® Platforms shall be deployed providing an interfacing data layer between any 3rd-party systems which shall provide distributed processing as well as normalised data into Niagara Objects, the middleware shall comprise of:

1. Platforms which shall be housed within dedicated enclosures or racks as required by the project requirements
2. Deployment of Overarching Management Level using Niagara N4 Server with overarching Single Pain of Glass (SPoG) to provide a Graphical User Interface, Multi System Navigation from Landing Page with ability to simply navigate and individual system/plant

page graphics using N4 Navigation
3. Setup and configuration of stations in accordance with the Niagara Hardening Guide.
4. Structured Tagging, Templating, Analytics and “Cause & Effect” functionality as required to provide SPoG design requirements. The middleware shall comprise of:
5. Multi System Alarm Management, Handling and Reporting

1.11 Middleware Interfacing

A. The Middleware and its associated Management Systems shall comprise of a number Niagara Platforms distributed throughout the facility to suit interfacing requirements to:

1. Access Control Systems
2. Automated Demand Response (ADR)
3. Audio Visual (AV)
4. Combined Heat & Power (CHP)
5. Building Management Systems (BMS / HVAC)
6. Closed Circuit Television (CCTV)
7. Elevators
8. Energy Monitoring & Management Systems (EMS)
9. Escalators
10. Enterprise
11. Facility Management
12. Fire Alarm
13. Heat Pumps
14. Lighting
15. Pumps
16. Renewable Power Systems (e.g. Solar PV, Wind Turbines, Battery Storage)
17. SCADA/PLC (Electrical HV/LV Switching)
18. Signage
19. Uninterruptable Power Supplies (UPS)
20. Variable Speed Drives (Inverters)
21. Variable Refrigerant Volume Systems (VRV)

END OF SECTION

SECTION 28 25 10
SMART BUILDING NIAGARA FRAMEWORK

PART 1 - GENERAL

1.01 SUMMARY

A. The Smart Building system shall be based on a design for an Open Systems Architecture (OSA) within a multi-user, multi-tasking environments allowing for simultaneous access by multiple users and distributed network interfacing to provide connectivity to multiple sub-systems via the Internet / cloud.
B. Data exchange shall be facilitated by utilizing the Niagara Framework® as a “Middleware” to interface with Open and proprietary 3rd party systems over the Common Network Infrastructures and to present data into an overarching Management Level System via HTML 5 and Visualisation using Niagara N4
C. The N4 architecture shall be based on a scalable framework to accommodate any changes in data usage and connectivity within the buildings and their systems to meet with any future requirements, thus future proofing client’s investment into Smart Buildings Systems, infrastructures and services.

1.02 ARCHITECTURE

A. The Smart Building Middleware system shall be based on the Niagara N4 Framework architecture, designed around open and secure communications standards using HTML5 WEB technology.
B. The Middleware shall have the capability to communicate via multiple industry open protocols running over Building Network Infrastructures and computer networks, the Niagara Framework® provides support for the following protocols as standard:

    1. BACnet
    2. Modbus
    3. SNMP
    4. HTTP (HTML 5 / XML Mark-up Languages)
    5. Niagara (FOXS)

C. Once any subsystem is integrated into the Niagara Framework® via JACE Platforms to form a distributed middleware layer, the associated system data point objects shall then be normalised into the Niagara Framework® objects for data manipulation, alarming and visualisation requirements.
D. The Middleware shall provide the capability to allow Open development of specific solutions or any 3rd Party drivers or Applications (Apps) to meet current or future requirements and to connect to IoT Services, subject to meeting Tridium’s Certification Programme (TCP) Niagara Certified Training (N4, Analytics and Development).
E. Where communications with 3rd Party systems do not conform to any of the Industry Open communication standards and utilise proprietary protocols and networks, they shall be integrated via Niagara Platforms using 3rd party communications drivers if available (Refer to Latest Tridium Driver List), or a 3rd Party drivers developed specifically to meet requirements.
F. The Middleware Server shall provide access to the 3rd Party systems via HTML5 compatible Browsers over the Network Infrastructures using Niagara N4 Graphics which shall require no special software, e.g. ActiveX components or JAVA Plugins to be installed on to the Client PC’s or any other user interfaces (UI’s).
G. Niagara stations shall be configured in accordance with the Niagara Hardening Guide.
H. Communication between the HTML Web Browser UI’s and Middleware Server shall be secured

via encryption using 128-bit encryption technology within Secure Socket Layers / Transport Layer Security (TLS/SSL) over HTTPS.

I. In order to protect the Cyber Security of all connected systems, Niagara Systems shall not be directly exposed on the Internet. If remote access to these systems is required, Niagara systems can be protected by a VPN gateway, providing security protection. Keeping stations behind a properly configured VPN ensures that they are not exposed, reducing the system's attack surface. For more information, see "Using a VPN with Niagara Systems" available from the Niagara Framework Software Security Resource Centre on Niagara Community.

J. As part of the Middleware deployment requirements Niagara N4 Server Software shall be setup to operate on its own dedicated Server environment but shall have the capability to operate under a Virtual server environment if required.

K. The Niagara framework architecture shall provide Operator(s) complete access to the Middleware system via HTML5 WEB browsers, both operationally and also for engineering requirements via Niagara Software Engineering Tools (Workbench).

L. The functionality provided through the HTML5 Browser interface shall be not altered, or restricted, based on the location, or type of device used to access the system, the only applicable restrictions shall be those associated with each individual Roll based Access based on their Login credentials.

1.03 NIAGARA INFORMATION AND CONFORMANCE STATEMENT (NICS)

A. The Niagara Compatibility Statement (NICS) for all Niagara Software shall allow open access and be set as follows: accept.station.in="*" accept.station.out="*" accept.wb.out="*" accept.wb.in="*". In any case, the End User shall maintain the right to instruct the contractor to modify any software license, regardless of supplier, as desired by the End User. The Contractor shall not install any "brand specific" software, applications or utilities on Niagara Framework based devices.

B. All hardware and field level devices installed, shall not be limited in their ability to communicate with a specific brand of Niagara Framework JACE. They shall also be constructed in a modular fashion to permit the next generation and support components to be installed in replace of or in parallel with existing components.

C. At the completion of the project the owner shall be given all existing platform and station log in credentials to include; Super User (Admin) usernames; passwords and passphrases.

D. The HTML5 WEB browser User Interface (UI) shall be completely interactive and provide the following functionality as a minimum:

1. Single Pain of Glass (SPoG) Visualisation and access to all Systems
2. Alarm / Event information
3. Real-Time Graphics
4. Browser Based Navigation of Systems & Graphics
5. Trending (Data Historian)
6. Time Scheduling
7. Analytics
8. Control Logic Definitions (Wire Sheets)
9. Parameter/Setpoints and Override Adjustment
10. Client Alarm Popup and Annunciation
11. Single Tool for Live Software & Graphics Engineering
12. Platform / Station Configuration & Maintenance

1.04 NIAGRA SOFTWARE COMPONENTS

A. The Niagara Framework® architecture shall provide a Middleware layer which is fully extensible and scalable to meet any future expansion or enhancement requirements. The Middleware shall also facilitate Enhanced Cause and Effect between systems which can be

designed, delivered and commissioned via TCP Trained Niagara Specialists. All components of the Middleware software shall be configured, setup and completed in accordance with the required specifications, software components shall include:

1. Server Software including latest Operating System (Windows or Linux RHEL)
2. Niagara N4 Core Software and Licenses
3. Single WEB based Application & Tools (Workbench)
4. Graphical Programming Tool
5. Control Logic Software Tool
6. Application Software (Alarming, Trending, Time Scheduling, Logging)
7. Analytics

1.05 Enterprise Connectivity

A. Subject to licensing and requirements, the Enterprise Management Level shall allow real time Connectivity of data via any of the following accepted methods:

1. SQL (**S**tructured **Q**uery **L**anguage)
2. OPC (**O**bject Link Embedding for **P**rocess **C**ontrol)
3. oBIX (**O**pen **B**uilding **I**nformation e**X**change)
4. SNMP (**S**imple **N**etwork **M**anagement **P**rotocol)
5. API (**A**pplication **P**rogramme **I**nterface)

B. While still employed as a common means of transferring data, Simple Text file transfer e.g. Comma Separated Value (CSV) mechanisms are not recommended as part of the Open System Architecture requirements as this are inherently prone to failure and data loss, oBIX (XML) and API based data transferred are the recommended data transfer methods into Niagara.

1.06 Framework architecture Overview

A. The Framework shall be based on a distributed architecture with real time data access via open industry protocols providing WEB based engineering capability and System monitoring and management of the connected subsystems data at multiple levels over secured networks and infrastructures:

1. Cloud
2. Enterprise
3. Edge

B. The Tridium **J**AVA **A**pplication **C**ontrol **E**ngine (JACE) shall be deployed to provide peer-to-peer connection and Edge device connectivity, allowing subsystem devices to continue operating without loss of data in the event of network or Server failure.

C. A Middleware formed of multiple distributed JACE's shall be deployed to provide a Smart Building System, with the capability to allow any data objects to be connected to facilitate future Enhanced Cause & Effect (EC&E) requirements.

D. The Network Infrastructure shall be designed to consider speed, latency, performance, traffic flow, network security requirements and data separation via VLAN's for all connected sub-systems.

E. The Middleware Platform shall be the latest Niagara N4 JACE together with Niagara N4 Server / Supervisor which shall provide a Framework of data Management to reduce the traffic flow to improve speed performance between subsystems between the Middleware Platform and Overarching Management Levels.

F. Middleware JACE Platforms shall be deployed using TLS and data security between the Network Infrastructure and Connected Subsystems.

G. The JACE Middleware Platforms shall provide distributed processing of data and reduce the Management Level Server processing and network throughput requirements. Where High Availability and Fault Tolerance is required within critical environments, 3rd Party solutions can be deployed to provide critical backup, e.g. Stratus EverRun.
H. As the Middleware system scales, the data traffic loads shall be managed at the Middleware Platform Level (JACE), network traffic, data visualisation, alarm management, reporting and data logging shall be managed at the Management level.

1.07 Network Infrastructure

A. To ensure data separation of subsystem services, VLAN's shall be deployed to separate each subsystem service with VLAN Routing to connect systems and data where required into a separate Middleware VLAN to provide an "Open" Data Connectivity layer across connected systems.

1.08 Middleware Platforms & Management Level

A. All Middleware subsystem communications shall be managed via dedicated Niagara N4 JACE platforms to provide distributed processing with reporting to a N4 Management Level Framework Architecture.
B. JACE Hardware Platforms shall be connected to their respective sub systems via High Level Protocols (Refer to Table 1 for details of Ports, Protocols and Services) over IP or RS232/485 serial connections.

1.09 Operating System & Security

A. The embedded JACE hardware uses a QNX Operating System at the Platform level together with JAVA at the N4 Supervisory level using the "Foxs" protocol to communicate with Web Services
B. To ensure Niagara is deployed using the strongest security levels possible at all levels (Edge, Enterprise and Cloud), all communications shall be encrypted using a minimum of TLS V1.2, additionally each JACE Platform Middleware, shall have User Level Access and Authentication
C. Niagara hardware platforms together with their operating system shall be configured with a common "Strong" password for access, the local user password must meet this minimum requirement.
D. All messages shall be encrypted, including the usernames and passwords used to access the system either as a browser GUI user, or for Niagara Workbench development engineering use.

1.10 Ports and Protocol Control

A. Access from the Tridium Niagara Platform (Station) over network Infrastructures shall also require following Ports and Protocols to be permitted for each respective service, unused Ports shall be disabled to prevent any unauthorised access:

Services	TCP Port	UDP Port	IP Protocols	Notes
Niagara V4				

Services	TCP Port	UDP Port	IP Protocols	Notes
Secured Fox Service (Workbench)	3911	—	FoxS	Default port for a Station's Secure Fox Service Used for Workbench To Station and also Station To Station communications
Secured Web Service	443	—	HTTPS	Default port for a Station's Web Service and used for browser access
Secured Platform daemon	5011	—	HTTPS	Default ports for Platform connection for access / administration via the Workbench engineering tool.
Optional Services				
Client Connection to Mail Server for e-mail Notifications	25	—	SMTP	Mail Service
Internet Time Protocol service	37	—	—	
DHCP	—	67, 68	—	Static IP Address's to be assigned to all Middleware Devices
Niagara Drivers *				
SNMP	—	161	SNMP	SNMP protocol
SNMP Trap	—	162	SNMP	
Modbus TCP	502	—	—	
BACnet Ethernet	—	—	—	(Not used)
BACnet/IP	—	47808	—	
OPC Client (Uses DCOM)	135	135	—	DCOM, using RPC (See below).
KNX				
LON				
Others				

Services	TCP Port	UDP Port	IP Protocols	Notes
RPC, used by NetBIOS (Browsing, File Shares, etc.) and also Windows Update, Browser, OPC client & server	137, 138, 139	137, 138, 139	—	Required for JACE to appear in browser lists and for Network Shares. Required by OPC client driver.
PING	—	—	ICMP	Basic “Ping” Test of connection.
DCOM	135	135	—	See Requirements for OPC Client
Microsoft SQL Server	1433	1433	—	
Network Time Protocol	—	123	—	Sync with Time Server.

Table 1: Niagara Ports and Protocols

*Note: Protocols & Ports required by each particular driver must be unlocked and specified within the configuration of the corresponding Niagara driver as well as within the Network Routers for Cloud access.

NOTE: FOR DETAILED GUIDANCE AND SECURITY CONFIGURATION OF PORTS, PLEASE SEE THE NIAGARA HARDENING GUIDE

1.11 Access and Permissions

A. Niagara Framework® Access and Permissions shall be based on Role-Based Access Control **(RBAC)** whereby User Groups, Categories and Permissions are defined by User Roles.
B. Each User Group shall be granted a set of permissions in each category. This combination of categories and permissions shall define exactly what each User Group can do with each object defined within the system, the following sections outline the Niagara “Station” Security requirements:
C. User Groups

1. A set of pre-defined Roles based on User Groups” shall be defined across all Stations and every User of the system shall be given a unique “Username” and “Password” Login to provide audit logs.

a. “Admin” - Shall always be a Super User, having all permissions in every Category and can thus access everything in a Station that cannot be deleted or renamed.
b. “Engineers” - Shall provide Station access from the Web browser with Individual User Accounts and Login Authentication having Read / Write permissions to all Categories and to be able to undertake all Engineering and Graphics configuration including Project Backup and Restore.
c. “Operator” - Shall provide Station access from the Web browser and shall have the ability to navigate following assigned objects:

1) “Read” Permission (All Objects)
2) “Write” *permission (Alarms)*

d. “Guest” - Shall provide Station access from the Web browser with no authentication

(User is not prompted to login) and shall have the ability to navigate to any object that has been assigned “Read only” permission.

e. Groups and Users shall be stored in the Station's local database by default and verified by the Station's “User Service”.

D. Categories

1. Categories shall be defined for logical grouping of items or components. Categories shall be typically named to reflect each Grouping, as a minimum the following Categories shall be defined for each 3rd Party Subsystem:
2. Objects requiring further protection with individual security rules shall also be assigned to additional categories as required.

E. Permissions

1. Permissions shall be used to define the rights a User has within each of the Categories in the station.
2. Within each account level, Separate user rights shall be applied to “Read Access” and “Write Access”
3. Every “User” defined in the Station shall be configured with a “Permissions Map” which shall be used to grants the “User” permissions for each Category defined in the Station

F. Authentication

1. There are three authentication points in the Niagara Framework®
2. Workbench to Station via the FOXS Protocol
3. Station to Station via FOXS Protocol
4. Web Browser-to-Station (HTTPs)
5. Whenever a Station connection attempt is made, the User's login credentials shall be authenticated in accordance with the Niagara Hardening Guide.

1.12 Security & Domain Interfacing

A. This section outlines the Security and Domain Services which if required which shall require full co-ordination, design and development prior to being deployed over a Clients Network infrastructure:
B. Domain Considerations
C. The following Domain requirements shall be fully ascertained and agreed before any deployment:

1. Network Administrator access to Middleware Server / Workstation for the updating of profiles, adding/removing of machines, user account password management.
2. No Active Directory security policies shall be “Pushed” down to the Smart Building Server / Workstations without review and agreement as certain policies may conflict with Middleware applications and platform security functions
3. If any applicable security policies are required, these shall only be deployed in full consultation with the respective suppliers of the subsystems and undertaking of connectivity/functionality testing to determine any impact on the Middleware system architecture and performance.
4. All Testing and implementation of User Account Groups and Profiles together with the Rights of these User Accounts shall be co-ordinated with the Client IT
5. A single Domain Logon for Middleware Platforms, Servers and Workstation to facilitate future Enhanced Cause & Effect and middleware data object access.
6. Where Email Services are required, these shall be co-ordinated with the Clients IT to provide an Exchange Account if required.

7. Time synchronization of Middleware Server, Workstation and JACE platforms to a NTP Server which shall be available across the clients IT Network Infrastructure.
8. The NTP server shall be synchronized with other systems to within 1 second to ensure that logging of data and events is accurate. Any Time disparity in time clocks between subsystem server processors shall cause an alarm to be generated.

1.13 Software & Database Backup

A. Application software/operating system software shall be backed up onto suitable digital media such as a Network Attached Storage (NAS).
B. The N4 System Supervisor shall be automatically configured to backup any Historical Trend, Logging, Alarm and System/User Event databases according to user configurable periods to ensure databases are consistently and automatically maintained and Databases regularly compacted to ensure maximum performance at all times.
C. Back-up of the entire N4 Management Level systems, including configuration and setup data shall be automatically performed on a weekly basis or any time a change is made to the system configuration to ensure that even in the most catastrophic of events the system can be fully restored from the back-up files and, at worst, only one week of data would be lost.
D. In the case where system changes are carried out, a backup copy shall be taken prior to commencement of any software changes, each version shall be version controlled and date/time stamped, in the event of any failure the system can be reverted to previous backup version.
E. From Niagara version 4.3, Backup as a Service (Baas) is included with every installation of Niagara.
F. Niagara BaaS allows any N4 station to be securely backed up to the cloud whereby should any hardware failure or corruption happen, the latest or historical can be traced tracked and downloaded 24/7/365 by authorised individuals from a secure cloud login, and then manually installed on the jace®.
G. This facility includes the following features:

1. Initiate backups with 1GB of storage
2. Automated/scheduled backups
3. View, delete backups
4. Add, edit and delete notes
5. Notifications
6. Geo-located backup service
7. Soft backup limits

END OF SECTION

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NIAGARA MANAGEMENT LEVEL REQUIREMENTS

PART 1 - GRAPHICS USER INTERFACE

1.01 GENERAL

A. This section outlines the Niagara Middleware HTML5 WEB based Graphics User Interface (GUI) as well as the Single Pain of Glass (SPoG) deployment philosophy which shall be to unify the display of multiple sub systems to present a single operational view of data in a way that's easier to interpret and manage.
B. Each of the connected subsystems has their own Management Level Operator Workstations and different graphical user interface standards. The Middleware requirements are to bring a common set of Graphics that shall provide Operators with intuitive and instant overview / status information across these systems and where required detailed system graphics.
C. The WEB based GUI standard shall detail the visual layout and design of graphics, static and dynamic symbols and their representation on graphic pages for the systems covered by these works along with site plan and hierarchy/navigational requirements. The Trade Contractor shall develop a 2/3D dynamic/active graphics library for each subsystem discipline covered by these works along with Landing Page, System Overview Status and Graphical hierarchy/navigation for future expansion.
D. Active 2/3D colour graphics shall be provided depicting the connected Middleware systems monitored by the Middleware system.
E. The Graphics shall be designed to be intuitive and operated either from a Workstation which shall be mouse / keyboard driven or via Smart Devices using Touch screens and be intuitive.
F. All Graphic Pages shall be submitted to the clients engineer for comment as part of each system design requirement, together with all necessary overviews and navigational requirements.
G. Graphic Browser Navigation
H. The Graphics Browsing shall be designed to facilitate operation via:

    1. Middleware Operator Workstation
    2. Smart / Mobile devices such as Smart phones and/or tablet computers

I. The Client UI shall provide a comprehensive user interface using a collection of pages to provide a seamless link to all applications and subsystem data.
J. It shall be possible to navigate through the system using a browser to accomplish the functionality detailed within this specification without the need for any mouse or keyboard. The Graphics Browser Interface shall as a minimum provide:

    1. A Landing Page with an Overview of Systems and overall Alarm Status Information
    2. A Navigation area with Navigation tree
    3. A Common Navigation bar with shall be used on all graphical displays
    4. Action area for display and operation of graphics
    5. Access to Applications such as Alarms and Events & Histories, Time Scheduling
    6. Live Graphic Programming
    7. Administration Configuration
    8. Reports and Reporting actions for Alarms and Events.

K. The “Look and Feel” for the UI pages representing each of the above applications shall be developed in a consistent manner and the WEB Application shall fully utilise the same developed graphics and standards.

1.02 User Interface (UI)

A. On launching the Logon from the Client Workstation or Tablet device and selecting the appropriate entry via SPoG HTML5 WEB Graphics, the operator shall be presented with a login page based on the User Roles that shall require a unique Login Name and Password.
B. Navigation within the Middleware system shall be wholly dependent on the operator's role, privileges, and geographic area of responsibility.
C. The Middleware system shall be capable of complete scalability in terms of User Access and Object privileges. This shall apply to, but not be limited to, individual systems access, functionality and subsystem interaction.
D. SPoG Landing Page

1. The Landing Page shall provide access for each connected subsystem together with Alarm Overview / Status. An operator shall be able to select the required System and associated Graphics pages by clicking on buttons / hot spots, corresponding to the highlighted system.

E. Navigation Task Bar

1. SPoG shall provide the ability for any user to accomplish the following actions by clicking appropriate Button Icons / menu's in a Graphical Navigation Taskbar which shall be common to all Graphic pages:

a. Log In / Out
b. Navigation Tree
c. Alarm Status Display
d. Home Page
e. Page Forward/Back
f. System Topology
g. Application Access (Time Scheduling, Trending, Alarming & Event Logging)
h. Print
i. Help Menu
j. Hide / Show Navigation Pane

1.03 Specific Graphical Requirements

A. The Middleware UI shall make extensive use of 2D / 3D static and dynamic symbols together with iconic representation of system components in the graphic area to communicate information related to Viewing and Operational elements of each subsystem, the Middleware UI shall provide the following:

1. Graphical Display Size: The Trade Contractor shall make allowances to fully develop a Graphical Standard to meet the requirements as detailed. The UI shall as a minimum be optimised to graphically display in HD 1080p, True Colour or higher and shall be compatible with High Resolution Touch screens and WEB UI's without Horizontal or Vertical scroll bars.
2. Screen Display: Client Workstations shall have 1080p HD Wide Screens suitable for displaying High Resolution Graphics.
3. Bitmaps, JPEG's shall be optimised for 1080p HD Resolution screen display following the UI standards as detailed. N4 support Scalable Vector Graphics (SVG)
4. Colour Concept: The Graphic backdrop colour shall be a passive colour that shall be non-invasive and consistent across all subsystem disciplines and shall allow dynamic objects to be displayed clearly, the Plant Graphics shall be designed to be clean and non-cluttered and shall use:
5. Dynamically Displayed Values and units of any input / output values shall correspond to the quantity it represents throughout all levels of Graphics.

6. Analogue values shall be capable of being displayed to 2 decimal places which shall include inputs, outputs and calculated values.
7. Digital values shall be represented by either an Icon representation or a full English word that truly and correctly represents the status and type of point being displayed; this shall include inputs, outputs and calculated values.
8. The Trade Contractor shall submit a Project Specific HMI Standards Document to the engineer, fully detailing all proposed symbols, icons, page layouts and graphic standards to be deployed on this project.

1.04 Application Requirements

A. As well as the subsystem specific graphic requirements the following WEB based Applications shall be accessible via SPoG:
B. Schedules

1. Niagara N4 shall provide time scheduling capability for all connected systems and commandable Niagara Objects.
2. Utilizing the navigation area displayed in the GUI, an operator with password access levels shall be able to define a Normal, Holiday or Override schedule priorities for each individual piece of equipment or zones, or choose to apply a single schedule to part of the system, site or floor area. For example, a schedule for one floor in the system would be created by selecting the designated floor and entering the relevant schedule at that location.
3. No further operator intervention would be required and every control module controlling that floor would be automatically downloaded with the data for that newly entered schedule.
4. The system shall include the option to have an area opt out of the tiered scheduling criteria to allow specific and separate scheduling of that area with minimal intervention.
5. All schedules that affect the system, area or piece of equipment highlighted in the navigation area shall be shown in a summary schedule table and graph.
6. Schedules shall be compatible with BACnet standards and verified using the 3rd Party PIC's Statement, (Schedule Object, Calendar Object, Weekly Schedule property and Exception Schedule property) and shall allow events to be scheduled based on:

    a. Types of schedule shall be Normal, Holiday or Override
    b. A specific date
    c. A range of dates
    d. Any combination of Month of Year (1-12, any), Week of Month (1-5, last, any), Day of Week (M-Sun, Any)
    e. Wildcard (example, allow combinations like second Tuesday of every month).

C. The system shall allow operators to define and edit scheduling categories, different types of items to be scheduled; for example, lighting, HVAC occupancy, etc. The categories shall include: name, description, icon representation to display in the hierarchy tree when icon option is selected and type of value to be scheduled.
D. In addition to a tiered system of scheduling, operators shall be able to define functional Schedule Groups, comprised of an arbitrary group of areas, rooms or equipment scattered throughout the facility and site. For example, the operator shall be able to define "Individual" plant groups to reflect the usage occupancy of the different areas within each of the buildings Floors / Area's.
E. Group Schedules, when applied shall automatically be downloaded to control modules associated with the relevant area's spaces.
F. The system shall be designed to automatically turn on any supporting equipment needed to control the environment in an occupied space. Demand shall be created at the point of delivery and that demand shall be passed back through to all plant and equipment necessary to achieve the demand at the point of delivery. For example, if an operator schedules an individual rooms

/ area's served by Re-heaters for occupancy, the system shall automatically enable the respective AHU, Chiller, Boiler, pumps and/or any other equipment required to achieve and maintain the specified comfort and environmental conditions within the room.

G. It shall be possible to setup and apply Site Wide as well as local exception Schedules to accommodate a time range specified by the operator (e.g.: Operating Theatres that need to be operated in an Emergency from 6pm to 12pm overrides Normal schedule), including any Bank or Public Holidays.

H.

I. The Schedule summary shall clearly show Normal versus Holiday versus Exception Schedules, and the net operating schedule that results from all contributing schedules. Where more than one schedule is applied, it shall be possible to prioritise.

J. The system shall be capable of maintaining Master Schedules for reliability and performance, which shall maintain a single schedule in a JACE that writes over the network to notify other devices when a scheduled event occurs.

1.05 Alarm Handling, Notification and Management

A. The Niagara Alarming System shall provide any required Alarm and Event Management setup and configuration for the data points and devices associated with each connected subsystem.

B. Alarms and Events shall be configured to generate system messages that provide operators with information such as communications failure and subsystem specific alarms such as breaker status monitoring, elevator status etc.

C. The Alarm Handling and Management System shall have the capability of providing any of the following possible actions:

1. Display of the most recent Highest Priority Alarms for each system category in the Landing Page Alarm Banner
2. Initiate a Pop-up Window on any designated Alarm Monitoring Workstations
3. Operator Acknowledgement and Reset capability subject to object access and privileges
4. Routing to Specified Workstations or Receiving devices
5. Routing to Help Desk for further action
6. Send to key personnel e-mail account with the relevant alarm information

D. An alarm matrix shall be produced for each system which shall include:

1. System
2. Categories
3. Priorities
4. Messages
5. Annunciation
6. Network Printing, Email, Mobile Devices)

1.06 Alarms associated with a specific system, area, or equipment shall have the following capabilities:

A. Each currently active alarm shall be displayed using different icons together with date/time of occurrence, current status and a context link to the associated graphic for the selected system, area or equipment.

B. An operator shall be able to sort events on any available data field.

C. Systems shall be defined for each subsystem type such as BMS/HVAC, SCADA/PLC, EMS, Lighting, Lifts, EMS or Fire. An icon shall be associated with each category, enabling the operator to easily sort through multiple alarm events displayed using a built-in filter capability.

D. Alarm Categories shall be defined for different types of alarms types such as Life Safety, Critical, Maintenance and Abnormal together with their associated properties. As a minimum, properties shall include a reference name, Category, Priority, text description at least 256

characters in length, severity of event, Acknowledgement and Reset requirements, high/low limit out of range and reliability information.

E. All Alarm shall be Time/Date Stamped, all events shall be generated at the JACE and shall comprise the Time/Date Stamp using the synchronised time and date.
F. Operator Actions shall also be logged for each associated Alarm which shall include any Acknowledgement or Reset notification as well as return to Normal status.
G. Alarm Summary Counters for each system shall be displayed across the top of each Graphic page. The view shall provide a numeric counter, indicating how many alarm events are active (In Alarm) and require acknowledgement, and total number of events in the Middleware Alarm Server database.
H. Alarm Events that have been Acknowledged, Reset (Where Required) and have returned to Normal shall be auto-deleted from the Alarm Banner view and stored in the Server Log database and archived after an operator-defined period.
I. Alarm Reporting Actions specified shall be automatically launched under certain conditions on receiving an event request. Operators shall be able to fully define these Reporting Actions using the Navigation Tree and Graphic Area in the WEB Browser GUI.
J. Reporting Actions shall be as follows:

    1. Alarms shall be routed and printed to any networked printer and shall print immediately after the previous Alarm.
    2. Email shall be sent via any Exchange compatible email server. Email messages may be routed to several email accounts.
    3. The Simple Network Management Protocol (SNMP) shall be used where reporting Network Events and shall send an SNMP trap to the Network Management system (NMS).

K. The SPoG Web Browser Interface shall provide an Event Simulator to test assigned Reporting Actions. Any operator with sufficient object access and privilege shall have the option of using current time or scheduling a specific time to generate the Event.
L. Utilizing the Navigation Tree and drop-down menus in the Graphic Area, the operator shall be able to select any Alarm / Event Type, Category, Status, Notification, Priority, Message, and whether Acknowledgement and Reset is required.

1.07 Histories

A. The system shall be able to Trend and Display graphically via SPoG any analogue, digital or calculated point. A Trend log's properties shall be editable using the Navigation Tree and shall provide the following:

    1. The operator shall have the ability to view trends by using the Navigation Tree and selecting a Trend button in the Graphic Area. The system shall allow y-axis and x-axis maximum ranges to be specified and shall be able to simultaneously graphically display multiple trends per graph.
    2. Trend data shall be collected from any connected subsystem and periodically uploaded based on automatic configuration to the N4 Server; Trend data shall be retained in non-volatile module memory and archived after an operator-defined period.
    3. Sample intervals shall be as small as one second. Each trended point shall have the ability to be trended at a different trend interval. When multiple points are selected for display, which have different trend intervals, the system shall automatically scale the axis.
    4. Trends shall be able to dynamically update at operator-defined intervals.
    5. It shall be possible to zoom-in on a particular section of a trend for more detailed examination; the system shall be able to Zoom Out or Reset the Trend view to the standard range.
    6. It shall be possible to pick any sample on a trend and have the numerical value displayed without moving to a different screen.

7. The system shall extract information directly from any relevant data within the Middleware JACE's to initiate trend logging facilities, retrieving real time values of any I/O or from process control loops and then display/print the logged data for tuning/diagnostic purposes. The measured value shall be the actual reading at the sensing device.
8. The capacity of each JACE shall allow all for all points to be logged in the system at 1 minute intervals for a minimum of 24 hours within the same controller that they are connected to. In addition, each controller shall be able to log all calculated points and shall have the capacity to log 75% of these points at 5 minute intervals within the same controller that they are held.
9. The data collected from a point shall be stored in non-volatile memory. The time periods of data logging shall be variable between a minimum of 1 minute to a maximum of once per day. This shall be selectable at the time of initiation of the logging period.
10. The Operator shall have the option to specify the start and/or stop time of the trend log period. The logs shall also be capable of being held, overwritten on a first-in first-out basis.
11. The value stored periodically shall be the average reading since the previous reading. Spot readings at the time of the sample shall not be acceptable. The Operator shall have the option to read the maximum and minimum logged values.
12. All Trend log data shall be initially stored in memory buffers of the JACE's which shall also support short term (1 Day) logging requirements.
13. The Middleware JACE's shall archive Trend values to the Middleware Server prior to them being over-written in the JACE. The Middleware Server hardware shall be sized such that one year's worth of archived data may be held for retrieval on an "Instantaneous" basis.
14. The Middleware system shall have the facility to automatically archive trend data older than one year to the Network Attached Storage (NAS) with the capability of being retrieved for viewing at any time in the future.
15. System operating Logs shall be configured to log all events during commissioning and samples shall be included within the Trade Contractors system commissioning report. These system operating logs shall contribute towards providing evidence of the satisfactory completion of commissioning.

1.08 Reporting

A. The N4 Middleware Management system shall have the facility to configure to generate the following daily/monthly management and system reports on an ad-hoc and on-line basis:

   1. Alarm Console
   2. Energy Usage
   3. Monthly Service Call
   4. Response Time Monitoring

B. The Reporting function will allow for the creation of configurable (user-defined) reports via a report builder tool. The Reporting function will provide functionality to ensure that certain types of user-defined reports are made available only to specific user roles.
C. The Reporting function will allow for specification of filter conditions to refine the data being displayed in standard and user-defined reports.
D. The Reporting function will allow for dynamic analysis on both standard and user-defined reports by providing the following features:

   1. Changing of row and column orders for different presentation layouts.
   2. Grouping/aggregation to view data at a summary as well as detailed level within the same report
   3. Slice-and-dice capabilities for advanced analysis

E. The Reporting function will allow for exporting of data into Microsoft Excel, comma-separated text (CSV), PDF or other suitable formats.

F. The Reporting function will be compatible with standard reporting engines so that new reporting templates can be developed.
G. The Reporting function will have facility for the users to select whether to generate a report on-line or in batch mode.
H. The Reporting function will allow preview of all reports on screen before it is sent for printing on desktop printers or network printers.
I. The Reporting function will allow the user to generate reports in a graphical format, for example, bar chart, pie chart, etc.

1.09 ENTERPRISE SERVER & WEB BROWSER GUI

A. Rack mounted Enterprise Servers shall be deployed in the Clients IT Rack Space and shall be configured to Run the Middleware Application as a “Service” and be capable of multiple client logins.
B. To allow the users to view the monitored middleware system data, dedicated Client Workstations shall be provided in all required locations.
C. Additionally, the Middleware Server shall be configured to provide WEB Services to any WEB Client Device such as Tablets or any Client Desktop dependant on network Security and User Access and Privileges.
D. The Server Manufacture type and model shall be approved by the Clients IT who shall also ensure that the environments comply with their own corporate Security and Management requirements.
E. Servers shall be of sufficient specification to meet this specification plus 50% expansion in the future with Remote Desktop Access for Administrators.
F. The Niagara N4 Server shall be supplied to allow a minimum of ten concurrent Client users without any performance degradation.
G. As detailed above, Servers, NAS and Workstations connected to the Network Infrastructure, shall subject to User Login and any Security Privileges and User Base Roles.
H. Niagara Middleware Server & Network Storage
I. Example - The Middleware and Network Storage Servers shall be of minimum specification:

1. Intel Xeon E5640 Processor 2.66GHz
2. 4GB Memory CPU
3. Integrated Level 10 RAID controller with 5 2.5” Disks Hot Plug (1 Hot Standby)
4. 16X DVD-ROM Drive SATA
5. GB Network Card
6. Windows Server 2012 Enterprise SP2 64 bit
7. Microsoft SQL2014
8. KVM Console with 17" LCD Display Keyboard & Touchpad Mouse
9. The Network Attached Storage Server NAS shall have RAID Level 5 with 4 2.5” Disks Hot Plug (1 Hot Standby)

1.10 OPEN, INTEROPERABLE, INTEGRATED ARCHITECTURE

A. The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system utilizing the BACNet technology communication protocol in one open, interoperable system.
B. The supplied computer software shall employ object-oriented technology (OOT) for representation of all data and control devices within the system. Physical connection of any BACnet control equipment, such as chillers, shall be via Ethernet.
C. All components and controllers supplied under this contract shall be true “peer-to-peer” communicating devices. Components or controllers requiring “polling” by a host to pass data shall not be acceptable.
D. All components and controllers supplied under this contract shall be true “peer-to-peer”

communicating devices. Components or controllers requiring “polling” by a host to pass data shall not be acceptable.

E. The supplied system must incorporate the ability to access all data using Java enabled browsers without requiring proprietary operator interface and configuration programs. An Open Database Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. This data shall reside on the existing Operating System Server currently located in the Facilities Office on the LAN. Systems requiring proprietary database and user interface programs shall not be acceptable.

F. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer’s internal Intranet network. Systems employing a “flat” single tiered architecture shall not be acceptable.

1. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 5 seconds for network connected user interfaces.
2. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 60 seconds for remote or dial-up connected user interfaces.

1.11 BAS SERVER HARDWARE

A. Minimum Computer Configuration (Hardware Independent)

1. Central Server. Owner shall provide a dedicated BAS server with configuration that includes the following components as a minimum:
2. 2 GHz, P4 or higher CPU – Dual Processor
3. 2 Gb of RAM minimum.
4. 80 gigabyte hard disk, SVGA Card with 1024 x 768, 24-bit True Color, Back-up system 24X CD Rom Drive, 19” Flat Screen Color Monitor, Keyboard and mouse
5. Operating system for the server shall be Microsoft Windows XP, 7 or RedHat Linux 6.0.
6. Internet Explorer 8.0 or later
7. 10/100Base-T Ethernet Port

B. Standard Client: The thin-client Web Browser BAS GUI shall be Microsoft Internet Explorer (8.0 or later) running on Microsoft 98, 2000, NT, XP, or 7. No special software shall be required to be installed on the PCs used to access the BAS via a web browser.

1.12 SYSTEM NETWORK CONTROLLER (SNC)

A. These controllers are designed to manage communications between the programmable equipment controllers (PEC), application specific controllers (ASC), and advanced unitary controllers (AUC) which are connected to its communications trunks, manage communications between itself and other system network controllers (SNC) and with any operator workstations (OWS) that are part of the BAS, and perform control and operating strategies for the system based on information from any controller connected to the BAS.

B. The controllers must be fully programmable to meet the unique requirements of the facility it must control.

C. The controllers must be capable of peer-to-peer communications with other SNC’s and with any OWS connected to the BAS, whether the OWS is directly connected, connected via modem or connected via the Internet.

D. The communication protocols utilized for peer-to-peer communications between SNC’s will be Niagara AX, BACnet TCP/IP and SNMP. Use of a proprietary communication protocol for peer-to-peer communications between SNC’s is not allowed.

E. The SNC shall be capable of executing application control programs to provide:

1. Calendar functions

2. Scheduling
3. Trending
4. Alarm monitoring and routing
5. Time synchronization
6. Integration of BACnet and Modbus controller data
7. Network management functions for all SNC, PEC and ASC based devices

F. The SNC must provide the following hardware features as a minimum:

1. One Ethernet Port-10/100 Mdps
2. One RS-232/485 port
3. One BACnet Interface Port – 78KB FTT-10A
4. Battery Backup
5. Flash memory for long term data backup (If battery backup or flash memory is not supplied, the controller must contain a hard disk with at least 1 gigabyte storage capacity)

G. The SNC shall support standard Web browser access via the Intranet/Internet. It shall support a minimum of 16 simultaneous users.

H. The SNC shall provide alarm recognition, storage, routing, management and analysis to supplement distributed capabilities of equipment or application specific controllers.

I. The SNC shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via dial-up, telephone connection, or wide-area network.

1. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but not limited to:

a. Alarm,
b. Return to normal,
c. To default.

2. Alarms shall be annunciated in any of the following manners as defined by the user:

a. Screen message text,
b. Email of complete alarm message to multiple recipients.
c. Pagers via paging services that initiate a page on receipt of email message.
d. Graphics with flashing alarm object(s).

3. The following shall be recorded by the SNC for each alarm (at a minimum):

a. Time and date
b. Equipment (air handler #, accessway, etc.)
c. Acknowledge time, date, and user who issued acknowledgement.

J. Programming software and all controller “Setup Wizards” shall be embedded into the SNC.

1.13 PROGRAMMABLE EQUIPMENT CONTROLLER (PEC)

A. HVAC control shall be accomplished using BACnet™ based devices where the application has a BACnet profile defined. For each BACnet device that does not have BACnet certification, the device supplier must provide an XIF file for the device. The controller platform shall provide options and advanced system functions, programmable and configurable using Niagara AX Framework™, that allow standard and customizable control solutions required in executing the “Sequence of Operation”.

B. All PECs shall be application programmable and shall at all times maintain their BACnet certification. All control sequences within or programmed into the ILC shall be stored in non-

volatile memory, which is not dependent upon the presence of a battery to be retained.

C. The PECs shall communicate with the SNC at a baud rate of not less than 78.8K baud. The PEC shall provide LED indication of communication and controller performance to the technician, without cover removal.

D. The following integral and remote Inputs/Outputs shall be supported per each PEC:

1. Eight integral dry contact digital inputs.
2. Any two digital inputs may be configured as pulse counters with a maximum pulse read rate of 15 Hz.
3. Eight integral analog inputs (configurable as 0-10V, 0-10,000 ohm or, 20K NTC).
4. Six integral 4-20 ma analog outputs.
5. Eight integral 24 Vac Triac digital outputs, configurable as maintained or floating motor control outputs.
6. One integral 20 Vdc, 65-mA power supply for auxiliary devices.
7. If a 20 Vdc 65-mA power supply terminal is not integral to the ILC, provide at each PEC a separate, fully isolated, enclosed, current limited and regulated UL listed auxiliary power supply for power to auxiliary devices

E. Each PEC shall have expansion ability to support additional I/O requirements through the use of remote input/output modules

F. PEC Controllers shall support the following control techniques:

1. Ten configurable general-purpose control loops that can incorporate Demand Limit Control strategies, Setpoint reset, adaptive intelligent recovery, and time of day bypass.
2. Ten general-purpose, non-linear control loops.
3. Eight start/stop Loops.
4. Thirty-two If/Then/Else logic loops.
5. Thirty six Math Function loops (MIN, MAX, AVG, SUM, SUB,SQRT, MUL, DIV, ENTHALPY).

1.14 ADVANCED UNITARY CONTROLLER

A. The advanced unitary controller (AUC) platform shall be designed specifically to control HVAC – ventilation, filtration, heating, cooling, humidification, and distribution. Equipment includes constant volume air handlers, VAV air handlers, packaged RTU, heat pumps, unit vents, fan coils, natural convection units, and radiant panels. The controller platform shall provide options and advanced system functions, programmable and configurable using Niagara AX Framework™, that allow standard and customizable control solutions required in executing the “Sequence of Operation”.

B. Minimum Requirements:

1. The controller shall be fully programmable with full functionality on any Niagara AX brand platform.

   a. Support downloads to the controller from any brand of Niagara AX platform.
   b. Support uploads from the controller to any brand of Niagara AX platform.
   c. Support simulation/debug mode of the controller.
   d. Maintain native GUI.
   e. Native function-block programming within the Niagara AX environment.

2. The controller shall be capable of either integrating with other devices or stand-alone operation.
3. The controller shall have two microprocessors. The Host processor contains on-chip FLASH program memory, FLASH information memory, and RAM to run the main HVAC application. The second processor for network communications. Controller memory

minimum requirements include:

a. FLASH Memory Capacity: 60 Kilobytes with 8 Kilobytes for application program.
b. FLASH Memory settings retained for ten years.
c. RAM: 2 Kilobytes

4. The controller shall have an FTT transformer-coupled communications port interface for common mode-noise rejection and DC isolation.
5. The controller shall have an internal time clock with the ability to automatically revert from a master time clock on failure.

   a. Operating Range: 24-hour, 365 day, multi-year calendar including day of week and configuration for automatic day-light savings time adjustment to occur on configured start and stop dates.
   b. Accuracy: ±1 minute per month at 77° F (25° C).
   c. Power Failure Backup: 24 hours at 32° to 122° F (0° to 50° C).

6. The controller shall have Significant Event Notification, Periodic Update capability, and Failure Detect when network inputs fail to be detected within their configurable time frame.
7. The controller shall have an internal DC power supply to power external sensors.

   a. Power Output: 20 VDC ±10% at 75 mA.

8. The controller shall have a visual indication (LED) of the status of the devise:

   a. Controller operating normally.
   b. Controller in process of download.
   c. Controller in manual mode under control of software tool.
   d. Controller lost its configuration.
   e. No power to controller, low voltage, or controller damage.
   f. Processor and/or controller are not operating.

9. The minimum controller Environmental ratings

   a. Operating Temperature Ambient Rating: -40° to 150° F (-40° to 65.5° C).
   b. Storage Temperature Ambient Rating: -40° to 150° F (-40° to 65.5° C).
   c. Relative Humidity: 5% to 95% non-condensing.

10. The controller shall have the additional approval requirements, listings, and approvals:

    a. UL/cUL (E87741) listed under UL916 (Standard for Open Energy Management Equipment) with plenum rating.
    b. CSA (LR95329-3) Listed
    c. Meets FCC Part 15, Subpart B, Class B (radiated emissions) requirements.

11. The controller housing shall be UL plenum rated mounting to either a panel or DIN rail (standard EN50022; 7.5mm x 35mm).
12. The controller shall have a mix of digital inputs (DI), digital Triac outputs (DO), analog outputs (AO), and universal inputs (UI).

    a. Analog outputs (AO) shall be capable of being configured as digital outputs (DO)
    b. Input and Output wiring terminal strips shall be removable from the controller without disconnecting wiring.
    c. Input and Output wiring terminals shall be designated with color coded labels.
    d. Universal inputs shall be capable of being configured as binary inputs, resistive inputs, voltage inputs (0-10 VDC), or current inputs (4-20 mA)

13. The controller shall provide for "user defined" Network Variables (NV) for customized configurations and naming using Niagara AX Framework™.

    a. The controller shall support 62 Network Variables with a byte count of 31 per variable.
    b. The controller shall support 1,922 separate data values.

14. The controller shall provide **"continuous"** automated loop tuning with an Adaptive Integral Algorithm Control Loop.
15. The controller platform shall have standard HVAC application programs that are modifiable to support both the traditional and specialized "sequence of operations" as outlined in Section 4.

    a. Discharge air control and low limit
    b. Pressure-dependent dual duct without flow mixing.
    c. Variable air volume with return flow tracking.
    d. Economizer with differential enthalpy.
    e. Minimum airflow coordinated with CO2.
    f. Unit ventilator cycle (1,2,3) 2-pipe.
    g. Unit ventilator cycle (1,2,3) 2-pipe with face/bypass.
    h. Unit ventilator cycle (1,2,3) 4-pipe.
    i. Unit ventilator cycle (1,2,3) 4-pipe with EOC valve.

1.15 ADVANCED VARIABLE AIR VOLUME CONTROLLER

A. The advanced VAV controller platform shall be designed specifically for room-level VAV control – pressure-independent air flow control, pressure dependent damper control, supply and exhaust pressurization/de-pressurization control; temperature, humidity, complex CO2, occupancy, and emergency control. Equipment includes: VAV terminal unit, VAV terminal unit with reheat, Series fan powered terminal unit, Parallel fan powered terminal unit, Supply and Exhaust air volume terminals, and Constant volume dual-duct terminal unit. The controller platform shall provide options and advanced system functions, programmable and configurable using Niagara AX Framework™, that allow standard and customizable control solutions required in executing the "Sequence of Operation".

B. Minimum Requirements:

1. The controller shall be fully programmable with full functionality on any Niagara AX brand platform.

    a. Support downloads to the controller from any brand of Niagara AX platform.
    b. Support uploads from the controller to any brand of Niagara AX platform.
    c. Support simulation/debug mode of the controller.
    d. Maintain native GUI.
    e. Native function-block programming within the Niagara AX environment.

2. The controller shall be capable of either integrating with other devices or stand-alone room-level control operation.
3. The controller shall have an internal velocity pressure sensor.

    a. Sensor Type: Microbridge air flow sensor with dual integral restrictors.
    b. Operating Range: 0 to 1.5 in. H2O (0 to 374 Pa).
    c. Accuracy: ±2% of full scale at 32° to 122° F (0° to 50° C); ±1% of full scale at null pressure.

4. The controller shall have two microprocessors. The Host processor contains on-chip FLASH program memory, FLASH information memory, and RAM to run the main HVAC

application. The second processor for network communications.

a. FLASH Memory Capacity: 60 Kilobytes with 8 Kilobytes for application program.
b. FLASH Memory settings retained for ten years.
c. RAM: 2 Kilobytes

5. The controller shall have an FTT transformer-coupled communications port interface for common mode-noise rejection and DC isolation.
6. The controller shall have an internal time clock with the ability to automatically revert from a master time clock on failure.

a. Operating Range: 24-hour, 365 day, multi-year calendar including day of week and configuration for automatic day-light savings time adjustment to occur on configured start and stop dates.
b. Accuracy: ±1 minute per month at 77° F (25° C).
c. Power Failure Backup: 24 hours at 32° to 122° F (0° to 50° C).

7. The controller shall have Significant Event Notification, Periodic Update capability, and Failure Detect when network inputs fail to be detected within their configurable time frame.
8. The controller shall have an internal DC power supply to power external sensors.

a. Power Output: 20 VDC ±10% at 75 mA.

9. The controller shall have a visual indication (LED) of the status of the devise:

a. Controller operating normally.
b. Controller in process of download.
c. Controller in manual mode under control of software tool.
d. Controller lost its configuration.
e. No power to controller, low voltage, or controller damage.
f. Processor and/or controller are not operating.

10. The minimum controller Environmental ratings:

a. Operating Temperature Ambient Rating: 32° to 122° F (0° to 50° C).
b. Storage Temperature Ambient Rating: 32° to 122° F (0° to 50° C).
c. Relative Humidity: 5% to 95% non-condensing.

11. The controller shall have the additional approval requirements, listings, and approvals:

a. UL/cUL (E87741) listed under UL916 (Standard for Open Energy Management Equipment) with plenum rating.
b. CSA (LR95329-3) Listed
c. Meets FCC Part 15, Subpart B, Class B (radiated emissions) requirements.

12. The controller housing shall be UL plenum rated mounting to either a panel or DIN rail (standard EN50022; 7.5mm x 35mm).
13. The controller shall provide an integrated actuator option.

a. Actuator type: Series 60 Floating.
b. Rotation stroke: 95° ±3° for CW or CCW opening dampers.
c. Torque rating: 44 lb-in. (5 Nm).
d. Run time for 90° rotation: 90 seconds at 60 Hz.

14. The controller shall have four digital inputs (DI), eight digital Triac outputs (DO) or six digital Triac outputs (DO) with Integrated Actuator, three analog outputs (AO), and six universal inputs (UI).

a. Analog outputs (AO) shall be capable of being configured as digital outputs (DO).
b. Input and Output wiring terminal strips shall be removable from the controller without disconnecting wiring.
c. Input and Output wiring terminals shall be designated with color coded labels.

15. The controller shall provide for **"user defined"** Network Variables (NV) for customized configurations and naming using Niagara AX Framework™.

    a. The controller shall support a range of Network Variables to 62 with a byte count of 31 per variable.
    b. The controller shall support 1,922 separate data values.

16. The controller shall provide **"continuous"** automated loop tuning with an Adaptive Integral Algorithm Control Loop.
17. The controller shall have a loop execution response time of 1 second.
18. The controller platform shall have standard HVAC application programs that are modifiable to support both the traditional and specialized "sequence of operations" as outlined in Section 4.

    a. VAV terminal unit.
    b. VAV terminal unit fan speed control.
    c. Series fan.
    d. Parallel fan.
    e. Regulated air volume (room pressurization/de-pressurization).
    f. CV dual-duct
    g. Room CO2 control
    h. Room Humidity
    i. TOD occupancy sensor stand-by setpoints

1.16 OTHER CONTROL SYSTEM HARDWARE

A. Motorized control dampers that will not be integral to the equipment shall be furnished by the Control System Contractor. Control damper frames shall be constructed of galvanized steel, formed into changes and welded or riveted. Dampers shall be galvanized, with nylon bearings. Blade edge seals shall be vinyl. Blade edge and tip seals shall be included for all dampers. Blades shall be 16-gauge minimum and 6 inches wide maximum and frame shall be of welded channel iron. Damper leakage shall not exceed 10 CFM per square foot, at 1.5-inches water gauge static pressure.
B. Control damper actuators shall be furnished by the Control System Contractor. Two-position or proportional electric actuators shall be direct-mount type sized to provide a minimum of 5 in-lb torque per square foot of damper area. Damper actuators shall be spring return type. Operators shall be heavy-duty electronic type for positioning automatic dampers in response to a control signal. Motor shall be of sufficient size to operate damper positively and smoothly to obtain correct sequence as indicated. All applications requiring proportional operation shall utilize truly proportional electric actuators.
C. Control Valves: Control valves shall be 2-way or 3-way pattern as shown and constructed for tight shutoff at the pump shut-off head or steam relief valve pressure. Control valves shall operate satisfactorily against system pressures and differentials. Two-position valves shall be 'line' size. Proportional control valves shall be sized for a maximum pressure drop of 5.0 psi at rated flow (unless otherwise noted or scheduled on the drawings). Valves with sizes up to and including 2 inches shall be "screwed" configuration and 2-1/2 inch and larger valves shall be "flanged" configuration. All control valves, including terminal unit valves, less than 2 inch shall be globe valves. Electrically actuated control valves shall include spring return type actuators sized for tight shut-off against system pressures (as specified above) and, when specified, shall be furnished with integral switches for indication of valve position (open-closed).

Pneumatic actuators for valves, when utilized, shall be sized for tight shut-off against system pressures (as specified above).

D. Control Valve Actuators: Actuators for VAV terminal unit heating coils shall be “drive-open; drive-closed” type. All actuators shall have inherent current limiting motor protection. Valve actuators shall be 24-volt, electronic type, modulating or two-position as required for the correct operating sequence. Actuators on valves needing ‘fail-safe’ operation shall have spring return to Normal position. Modulating valves shall be positive positioning in response to the signal. All valve actuators shall be UL listed.

1. All control valves 2 ½” or larger shall have position indication. All hot water control valves shall be Normally-Open arrangement; all chilled water control valves shall be Normally-Closed arrangement.
2. Wall Mount Room Temperature sensors: Each room temperature sensor shall provide temperature indication to the digital controller, provide the capability for a software-limited occupant set point adjustment (warmer-cooler slider bar or switch) and limited operation override capability. Room Temperature Sensors shall be 20,000-ohm thermistor type with a temperature range of -40 to 140 degrees F. The sensor shall be complete with a decorative cover and suitable for mounting over a standard electrical utility box. These devices shall have an accuracy of 0.5 degrees, F., over the entire range.
3. Duct-mounted and Outside Air Temperature Sensors: 20,000-ohm thermistor temperature sensors with an accuracy of ± 0.2ºC. Outside air sensors shall include an integral sun shield. Duct-mounted sensors shall have an insertion measuring probe of a length appropriate for the duct size, with a temperature range of -40 to 160 degrees F. The sensor shall include a utility box and a gasket to prevent air leakage and vibration noise. For all mixed air and preheat air applications, install bendable averaging duct sensors with a minimum 8 - foot long sensor element. These devices shall have accuracy of 0.5 degrees, F., over the entire range.
4. Humidity sensors shall be thin-film capacitive type sensor with on-board nonvolatile memory, accuracy to plus or minus two percent (2%) at 0 to 90% RH, 12 - 30 VDC input voltage, analog output (0 - 10 VDC or 4 - 20mA output). Operating range shall be 0 to 100% RH and 32 to 140 degree F. Sensors shall be selected for wall, duct or outdoor type installation as appropriate.
5. Carbon Dioxide Sensors (CO_2): Sensors shall utilize Non-dispersive infrared technology (N.D.I.R.), repeatable to plus or minus 20 PPM. Sensor range shall be 0 - 2000 PPM. Accuracy shall be plus or minus five percent (5%) or 75 PPM, whichever is greater. Response shall be less than one minute. Input voltage shall be 20 to 30 VAC or DC. Output shall be 0 - 10 VDC. Sensor shall be wall or duct mounted type, as appropriate for the application, housed in a high impact plastic enclosure.
6. Current Sensitive Switches: Solid state, split core current switch that operates when the current level (sensed by the internal current transformer) exceeds the adjustable trip point. Current switch to include an integral LED for indication of trip condition and a current level below trip set point.
7. Differential Analog (duct) Static Pressure Transmitters Provide a pressure transmitter with integral capacitance type sensing and solid-state circuitry. Accuracy shall be plus or minus 1% of full range; range shall be selected for the specific application. Provide zero and span adjustment capability. Device shall have integral static pickup tube.
8. Differential Air Pressure Switches: Provide SPDT type, UL-approved, and selected for the appropriate operating range where applied. Switches shall have adjustable setpoints and barbed pressure tips.
9. Water Flow Switches: Provide a SPST type contact switch with bronze paddle blade, sized for the actual pipe size at the location. If installed outdoors, provide a NEMA-4 enclosure. Flow switch shall be UL listed.
10. Temperature Control Panels: Furnish temperature control panels of code gauge steel with locking doors for mounting all devices as shown. All electrical devices within a control

panel shall be factory wired. Control panel shall be assembled by the BMS in a UL-Certified 508A panel shop. A complete set of 'as-built' control drawings (relating to the controls within that panel) shall be furnished within each control panel.

11. Pipe and Duct Temperature sensing elements: 20,000-ohm thermister temperature sensors with and accuracy of ±1% accuracy. Their range shall be -5- to 250 deg. F. Limited range sensors shall be acceptable provided they are capable of sensing the range expected for the point at the specified accuracy. Thermal wells with heat conductive gel shall be included.
12. Low Air Temperature Sensors: Provide SPST type switch, with 15 to 55 degrees F., range, vapor-charged temperature sensor. Honeywell model L482A, or approved equivalent.
13. Relays: Start/stop relay model shall provide either momentary or maintained switching action as appropriate for the motor being started. All relays shall be plugged in, interchangeable, mounted on a subbase and wired to numbered terminals strips. Relays installed in panels shall all be DPDT with indicating lamp. Relays installed outside of controlled devices shall be enclosed in a NEMA enclosure suitable for the location. Relays shall be labeled with UR symbol. RIB-style relays are acceptable for remote enable/disable.
14. Emergency Stop Switches: Provide toggle-type switch with normally-closed contact. Switch shall be labeled "AIR HANDLER EMERGENCY SHUTOFF, NORMAL - OFF.".
15. Transducers: Differential pressure transducers shall be electronic with a 4-20 mA. output signal compatible to the Direct Digital Controller. Wetted parts shall be stainless steel. Unit shall be designed to operate in the pressure ranges involved.
16. Control Power Transformers: Provide step-down transformers for all DDC controllers and devices as required. Transformers shall be sized for the load, but shall be sized for 50 watts, minimum. Transformers shall be UL listed Class 2 type, for 120VAC/24VAC operation.
17. Line voltage protection: All DDC system control panels that are powered by 120 VAC circuits shall be provided with surge protection. This protection is in addition to any internal protection provided by the manufacturer. The protection shall meet UL, ULC 1449, IEEE C62.41B. A grounding conductor, (minimum 12 AWG), shall be brought to each control panel.

1.17 BAS SERVER & WEB BROWSER GUI

A. The BAS Contractor shall provide system software based on server/thin-client architecture, designed around the open standards of web technology. The BAS server shall communicate using Ethernet and TCP\IP. Server shall be accessed using a web browser over Owner intranet and remotely over the Internet.
B. The intent of the thin-client architecture is to provide the operator(s) complete access to the BAS system via a web browser. The thin-client web browser Graphical User Interface (GUI) shall be browser and operating system agnostic, meaning it will support Microsoft and Netscape Navigator browsers (6.0 or later versions), and Windows as well as non-Window operating systems. No special software, other than free public domain programs such as "JAVA VIRTUAL MACHINE" shall be required to be installed on PC's used to access the BAS via a web browser.
C. The BAS server software must support at least the following server platforms (Windows, and/or Linux). The BAS server software shall be developed and tested by the manufacturer of the system stand-alone controllers and network controllers/routers.
D. The web browser GUI shall provide a completely interactive user interface and must offer and be configured with the following features as a minimum:

    1. Trending
    2. Scheduling
    3. Electrical demand limiting

4. Duty Cycling
5. Downloading Memory to field devices
6. Real time 'live' Graphic Programs
7. Tree Navigation
8. Parameter change of properties
9. Setpoint Adjustments
10. Alarm / Event information
11. Configuration of operators
12. Execution of global commands
13. Add, delete, and modify graphics and displayed data

E. Software Components: All software shall be the most current version. All software components of the BAS system software shall be provided and installed as part of this project .BAS software components shall include:

1. Server Software, Database and Web Browser Graphical User Interface
2. System Configuration Utilities for future modifications to the system, and controllers.
3. Graphical Programming Tools
4. Direct Digital Control software
5. Application Software
6. Any required third party software
7. If licensing credits are required provide a minimum of 10% additional to as built control system requires.

F. BAS Server Database: The BAS server software shall utilize a Java DataBase Connectivity (JDBC) compatible database such as: MS SQL 8.0, Oracle 8i or IBM DB2. BAS systems written to Non -Standard and/or Proprietary databases are NOT acceptable.

G. Database Open Connectivity: The BAS server database shall allow real time access of data via the following standard mechanisms:

1. Open protocol standard like SOAP
2. OLE/OPC (for Microsoft Client's/Server platform only)
3. Import/Export of the database from or to XML (eXtensible Mark-up Language)

H. Communication Protocol(s): The native protocol for the BAS server software shall be TCPIP over Ethernet. Proprietary protocols over TCP/IP are NOT acceptable.

I. Thin Client – Web Browser Based: The GUI shall be thin client or browser based and shall meet the following criteria:

1. Web Browser's for PC's: Only a 5.5 or later browser (Explorer/Navigator) will be required as the GUI, and a valid connection to the server network. No installation of any custom software shall be required on the operator's GUI workstation/client. Connection shall be over an intranet or the Internet.
2. Secure Socket Layers: Communication between the Web Browser GUI and BAS server shall offer encryption using 128-bit encryption technology within Secure Socket Layers (SSL). Communication protocol shall be Hyper-Text Transfer Protocol (HTTP)

1.18 WEB BROWSER GRAPHICAL USER INTERFACE

A. Web Browser Navigation: The Thin Client web browser GUI shall provide a comprehensive user interface. Using a collection of web pages, it shall be constructed to "feel" like a single application and provide a complete and intuitive mouse/menu driven operator interface. It shall be possible to navigate through the system using a web browser to accomplish requirements of this specification. The Web Browser GUI shall (as a minimum) provide for navigation, and for display of animated graphics, schedules, alarms/events, live graphic programs, active

graphic setpoint controls, configuration menus for operator access, reports, and reporting actions for events.

B. Login: On launching the web browser and selecting the appropriate domain name or IP address, the operator shall be presented with a login page that will require a login name and password. Navigation in the system shall be dependent on the operator's role privileges, and geographic area of responsibility.

C. Navigation: Navigation through the GUI shall be accomplished by clicking on appropriate level of a navigation tree (consisting of expandable and collapsible tree control like Microsoft's Explorer program), and/or by selecting dynamic links to other system graphics. Both the navigation tree and action pane shall be displayed simultaneously, enabling the operator to select a specific system or equipment, and view the corresponding graphic. The navigation tree shall as a minimum provide the following views: Geographic, Network, Groups and Configuration.

1. Geographic View shall display a logical geographic hierarchy of the system including: cities, sites, buildings, building systems, floors, equipment and objects.
2. Groups View shall display Scheduled Groups and custom reports.
3. Configuration View shall display all the configuration categories (Operators, Schedule, Event, Reporting and Roles).

D. Action Pane: The Action Pane shall provide several functional views for each HVAC or mechanical/electrical subsystem specified. A functional view shall be accessed by clicking on the corresponding button:

1. Graphics: Using graphical format suitable for display in a web browser, graphics shall include aerial building/campus views, color building floor-plans, equipment drawings, active graphic setpoint controls, web content, and other valid HTML elements. The data on each graphic page shall automatically refresh.
2. Properties: Shall include graphic controls and text for the following: Locking or overriding objects, demand strategies, and any other valid data required for setup. Changes made to the properties pages shall require the operator to depress an 'accept/cancel' button.
3. Schedules: Shall be used to create, modify/edit and view schedules based on the systems geographical hierarchy (using the navigation tree).
4. Alarms: Shall be used to view alarm information geographically (using the navigation tree), acknowledge alarms, sort alarms by category, actions and verify reporting actions.
5. Trends: Shall be used to display associated trend and historical data, modify colors, date range, axis and scaling
6. Logic - Live Graphic Programs: Shall be used to display' live' graphic programs of the control algorithm, (micro block programming) for the mechanical/electrical system selected in the navigation tree.
7. Other actions such as Print, Help, Command, and Logout shall be available via a drop-down window.

E. Color Graphics: The Web Browser GUI shall make extensive use of color in the graphic pane to communicate information related to setpoints and comfort. Animated .gifs or .jpg, vector scalable, active setpoint graphic controls shall be used to enhance usability. Graphics tools used to create Web Browser graphics shall be non-proprietary and conform to the following basic criteria:

1. Display Size: The GUI workstation software shall graphically display in 1024 by 768 pixels 24-bit True Color.
2. General Graphic: General area maps shall show locations of controlled buildings in relation to local landmarks.
3. Color Floor Plans: Floor plan graphics shall show heating and cooling zones throughout the buildings in a range of colors, as selected by Owner. Provide a visual display of

temperature relative to their respective setpoints. The colors shall be updated dynamically as a zone's actual comfort condition changes.

4. Mechanical Components: Mechanical system graphics shall show the type of mechanical system components serving any zone through the use of a pictorial representation of components. Selected I/O points being controlled or monitored for each piece of equipment shall be displayed with the appropriate engineering units. Animation shall be used for rotation or moving mechanical components to enhance usability.
5. Minimum System Color Graphics: Color graphics shall be selected and displayed via a web browser for the following:

    a. Each piece of equipment monitored or controlled including each terminal unit
    b. Each building
    c. Each floor and zone controlled

F. Hierarchical Schedules: Utilizing the Navigation Tree displayed in the web browser GUI, an operator (with password access) shall be able to define a Normal, Holiday or Override schedule for an individual piece of equipment or room, or choose to apply a hierarchical schedule to the entire system, site or floor area. For example, Independence Day 'Holiday' for every level in the system would be created by clicking at the top of the geographic hierarchy defined in the Navigation Tree. No further operator intervention would be required and every control module in the system with would be automatically downloaded with the 'Independence Day' Holiday. All schedules that affect the system/area/equipment highlighted in the Navigation Tree shall be shown in a summary schedule table and graph.

1. Schedules: Schedules shall comply with the BACNet standards, (Schedule Object, Calendar Object, Weekly Schedule property and Exception Schedule property) and shall allow events to be scheduled based on:

    a. Types of schedule shall be Normal, Holiday or Override
    b. A specific date,
    c. A range of dates,
    d. Any combination of Month of Year (1-12, any), Week of Month (1-5, last, any), Day of Week (M-Sun, Any)
    e. Wildcard (example, allow combinations like second Tuesday of every month).

2. Schedule Categories: The system shall allow operators to define and edit scheduling categories (different types of "things" to be scheduled; for example, lighting, HVAC occupancy, etc.). The categories shall include: name, description, icon (to display in the hierarchy tree when icon option is selected) and type of value to be scheduled.
3. Schedule Groups: In addition to hierarchical scheduling, operators shall be able to define functional Schedule Groups, comprised of an arbitrary group of areas/rooms/equipment scattered throughout the facility and site. For example, the operator shall be able to define an 'individual tenant' group – who may occupy different areas within a building or buildings. Schedules applied to the 'tenant group' shall automatically be downloaded to control modules affecting spaces occupied by the 'tenant group'
4. Intelligent Scheduling: The control system shall be intelligent enough to automatically turn on any supporting equipment needed to control the environment in an occupied space. If the operator schedules an individual room in a VAV system for occupancy, for example, the control logic shall automatically turn on the VAV air handling unit, chiller, boiler, and/or any other equipment required to maintain the specified comfort and environmental conditions within the room.
5. Partial Day Exceptions: Schedule events shall be able to accommodate a time range specified by the operator (ex: board meeting from 6 pm to 9 pm overrides Normal schedule for conference room).
6. Schedule Summary Graph: The schedule summary graph shall clearly show Normal

versus Holiday versus Override Schedules, and the net operating schedule that results from all contributing schedules. Note: In case of priority conflict between schedules at the different geographic hierarchy, the schedule for the more detailed geographic level shall apply.

G. Alarms: Alarms associated with a specific system, area, or equipment selected in the Navigation Tree, shall be displayed in the Action Pane by selecting an 'Alarms' view. Alarms, and reporting actions shall have the following capabilities:

1. Alarms View: Each Alarm shall display an Alarms Category (using a different icon for each alarm category), date/time of occurrence, current status, alarm report, and a bold URL link to the associated graphic for the selected system, area or equipment. The URL link shall indicate the system location, address and other pertinent information. An operator shall easily be able to sort events, edit event templates and categories, acknowledge or force a return to normal in the Events View as specified in this section.
2. Alarm Categories: The operator shall be able to create, edit or delete alarm categories such as HVAC, Maintenance, Fire, or Generator. An icon shall be associated with each alarm category, enabling the operator to easily sort through multiple events displayed.
3. Alarm Templates: Alarm template shall define different types of alarms and their associated properties. As a minimum, properties shall include a reference name, verbose description, severity of alarm, acknowledgement requirements, and high/low limit and out of range information.
4. Alarm Areas: Alarm Areas enable an operator to assign specific Alarm Categories to specific Alarm Reporting Actions. For example, it shall be possible for an operator to assign all HVAC Maintenance Alarm on the 1st floor of a building to email the technician responsible for maintenance. The Navigation Tree shall be used to setup Alarm Areas in the Graphic Pane.
5. Alarm Time/Date Stamp: All events shall be generated at the DDC control module level and comprise the Time/Date Stamp using the standalone control module time and date.
6. Alarm Configuration: Operators shall be able to define the type of Alarm generated per object. A 'network' view of the Navigation Tree shall expose all objects and their respective Alarm Configuration. Configuration shall include assignment of Alarm, type of Acknowledgement and notification for return to normal or fault status.
7. Alarm Summary Counter: The view of Alarm in the Graphic Pane shall provide a numeric counter, indicating how many Alarms are active (in alarm), require acknowledgement, and total number of Alarms in the BAS Server database.
8. Alarm Auto-Deletion: Alarms that are acknowledged and closed shall be auto-deleted from the database and archived to a text file after an operator defined period.
9. Alarm Reporting Actions: Alarm Reporting Actions specified shall be automatically launched (under certain conditions) after an Alarm is received by the BAS server software. Operators shall be able to easily define these Reporting Actions using the Navigation Tree and Graphic Pane through the web browser GUI. Reporting Actions shall be as follows:

    a. Print: Alarm information shall be printed to the BAS server's PC or a networked printer.
    b. Email: Email shall be sent via any POP3-compatible e-mail server (most Internet Service Providers use POP3). Email messages may be copied to several email accounts. Note: Email reporting action shall also be used to support alphanumeric paging services, where email servers support pagers.
    c. File Write: The ASCII File write reporting action shall enable the operator to append operator defined alarm information to any alarm through a text file. The alarm information that is written to the file shall be completely definable by the operator. The operator may enter text or attach other data point information (such as AHU discharge temperature and fan condition upon a high room temperature alarm).
    d. Write Property: The write property reporting action updates a property value in a

hardware module.

e. SNMP: The Simple Network Management Protocol (SNMP) reporting action sends an SNMP trap to a network in response to receiving an alarm.
f. Run External Program: The Run External Program reporting action launches specified program in response to an event.

H. Trends: Trends shall both be displayed and user configurable through the Web Browser GUI. Trends shall comprise analog, digital or calculated points simultaneously. A trend log's properties shall be editable using the Navigation Tree and Graphic Pane.

1. Viewing Trends: The operator shall have the ability to view trends by using the Navigation Tree and selecting a Trends button in the Graphic Pane. The system shall allow y- and x-axis maximum ranges to be specified and shall be able to simultaneously graphically display multiple trends per graph.
2. Local Trends: Trend data shall be collected locally by Multi-Equipment/Single Equipment general-purpose controllers, and periodically uploaded to the BAS server if historical trending is enabled for the object. Trend data, including run time hours and start time date shall be retained in non-volatile module memory. Systems that rely on a gateway/router to run trends are NOT acceptable.
3. Resolution. Sample intervals shall be as small as one second. Each trended point will have the ability to be trended at a different trend interval. When multiple points are selected for displays that have different trend intervals, the system will automatically scale the axis.
4. Dynamic Update. Trends shall be able to dynamically update at operator-defined intervals.
5. Zoom/Pan. It shall be possible to zoom-in on a particular section of a trend for more detailed examination and 'pan through' historical data by simply scrolling the mouse.
6. Numeric Value Display. It shall be possible to pick any sample on a trend and have the numerical value displayed.
7. Copy/Paste. The operator must have the ability to pan through a historical trend and copy the data viewed to the clipboard using standard keystrokes (i.e. CTRL+C, CTRL+V).

I. Security Access: Systems that Security access from the web browser GUI to BAS server shall require a Login Name and Password. Access to different areas of the BAS system shall be defined in terms of Roles, Privileges and geographic area of responsibility as specified:

1. Roles: Roles shall reflect the actual roles of different types of operators. Each role shall comprise a set of 'easily understood English language' privileges. Roles shall be defined in terms of View, Edit and Function Privileges.

a. View Privileges shall comprise: Navigation, Network, and Configuration Trees, Operators, Roles and Privileges, Alarm/Event Template and Reporting Action.
b. Edit Privileges shall comprise: Setpoint, Tuning and Logic, Manual Override, and Point Assignment Parameters.
c. Function Privileges shall comprise: Alarm/Event Acknowledgement, Control Module Memory Download, Upload, Schedules, Schedule Groups, Manual Commands, Print, and Alarm/Event Maintenance.

2. Geographic Assignment of Roles: Roles shall be geographically assigned using a similar expandable/collapsible navigation tree. For example, it shall be possible to assign two HVAC Technicians with similar competencies (and the same operator defined HVAC Role) to different areas of the system.

1.19 GRAPHICAL PROGRAMMING

A. The system software shall include a Graphic Programming Language (GPL) for all DDC control algorithms resident in all control modules. Any system that does not use a drag and drop

method of graphical icon programming shall not be accepted. All systems shall use a GPL is a method used to create a sequence of operations by assembling graphic micro blocks that represent each of the commands or functions necessary to complete a control sequence. Micro blocks represent common logical control devices used in conventional control systems, such as relays, switches, high signal selectors, etc., in addition to the more complex DDC and energy management strategies such as PID loops and optimum start. Each micro block shall be interactive and contain the programming necessary to execute the function of the device it represents.

B. Graphic programming shall be performed while on screen and using a mouse; each micro block shall be selected from a micro block library and assembled with other micro blocks necessary to complete the specified sequence. Micro blocks are then interconnected on screen using graphic "wires," each forming a logical connection. Once assembled, each logical grouping of micro blocks and their interconnecting wires then forms a graphic function block which may be used to control any piece of equipment with a similar point configuration and sequence of operation.

C. Graphic Sequence: The clarity of the graphic sequence must be such that the operator has the ability to verify that system programming meets the specifications, without having to learn or interpret a manufacturer's unique programming language. The graphic programming must be self-documenting and provide the operator with an understandable and exact representation of each sequence of operation.

D. GPL Capabilities: The following is a minimum definition of the capabilities of the Graphic Programming software:

1. Function Block (FB): Shall be a collection of points, micro blocks and wires which have been connected together for the specific purpose of controlling a piece of HVAC equipment or a single mechanical system.
2. Logical I/O: Input/output points shall interface with the control modules in order to read various signals and/or values or to transmit signal or values to controlled devices.
3. Macroblocks: Shall be software devices that are represented graphically and may be connected together to perform a specified sequence. A library of macroblocks shall be submitted with the control contractors bid.
4. Wires: Shall be Graphical elements used to form logical connections between micro blocks and between logical I/O.
5. Reference Labels: Labels shall be similar to wires in that they are used to form logical connections between two points. Labels shall form a connection by reference instead of a visual connection, i.e. two points labeled 'A' on a drawing are logically connected even though there is no wire between them.
6. Parameter: A parameter shall be a value that may be tied to the input of a micro block.
7. Properties: Dialog boxes shall appear after a micro block has been inserted which has editable parameters associated with it. Default parameter dialog boxes shall contain various editable and non-editable fields and shall contain 'push buttons' for the purpose of selecting default parameter settings.
8. Icon: An icon shall be graphic representation of a software program. Each graphic micro block has an icon associated with it that graphically describes its function.
9. Menu-bar Icon: Shall be an icon that is displayed on the menu bar on the GPL screen, which represents its associated graphic micro block.
10. Live Graphical Programs: The Graphic Programming software must support a ‘live’ mode, where all input/output data, calculated data, and setpoints shall be displayed in a ‘live’ real-time mode.

1.20 BACNET NETWORK MANAGEMENT

A. Systems requiring the use of third party BACnet network management tools shall not be accepted.

B. Network management shall include the following services: device identification, device installation, device configuration, device diagnostics, device maintenance and network variable binding.
C. The Network configuration tool shall also provide diagnostics to identify devices on the network, to reset devices, and to view health and status counters within devices.
D. These tools shall provide the ability to “learn” an existing BACnet network, regardless of what network management tool(s) were used to install the existing network, so that existing BACnet devices and newly added devices are part of a single network management database.
E. The network management database shall be resident in the Network Area Controller (NAC), ensuring that anyone with proper authorization has access to the network management database at all times. Systems employing network management databases that are not resident, at all times, within the control system shall not be accepted.

1.21 PORTABLE OPERATOR’S TOOL (LAPTOP COMPUTER)

A. The laptop computer shall consist of an Intel Core i7 based laptop computer (**minimum processing speed of 2.67 GHz with 8 GB RAM and a 500 -gigabyte minimum hard drive**). It shall include a CD-ROM drive, and appropriate connectors and cables for communication with the Ethernet network.

END OF SECTION

SECTION 28 26 00
OUTDOOR WIRELESS NETWORKING – RUCKUS (BROCADE)

PART 1 - GENERAL

1.01 SUMMARY

A. Ruckus helps you address the top three challenges of school IT: network scaling, securing student data privacy, and network reliability for digital instruction. Our goal is to help you provide a safe and reliable learning environment at an affordable price.
B. Ruckus Access Points Outperform the Competition

1. Ruckus was tested and independently verified as the only vendor able to deliver stall-free video to 60 devices at once, both with and without data loading at the same time. No other vendor came close. Testing was conducted with the Ruckus R610 using Chromebooks, uncached streaming video and conducted in a classroom setting.

C. Need more convincing?

1. For many schools, a Wi-Fi access point in every other classroom may provide sufficient coverage and capacity, with edge switching to carry the data back to a closet or core switch and eventually to your Internet or Cloud service provider. For larger schools, or districts, Ruckus offers centralized management and security of your connections – and with multi-tenancy and high-availability options has provided Counties and Ministries of Education with the ability to manage the networks of their constituent schools.

D. The Ruckus R720 indoor access point is our highest-capacity four-stream 802.11ac Wave 2 Wi-Fi AP. It features multi-gigabit technology, so you can step up to faster Wi-Fi speeds and 2.5GbE backhaul connectivity without having to replace your Cat 5e cabling or use additional switch ports.
E. Deploy a high-performance, highly resilient Wi-Fi network without breaking the bank.

1. With hundreds of devices and nonstop wireless noise and interference, busy indoor environments can be the most challenging Wi-Fi deployments. The R720 makes it easy to deliver reliable, high-performance connectivity in large enterprises, office buildings, university campuses, convention centers, and practically any other indoor space.
2. The R720 802.11ac Wave 2 Wi-Fi AP incorporates patented technologies found only in the Ruckus Wi-Fi portfolio.

F. Extended coverage with patented BeamFlex+ utilizing multi-directional antenna patterns
G. Improve throughput with ChannelFly which dynamically find less congested Wi-Fi channels to use
H. With four stream MU-MIMO connectivity, the R720 can simultaneously transmit to multiple Wave 2 clients in the widest available channels, drastically improving RF efficiency even for non-Wave 2 clients. Additionally, the R720's integrated multi-gigabit technology provides a 2.5Gbps Ethernet interface, so you can more than double your backhaul capacity utilizing existing switches.
I. Whether you're deploying ten or ten thousand APs, the R720 is also easy to manage through Ruckus' appliance, virtual and cloud management options.

1.02 RUCKUS BENEFITS

A. MULTI-GIGABIT ACCESS SPEEDS

1. Liberate the multi-gigabit power of Wave 2 Wi-Fi by using built-in 2.5GbE (802.3bz)

backhaul to connect to multi-gigabit switches.

B. STUNNING PERFORMANCE

1. Provide a great user experience no matter how challenging the environment with BeamFlex+™ adaptive antenna technology and a library of 4K+ directional antenna patterns.

C. SERVE MORE DEVICES

1. Connect more devices simultaneously with four MU-MIMO spatial streams and concurrent dual-band 2.4/5GHz radios while enhancing non-Wave 2 device performance.

D. MULTIPLE MANAGEMENT OPTIONS

1. Manage the R720 from the cloud, or with on-premises physical/virtual appliances.

E. AUTOMATE OPTIMAL THROUGHPUT

1. ChannelFly™ dynamic channel technology uses machine learning to automatically find the least congested channels. You always get the highest throughput the band can support.

F. BETTER MESH NETWORKING

1. Reduce expensive cabling, and complex mesh configurations by checking a box with SmartMesh™ wireless meshing technology to dynamically create self-forming, self-healing mesh networks.

G. EXPANDABLE CAPABILITIES

1. Augment AP capabilities through the onboard USB 2.0 port to provide additional technologies like BLE.

H. MORE THAN WI-FI

1. Support services beyond Wi-Fi with Ruckus IoT Suite, Cloudpath security and onboarding software, SPoT Wi-Fi location engine, and SCI network analytics.

1.03 ACCESS POINT ANTENNA PATTERN

A. Ruckus' BeamFlex+ adaptive antennas allow the R720 AP to dynamically choose among a host of antenna patterns (over 4,000 possible combinations) in real-time to establish the best possible connection with every device. This leads to:

1. Better Wi-Fi coverage
2. Reduced RF interference

B. Traditional omni-directional antennas, found in generic access points, oversaturate the environment by needlessly radiating RF signals in all directions.
C. In contrast, the Ruckus BeamFlex+ adaptive antenna directs the radio signals per-device on a packet by-packet basis to optimize Wi-Fi coverage and capacity in real-time to support high device density environments.
D. BeamFlex+ operates without the need for device feedback and hence can benefit even devices using legacy standards.

1.04 Platform Overview

RUCKUS CLOUD WI-FI

Simplified Management. Simply Better Wi-Fi.

RUCKUS an ARRIS company

DATA SHEET



YOUR RUCKUS CLOUD WI-FI SUBSCRIPTION INCLUDES:

- AP management
- Instant availability of new features
- Free mobile app for anywhere management
- Native full-featured mobile app
- 24x7 phone/chat/web technical support
- Choice of 1-, 3- or 5-year subscriptions

Ruckus Cloud Wi-Fi simplifies deployment, monitoring and management of your distributed wireless network. Manage all of your WLANs from anywhere using the intuitive web interface or our full-featured mobile app. Administrators get a unified ("single pane of glass") view of all locations, as well as connected access points (APs) and clients.

MANAGEMENT SIMPLICITY

Radically simplify WLAN administrative tasks—from day-to-day management to setting up new venues and creating guest networks. Improve responsiveness to organizational needs while reducing IT overhead.

VISIBILITY AND CONTROL FROM ANYWHERE

Get a single-pane-of-glass view of your WLANs, connected APs and clients across multiple sites. View real-time and historical data on applications, traffic, clients and more. Manage your Wi-Fi network from anywhere using the web interface or mobile app.

BETTER PERFORMANCE AT A LOWER COST OF OWNERSHIP

Give users a superior Wi-Fi experience while saving money. Our high-density access points (APs) support more users per AP than competitive offerings. Greater capacity and coverage mean you save on your Wi-Fi infrastructure as you grow.

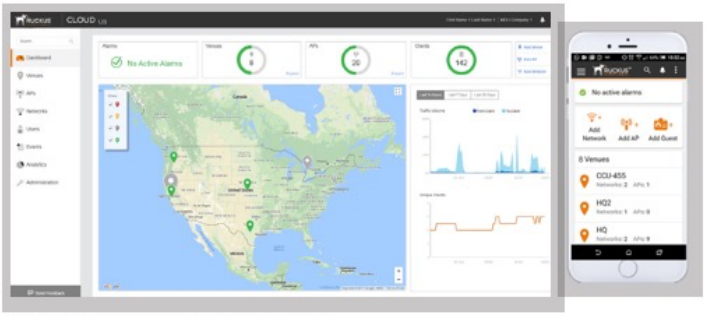


Figure 1: Ruckus Cloud Web UI and mobile app

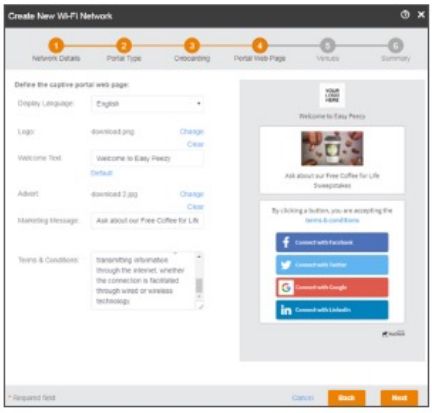


Figure 2: Captive portal customization

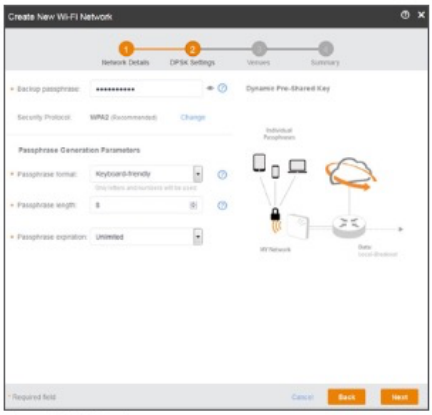


Figure 3: DPSK setup

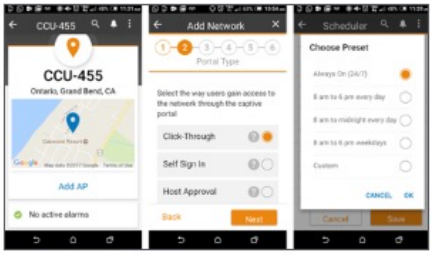


Figure 4: Mobile app capabilities


Figure 5: Application visibility

RUCKUS CLOUD WI-FI HIGHLIGHTS

HIGH PERFORMANCE APS

- Patented BeamFlex™ and ChannelFly™ technologies in Ruckus APs deliver better performance in challenging RF environments (high client density, high interference, and/or high loss).
- Superior capacity and coverage than competitive solutions (30% to 50% more clients supported per AP) lower Wi-Fi total cost of ownership.
- Automatic client load balancing and band balancing ensure QoS for all clients.
- SmartMesh, enabled with a click on the Ruckus Cloud UI, reduces cabling and installation costs.

INTUITIVE UI AND STREAMLINED WORKFLOWS

- Single-pane-of-glass web UI provides a high-level view of WLANs; click to drill down on venues, networks, APs, client details and applications.
- View historical client data and trends.
- See the health of your network at a glance and identify issues before they affect users.
- Intuitive UI makes management easy for administrators with any level of expertise, reducing dependence on specialized IT resources.
- Wizard-guided, streamlined workflows save time on everyday tasks.

EASY, FLEXIBLE GUEST AND EMPLOYEE NETWORK SETUP

- Self-help or sponsored guest WLANs
- Customized, branded captive portal for guests in six easy steps
- Integration with third-party captive portal solutions
- Ability to choose the way you secure guest networks, including:
  - Social login, SMS, email, click-through, passcode
  - Secure employee access using DPSK, PSK, Cloudpath or 802.1x with AAA

FULL-FEATURED MOBILE APP

- Provision, monitor and manage your WLANs using the Ruckus Cloud mobile app.
- Get push notifications to alert you of network issues or changes.
- Scan AP barcodes with your smartphone camera to register APs (individually or batch).
- Scan business cards to generate guest passes.
- Set up and configure new employee and guest networks.
- Customize captive portal messages and images on the go.

BUILT-IN REPORTING AND ANALYTICS

- 10 different report options, including traffic reports (by venue, AP, SSID, radio), application visibility and unique clients
- Up to 6 months of stored data to support long-term trending analysis
- Reports available at high granular 15-minute intervals

AP INVESTMENT PROTECTION

Maintain the flexibility to migrate from one management architecture to another (or hybrid management) without losing use of your Ruckus APs. Your APs remain operational even if your Ruckus Cloud Wi-Fi subscription is no longer active.

ADDITIONAL FEATURES AND SPECIFICATIONS

High-performance APs	• Management of a wide range of indoor and outdoor Ruckus APs, including the latest Ruckus 802.11ac Wave 1 and Wave 2APs • Automatic load balancing (between APs)	• Airtime fairness • Easy-to-configure, secure and reliable mesh networking
AP models supported	• See http://www.ruckuswireless.com/cloud-devices for a list of supported AP models.	
Full-featured mobile app	• Scan to register APs to the Ruckus Cloud. • Push notifications for alarms • Monitor status of AP, WLAN and clients. • Create and configure new SSIDs (enterprise or guest).	• Customize captive portal elements (images and message). • Schedule SSIDs by day of the week and time of day. • Native support for iOS and Android
Zero-touch provisioning	• Zero-touch AP provisioning and bulk scanning	• Cloud auto-updates of firmware once APs are connected to Ruckus Cloud
Employee Wi-Fi	• Multiple employee authentication options available: – Dynamic pre-shared key (DPSK) – Traditional PSK (WPA/WPA2) 802.11x with AAA and dynamic VLAN support	• Ability to set bandwidth rate limit per client and per SSID
Guest Wi-Fi	• Flexible login options: – Open, SMS, email, click-through, passcode – Social networking login (Google, LinkedIn, Facebook, Twitter) – PSK, captive portal, sponsored guest • Bulk creation of guest credentials • Control access to network resources: – Time-based scheduling of SSIDs – Free Wi-Fi with lock-out period and simple unblock options • Granular administrative controls – Per WLAN aggregate bandwidth limit – Per WLAN and per client bandwidth limit	• Guest manager (front desk) admin portal • MAC caching to allow repeat customers quick access to guest Wi-Fi • Easily customizable built-in captive portal • Integration with third-party guest Wi-Fi marketing platforms including Linkyfi, Purple Wi-Fi and more • Captive portal languages: English, Danish, Finnish, French, Dutch, Norwegian, Swedish, Italian, Spanish, German, Portuguese, Turkish, Greek, Romanian, Polish
Security, privacy and data protection	• All traffic to and from the cloud is encrypted. • Only AP and client management traffic is sent to the cloud. • Client data traffic stays local (broken out to local LAN and sent through your existing firewall). • All data stored in Ruckus Cloud is encrypted at rest. • Ruckus offers EU-located datacenters for European customers. • Latest security patches are automatically updated.	• Role-based access control is provided for administrative privileges. • Admin is able to grant and revoke access to partners and Ruckus support. • Client isolation is enabled by default for guest SSID. • SSID scheduling prevents unauthorized use of Wi-Fi network. • Advertise only certain APs within a venue. • View Ruckus Cloud privacy policy.
Dynamic Pre-Shared Key (DPSK)	• More secure than PSK, DPSK enables easy implementation of unique PSKs for each device. • Generate PSKs individually or upload in bulk for known devices.	• Set password complexity and expiration policies. • Export DPSK list for your records.
Cloudpath support (subscription sold separately)	• Add-on service enables self-service onboarding and granular per user, per device-based policy.	• Muse® multiple certificate sources, including built-in public key infrastructure (PKI), Microsoft CA and InCommon, provide stronger security than passwords/PSKs.
Built-in reporting and analytics	• 10 different report options, including: – Traffic per AP, per SSID, per venue, per radio – Top 10 applications – Session details – Unique client reports (tracking 2.4 vs. 5GHz clients over time)	• Up to 6 months data storage for trending with big data analytics – Big data architecture using Hadoop multi-node clusters – Indexed structured reporting for fast access

ADDITIONAL FEATURES AND SPECIFICATIONS (continued)

Other management highlights	• Ability to select RF policies, WLAN types (private, public, sponsored guest), guest access options, QoS and VLANs • Flexibility to segment APs within a venue into different AP groups • Channel and power control per venue, per AP group and per AP • Configuration of LAN ports on AP (certain models only) at the venue or at the AP level to connect wired desktops, printers and other devices or to extend network over mesh	• Automatic or selectable band balancing (between 2.4 and 5GHz radios on the same AP) • Global search by Mac address, username, hostname, OS type, IP address, AP name logs pre-filtered by venue, WLAN, APs, clients • Google Maps integration • Ability to import floor plans to visualize physical location of APs
Troubleshooting	• Remotely reboot APs, pull diagnostics information. • Get notifications of network status via SMS or email. • Event logs are sorted by venue, SSID, AP, client.	• Alarms are generated for AP status. • View historical client data to troubleshoot issues that happened in the past.
Partner admin delegation	• Delegate management of your Wi-Fi network to a Ruckus authorized VAR (value added reseller).	• Revoke administrative privileges at any time.
Cloud datacenter	• Hosted in USA and Europe on world-class IAAS provider with: – ISO 27001 information security certification – SSAE-16, SOC 1, SOC 2 and SOC 3 certifications – Stringent physical, data access, data disposal security measures – Per-tenant migration capabilities – Green carbon-neutral facilities – Dedicated inter-DC fiber connectivity	• Ability to choose the hosting region for your service (USA or EU)
SLA	• 99.9% network availability (does not include planned maintenance, including periodic software upgrades and other pre-announced activities)	
Technical support	• Easy button access to support • 24x7 chat/online ticketing system/phone support • U.S.-based Ruckus NOC	• AP hardware warranty is covered separately with the AP purchase (refer to AP datasheet); advanced hardware replacement for each AP is sold separately (SKUs starting with 803-)
Cloud SKUs	• 1-year Cloud Wi-Fi license for one AP – CLD-RKWF-1001 • 3-year Cloud Wi-Fi license for one AP – CLD-RKWF-3001	• 5-year Cloud Wi-Fi license for one AP – CLD-RKWF-5001 • 5-year state, local, EDU license for one AP – CLD-RWED-5001

A PARTNER AND PLATFORM FOR THE FUTURE

Ruckus Cloud Is our platform for innovation—with planned support of breakthrough wired/wireless technologies, IoT, big data and continued advances in management automation. Our open architecture also allows us to integrate a wide variety of complementary third-party services that enhance the value of your Wi-Fi network and provide greater user insight. We're working on every level—on the ground and in the cloud—to support your wireless business initiatives.

1.06 R720 Data Sheet

Ruckus R720 Access Point

Indoor 802.11ac Wave 2 4x4:4 Wi-Fi Access Point
with 2.5Gbps backhaul

Ruckus™

DATA SHEET



BENEFITS

MULTI-GIGABIT ACCESS SPEEDS

Liberate Wi-Fi Wave 2 performance by connecting to multi-gigabit switches using the onboard 2.5GbE (802.3bz) port

UNMATCHED PERFORMANCE

Mitigate interference and extend coverage with patented BeamFlex+ utilizing over 4,000 directional antenna patterns.

SERVICE MORE DEVICES

Support more devices simultaneously with four MU-MIMO spatial streams.Finds more capacity

OPTIMIZE THROUGHPUT

Improve performance automatically with ChannelFly and machine learning, which finds less congested Wi-Fi channels with dynamic RF channel selection

MORE DEVICES SUPPORTED

Connects the latest devices with concurrent dual-band radios (2.4/5GHz) and with support of legacy clients

EXPANDING CAPABILITIES

Augment AP capabilities through the onboard USB 2.0 port to support additional technologies like BLE

MULTI-FREQUENCY SUPPORT

Concurrent dual-band radios (2.4GHz/5GHz) provide support for even 2.4GHz only devices

GREAT APPLICATIONS

The R720 is more than just great Wi-Fi with support for onboarding with Cloudpath, locationing with SPoT, analytics with SCI and more

Organizations must support accelerating demands on their WLAN infrastructure with the rise of Internet of Things (IoT), bandwidth hungry applications and Bring Your Own Device (BYOD). The need for employees and customers to have the best user experience is driving organizations in every vertical to adopt the best possible network infrastructure. The Ruckus R720 allows all enterprises to deploy an affordable, high performance and highly resilient Wi-Fi network.

The Ruckus R720 indoor AP is the industry's highest capacity four-stream 802.11ac Wave 2 wireless access point. The R720 delivers reliable connectivity for high-density Wi-Fi environments where noise and interference are a big challenge. With MU-MIMO, the R720 can simultaneously transmit to multiple Wave 2 clients in the widest available channels, drastically improving RF efficiency even for non-Wave 2 clients. In today's networks, it only takes a few 802.11ac clients to impact overall network performance by overdriving a 1Gbps backhaul network connection. This problem is easily solved by the R720's 2.5Gbps backhaul connection, eliminating the need for additional cable runs and switch ports.

Large enterprises, office buildings, university campuses, convention centers—these are just some of the environments where high-speed, high-capacity Wi-Fi is critical to productivity, revenue generation, and customersatisfaction.

This high-end 802.11ac Wave 2 wireless access point incorporates patented technologies found only in the Ruckus Wi-Fi portfolio.

- BeamFlex+™ adaptive antenna technology directs each packet over the best performing signal path, extending coverage range and mitigating interference automatically.
- ChannelFly technology chooses the best channel to give users the highest throughput—delivering up to 50 percent capacity gain over competitive dynamic channel selection approaches.

Whether organizations are deploying ten or ten thousand APs, the Ruckus R720 is also easy to manage through Ruckus' appliance, virtual and cloud management options.

BeamFlex Adaptive Antenna



1.07 R720 Features

Ruckus R720 Access Point

Indoor 802.11ac Wave 2 4x4:4 Wi-Fi Access Point with 2.5Gbps backhaul

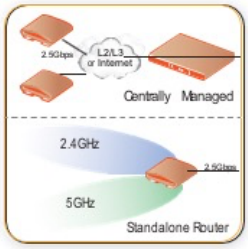
DATA SHEET



Blinding fast Wave 2 4x4:4
802.11ac with MU-MIMO



Deployment Scenarios



Architectural Flexibility



Weight is 1.12 kg. (2.5 lbs.)

FEATURES

WIRELESS FEATURES

- 4-stream 802.11ac Multi-User MIMO (MU-MIMO)
- Concurrent dual-band (5GHz/2.4GHz) support
- 80MHz, 80+80MHz and 160MHz channelization; 256-QAM modulation support; 1733 Mbps PHY rates at 5GHz
- 256-QAM support on 2.4GHz
- 802.11ac standard Tx Beamforming
- Backward compatible with legacy 802.11 clients
- Space Time Block Coding for increased handset performance
- Improved Maximum Ratio Combining (MRC) for best-in-class receive sensitivity
- Low Density Parity Check (LDPC) for increased data throughput at all ranges
- BeamFlex+ (PD-MRC) improves signal reception of mobile devices
- Integrated smart antenna with many unique patterns for ultra reliability
- Unmatched Rx sensitivity down to -104 dBm

INTERFACES

- One 2.5Gbps Ethernet port and one 1Gbps Ethernet port
- Ethernet Port Link Aggregation (LACP)
- USB port for hosting Internet-of-Things (IoT) devices such as Bluetooth Low Energy (BLE) smart beacons

POWER

- 802.3af/at/bt Power over Ethernet (PoE, PoE+, PoH, UPoE) via the 2.5Gbps Ethernet port.
- 12V DC input

Power Source	2.4GHz	5GHz	2nd Eth	USB
802.3af PoE	1x4 18dBm/chain	1x4 20dBm/chain	–	–
802.3at PoE+	4x4 18dBm/chain	4x4 20dBm/chain	–	–
PoH, UPoE, Injector, 12VDC	4x4 23dBm/chain	4x4 22dBm/chain	Yes	Yes

SOFTWARE

- Four software QoS queues per client station
- Up to 16 BSSIDs per radio with unique QoS and security policies
- Either standalone or centrally managed
- Integrated NAT and DHCP support
- Multicast IP video streaming support
- WPA-PSK (AES), 802.1X support for RADIUS and AD*
- SmartMesh Networking*
- Zero-IT (BYOD) and Dynamic PSK*
- Admission control/load balancing*
- Band balancing
- Captive portal and guest accounts*

* when used with management

ACCESSORIES

- Wall or ceiling mountable with padlock security
- Built in mounting options for fast and easy deployment

1.08 R720 Technology

Ruckus R720 Access Point

Indoor 802.11ac Wave 2 4x4:4 Wi-Fi Access Point with 2.5Gbps backhaul

DATA SHEET

PATENTED BEAMFLEX+ TECHNOLOGY EXTENDS SIGNAL RANGE, IMPROVES STABILITY OF CLIENT CONNECTIONS

The Ruckus R720 integrates patented software-controlled adaptive antennas that delivers additional signal gain per radio chain. As BeamFlex+ adapts to client locations and antenna polarity, the smart antenna technology optimizes the RF energy toward client on a per packet basis. This allows for substantial performance improvement and a reduction in packet loss from the ability to automatically mitigate interference. BeamFlex+, with PD-MRC or polarization diversity, ensures the R720 listens in all polarizations simultaneously. This results in significant receive signal gain from mobile devices with weak transmitters.

MULTI-USER MIMO (MU-MIMO)

802.11ac MU-MIMO allows the R720 to transmit multiple spatial streams to multiple client devices simultaneously, increasing the total throughput and capacity of the wireless network. The R720 is able to provide up to four clients each their own dedicated full-bandwidth channel using an MU-MIMO technique known as spatial reuse. This capability enables several benefits:

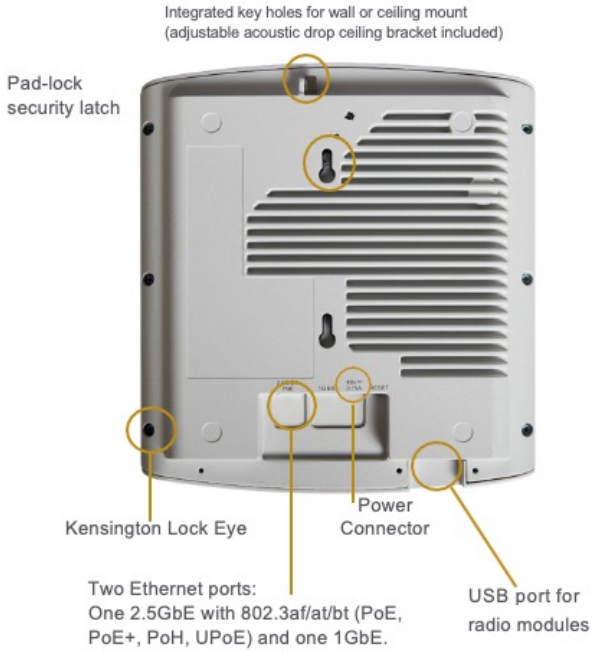
1. Efficient use of available spectrum effectively multiplies the total capacity of a network, allowing it to meet the increasing data demand driven by the proliferation of mobile Wi-Fi clients and data-hungry applications such as high-definition video streaming.
2. Additionally, MU-MIMO does not require client devices to time-share connections with other clients on the network as in legacy Wi-Fi, which means each device experiences less wait time and makes the network more responsive overall. Even legacy clients benefit from MU-MIMO on the wireless network, because substantially increased efficiency for MU clients leaves the network with more free time and capacity by supporting multiple users.

ADVANCED WLAN APPLICATIONS

When used with the Ruckus WLAN management systems, the Ruckus R720 supports a wide range of value-added applications such as guest networking, Dynamic PSK, hotspot authentication, wireless intrusion prevention and many more. WLANs can also be grouped and shared by specific APs. In a centrally managed configuration, the R720 works with various authentication servers including AD, LDAP, and RADIUS.



Front View





BeamFlex+ Adaptive Antenna Technology

1.09 R720 SPECIFICATIONS

PHYSICAL CHARACTERISTICS	
Power[1]	• DC Input: 12 VDC 2A • PoE: 802.3af/at/bt
Physical Size	• 23 cm (L), 21 cm (W), 6 cm(H)
Weight	• 1.12 kg (2.5 lb.)
Ethernet Ports	• One 2.5Gbps Ethernet port and one 1Gbps Ethernet port • Power over Ethernet (802.3af/at/bt) with Category 5/5e/6 cable • Link Aggregation (LACP)
USB Port	• USB 2.0 • Type A connector - ideal for BLE dongles and sensors
Mounting Options	• Electrical wallbox; Standard US and EU single gang wall jack • Optional bracket for offset & wall mount
Environmental Conditions	• Operating Temperature: -4°F (-20°C) - 140°F (60°C) • Operating Humidity: up to 95% non-condensing
Lock Options	• Hidden latching mechanism • Kensington Lock Hole • T-bar Torx • Bracket (902-0108-0000) Torx screw & padlock (sold separately)
Power Draw	• 5.5W (minimum) • 11.4W (typical) • 12.95W peak with 802.3af • 25W peak with 802.3at • 35W peak with full power

RF	
Antenna	• Adaptive antenna that provides up to 4000+ unique antenna patterns • Maximum transmit power (aggregate) is 28dBm for both 2.4 & 5GHz
Physical Antenna Gain	• 3dB (2.4 and 5GHz)
Beamflex+ SINR Tx Gain[2]	• up to 6dB
Beamflex+ SINR Rx Gain	• up to 3-5dB
Interference Mitigation	• up to 15dB
Minimum Rx Sensitivity[3]	• -104dBm

PERFORMANCE AND CAPACITY	
Phy Data Rates	• Up to 800Mbps (2.4GHz) • Up to 1733Mbps (5GHz)
Concurrent Stations	• Up to 512
Simultaneous VoIP Clients	• Up to 60 (802.11e/WMM), 30 per radio

NETWORK ARCHITECTURE	
IP	• IPv4, IPv6, dual-stack
VLANs	• 802.1Q (1 per BSSID or dynamic, per user based on RADIUS) • Port-based
802.1X for Wired Ports	• Authenticator • Supplicant
Tunneling	• L2TP

MULTIMEDIA AND QUALITY OF SERVICE	
802.11e/WMM	• Supported
Software Queues	• Per WLAN priority (2), Per traffic type (4), per client
Traffic Classification	• Automatic, heuristics and TOS based or VLAN-defined
Rate Limiting	• Dynamic per-user or per-WLAN

*Ruckus wireless proprietary and confidential. Specifications subject to change without notice.

MANAGEMENT	
Deployment Options	• Standalone (individually managed) • Centrally managed

WI-FI	
Standards	• IEEE 802.11a/b/g/n/ac
Supported Data Rates	• 802.11ac: 29.3 Mbps – 1733 Mbps (160MHz[4]) • 802.11n: 6.5 Mbps – 216.7 Mbps(20MHz) 13.5 Mbps – 800 Mbps (40MHz) • 802.11a: 54, 48, 36, 24, 18, 12, 9 and 6 Mbps • 802.11b: 11, 5.5, 2 and 1 Mbps • 802.11 Gbps: 54, 48, 36, 24, 18, 12, 9 and 6 Mbps
Radio Chains	• 4x4
Spatial Streams	• 4
MIMO	• SU-MIMO — Up to 4 streams • MU-MIMO — Up to 4 streams
Channelization	• 20MHz, 40MHz, 80MHz, 80+80MHz and/or 160MHz
Frequency Band	• IEEE 802.11ac: 5.15 – 5.85GHz • IEEE 802.11a/n: 5.15 – 5.85GHz • IEEE 802.11b: 2.4 – 2.484GHz
BSSIDs	• Up to 16 (2.4GHz) • Up to 16 (5GHz)
Power Save	• Supported
Certifications	• WEEE/RoHS compliance • EN 60601-1-2 Medical • Wi-Fi Alliance certified • UL 2043 plenum rated
Subway And Railroad Certifications	• EN50121-1 EMC • EN50121-4 Immunity • IEC 61373 Shock & Vibration

PRODUCT ORDERING INFORMATION

MODEL	DESCRIPTION
Ruckus R720 Smart Wi-Fi 802.11ac Access Point	
901-R720-XX00[5]	R720 dual-band (5GHz and 2.4GHz concurrent) Wave 2 802.11ac wireless access point, 4x4:4 streams, adaptive antennas, dual ports, PoE support. Includes adjustable acoustic drop ceiling bracket. One Ethernet port is 2.5GbE. Does not include power adaptor.
Optional Accessories	
902-0180-XX00	PoE injector (90 – 264 VAC 47-63 Hz)
902-1170-XX00	AC/DC Power supply - 48V - 36W
902-0120-0000	Secure Mounting Bracket

When ordering Ruckus Indoor APs, you must specify the destination region by indicating -US, -WW, or -Z2 instead of XX. When ordering PoE injectors or power supplies, you must specify the destination region by indicating -US, -EU, -AU, -BR, -CN, -IN, -JP, -KR, -SA, -UK, or -UN instead of -XX.

For access points, -Z2 applies to the following countries: Algeria, Egypt, Israel, Morocco, Tunisia, and Vietnam

1 Max power varies by country setting, band, and MCS rate
2 BeamFlex+ gains are statistical system-level effects (including TxBF), translated to enhanced SINR here, and based on observations over time in real-world conditions with multiple APs and many clients
3 Rx sensitivity varies by band, channel width, and MCS rate
4 With 160MHz channelization enabled, the R720 runs in two spatial stream mode (2x2:2)
5 Refer to price list for the complete list of current country certifications

Warranty: Sold with a limited lifetime warranty.
For details see: http://support.ruckuswireless.com/warranty

END OF SECTION

SECTION 28 27 00
CISCO CLOUD WEB SECURITY

PART 1 - GENERAL

1.01 Cisco Cloud Web Security

A. Hacking has become a recognized industry, supporting sophisticated and well-funded criminal enterprises. Attacks are also evolving continually, becoming more damaging and harder to detect. Traditional web security methods can block known threats but are not able to adapt to the changing threat landscape. And they can't handle advanced malware.

B. Perimeter defenses don’t address how your users access information and resources. Now it isn’t just people outside your organization who are of concern; your own users may consume excess bandwidth or access inappropriate content that can put your organization at risk. Their personal devices may introduce malware from inside the firewall.

C. Built on an industry-leading global threat-visibility network, Cloud Web Security offers highly effective protection against advanced and targeted threats. It continuously monitors both network and file behavior. It identifies threats operating in the environment with Cisco Advanced Malware Protection (AMP) and Cognitive Threat Analytics.

D. Cloud Web Security controls web usage and blocks sites based on signature, reputation, and content analysis. It also delivers best-in-class malware scanning through outbreak intelligence, a heuristics-based engine that analyzes each webpage component in real time to block threats.

E. Cisco AMP protects against advanced malware threats, using file retrospection to track a file’s disposition over time. Cognitive Threat Analytics continuously scans for symptoms of a breach, reducing the time to discover threats that bypass perimeter defenses.

F. As a cloud service, Cloud Web Security delivers superior flexibility. You can easily deploy and scale the service with multiple connection options while using the existing infrastructure. A single management interface provides global control, providing enforcement of detailed web-usage policies across an entire organization no matter where users are located or on what device. Through the Cisco AnyConnect® Secure Mobility Client, Cloud Web Security extends its strong protection to roaming laptop users and enforces the same on-premises policies.

G. Our advanced global threat visibility network continually updates Cloud Web Security against the latest threats, and the most actionable cloud-delivered intelligence reporting helps ensure superior visibility into web usage. Top-tier data center facilities in 23 locations around the globe deliver a service-level agreement (SLA) of 99.999 percent uptime, so that information is always available. Cloud Web Security also comes with Cisco’s award-winning 24- hour support.

1.02 Features and Benefits by License

Several licenses are available. Cloud Web Security Essentials is the base offering for new and renewing customers. Other bundles and individual options are also available. The major features of each license are described in Tables 1 through 5.

Table 1. Essentials License

Feature	Description
Web filtering	Control web access to more than 50 million known websites by applying filters from a list of over 75 web categories.
Malware scanning	Increase the catch rate with an intelligent multiscanning technology that divides web traffic into functional elements and efficiently analyzes it in real time.
Outbreak intelligence	Identify unknown and unusual behaviors and zero-hour outbreaks through a heuristics-based antimalware engine. Outbreak intelligence runs webpage components in a virtual emulation environment before permitting user access. Using proprietary “scanlet” engines for Java, PDF, executables, and more, outbreak intelligence opens up the individual components of a webpage to determine how each component behaves and blocks any malware.
Web reputation	Restrict website access based on site reputation. Analyze data such as the domain owner, the hosting server, the time created, the type of site requested, and more than 50 other distinct parameters to provide a reputation score for the site requested.[1]
Application visibility and control	Increase employee productivity by controlling access to webpages, individual web parts, or microapplications so that employees can access the sites needed for work without unnecessary distractions. Simultaneously prevent access to inappropriate content.
Dynamic content analysis	Defend against compliance, liability, and productivity risks by combining traditional URL filtering with real-time dynamic content analysis (DCA). The DCA engine automatically categorizes the content of an unknown URL by analyzing the content of the page itself, scoring relevancy to web categories (such as pornography, hate speech, gambling, and illegal downloads) and blocking the page if it conflicts with web security policies.
Centralized management and reporting	Receive actionable insight across threats, data, and applications. A powerful centralized tool controls both security operations (such as management) and network operations (such as analysis of bandwidth consumption). Administrators have access to a variety of predefined reports and can create customized dashboards and set notifications. All reports are generated and stored in the cloud, so they are delivered in seconds as opposed to hours. Reports can be also be saved and scheduled for automated delivery. These capabilities provide flexibility, offering detail down to the user level, and help enable administrators to spotlight potential issues quickly.
Roaming laptop user protection	Protect roaming users with the same in-house policies through Cisco AnyConnect. AnyConnect routes all roaming web traffic through an SSL tunnel directly to the closest Cisco cloud proxy and enforces the same security features that are on premises. By eliminating the need to backhaul web traffic through VPN, Cloud Web Security relieves web congestion at the headquarters, reducing bandwidth use while improving the end-user experience.

[1] See “Protect Against URL-Based Threats” on the Cisco Web Reputation Technology page.

The Cloud Web Security Premium license, shown in Table 2, includes all the features from the Cloud Web Security Essentials bundle and adds AMP and Cognitive Threat Analytics.

Table 2. Premium License

Feature	Description
Cisco AMP (also available separately)	Protect against the latest and most advanced forms of malware with AMP's detection and blocking, continuous analysis, and retrospective alerting. AMP uses the vast cloud security intelligence networks of both Cisco and Sourcefire (now part of Cisco). AMP augments the antimalware detection and blocking capabilities already offered in Cloud Web Security with enhanced file reputation capabilities, detailed file sandboxing, and file retrospection. The only solution with all of these capabilities, Cisco AMP tracks a file's disposition over time inside the network perimeter. If a file is later found to be malicious, file retrospection identifies where the file entered and where it traveled to help in the remediation process. Learn more.
Cognitive Threat Analytics (also available separately)	Reduce the time to discovery of threats operating inside the network. Cognitive Threat Analytics addresses gaps in perimeter-based defenses by identifying the symptoms of a malware infection or data breach using behavioral analysis and anomaly detection. Unlike traditional monitoring systems, it relies on advanced statistical modeling and machine learning to independently identify new threats, learn from what it sees, and adapt over time. Learn more.

Table 3. Advanced Threat Detection and A la carte Licenses

Feature	Description
Log extraction API	Automatically pull web-usage data quickly for highly secure analysis with an S3-compatible HTTPS API. Log data is compiled in W3C text format that can be correlated with existing data using a variety of reporting and analysis tools such as security information and event management (SIEM). Log information consisting of more than 20 attributes is typically available within 15 minutes of the event. Log extraction can be added to any existing Cloud Web Security license. It is ideal for customers with 4000 seats or more.
AMP	See Table 2.
Cognitive Threat Analytics	See Table 2.
Data retention	Data for blocked web requests (policy or malware blocks) is retained for one year, and allowed data is retained for 45 days. Customers can retain data for longer periods to match the terms of their subscription.

Advanced threat detection is an add-on license that includes Cisco AMP and Cognitive Threat Analytics (see descriptions in the tables above) and is available to customers with a current Cloud Web Security Essentials license.

Table 4. Web Security Bundle

Feature	Description
Web Security bundle	The Web Security bundle comprises the Cisco Web Security Appliance and Cloud Web Security. Customers can consume Cisco Web Security across the cloud or on premises. The bundle includes: • **Web Security Appliance Premium:** Combines URL filtering defense with deep content scanning (web-usage controls, web reputation, Sophos Anti-malware, Webroot Anti-malware, and software subscription support); includes license for the Web Security Virtual Appliance. See the Web Security Appliance data sheet for more details. • **Cloud Web Security Essentials:** See Table 1. • **Web reporting application (optional):** The Cisco Web Security reporting application provides a single pane of glass for monitoring your web security regardless of deployment. It includes a customized application in one transparent installation. It polls log data collected from multiple Web Security Appliances and Cloud Web Security for predefined reports. Customers can also perform searches using the flash timeline view and web- tracking forms. • **Log extraction (optional):** See Table 3. • **AMP:** See Table 2.

These benefits are included with all Cloud Web Security licenses.

Talos Security and Research Group: With a 24-hour view into global traffic activity, Talos analyzes anomalies, uncovers new threats, and monitors traffic trends. Talos generates new rules and updates every 3 to 5 minutes, providing threat defense hours and even days ahead of competitors. Receive fast and comprehensive web protection backed by one of the largest threat-detection networks in the world, with the broadest visibility and largest footprint based on:

- 130 billion web requests served by Cloud Web Security per month
- 3.6 petabytes of bandwidth pumped through Cloud Web Security monthly
- 100 TB of intelligence gathered daily
- 4.9 billion antivirus and web filtering blocks per month
- 1.6 million sensors
- Support on all major operating systems and platform

1.03 Cloud Web Security Traffic Redirection Connection Methods

A. Cloud Web Security allows for flexible deployment options that include Cisco appliances... or not. There are many ways to redirect traffic to the Cloud Web Security web proxy. Redirection can be accomplished through the Cisco Adaptive Security Appliances (both physical and virtual), Cisco Integrated Services Routers (ISR) G2, Cisco 4000 Series Integrated Services Routers (through generic routing encapsulation over IPsec) and the Web Security Appliances (physical and virtual). These redirect traffic to Cloud Web Security for web security functions.

B. **Next-Generation Firewall** (Cisco Adaptive Security Appliances, physical and virtual): Capitalize on your Adaptive Security Appliance investments by offloading content scanning to Cisco's cloud through Cloud Web Security. Apply acceptable-use policy to the company, groups, or individual users.

C. **Web Security Appliance** (physical and virtual): Integrate Cloud Web Security and the Web Security Appliance so that identity information can be sent to the cloud. And extend other on-premises enterprise features to Cloud Web Security customers.

D. **Cisco ISR G2:** Save bandwidth, money, and resources and improve Internet speed at the branch by intelligently redirecting Internet traffic from branch offices directly to the cloud to enforce security and control policies. Apply acceptable-use policy to all users regardless of location.

E. **Cisco 4000 Series ISR:** Get the same benefits of redirecting through the ISR G2. At the same time, you reduce maintenance costs by adopting industry-standard GRE over IPsec technology that is reliable, well understood, and mature. See Controlled Availability notification for more information

F. **AnyConnect Secure Mobility Client:** Authenticate and redirect web traffic off the corporate network whenever the end user is. Cloud Web Security uses cached user credentials and directory information when users are away from the office or connecting through a VPN, helping to ensure that the same web usage policies are applied.

G. **Standalone deployment:** Deploy a simple web security solution that does not require additional hardware. Connect to the Cloud Web Security service using existing browser settings and Proxy Auto-Configuration (PAC) or Web Proxy Auto-Discovery (WPAD) files.

H. Every Cloud Web Security deployment option includes directory authentication methods that enhance end-user identification, enabling administrators to apply precise filter controls at the user or group level and run detailed log reports.

1.04 Subscriptions

A. All Cisco Cloud Web Security subscriptions are term-based subscriptions of 1, 3, or 5 years.

1.05 Seat-Based Subscription

A. The Cisco Web Security portfolio uses tiered pricing based on the number of users, not devices. Sales and partner representatives can help to determine the correct tier for each customer deployment.

1.06 Bandwidth-Based Subscription

A. Customers can consume Cloud Web Security on a bandwidth basis by aggregating the total traffic across various deployment sites that will be directed to Cloud Web Security data centers.

1.07 Security Enterprise License Agreements

A. Cisco Security Enterprise Licensing Agreements (ELAs) offer simplified license management and license costs savings through a single agreement. Customers with ELA v3 can add Cloud Web Security Essentials, and customers with ELA v4 can add Cloud Web Security Premium, all at no additional cost. To learn more about Security Enterprise License Agreements, talk to your Cisco account representative.

1.08 Software Subscription Support

A. Every Cloud Web Security subscription also includes the following support benefits:

1. Automatic application of patches, software updates, and maintenance to the Cisco cloud to keep applications and platform software current

2. Access to the Cisco Technical Assistance Center (TAC) 24 hours a day, 7 days a week

3. Access to an online repository of application tools, technical documents, and training

4. Registered access to Cisco.com for online technical information and service request management

1.09 Services

A. Cisco takes a threat-centric approach to security to protect network infrastructures and assets on the network. Our services help you take full advantage of security appliances and systems you've installed.

B. **Cisco Web Security Configuration and Installation Service:** Helps mitigate web security risks by installing, configuring, and testing to implement:

1. Acceptable-use policy (AUP) controls

2. Reputation and malware filtering

3. Data security

4. Application visibility and control

C. **Cisco Security Optimization Service:** Helps you evaluate and strengthen your network's ability to prevent, detect, and mitigate threats. This service combines network security assessment, design, support, and learning activities in one comprehensive subscription package.

D. **Cisco Managed Threat Defense:** Provides dynamic real-time detection and remediation against known vulnerabilities as well as advanced persistent threats. Cisco provides the hardware, software, and expertise to deliver threat defense in a subscription-based model through a global network of security operation centers.

1.10 Collaborative/Partner Services

A. A wide range of valuable services from Cisco partners is available across the planning, design, implementation, and optimization lifecycle. They include the following:

B. **Cisco Network Device Security Assessment:** Helps you implement and maintain a hardened network device environment by identifying gaps in your Cisco network infrastructure security.

C. **Smart Care Service (provided by a Cisco Certified Partner):** Helps you simplify network maintenance through proactive network monitoring, assessments, software repairs, and technical support.

1.11 Other Services

A. **Cisco Product Security Incident Response Team (PSIRT):** The PSIRT is a dedicated global team that manages the receipt, investigation, and public reporting of security vulnerability information related to Cisco products and networks.

B. **Cisco Secure Development Lifecycle (SDL):** This is a repeatable and measurable process

designed to increase the resiliency and trustworthiness of our products.

1.12 Cisco Cloud Web Security and Data Privacy

A. As part of Cisco's commitment to protecting the confidentiality and safety of our customer data, Cisco® Cloud Web Security (CWS) enforces a stringent privacy and security policy.

B. Access to private and confidential data on our systems is limited to those employees with a specific need to retrieve this information. Cisco CWS uses a number of computer security safeguards to protect its databases and servers against the risk of loss, unauthorized access, destruction, misuse, modification, or the inadvertent or improper disclosure of data.

1. Customer web requests are stored on a separate database and server that can be accessed by a limited number of Cisco CWS employees on a need-to-know basis, with logging. Cisco CWS otherwise accesses data only for threat and statistical purposes and only on an anonymized basis. We segregate any personally identifiable information provided by customers.

2. Cisco CWS operates on a multitenant architecture. Customers can access only their own data based on hierarchical access control through Cisco ScanCenter with a user-defined password that meets strict password requirements. Customer data is logically separated to prevent any accidental overlap.

3. All data saved for reporting purposes is stored in a dedicated data warehouse located in London, England. Blocked traffic data is retained one year, and allowed traffic data is retained 45 days. The retention of allowed traffic data can be extended to one year at additional cost.

1.13 Physical Security

A. Cisco CWS uses high-security facilities with biometric access control and authorized access approval. Only a small number of trusted dedicated hands are allowed access and control of hardware and inventory globally.

1.14 Data Security

A. A dedicated data team manages and supports the data associated with our customers. Data is replicated locally and off site in separate data centers for disaster recovery purposes. Any sensitive data such as user passwords or private keys is encrypted both in transfer and storage. Nonsensitive data is not encrypted when it is stored; it is encrypted only during transfer.

1.15 Logical Security

A. The dedicated operations team is sandboxed from corporate networks for administration of the service. The use of best-practice procedures and tools following ITIL® workflows helps ensure highly secure access to systems.

B. Centralized auditing and monitoring solutions are in place to help ensure protection and delivery of the service.

1.16 Network Security

A. Cisco CWS uses Cisco firewall products to protect every point of entry. CWS also uses other

host-based protection measures and auditing tools. Furthermore, Cisco CWS uses multiple upstream providers for network connectivity with DDoS-mitigation tools. Full access and traffic monitoring helps ensure the capture and analysis of all potential attacks.

1.17 Cisco CWS's Stance with Regard to Privacy Shield

A. Cisco CWS (ScanSafe) is a wholly owned subsidiary of Cisco Systems Inc. and is covered by Cisco's Privacy Shield registration.

1.18 Is CWS compliant with the Health Insurance Portability and Accountability Act (HIPAA)?

A. Cisco provides a range of security products that can be used by customers to meet many of the requirements outlined in the HIPAA standards but only if they are properly configured, maintained, and monitored. Deployment of a single product or set of products will not, in and of itself, ensure HIPAA compliance.

B. Additional details on the HIPAA standard and how Cisco security products comply can be found in this blog post.

1.19 Application Security

A. Customer administration is provided through a highly secure web portal. Each administrative account is accessed by a unique username and password. The entire session is encrypted using SSL.

1.20 Anonymizing Users' Personal Details in Web Logs

A. In some locations it is necessary for our customers to protect their users' identity within the reporting logs. A customer can configure this functionality through the web filtering policy. The rule with the action Anonymize can be applied globally or to specific groups of users (LDAP, Active Directory, directory, or custom). When the rule is applied, the following actions occur:

1. User identity is still read by the tower at the time a web request is processed

2. Web filtering policy is applied according to user identity

3. Before the tower forwards the transaction details to the data warehouse in the core data center (in London), the following user identity attributes are stripped out:

a. User is replaced with "Undisclosed"
b. Group is replaced with "Undisclosed"
c. Internal IP is replaced with "0.0.0.0"
d. External IP is replaced with "0.0.0.0"

B. The web filtering policy is still applied normally to anonymized users, but the details of their identity are not retained after the policy has been applied. Reports generated around the transaction details will not contain the specifics of the user's identity. They will be replaced with the details noted above. The anonymization process happens locally at the cloud proxy at the time of processing, and the data sent back to the core data center is already anonymized. Anonymization is compatible with HTTPS inspection.

1.21 User Privacy with HTTPS Traffic

A. When HTTPS traffic is decrypted for inspection, it is possible to select only specific traffic that will be decrypted. The selection can be based on certain categories or a list of domains. Customers can also list specific hosts and domains that should be excluded from HTTPS inspection. Or they can choose to decrypt only the applications covered by the Application Visibility and Control settings.

B. Note also that when HTTPS traffic gets inspected, CWS does not log the **Path** and **Query** attributes of the URL. Only the **Host** will be logged. For example, if a user browses to Google and searches for "cisco cloud web security" and presses Enter, the full URL will be: https://www.google.com/?gws_rd=ssl#q=cisco+cloud+web+security

C. That full URL can be broken down to these three attributes:

1. Host: https://www.google.com

2. Path: ?gws_rd=ssl# (where on the site the user went to)

3. Query: q=cisco+cloud+web+security (what they searched for)

So for privacy reasons CWS will log only the **Host** and not the **Path** or the **Query** for HTTPS traffic that is inspected.

1.22 Cisco CWS's Stance with Regard to the U.S. Patriot Act

A. The U.S. Patriot Act gives certain U.S. law enforcement authorities the power to require U.S. companies and their subsidiaries (which would include all Cisco subsidiaries) to hand over data in their possession. This data would potentially include customer traffic data.

B. Note also that disclosure can be required under the Patriot Act only (1) "to obtain foreign intelligence information not concerning a United States person"; or (2) "to protect against international terrorism or clandestine intelligence activities." It cannot be used to investigate ordinary crimes.

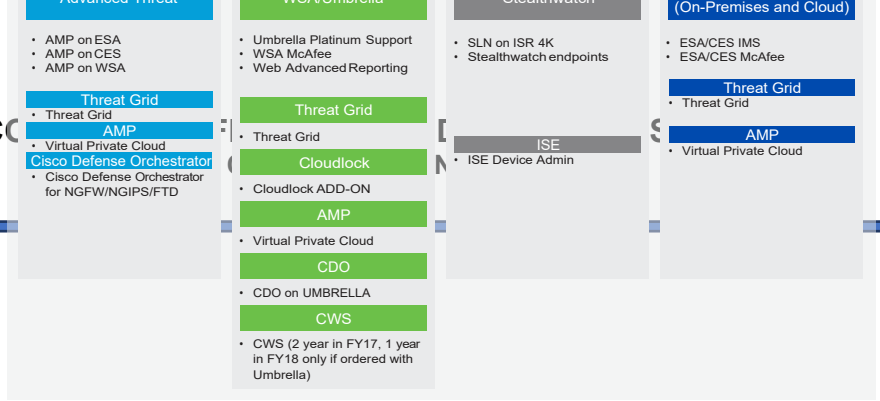
C. Where permitted by law to do so, we will always consult with the customer before releasing any of their data.

1.23 Transparency and Law Enforcement Requests for Customer Data

A. We are committed to publishing information regarding the requests or demands for customer data that we receive from law enforcement and national security agencies around the world. We publish this data twice yearly (covering a reporting period of either January-June or July-December). Like other technology companies, Cisco publishes this data six months after the end of a given reporting period, in compliance with restrictions on the timing of such reports.

1.24 Cisco's Principled Approach

A. CWS follows Cisco's approach to data privacy. We believe that law enforcement and national security agencies should go directly to our business and government customers to obtain information or data regarding those entities, their employees, and their users.



1.25 Cloud Security Enterprise Licensing Overview

A. The Cisco Enterprise Agreement for security enables customers to simply procure and flexibly deploy infrastructure software across their organization. The solution is available in multiple software suites:

1. Email Security Suite
2. Cloud and Web Security Suite
3. Policy and Visibility Suite
4. Security Essentials Suite

1.26 Cisco Enterprise Agreement for Security – Email Security Suite

A. The Cisco Email Security Suite comprises on-premises and cloud email security subscription licenses (Table 1). These include the Premium, Advanced Malware Protection (AMP), Graymail Safe-Unsubscribe (GSU) and Security Management Appliances (SMA) licenses for the Cisco



Email Security Appliance (ESA). It also includes the Premium, AMP, and GSU licenses for Cloud Email Security (CES). This suite also includes Email Intelligent Multi-Scan, McAfee Anti-virus, Cisco AMP Threat Grid and Cisco AMP Virtual Private Cloud that are available as optional add-ons. Additional features may be added over time as part of ongoing innovation.

Suite Name	Product	Feature Description
Email Security Suite	Email Security Appliance	Cisco ESA Premium Software Bundle (AS, AV, OF, DLP, ENC) License
		Cisco ESA Advanced Malware Protection License
		Cisco ESA Graymail Safe-Unsubscribe License
		Cisco SMA Centralized Email Management Reporting License
	Cloud Email Security	Cisco Cloud Email Security Premium License
		Cisco Cloud Email Security AMP Add-on

Suite Name	Product	Feature Description
		Cisco CES Graymail Safe-Unsubscribe License
	AMP Threat Grid	Cisco AMP Threat Grid Daily Submissions License
		Cisco AMP Threat Grid Private Tagging License
		Cisco AMP Threat Grid File Packs
		Cisco AMP Threat Grid Threat Feeds License
	AMP Virtual Private Cloud	Cisco AMP virtual Private Cloud Service Subscription

1.27 Cisco Enterprise Agreement for Security – Cloud and Web Security Suite

A. The Cisco Cloud and Web Security Suite comprises subscription licenses for Cisco Web Security Appliance (WSA), Cisco Umbrella, and Cisco Cloudlock. It also includes optional licenses for Cisco AMP Threat Grid, Cisco AMP Virtual Private Cloud, Cisco Defense Orchestrator for Umbrella, and Cisco Cloud Web Security.

Suite Name	Product	Feature Description
Cloud and Web Security Suite	Web Security Appliance	Cisco Web Premium Software Bundle (WREP, WUC, AMAL) Licenses
		Cisco WSA Advanced Malware Protection License
		Cisco SMA Centralized Web Management Reporting License
		Cisco Web Anti-Virus McAfee License Key
		Cisco Web Security Advanced Reporting License
	Umbrella	Cisco Umbrella Insights + Gold Support
		Cisco Umbrella Platform + Gold Support
		Cisco Umbrella Platinum Support
	Cloudlock	Cisco Cloudlock 1-7 Apps License for Commercial Customers
		Cisco Cloudlock 1-7 Apps License for Federal Customers
		Cisco Cloudlock Add-ons for Commercial Customers
		Cisco Cloudlock Add-ons for Federal Customers
Cloud and Web Security Suite	Threat Grid	Cisco AMP Threat Grid Daily Submissions License
		Cisco AMP Threat Grid Private Tagging License
		Cisco AMP Threat Grid File Packs
		Cisco AMP Threat Grid Threat Feeds License
	AMP Virtual Private Cloud	Cisco AMP virtual Private Cloud Service Subscription
	Defense Orchestrator for Umbrella	Cisco Defense Orchestrator for Umbrella
	Cloud Web Security	Cisco Cloud Web Security Premium Bundle (Base, CTA, AMP)

1.28 Cisco Enterprise Agreement for Security – Policy and Visibility Suite

A. The Cisco Policy and Visibility Suite comprises subscription licenses for Cisco Stealthwatch™ (WSA) and Cisco Identity Services Engine (ISE). (See Table 3.)

B. New features may be added over time as part of ongoing innovation.

Suite Name	Product	Feature Description
Policy and Visibility Suite	Cisco Stealthwatch	Cisco Stealthwatch Flow Rate License

		Cisco Stealthwatch Cloud License
		Cisco Stealthwatch Endpoint License
		Cisco Stealthwatch Learning Network License
Policy and Visibility Suite	Identity Services Engine (ISE)	Cisco Identity Services Engine Base License
		Cisco Identity Services Engine Plus License
		Cisco Identity Services Engine Apex License
		Cisco ISE Device Administration License

1.29 Cisco Enterprise Agreement for Security – Security Essentials Suite

A. The Cisco Security Essentials Suite comprises IPS, Apps, AMP and URL subscription licenses for Cisco Next-Generation Firewall (NGFW), Cisco Next-Generation Intrusion Prevention Systems (NGIPS), Cisco Integrated Services Routers (ISR), Cisco AMP for Endpoints, Cisco AnyConnect, Cisco AMP on ESA, Cisco AMP on CES, Cisco AMP on WSA, Cisco AMP Threat Grid, Cisco AMP Virtual Private Cloud, and Cisco Defense Orchestrator. (See Table 4.)

Suite Name	Product	Feature Description
Security Essentials Suite	FirePOWER Services for NGFW	Cisco NGIPSv IPS, Apps, AMP and URL Services License for Next-Generation Firewall devices
	FirePOWER Services for NGIPS	Cisco NGIPSv IPS, Apps, AMP and URL Services License for Next-Generation IPS devices
	FirePOWER Services for ISR	Cisco NGIPSv IPS, Apps, AMP and URL Services License for Integrated Services Routers
	Cisco AnyConnect	Cisco AnyConnect Apex License
	AMP for Endpoints	Cisco Advanced Malware Protection Service for Endpoints License
Security Essentials Suite	Threat Grid	Cisco AMP Threat Grid Daily Submissions License
		Cisco AMP Threat Grid Private Tagging License
		Cisco AMP Threat Grid File Packs
		Cisco AMP Threat Grid Threat Feeds License
	AMP for ESA	Cisco ESA Advanced Malware Protection License
	AMP for WSA	Cisco WSA Advanced Malware Protection License
	AMP for CES	Cisco CES Advanced Malware Protection License
	AMP Virtual Private Cloud	Cisco AMP virtual Private Cloud Service Subscription
	Cisco Defense Orchestrator	Cisco Defense Orchestrator for Next-Generation Firewall and Next-Generation IPS

1.30 Quoting Process

A. The quoting and ordering process will be done in close collaboration with your Cisco account team.

B. The following information needs to be provided by Cisco Sales for the quoting process through the Cisco EA Legal Tool:

1. Define the Enterprise Boundaries – Names of customer and customer entities that will use the suite software and subscriptions. (Customer entities must have at least 50 percent

ownership by customer and roll up into customer's consolidated financial statement.)

2. Outline Deployment Strategy – Which Cisco Enterprise Agreement suites for security Suite (s) the customer will purchase; expected number of years to deploy/duration of Cisco Enterprise Agreement term (3 or 5 years); and the expected Cisco EA migration or start date.

3. Choose Cisco Enterprise Agreement suites for security – Need to understand which Cisco Enterprise Agreement suites for security will be part of this agreement.

4. Calculate Software Penetration – While the Cisco EA supports full enterprise coverage, not all software suite or suite elements are mandated. The following represents the minimum requirements to price-quote a Cisco Enterprise Agreement for security:

   a. Email Security – 100% of the user population must be covered.
   b. Cloud and Web Security – 100% of the user population must be covered.
   c. Policy and Visibility – 100% of the ISE endpoints must be covered. 100% of the Stealthwatch flows must be covered.
   d. Security Essentials – 100% of the network appliances must be covered. 100% of the endpoints and 100% of the user population need to be covered.
   e. For product specific minimum ordering thresholds, please reference the Cisco Enterprise Agreement for security ordering rules.

5. Gather Enterprise Device Counts – Accurate device count is the basis of ELA pricing. For the chosen suites, device counts will need to be provided in the Cisco EA Legal Tool. If obtaining device count proves to be a challenge, Cisco can query available records to provide a device count profile for review.

6. Obtain BU approval of the End User Information Form from the Cisco EA Legal Tool – The Cisco account team and the Cisco EA Licensing Executive/BDM should work with the customer and/or partner to enter the Cisco EA parameters above (Customer, Legal affiliates, term, suite(s) selected, device counts, etc.) into the Cisco EA Legal Tool.

7. Bill of Materials (BOM) and Deal Support Automation (DSA) submission process – The final price quote will be converted into a Cisco EA-compliant BOM by CPS. No BOMs will be created for a Cisco EA opportunity that has not been approved in the Cisco EA.

8. No BOMs may be shared externally (e.g., with partners or customers) without DSA approval and a BU-approved BOM.

9. The Cisco account team will provide the customer and/or partner with the appropriate BOM to be ordered through Cisco Commerce per the above step.

1.31 Ordering Process

A. In order to have a valid order, the partner must have an approved My Deal Manager (MDM) request to purchase Cisco EA. This MDM approval number must be referenced in the order placed to Cisco. In addition, the partner (if indirect) or customer (if direct) must provide Cisco with a completed and signed End User Information Form(s) prior to placing an Cisco EA order.

B. The ELA suite part numbers and quantities must be placed through Cisco Commerce (CCW) using the standard Cisco ordering process. The Customer Partner Services (CPS) team is responsible for constructing the BOM. If Adoption Services or Advanced Services SKUs are

required, they must be quoted through the Advanced Services Pricing Tools (ASPT) and ordered through the Cisco Service Contract Center.

1.32 Additional Resources

A. For further assistance, please contact your Cisco account team manager or send an email to the Software Operations Help Desk:

1. Americas: sw-ops-helpdesk-americas@cisco.com
2. Europe, Middle East, Africa, and Russia: sw-ops-helpdesk-emear@ cisco.com
3. Asia Pacific: sw-ops-helpdesk-apac@cisco.com

END OF SECTION

SECTION 28 31 00
FIRE ALARM SYSTEM

PART 1 - SUMMARY

1.01 GENERAL

A. Fire alarm system shall consist of one fire alarm control panel or networked nodes, of the same make and CSFM (California State Fire Marshall) listed for the application as indicated in drawings.

B. All labor, equipment, materials, connections, testing, and performance of operations in the installation of fire alarm system as indicated on Design Drawings or as specified herein.

1.02 SYSTEM REQUIREMENTS:

A. Fire detection system shall continually supervise and monitor the following initiating, signaling, and monitoring circuits:

1. Manual fire-pull stations.
2. Smoke and heat detectors, duct detectors, including those installed under other sections.
3. Fire sprinkler flow and tamper switches. In existing installations also include PIV tamper switches.
4. Alarm signaling circuits including alarm bells, horns and visual alarm units.
5. Annunciators.
6. Power supplies and batteries.
7. Interconnection with Central and Autonomous Public Address systems, telephone network system, Clock System-Classroom/Program schedule change, HVAC system where applicable, kitchen fire suppression system, Theatrical Lighting, and elevator equipment for control of recall function and elevator circuit breaker shunt trip to control power.

B. System controls shall be UL listed for power limited applications in accordance with California Electrical Code.

C. The fire alarm devices and equipment shall be listed for installation for the fire alarm control panel to which they are being connected.

D. Complete installation shall conform to the version of NFPA 72, California Fire Code, California Building Code (CBC), and California Electrical Code (CEC) as approved by DSA on stamped drawings.

E. System labels and devices programming addresses shall be based on final signage and building labeling submittals. For existing facilities contractor shall obtain from Owner Authorized Representative a copy of the current site layout and building labeling designations.

1.03 CERTIFICATION

A. Certification: Installation of fire alarm system shall not begin until Shop Drawings, including State Fire Marshal listing numbers of fire alarm components, are submitted and reviewed by the Architect. Written certification by fire alarm equipment distributor or manufacturer shall be submitted to the Architect stating that system and its component parts are as approved and listed by the State Fire Marshal, and that the design conforms to requirements set forth in CBC and CFC.

1.04 PERFORMANCE

A. System shall be fully programmable, configurable, and expandable in the field without special tools or PROM programmers and shall not require replacement of memory ICs. Installer shall

provide a CD of all system installed software, site specific system programming and all information and tools required to re-program or modify the system.

1.05 SYSTEM DESCRIPTION

A. A new intelligent reporting, Style 7 networked, fully peer-to-peer, microprocessor-controlled fire detection and emergency voice alarm communication system shall be installed in accordance with the specifications and as indicated on the Drawings.

B. Each Signaling Line Circuit (SLC) and Notification Appliance Circuit (NAC): Limited to only 80 percent of its total capacity during initial installation.

C. Basic Performance:

1. Network Communications Circuit (NetSOLO) Serving Network Nodes: Wired using single twisted non-shielded 2-conductor cable or connected using approved fiber optic cable between nodes in Class A configuration.

2. Signaling Line Circuits (SLC) Serving Addressable Devices: Wired Class B.

3. Initiation Device Circuits (IDC) Serving Non-addressable Devices Connected to Addressable Monitor Modules: Wired Class B.

4. Notification Appliance Circuits (NAC) Serving Strobes, and Speakers: Wired Class A.

5. On Class A Configurations: Single ground fault or open circuit on Signaling Line Circuit shall not cause system malfunction, loss of operating power, or ability to report an alarm.

6. Alarm Signals Arriving at INCC COMMAND CENTER: Not be lost following primary power failure until alarm signal is processed and recorded.

7. Transponders:

a. Operate in peer-to-peer fashion with other panels and transponders in system.
b. Each transponder shall store copy of audio evacuation messages and tones.
c. Systems that use centralized message storage and control at main fire alarm control panel shall not be acceptable.

8. Network Node Communications, Audio Evacuation Channels and Fire Phone Communications:

a. Communicated between panels and transponders on single twisted pair of copper wires or fiber optic cables.
b. To enhance system survivability, ability to operate on loss of INCC Command Center, short or open of entire riser at INCC Command Center shall be demonstrated at time of system acceptance testing.
c. Systems that are not capable of providing true Class A performance for fire fighter's phone communications shall not be acceptable.

9. Signaling Line Circuits (SLC):

a. Reside in remote transponders with associated audio zones.
b. SLC modules shall operate in peer-to-peer fashion with all other panels and transponders in system.
c. On loss of INCC Command Center, each transponder shall continue to communicate with remainder of system, including all SLC functions and audio messages located in all transponders.
d. Systems that provide a "Degraded" mode of operation upon loss of INCC Command Center or short in riser shall not be acceptable.

10. Audio Amplifiers and Tone-Generating Equipment: Electrically supervised for normal and abnormal conditions.

11. Amplifiers: Located in transponder cabinets serving no more that 3 floors per transponder to enhance system survivability, reduce required riser wiring, simplify installation, and reduce power losses in length of speaker circuits.
12. Speaker NAC Circuits: Arranged such that there is a minimum of 1 speaker circuit per fire alarm zone.
13. Notification Appliance Circuits (NAC), Speaker Circuits, and Control Equipment: Arranged such that loss of any 1 speaker circuit will not cause loss of any other speaker circuit in system.
14. Speaker Circuits:
    a. Electrically supervised for open and short circuit conditions.
    b. If short circuit exists on speaker circuit, it shall not be possible to activate that circuit.
    c. Arranged for 25 or 70 VRMS and shall be power limited in accordance with NEC
    d. 20 percent spare capacity for future expansion or increased power output requirements.
15. Speaker Circuits and Control Equipment:
    a. Arranged such that loss of any 1 speaker circuit will not cause loss of any other speaker circuit in system.
    b. Systems utilizing “bulk” audio configurations shall not be acceptable.
16. 2-Way Telephone Communication Circuits:
    a. Shall communicate digitally over the network between transponders.
    b. Supervised for open and short circuit conditions.
    c. Short circuit condition on 2-way telephone communications circuit shall result in trouble condition and not result in call-in condition.
17. Voice Communication:
    a. Connect telephone circuits to speaker circuits to allow voice communication over speaker circuit from telephone handset.
    b. Capable of remote phone-to-phone conversations and party-line communications as required.

D. Basic System Functional Operation: When fire alarm condition is detected and reported by 1 of the system alarm initiating devices, the following functions shall immediately occur:
    1. System Alarm LEDs: Flash.
    2. Local Piezo-Electric Signal in Control Panel: Sound at a pulse rate.
    3. 80-Character LCD Display: Indicate all information associated with fire alarm condition, including type of alarm point and its location within protected premises.
    4. Historical Log: Record information associated with fire alarm control panel condition, along with time and date of occurrence. History Log shall have capacity for recording up to 4,100 events.
    5. System output programs assigned via control-by-event equations to be activated by particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.
        a. Close Fire Doors
        b. Shot down air handlers as required by code
        c. Notify the Central Station or Municipal Tie.
    6. Strobes flash synchronized continuously.

7. Audio Portion of System: Sound alert tone followed by pre-recorded message determined by event and this scenario repeating or other message as approved by local authority until system is reset.

E. Fire Alarm System Functionality:

1. Provide complete, electrically supervised distributed, Class A networked analog/addressable fire alarm and control system, with analog initiating devices, integral multiple-channel voice evacuation, and fire fighter's phone system.

2. Fire Alarm System:

   a. Consist of multiple-voice channels with no additional hardware required for total of 4 channels.
   b. Incorporate multiprocessor-based control panels, including model E3 Series modules includes Intelligent Network INCC Command Center(s) (INCC), Intelligent Loop Interface (ILI-MB-E3 or ILI95-MB-E3), Intelligent Network Transponders (INX), communicating over peer-to-peer token ring network with standard capacity of up to 64 nodes expandable to 122.

3. Each ILI-MB-E3 or ILI95-MB-E3 Node: Incorporate 2 Signaling Line Circuits (SLC), with capacity to support in Velociti ® mode up to 159 analog addressable detectors and 159 addressable modules per ILI-MB-E3 SLC or support in Apollo mode up to 126 detectors and modules per ILI95-MB-E3 SLC.

4. Voice, Data, and Fire Fighter's Phone Riser: Transmit over single pair of wires or fiber optic cable.

5. Each Intelligent Network Transponder: Capable of providing 16 distributed voice messages, fire fighter phones connections, SLC loop for audio control devices, and integral network interface.

6. Each Network Node: Incorporate Boolean control-by-event programming, including as a minimum AND, OR, NOT, and Timer functions.

7. Control Panels: Capability to accept firmware upgrades via connection with laptop computer, without requirement of replacing microchips.

8. Network:

   a. Based on peer-to-peer token ring technology operating at 625 K baud, using Class A configuration.
   b. Capability of using twisted-pair wiring, pair of fiber optic Multi-mode cable strands up to 200 microns or Single-mode optimized for 9/125 microns, or any combination, to maximize flexibility in system configuration.

9. Each Network Node:

   a. Capability of being programmed off-line using Windows-based software supplied by fire alarm system manufacturer. Capability of being downloaded by connecting laptop computer into any other node in system. Systems that require system software to be downloaded to each transponder at each transponder location shall not be acceptable.
   b. Capability of being grouped with any number of additional nodes to produce a "Region", allowing that group of nodes to act as 1, while retaining peer-to-peer functionality. Systems utilizing "Master/Slave" configurations shall not be acceptable.
   c. Capability of annunciating all events within its "Region" or annunciating all events from entire network, on front panel LCD or touchscreen display without additional equipment.

10. Each SLC Network Node: Capability of having integral DACT (Digital Alarm Communicator Transmitter) that can report events in either its region, or entire network to single central

station monitoring account.

11. Each Control Panel: Capability of storing its entire program and allow installer to activate only devices that are installed during construction, without further downloading of system.
12. Password Protection: Each system shall be provided with 4 levels of password protection with up to 16 passwords.
13. Have the capacity for multiple pre-recorded messages (at least sixteen (16), but more if required by local AHJ) and address a list of subjects.
    a. Fire evacuation and relocation
    b. Intruder or hostile person sighted within or around the building grounds
    c. Directions to occupants to take cover within building
    d. Emergency weather conditions appropriate for local area
    e. All Clear

1.06 QUALITY ASSURANCE

A. Codes and Standards:
   1. NFPA: System shall comply with the following NFPA codes and standards:
      a. NFPA 12.
      b. NFPA 13.
      c. NFPA 15.
      d. NFPA 16.
      e. NFPA 16A.
      f. NFPA 17
      g. NFPA 17A
      h. NFPA 70.
      i. NFPA 72.
      j. NFPA 2001
      k. NFPA 90A.
      l. NFPA 101.
      m. NFPA 750.
      n. NFPA 5000.
   2. ADA: System shall conform to American with Disabilities Act (ADA).

B. To ensure reliability and complete compatibility, all items of fire alarm system, including control panels, power supplies, initiating devices, and notification appliances, shall be listed by Underwriters Laboratories Inc. (UL) and shall bear “UL” label.

C. Fire Alarm Control Panel Equipment: UL-listed under UL 864 Ninth Edition and UL 2572.

D. Equipment, Programming, and Installation Supervision:
   1. Provide services of approved Platinum Level engineered systems distributor of Gamewell-FCI for equipment, programming, and installation supervision.
   2. Provide proof of factory training within 14 calendar days of award of the Contract.

E. Software Modifications:
   1. Provide services of Platinum Level Gamewell-FCI factory-trained and authorized technician to perform system software modifications, upgrades, or changes.
   2. Provide use of all hardware, software, programming tools, and documentation necessary to modify fire alarm system software on-site.
   3. Modification includes addition and deletion of devices, circuits, zones, and changes to system operation and custom label changes for devices or zones.

4. System structure and software shall place no limit on type or extent of software modifications on-site.
5. Modification of software shall not require power-down of system or loss of system fire protection while modifications are being made.

1.07 COORDINATION

A. Coordinate the Work of this section with the Work of other sections, including existing sprinkler systems as HVAC systems as applicable.

1.08 WARRANTY

A. Warranty Period for System Equipment: 3 year from date of final acceptance.

PART 2 - PRODUCTS

2.01 MANUFACTURER

A. Gamewell-FCI, Honeywell Fire Systems, 12 Clintonville Road, Northford, Connecticut 06472. Phone (203) 484-7161. Fax (203) 484-7118. Website: www.gamewell-fci.com. District Standard – No substitutions permitted.

B. References to manufacturer's model numbers and other information is intended to establish minimum standards of performance, function, and quality. Equivalent equipment from Gamewell may be substituted for the specified equipment, as long as minimum standards are met. No other manufacturers, other than Gamewell-FCI, FCI, and Gamewell will be considered for use on this project.

2.02 DISTRIBUTED NETWORKED FIRE ALARM SYSTEM

A. Distributed Networked Fire Alarm System: Gamewell-FCI E3 Series Expandable Emergency Evacuation Fire Alarm System.

2.03 SYSTEM DESCRIPTION

A. Source Limitations for Fire-Alarm System and Components: Components shall be compatible with and operate as an extension of existing Campus Wide system. Provide system manufacturer's certification that all components provided have been tested as, and will operate as, a system.

B. Non-coded, UL-certified addressable system, with multiplexed signal transmission and horn/strobe evacuation.

C. Automatic sensitivity control of certain smoke detectors.

D. All components provided shall be listed for use with the selected system.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.04 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:

1. Manual stations.
2. Heat detectors.
3. Smoke detectors.
4. Duct smoke detectors.
5. Automatic sprinkler system water flow.
6. Fire standpipe system.

B. Fire-alarm signal shall initiate the following actions:

1. Continuously operate alarm notification appliances.
2. Identify alarm and specific initiating device at fire-alarm control unit and remote annunciators.
3. Transmit an alarm signal to the remote alarm receiving station at Campus Dispatch Fire Works Station.
4. Unlock electric door locks in designated egress paths.
5. Release fire and smoke doors held open by magnetic door holders.
6. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
7. Close smoke dampers in air ducts of designated air-conditioning duct systems.
8. Recall elevators to primary or alternate recall floors.
9. Activate elevator power shunt trip.
10. Activate emergency shutoffs for gas and fuel supplies.
11. Record events in the system memory.
12. Supervisory signal initiation shall be by one or more of the following devices and actions:

    a. Valve supervisory switch.
    b. Elevator shunt-trip supervision.
    c. Loss of communication with any panel on the network.

C. Mass Notification (MNEC) Activation: Operation shall be initiated only from the CCS or respective building ACU/FACP or Local Operations Console (LOC). No automatic operation shall be permitted.

1. Any operation of MNEC at the building ACU/FACP or LOC shall be indicated at the CCS.
2. Any operation of the MNEC from the CCS shall indicate at the ACU/FACP & LOC (if provided) that the respective building system is in MNEC mode.
3. Provide all indicators required by UL 2572 and AHJ.
4. Signal priority shall be in accordance with NFPA72 & UL 2572 as indicated below:

    a. Special suppression (CO2, Halon, FM200, Intergen or similar total flooding gaseous suppression system)
    b. Mass Notification
    c. Life Safety/Fire Alarm
    d. Other

5. The system shall be capable of live voice page from the CCS to each respective building. Live voice paging inside the respective building shall also be capable of being initiated from the ACU/FACP or LOC if provided.
6. Pre-recorded messages shall be selectable at the CCS and respective building ACU/FACP or LOC and shall consist of a minimum of the following:

    a. Lockdown
    b. Earthquake
    c. All Clear
    d. Evacuation
    e. Stand by
    f. Chemical emergency
    g. Test

D. System trouble signal initiation shall be by one or more of the following devices and actions:
   1. Open circuits, shorts, and grounds in designated circuits.
   2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
   3. Loss of communication with any addressable sensor, input module, relay, control module, or remote annunciator.
   4. Loss of primary power at fire-alarm control unit.
   5. Ground or a single break in internal circuits of fire-alarm control unit.
   6. Abnormal ac voltage at fire-alarm control unit.
   7. Break in standby battery circuitry.
   8. Failure of battery charging.
   9. Abnormal position of any switch at fire-alarm control unit or annunciator.

E. System Supervisory Signal Actions:
   1. Initiate notification appliances.
   2. Identify specific device initiating the event at fire-alarm control unit and remote annunciators.
   3. After a time delay of 200 seconds, transmit a trouble or supervisory signal to the remote alarm receiving station at campus Dispatch.

F. Elevator Recall:
   1. Elevator recall shall be initiated only by one of the following alarm-initiating devices:
   2. Elevator lobby detectors except the lobby detector on the designated floor.
   3. Smoke detector in elevator machine room.
   4. Smoke detectors in elevator hoist way if the hoist way is sprinklered.
   5. Elevator controller shall be programmed to move the cars to the alternate recall floor if lobby detectors located on the designated recall floors are activated.
   6. Water-flow alarm connected to sprinkler in an elevator shaft and elevator machine room shall shut down elevators associated with the location without time delay.
   7. Water-flow switch associated with the sprinkler in the elevator pit may have a delay to allow elevators to move to the designated floor.

2.05 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Fire-alarm control unit and raceways shall withstand the effects of earthquake motions determined according to ASCE/SEI 7

B. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.06 INTELLIGENT NETWORK INCC COMMAND CENTER HARDWARE

A. Intelligent Network INCC Command Center (INCC): Supply user interface, including touchscreen 1/4 VGA display, Intelligent Loop Interface Modules (ILI-MB-E3/ILI95-MB-E3), manual switching, phone, and microphone inputs to the network. INCC shall consist of the following units and components:

1. System Cabinet - Size Cabinets with associated inner door.
2. Power Supply Module (PM-9) with batteries.
3. Intelligent Network Interface Voice Gateway (INI-VG).
4. IPGSM – 46 Commercial Fire Communicator
5. Intelligent Loop Main Board Interface (ILI-MB-E3 or ILI95-MB-E3).
6. Optional Intelligent Loop Supplemental Interface (ILI-S-E3 or ILI95-S-E3).
7. Optional ARCNET Repeater (RPT-E3) with fiber-optic modules (FSL-E3 or FML-E3).
8. 1/4 VGA touch-screen display (NGA-6).
9. Optional Auxiliary Switch Module (ASM-16).
10. Optional LED Driver Module (ANU-48)
11. Microphone Assembly (INCC-MIC).
12. Optional Telephone Assembly (INCC-TEL).
13. Optional AM-50 Series amplifiers (AM-50, AM-50-70).
14. Optional Addressable Node Expander (ANX-SR, ANX-MR-FO, ANX-MR-UTP).

B. System Cabinet:

1. Surface or semi-flush mounted with texture finish.
2. Consist of back box, inner door, and door.
3. Available in at least 3 sizes to best fit project configuration.
4. Houses 1 or more PM-9 Power Supply Modules, INI-VG Intelligent Network Interface Voice Gateway, 1 or more ILI-MB-E3/ILI95-MB-E3 assemblies, and other optional modules as specified.
5. Construction: Dead-front steel construction with inner door to conceal internal circuitry and wiring.
6. Wiring Gutter Space: A minimum of 1-inch wiring gutter space behind mounting plate.
7. Wiring: Terminated on removable terminal blocks to allow field servicing of modules without disrupting system wiring.

C. Power Supply Module (PM-9): Use latest technologies to provide system power, incorporates the following features:

1. Power-saving switching technology using no step-down transformers.
2. 9-amp continuous-rated output to supply up to all power necessary under normal and emergency conditions for INCC Command Center Modules.
3. Integral battery charger with capacity to charge up to 55 amp-hour batteries while under full load.

D. Batteries:

1. Sufficient capacity to provide power for entire system upon loss of normal AC power for a period of 24 hours with 15 minutes of alarm signaling at end of this 24-hour period, as required by NFPA 72, Local Systems.

E. Intelligent Network Interface Voice Gateway INCC Command Center (INI-VG): INI-VG shall be a multi-function board interchangeable in both INCC and INX. Functions of board shall have the following features as a minimum:

1. Microprocessor shall monitor all system events and perform all system programs, for all control-by-event (CBE) functions. System program shall not be lost upon failure of both primary and secondary power. Programming shall supporting Boolean logic including AND, OR, NOT, TIMING functions for maximum flexibility.
2. Network Interface: Operate at 625 K baud configurable with any combination of wire and/or fiber topologies. Interface shall communicate with up to122 nodes in peer-to-peer fashion.
3. Fire Fighter Phone Riser (if applicable and shown on drawings): INI-VG shall generate local phone riser for use with AOM-TEL phone modules for connection to fire fighter phone stations and/or for connection of local phone when used as INCC Command Center, including phone circuits. INI-VG shall mix its local phone riser to network in true Class A fashion. Systems not capable of true Class A communications for fire fighter's phone risers shall not be acceptable.
4. Advanced Processing: INI-VG shall incorporate latest in digital signaling processing technology with supporting Boolean logic including AND, OR, NOT, TIMING, COUNT, SCHEDULE functions.
5. Microphone Input: On-board and allow for addition of local microphone when used as INCC Command Center, including speaker circuit control.
6. Signal Processing: INCC shall use advanced Digital Signal Processing (DSP) technology to allow maximum flexibility of digital audio and control capabilities and operation. Signals to and from INCC shall be transmitted over single pair of twisted unshielded wire or fiber optic pair.
7. Field Programmable: INCC shall be capable of being fully programmed or modified by Field Configuration Program (FCP), to be downloaded via portable computer from any node in system.
8. Control-by-Event Programming (CBE): INCC shall be capable of programming using Boolean logic including AND, OR, NOT, COUNT, TIMING, and SCHEDULE functions to provide complete programming flexibility.
9. Remote INCC Command Center Options: System shall have capability of adding remote INCC Command Centers or re-locating INCC Command Centers utilizing only single pair of twisted unshielded wire or fiber optic pair for all functions.
10. RS-485 Serial Output: System shall incorporate RS-485 bus via ribbon harness for connection of modules inside same cabinet, and via 4-wire quick connector for connection of modules up to 3,000 feet from cabinet.
11. Riser Wiring: All data, voice, and fire fighter phone riser shall transmit over single pair of twisted unshielded wire or fiber optic pair for all functions configured in Class A format. Any short or open in data, voice, or phone sections shall not affect transmission over remainder of network.
12. Class A Network: All communication between control panels and transponders shall be through supervised Style 7 token passing network. In event of single short, open, or ground, all system communication shall operate as normal and report fault. This protection shall incorporate all data, voice, and fire fighter phone transmissions. Upon single short, open, or ground of either system data, live voice, pre-recorded channels, or phone risers, the function of each of these items shall continue to operate. "Degrade" functionality shall not be acceptable. This shall be demonstrated at system acceptance.

F. Network Graphic Annunciator (NGA-6): Networkable, 1/4 VGA, touch-screen annunciator with the following characteristics and mounted in the FACP enclosure:

1. Custom Graphics: Panel shall permit uploading of custom bit-mapped graphic to display

screen. Graphic shall display when all systems are normal.

2. Intuitive Functions: In alarm or trouble condition, annunciator shall display only information pertaining to event, including control switches.

   a. Trouble Condition: Display shall indicate cause of trouble. Only controls available to operator shall be Acknowledge and Reset functions.
   b. Alarm Condition: Display shall indicate cause of alarm. Only controls available to operator shall be Acknowledge, Silence, and Reset functions.
   c. Operating Voltage: 24 VDC from the PM-9/PM-9G power supply.
   d. AGENCY LISTINGS AND APPROVALS:

      1) UL Listed: S1869, S1949,2572forMassNotification
      2) FM Approved: 3017416
      3) CSFM: 7165-1703:0125

G. Intelligent Loop Interface (ILI-MB-E3/ILI95-MB-E3): System shall be of multiprocessor design to allow maximum flexibility of capabilities and operation. Intelligent Loop Interface shall be capable of mounting in stand-alone enclosure or integrated with Intelligent Network INCC Command Center (INCC) as specified.

1. Field Programmable: System shall be capable of being programmed by Field Configuration Program (FCP), allowing programming to be downloaded via portable computer from any node on network.

2. RS-232C Serial Output: Supervised RS-232C serial port shall be provided to operate remote printers and/or video terminals, accept downloaded program from portable computer, or provide 80-column readout of all alarms, troubles, location descriptions, time, and date. Communication shall be standard ASCII code operating from 1,200 to 115,200 baud rate.

3. RS-485 Serial Output: Each ILI-MB-E3/ILI95-MB-E3 shall incorporate RS-485 bus via ribbon harness for connection of modules inside same cabinet, and via 4-wire quick connector for connection of modules up to 3,000 feet from cabinet. RS-485 bus shall support up to 16 ASM-16 auxiliary switch modules, 6 LCD-E3 main annunciators, and 5 LCD-7100 annunciators.

4. Peer-to-Peer Panel Configuration: All Loop Interface Modules shall incorporate own programming, log functions, Central Processor Unit, and control-by-event (CBE) programming. If any loop becomes disabled, each remaining loop driver shall continue to communicate with remainder of network and maintain normal operation. “Degrade” configurations under these conditions shall not be acceptable.

5. Control-by-Event (CBE) Program: ILI-MB-E3/ILI95-MB-E3 shall be capable of programming using Boolean logic including AND, OR, NOT, TIMING, COUNT, SCHEDULE functions to provide complete programming flexibility.

6. Alarm Verification: Smoke detector alarm verification shall be standard option while allowing other devices such as manual stations and sprinkler flow to create immediate alarm. This feature shall be selectable for smoke sensors that are installed in environments prone to nuisance or unwanted alarms.

7. Alarm Signals: All alarm signals shall be automatically latched or “locked in” at control panel until operated device is returned to normal and control panel is manually reset. When used for sprinkler flow, “SIGNAL SILENCE” switch may be bypassed, if required by AHJ.

8. Electrically Supervised:

   a. Each SLC and NAC circuit shall be electrically supervised for opens, shorts, and ground faults. Occurrence of fault shall activate system trouble circuitry but shall not

interfere with proper operation of other circuits.

b. Yellow “SYSTEM TROUBLE” LEDs shall light and system audible sounder shall steadily sound when trouble is detected in system. Failure of power, open or short circuits on SLC or NAC circuits, disarrangement in system wiring, failure of microprocessor or any identification module, or system ground faults shall activate this trouble circuit. Trouble signal shall be acknowledged by operating “TROUBLE ACKNOWLEDGE” switch. This shall silence sounder. If subsequent trouble conditions occur, trouble circuitry shall resound. During alarm, all trouble signals shall be suppressed with exception of lighting yellow “SYSTEM TROUBLE” LEDs.

9. Drift Compensation – Analog Smoke Sensors: System software shall automatically adjust each analog smoke sensor approximately once each week for changes in sensitivity due to effects of component aging or environment, including dust. Each sensor shall maintain its actual sensitivity under adverse conditions to respond to alarm conditions while ignoring factors which generally contribute to nuisance alarms. System trouble circuitry shall activate, display “DIRTY DETECTOR” and “VERY DIRTY DETECTOR” indications and identify individual unit that requires maintenance.

10. Analog Smoke Sensor Test: System software shall automatically test each analog smoke sensor a minimum of 3 times daily. Test shall be recognized functional test of each photocell (analog photoelectric sensors) and ionization chamber (analog ionization sensors) as required annually by NFPA 72. Failure of sensor shall activate system trouble circuitry, display “Test Failed” indication, and identify individual device that failed.

11. Central Station/Off – Premises Connection:

    a. Connect via Digital Alarm Communicator Transmitter (DACT) furnished with FACP with IPGSM – 4G – IP. The IPGSM-4G is a 4G Fire Alarm Communicator that offers Contact ID reporting that operates in conjunction with Fire Alarm Control Panel (FACP) that has a built-in dialer. IPGSM -4G is a dual path communicator connects directly to the primary and secondary communication ports of a Fire Panel's Digital Alarm Communicator Transmitter (DACT). Internet and GSM Dual Path Communicator, which offers Contact ID reporting that operates in conjunction with E3 series FACP to central station or remote station monitoring.

    b. In the event of an off-normal condition, the fire panel sends the Contact ID formatted information to the IPGSM-4G Communicator Panel. The IPGSM-4G then reformats the data into highly, encrypted Ethernet packets that are used for transmission to the Alarm-Net Receiver, via the customer-provided Internet/Intranet connection or to the Global System for the Mobile Communications (GSM) network.

    c. UL® Compliance

        1) To comply with UL Standard 864/NFPA, ensure the following installation requirements are met:

            i) IPGSM-4G must be installed in accordance with NFPA (National Fire Protection Association) Standards 70 and 72
            ii) IPGSM-4G must be mounted in the same room and within 20 feet of the fire panel.
            iii) IPGSM-4G, and all equipment used for the IP connection (such as: the router, hub, modem, etc.) must comply with the following:
                - Listed
                - Powered from an un-switched branch circuit
                - Provided with the appropriate standby power
            iv) IPGSM-4G must use the 7A/H battery (not supplied) to provide 24-hour backup capability.

    d. Programming

The IPGSM-4G Communicator can be pre- programmed using the 7720PProgrammer that allows you to enter all central-station information. This program is saved to the IPGSM-4G Communicator panel memory. When the IPGSM-4G Communicator is installed at the site and it is connected to the Internet/ Intranet, it registers itself with the Alarm Net Receiver.
For most installations, the only required parameters are:

1) Primary City ID (two digits) obtained from your monitoring station
2) Primary Central Station ID (two digits) obtained from your monitoring station
3) Primary Subscriber ID (four digits) obtained from your monitoring station
4) Communication Module's MAC ID, and MAC CRC number located on the outside of the box, and the inside of the module

Note: All parameters are assigned by the monitoring station.

e. Components:
f. IPGSM-4G: Internet and GSM Cellular Communicator shall include the following:

1) Red cabinet with key
2) Wall outlet box
3) Dialer Capture Module
4) GSM Communications Module Antenna and mounting adapter Power Boost Power Supply
5) 7626-50HC: Antenna Cable IPGSM-4G 50 FT Coax
6) 7626-25HC: Antenna Cable IPGSM-4G 25 FT Coax GSM-ANT3DB: 3 dB External/Remote Weatherproof Antenna
7) 7720P: Handheld Programmer, IPGSM-4G
8) HPTCOVER: Plug-in transformer box
9) BAT-1270: Battery 12 Volts, 7 A/H Sealed

12. Network Annunciator Option: Each ILI-MB-E3 or ILI95-MB-E3 and associated display shall provide option of being configured as network annunciator. Options for annunciation shall default as regional annunciator with capability of selecting global annunciation to provide system-wide protection and Acknowledge, Silence, and Reset capabilities.

13. Redundant History Log: Each ILI-MB-E3 or ILI95-MB-E3 shall contain full 4100 event history log supporting local and network functions. If a main processor or network node is lost the entire log shall be accessible at any other Loop Interface board. This shall be demonstrated by removing power from INCC Command Center followed by extraction of history log from any loop driver location, including INCC Command Center or Transponder.

14. LEDs Indicator and Outputs: Each ILI-MB-E3/ILI95-MB-E3 Loop Interface shall incorporate as a minimum the following diagnostic LED indicator:

    a. Power: Green.
    b. Alarm: Red.
    c. Supervisory: Yellow.
    d. General Trouble: Yellow.
    e. Ground Fault: Yellow.
    f. Transmit: Green.
    g. Receive: Green.

15. Auxiliary Power Outputs: Each ILI-MB-E3/ILI95-MB-E3 Loop Interface shall provide the following supply outputs:

    a. 24 VDC non-resettable, 1 amp. maximum, Class A power-limited.
    b. 24 VDC resettable, 1 amp. maximum, Class A power-limited.

16. Microprocessor: Loop interface shall incorporate 32-bit RISC processor. Isolated “watchdog” circuit shall monitor microprocessor and upon failure shall activate system

trouble circuits on display. Microprocessor shall access system program for all control-by-event (CBE) functions. System program shall not be lost upon failure of both primary and secondary power. Programming shall support Boolean logic including AND, OR, NOT, TIME DELAY functions for maximum flexibility.

17. Auto Programming: System shall provide for all SLC devices on any SLC loop to be pre-programmed into system. Upon activation of auto programming, only devices that are present shall activate. This allows for system to be commissioned in phases without need of additional downloads.
18. Environmental Drift Compensation: System shall provide for setting Environmental Drift Compensation by device. When detector accumulates dust in chamber and reaches unacceptable level but yet still below allowed limit, control panel shall indicate maintenance alert warning. When detector accumulates dust in chamber above allowed limit, control panel shall indicate maintenance urgent warning.
19. NON-FIRE Alarm Module Reporting: Non-reporting type ID shall be available for use for energy management or other non-fire situations. NON-FIRE point operation shall not affect control panel operation nor shall it display message at panel LDC. Activation of NON-FIRE point shall activate control by event logic, but shall not cause indication on control panel.
20. 1-Man Walk Test:
    a. System shall provide both basic and advanced walk test for testing entire fire alarm system. Basic walk test shall allow single operator to run audible tests on panel. All logic equation automation shall be suspended during test and while annunciators can be enabled for test, all shall default to disabled state. During advanced walk test, field-supplied output point programming shall react to input stimuli, such as CBE and logic equations. When points are activated in advanced test mode, each initiating event shall latch input. Advanced test shall be audible and shall be used for pull station verification, magnet activated tests on input devices, input and output device, and wiring operation/verification.
    b. Test feature is intended to provide for certain random spot testing of system and is not intended to comply with requirements of testing fire alarm systems in accordance with NFPA 72, as it is impossible to test all functions and verify items such as annunciation with only 1 person.
21. Signaling Line Circuits: Each ILI-MB-E3 module shall provide communication with analog/addressable (initiation/control) devices via 2 signaling line circuits. Each signaling line circuit shall be capable of being wired Class B, Style 4 or Class A, Style 6. Circuits shall be capable of operating in NFPA Style 7 configuration when equipped with isolator modules between each module type device and isolator sensor bases. Each circuit shall communicate with a maximum of 159 analog sensors and 159 addressable monitor/control devices. Unique 40-character identifier shall be available for each device. Devices shall be of the Velocity series with capability to poll 10 devices at a time with a maximum polling time of 2 seconds when both SLCs are fully loaded.
22. Notification Appliance Circuits: 2 independent NAC circuits shall be provided on ILI-MB, polarized and rated at 2 amperes DC per circuit, individually over current protected and supervised for opens, grounds, and short circuits. They shall be capable of being wired Class B, Style Y or Class A, Style Z.
23. Alarm Dry Contacts: Provide alarm dry contacts (Form C) rated 2 amps at 30 VDC (resistive) and transfer whenever system alarm occurs.
24. Supervisory Dry Contacts: Provide supervisory dry contacts (Form C) rated 2 amps at 30 VDC (resistive) and transfer whenever system supervisory condition occurs.
25. Trouble Dry Contacts: Provide trouble dry contacts (Form C) rated 2 amps at 30 VDC

(resistive) and transfer whenever system trouble occurs.

26. Permitted zone types shall be general zone, releasing zone, and special zone. Each output point (control module, panel circuit module) can support a list of up to eight zones including general zone, logic zone, releasing zone, and trouble zone. It shall be possible for output points to be assigned to list general alarm. Non-Alarm or Supervisory points shall not activate the general alarm zone.

27. Multiple Agent Releasing Zones: The system shall support up to eight releasing zones to protect against eight independent hazards. Releasing zones shall provide up to three cross-zone and four abort options to satisfy any local jurisdiction requirements.

H. Auxiliary Switch Module (ASM-16):

1. Each ASM-16 has 16 programmable push-button switches.
2. Each push-button switch has 3 associated status LEDs (red, yellow, and green), configurable to indicate any combination of functions.
3. Flexible switch configurations to allow flexible set-up of phone, speaker, and auxiliary function circuits.
4. An insertable label to identify function of each switch and LEDs combination.
5. Provide capability to communicate with up to 16 ASM-16 modules locally, up to 3,000 feet from INCC Command Center.
6. Specialty modules that only perform 1 task such as speaker, phone, or auxiliary shall not be acceptable.

I. Telephone Assembly: Include the following items:

1. Mounting cabinet which occupies 2 module locations on inner door of INCC.
2. Standard phone operating on piezo effect with integral 6-foot cord.
3. Interconnect cable for connection of phone to Command Center.

J. Microphone Assembly: Include the following items:

1. Mounting cabinet which occupies 1 module location on inner door of INCC.
2. Interconnect cable for connection of microphone to INI-VG.
3. 1 noise canceling microphone with push-to-talk button.

2.07 INTELLIGENT NETWORK TRANSPONDER (INX)

A. System shall be of multiprocessor design to allow maximum flexibility of capabilities and operation. INX shall receive, transmit, and regenerate voice, fire fighter phones, and data over single pair of wire or fiber optic cable.

B. INX shall provide full multi-channel distributed voice messaging, with integrated switching amplification, and SLC and extended phone riser. INX shall communicate with network system in true peer-to-peer fashion operating at 625 K baud over any combination of fiber or wire media. INX shall consist of the following units and components.

C. System Cabinet: System cabinet shall be surface or semi-flush mounted with texture finish and shall consist of 4 parts, back box, back plate, inner door, and outer door. System cabinet houses INI-VG, PM-9 power supply, up to 4 - AM50, microphone, and related circuitry.

D. Intelligent Network Interface Voice Gateway (INI-VG): INI-VG shall be a multi-function board interchangeable in both INCC and INX. Functions of board shall include the following features as a minimum:

1. Network interface operating at 625 K baud configurable with any combination of wire and/or fiber topologies. Interface shall communicate with up to 122 total INCC, INX, and E3 and S3 control panels in peer-to-peer fashion.
2. Fire Fighter Phone Riser: INI-VG shall generate local phone riser for use with AOM-TEL phone modules for connection to fire fighter phone. INI-VG shall mix its local phone riser to network in true Style 7 fashion.
3. Signaling Line Circuit (SLC): INI-VG shall generate local SLC to communicate with and control up to 16 AOM-TEL modules and 32 AOM-2S or AOM-MUX circuits for fire phone interfacing and additional split-speaker circuits.
4. RS-485: Provide capability to communicate with up to 16 ASM-16 modules, when used in INX mode up to 3,000 feet.
5. Advanced Processing: INI-VG shall incorporate latest in digital signaling processing technology with supporting Boolean logic including AND, OR, NOT, TIME DELAY functions.
6. Voice Generation: INI-VG shall incorporate all processing to allow for 16 distinct pre-recorded messages used in priority fashion with message 1 as highest priority. Total length for 1 to 16 messages shall be up to 3 minutes.

E. Power Supply Module (PM-9): PM-9 power supply shall supply all power necessary under normal and emergency conditions. Power supply shall provide capacity to charge up to 55 amp-hour batteries while under full load. Technology used shall be of power-saving switching configuration, eliminating need of stepping transformer.

F. Audio Amplifier (AM-50): Include as a minimum, the following features:

1. 50-watt switching audio amplifier:
   a. AM-50-70.7 amplifier produces $70V_{RMS}$ at 50 watts digital audio output.
2. 2 individually addressable speaker circuits, each with capability of handling part or all of 50-watt supplied power.
3. Power shall be 24 VDC supplied via terminal block from local PM-9 power supply.
4. Ability to select from 1 of 16 pre-programmed messages in INI-VG, and paging from locally or from INCC Command Center.
5. Back-up amplification configurable so 1 AM-50 can perform back-up or 3, or perform 1-to-1 back-up if configured to do so in programming.
6. Status LEDs to indicate normal operation and trouble condition.

2.08 SUPPLEMENTAL NOTIFICATION APPLIANCE CIRCUIT (HPF24)

A. Supplemental Notification Appliance Circuit (HPF24) shall be Model HPF24S6 offering (up to 6.0 amps 6.0 amps continuous) of regulated 24-volt power. HPF24 shall include the following features:

1. Integral Charger: Charge up to 6.0 amp-hour batteries and support 60-hour standby.
2. 2 Input Triggers. Input trigger shall be Notification Appliance Circuit (from fire alarm control panel) or relay.
3. Surface-mount back box.
4. Ability to delay AC fail delay in accordance with applicable NFPA requirements.
5. Power limited circuitry in accordance with applicable UL standards.
6. Operates as sync follower or a sync generator.

2.09 SYSTEM PERIPHERALS - Velocity

A. Addressable Devices – General:

1. Provide address-setting means using rotary-decimal switches.
2. Use simple to install and maintain decade-type (numbered 0 to 15) address switches by using standard screwdriver to rotate 2 dials on device to set address. Devices which use binary address set via dipswitch packages, handheld device programmer, or other special tools for setting device address shall not be acceptable.
3. Detectors: Analog and addressable. Connect to fire alarm control panel's Signaling Line Circuits.
4. Addressable Thermal and Smoke Detectors: Provide 2 status LEDs. Both LEDs shall flash under normal conditions, indicating detector is operational and in regular communication with control panel, and both LEDs shall be placed into steady illumination by control panel, indicating alarm condition has been detected. If required, flashing mode operation of detector LEDs can be programmed off via fire control panel program.
5. Fire Alarm Control Panel: Permit detector sensitivity adjustment through field programming of system. Sensitivity can be automatically adjusted by panel on time-of-day basis.
6. Using software in INCC Command Center, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. Detectors shall be listed by UL as meeting calibrated sensitivity test requirements of NFPA 72, Chapter 7.
7. Detectors shall be ceiling-mounted and shall include separate twist-lock base with tamper-proof feature.
8. Following bases and auxiliary functions shall be available:
    a. Standard base with remote LED output.
    b. Sounder base rated at 85 dBA minimum.
    c. Intelligent Addressable Sounder base rated at 75 dBA minimum.
    d. Form-C relay base rated 30 VDC, 2.0 A.
    e. Isolator base.
9. Detectors shall provide test means whereby they will simulate alarm condition and report that condition to control panel. Such test shall be initiated at detector itself by activating magnetic switch or initiated remotely on command from control panel.
10. Detectors shall store internal identifying type code that control panel shall use to identify type of device (PHOTO, THERMAL).

B. Addressable Manual Stations (MS-7AF):

1. Manual Fire Alarm Stations: Non-code, non-break glass type, equipped with key lock so they may be tested without operating handle.
2. Operated Station: Visually apparent, as operated, at a minimum distance of 100 feet (30.5 m) from front or side.
3. Stations shall be designed so after actual activation, they cannot be restored to normal except by key reset.
4. Manual stations shall be constructed of Lexan with clearly visible operating instructions provided on cover. The word FIRE shall appear on front of stations in raised letters, 1.75 inches (44 mm) or larger.
5. Addressable manual stations shall, on command from control panel, send data to panel representing state of manual switch and addressable communication module status.

C. Intelligent Photoelectric Smoke Detectors (ASD-PL2F): Use photoelectric (light-scattering) principal to measure smoke density and shall, on command from control panel, send data to panel representing analog level of smoke density.

D. Intelligent Photoelectric Smoke Detectors with Thermal Sensor (ASD-PTL2F)

E. Intelligent Thermal Detectors (ATD-RL2F): Intelligent addressable devices rated at 135 degrees F (58 degrees C) and have rate-of-rise element rated at 15 degrees F (9.4 degrees C) per minute. Connect via 2 wires to fire alarm control panel signaling line circuit.

F. Intelligent Thermal Detectors (ATD-HL2F): Intelligent addressable devices fixed high-temperature detection at 190 degrees F (88 degrees C). Connect via 2 wires to fire alarm control panel signaling line circuit.

G. Addressable Dry Contact Monitor Modules (AMM-2F):

1. Provide to connect 1 supervised IDC zone of conventional alarm initiating devices (any N.O. dry contact device) to 1 of the fire alarm control panel SLCs.
2. Mount in standard deep electrical box.
3. IDC Zone: Suitable for Style B operation.

H. Addressable Control Modules (AOM-2SF):

1. Provide to supervise and control operation of 1 conventional NAC of compatible, 24-VDC powered, polarized audio/visual notification appliances or UL-listed polarized relays for fan shutdown and other auxiliary control functions.
2. Mount in standard 4-inch (101.6-mm) square, 2-1/8-inch (54-mm) deep electrical box or to surface-mounted back box.
3. Control Module NAC: Wire for Style Z or Style Y (Class A/B) with up to 1 amp of inductive signal or 2 amps of resistive signal operation. Relay coil shall be magnetically latched to reduce wiring connection requirements and to ensure 100 percent of all auxiliary relay or NACs shall be energized at same time on same pair of wires.
4. Audio/Visual Power: Provide by separate supervised power circuit from main fire alarm control panel or from supervised, UL-listed remote power supply.

I. Addressable Relay Modules (AOM-2RF):

1. Provide two isolated sets of Form-C contacts, which operate as a double pole double throw switch. The module shall allow the control panel to switch these contacts on command. The module shall not provide supervision for the notification appliance circuit (NAC). Module shall have both normally open and normally closed connections available for field wiring.
2. Available for HVAC control and other building functions. Relay shall have 2 Form C sets of contacts that operate in tandem and are rated for a minimum of 2.0 amps resistive or 1.0 amps inductive. Relay coil shall be magnetically latched to reduce wiring connection requirements and to ensure 100 percent of all auxiliary relay or NACs shall be energized at same time on same pair of wires.
3. Mount in standard 4-inch (101.6-mm) square, 2-1/8-inch (54-mm) deep electrical box or to surface-mounted back box.
4. LEDs: Flash under normal conditions, indicating monitor module is operational and in regular communication with control panel.

J. Provide Functional Devices Inc. (RIBUIC) : Relay 10 Amp SPDT with 10-30 VAC/DC/120 VAC Coil CSFM listed (7300-1555-0100)

2.01 NOTIFICATION APPLIANCES

A. Speakers:

1. Operate on 25 VRMS or 70.7 VRMS with field-selectable output taps from 0.5 to 2.0 watts.
2. Speakers in Corridors and Public Spaces: Produce nominal sound output of 84 dBA at 10 feet (3 m).
3. Frequency Response: Minimum of 400 Hz to 4,000 Hz.
4. Back of Each Speaker: Sealed to protect speaker cone from damage and dust.
5. Provide System Sensor (SPRK-P): Plain Outdoor Speaker, Red, Includes Plastic Weatherproof Back Box (CSFM # 7320-1653:0201)

B. Strobes:

1. Compliance: ADA and UL 1971.
2. Maximum Pulse Duration: 0.2 second.
3. Strobe Intensity: UL 1971.
4. Flash Rate: UL 1971.
5. Strobe Candela Rating: Determine by positioning selector switch on back of device.
6. Provide System Sensor (SR-P) : Plain Wall Strobes Standard cd, Red, Clear Lens (CSFM # 7125-1653:0186)
7. Provide System Sensor (SCW-P) : Plain Ceiling Strobes Standard cd, White, Clear Lens (CSFM # 7125-1653:0186)

C. Speaker/Strobes:

1. Operate on 25 VRMS or with field-selectable output taps from 0.5 to 2.0 watt
2. Speakers in Corridors and Public Spaces: Produce nominal sound output of 84 dBA at 10 feet (3 m).
3. Frequency Response: Minimum of 400 Hz to 4,000 Hz.
4. Back of Each Speaker: Sealed to protect speaker cone from damage and dust.
5. Audibility: NFPA 72.
6. Maximum Pulse Duration: 0.2 second.
7. Strobe Intensity: UL 1971.
8. Flash Rate: UL 1971.
9. Strobe Candela Rating: Determine by positioning selector switch on back of device.
10. Provide System Sensor (SPSW-P): Plain Wall Speaker Strobes Standard cd, White, Clear Lens (CSFM # 7320-1653:0201)
11. Provide System Sensor (SPSCW-P): Plain Ceiling Speaker Strobes Standard cd, White, Clear Lens (CSFM # 7320-1653:0201)

D. Fire Alarm Bell

1. Provide Cooper Wheelock (MB-G10-24-R): 10" 24V Fire Alarm Bell, Red (CSFM # 7135-0785:0113)

E. System Record Documents (SRD)

1. Provide Space Age Electronics, Inc. (ACE-11) : System Record Documents (SRD)

2.02 WIRE AND CABLE

A. All Fire Alarm cables installed in conduits outdoor and underground shall be West Penn "Aqua Seal" (AQC) rated or equal. Transition from AQC rated cables to Non-AQC rated cables within building interiors shall be terminated at Fire Alarm Terminal Cabinets (FATC). Where no existing FATC is shown on drawings, provide new FATC 12"x8"x4" NEMA 1 screw cover box with terminal strips for termination. Locate FATC within building at the point of entry to building or as directed by district. No wiring splices are permitted, all cables shall be terminated at devices terminal or at FATC Signaling Line Circuits – Network Data: Twisted pair, not less than No. 18 AWG or as recommended by the manufacturer.

B. Provide conduit duct sealant water block Foam-Based duct sealing system at all conduit openings (both ends) at each underground pull boxes (existing/new)

C. Signaling Line Circuits – Intelligent Loop: Non-Twisted pair, not less than No. 16 AWG or as recommended by the manufacturer.

1. Circuit Integrity Cable: Provide as required to meet NFPA or Local Code requirements.
2. CI Cable shall meet article 760, power limited fire alarm service.

D. Notification Appliance Circuits –

1. Audio: Twisted pair, not less than No. 16 AWG or as recommended by the manufacturer.
2. Visual. Non-Twisted pair, not less than No. 14 AWG or as recommended by the manufacturer.

E. 120 VAC circuits

1. Minimum 10 AWG for panel power circuits. Minimum 12 AWG for all other circuits.
2. Sharing of neutrals is prohibited. Each circuit shall have its own dedicated neutral conductor.

Symbol	***Circuit Type***	***Cable Description***	***Color***	
		Indoor	***Outdoor***	
Z	Signature Analog Addressable Loop	2#16 Solid Unshielded FPLR West Penn D990	2#16 Unshielded AquaSeal West Penn AQ225	
V	Notification Appliance Circuit (NAC) 24Vdc	2#12 THHN/THWN Cerrowire 112-36	2#12 THHN/THWN Cerrowire 112-36	Blue + Yellow -
S	Speaker Circuit	2#18 Solid Shielded FPLR West Penn 293	2#18 Shielded AquaSeal West Penn AQ293	
P	24V DC Power Distribution	2#12 THHN/THWN Cerrowire 112-36	2#12 THHN/THWN Cerrowire 112-36	Red + Black -
D	24V DC Door Holder	2#12 THHN/THWN Cerrowire 112-36	2#12 THHN/THWN Cerrowire 112-36	Red + Black -
N	Network Cable, Anunciator Cable	2#16 Solid Unshielded FPLR West Penn D990	2#16 Unshielded AquaSeal West Penn AQ225	try
F	Network Cable	2#12 THHN/THWN Cerrowire 112-36	2#12 THHN/THWN Cerrowire 112-36	Red + Black -

2.03 Spare Parts: provide 10% of the total number of devices but not less than 2 as spare parts for all Initiating devices (manual Pull Stations, Smoke detectors, heat detectors, notification appliances strobes, strobe speakers).

2.04 INSTALLATION

A. Install fire alarm system in accordance with NFPA 72, NFPA 70, CBC, CEC and CFC, manufacturer's instructions.

B. Conceal conduit, junction boxes, and conduit supports and hangers in finished areas. Conceal or expose conduit, junction boxes, and conduit supports and hangers in unfinished areas.

C. Do not install smoke detectors before system programming and test period. If construction is ongoing during this period, take measures to protect smoke detectors from contamination and physical damage.

D. Flush-mount fire detection and alarm system devices, control panels, and remote annunciators in finished areas. Flush-mount or surface-mount fire detection and alarm system devices, control panels, and remote annunciators in unfinished areas.

E. Ensure manual stations are suitable for surface mounting or semi-flush mounting as indicated on the Drawings. Install manual fire-alarm box in the normal path of egress within 60 inches of the exit doorway. Install not less than 42 inches, nor more than 48 inches, above finished floor measured to operating handle. Any low-voltage copper wiring that leaves the protection of a building shall be provided with a system manufacturer specified UL 497B listed transient protection devices where the circuit leaves the building and where it enters the next building.

F. Equipment Mounting: Install MNEC/FA control unit on finished floor with tops of cabinets not more than 72 inches above the finished floor.

G. Smoke- or Heat-Detector Spacing:

1. Comply with NFPA72, "Smoke-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for smoke-detector spacing.

2. Comply with NFPA72, "Heat-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for heat-detector spacing.

3. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Appendix A in NFPA 72.

4. HVAC: Locate detectors not closer than 3 feet from air-supply diffuser or return-air opening.

5. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture.

H. Wall-Mounted Notification Appliances: Install so entire appliance is between 80 and 96 inches above finished floor on the wall.

I. MNEC/FA Control Units: Surface mounted, with tops of cabinets not more than 72 inches above the finished floor.

J. LOC/Annunciator: Install with top of panel not more than 72 inches above the finished floor.

K. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.

L. Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location. Do not install smoke detectors in Sprinklered elevator shafts.

2.05 PATHWAYS

A. All wiring shall be in conduit, surface raceway or open run above ceilings, under floors and in walls in a neat and protected minor as dedicated on design documents. Exposed circuits are only permitted when noted as exposed on design documents. Conduit fill shall be per table 3B of electrical code. Provide PVC schedule 40 for conduits underground, EMT conduit for interior exposed areas, and galvanized rigid steel for exposed exterior areas. Underground and exterior conduits to have watertight fittings and wire approved for wet locations.

B. Minimum conduit size shall be 3/4" contractor to adjust size for field conditions (i.e. no. Of bends, etc.) But shall not be smaller than 3/4". Maximum conduit size shall be 2"

C. Fire alarm junction box cover shall be painted red and labeled "fire alarm". All fire alarm conduits shall have a red stripe every 10ft.

D. All fire alarm wiring shall be fire power limit or fire power limited plenum as required for application. Wiring in conduit above underground may be THHN or THWN. Conduit fill shall be per table 3B of electrical code

E. All wiring is to be pulled through each junction box and connect directly to each fire alarm device. Do not splice the wire. There must be at least 6 ft of lead wire from box to the device. All box to be sized per CEC. Wiring shall not be looped through devices; wire must be cut for in and out at device junction box.

F. Point and common annunciation and T-tapping prohibited. (Except with addressable class B devices)

G. All wiring, initiating device and annunciator panel shall be supervised to the principal point of annunciation (fire alarm panel to supervise the annunciator panel, all circuits and initiating devices).

H. All penetrations of fire-rated assemblies, requiring opening protection shall be provided with a penetration fire stop system as identified in CBC chapter 7, UL or other lab testing criteria. Approve type of materials shall be identified within the specification within a fire alarm section. Installation and application, per manufacturer’s instructions. Refer to fire alarm detail drawing through-penetration fire stopping for all fire rated walls.

I. Conduit and junction boxes are not to be used for unrelated wiring.

2.06 CONNECTIONS

A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Division 8 Section "Door Hard-ware." Connect hardware and devices to fire-alarm system.

1. Verify that hardware and devices are NRTL listed for use with fire-alarm system in this Section before making connections.

B. Make addressable connections with a supervised interface device to the following de-vices and systems. Install the interface device less than 3 feet from the device con-trolled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.

1. Alarm-initiating connection to smoke-control system (smoke management) at fire-fighter smoke-control system panel.

2. Smoke dampers in air ducts of designated air-conditioning duct systems.

3. Alarm-initiating connection to activate emergency lighting control.

4. Supervisory connections at valve supervisory switches.

5. Supervisory connections at fire-suppression system.

6. Magnetically held-open doors.
7. Alarm-initiating connection to elevator recall system and components.
8. Supervisory connections at elevator shunt-trip breaker.

2.07 GROUNDING

A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

2.08 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section "Identification for Electrical Systems."

B. Provide signage "Fire Alarm Control Panel Inside" on doors of the room where FACP/FCPS is located to indicate location of FACP/FCPS. Provide signage at the inspectors test valve, riser, and supervisory device indicating that the fire sprinkler system is being monitored. The location of the inspectors test is to be labeled on the interior of the FACP door.

2.09 FIELD QUALITY CONTROL

A. Field tests shall be witnessed by authorities having jurisdiction DSA Project Inspector of Record (IOR).

B. Manufacturer's Field Services: Provide service of competent, factory-trained technician authorized by manufacturer to technically supervise and participate during pre-testing and acceptance testing of system.

C. Testing:

1. Conduct complete visual inspection of control panel connections and test wiring for short circuits, ground faults, continuity, and insulation before energizing cables and wires.
2. Close each sprinkler system control valve and verify proper supervisory alarm at INCC Command Center.
3. Verify activation of flow switches.
4. Open initiating device circuits and verify that trouble signal actuates.
5. Open signaling line circuits and verify that trouble signal actuates.
6. Open and short notification appliance circuits and verify that trouble signal actuates.
7. Ground initiating device circuits and verify response of trouble signals.
8. Ground signaling line circuits and verify response of trouble signals.
9. Ground notification appliance circuits and verify response of trouble signals.
10. Check alert tone and prerecorded voice message to alarm notification devices.
11. Check installation, supervision, and operation of intelligent smoke detectors.
12. Introduce on system each of the alarm conditions that system is required to detect. Verify proper receipt and proper processing of signal at INCC Command Center and correct activation of control points.
13. Consult manufacturer's manual to determine proper testing procedures when system is equipped with optional features. This is intended to address such items as verifying controls performed by individually addressed or grouped devices, sensitivity monitoring, verification functionality, and similar.

D. Acceptance Testing:

1. Before installation shall be considered completed and acceptable by AHJ, a complete test using as a minimum, the following scenarios shall be performed and witnessed by representative approved by Engineer. Monitoring company and/or fire department shall be notified before final test in accordance with local requirements.
2. Contractor's job foreman, in presence of representative of manufacturer, representative of Owner, and fire department shall operate every installed device to verify proper operation and correct annunciation at control panel.
3. Open signaling line circuits and notification appliance circuits in at least 2 locations to verify presence of supervision.
4. Completely disconnect INCC Command Center from rest of network, including Voice INCC Command Center. Activate initiating device from transponder. All speaker circuits activated from each transponder shall transmit the correct evacuation or alert message. These messages shall be same messages transmitted with INCC Command Center activated. Default tones or messages shall not be acceptable.
5. Completely disconnect INCC Command Center from rest of network. Activate initiating device. All control outputs supported by transponder SLC circuits shall operate under project programming mode. Default or degrade mode programming shall not be acceptable.
6. Fire fighter phone riser shall be directly shorted between INCC Command Center and first transponder, followed by test of fire phones between INCC Command Center and farthest transponder. Phones shall operate in normal fashion.
7. All audio risers shall be directly shorted between INCC Command Center and first audio transponder, followed by activation of alarm initiating device. Correct pre-recorded messages shall transmit from all speakers, including evacuation and alert channels. Default or degrade messages shall not be acceptable.
8. When testing has been completed to satisfaction of both Contractor's job foreman and representatives of manufacturer and Owner, a notarized letter co-signed by each attesting to satisfactory completion of said testing shall be forwarded to Owner and fire department.
9. Leave fire alarm system in proper working order and, without additional expense to Owner, replace defective materials and equipment provided within 1 year (365 days) from date of final acceptance by the owner.

2.10 Training

A. The System Supplier shall schedule and present a minimum of 8 hours of documented formalized instruction for the building Architect, detailing the proper operation of the installed System.

B. The instruction shall be presented in an organized and professional manner by a person factory trained in the operation and maintenance of the equipment and who is also thoroughly familiar with the installation.

C. The instruction shall cover the schedule of maintenance required by NFPA 72 and any additional maintenance recommended by the system manufacturer.

2.11 Instruction shall be made available to the Local Municipal Fire Department if requested by the Local Authority Having Jurisdiction.

2.12 Warranty: Provide 3 years unconditional warranty for entire system installed under this contract including labor and materials, system components, wiring, programming etc.

END OF SECTION

SYSTEM RECORD OF COMPLETION

This form is to be completed by the system installation contractor at the time of system acceptance and approval.
It shall be permitted to modify this form as needed to provide a more complete and/or clear record.
Insert N/A in all unused lines.
Attach additional sheets, data, or calculations as necessary to provide a complete record.

Form Completion Date: _____ Supplemental Pages Attached: _____

1. PROPERTY INFORMATION

Name of property: _____

Address: _____

Description of property: _____

Name of property representative: _____

Address: _____

Phone: _____ Fax: _____ E-mail: _____

2. INSTALLATION, SERVICE, TESTING, AND MONITORING INFORMATION

Installation contractor: _____

Address: _____

Phone: _____ Fax: _____ E-mail: _____

Service organization: _____

Address: _____

Phone: _____ Fax: _____ E-mail: _____

Testing organization: _____

Address: _____

Phone: _____ Fax: _____ E-mail: _____

Effective date for test and inspection contract: _____

Monitoring organization: _____

Address: _____

Phone: _____ Fax: _____ E-mail: _____

Account number: _____ Phone line 1: _____ Phone line 2: _____

Means of transmission: _____

Entity to which alarms are retransmitted: _____ Phone: _____

3. DOCUMENTATION

On-site location of the required record documents and site-specific software: _____

4. DESCRIPTION OF SYSTEM OR SERVICE

This is a: ☐ New system ☐ Modification to existing system Permit number: _____

NFPA 72 edition: _____

4.1 Control Unit

Manufacturer: _____ Model number: _____

4.2 Software and Firmware

Firmware revision number: _____

4.3 Alarm Verification

☐ This system does not incorporate alarm verification.

Number of devices subject to alarm verification: _____ Alarm verification set for _____ seconds

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5. SYSTEM POWER

5.1 Control Unit

5.1.1 Primary Power

Input voltage of control panel: _____ Control panel amps: _____

Overcurrent protection: Type: _____ Amps: _____

Branch circuit disconnecting means location: _____ Number: _____

5.1.2 Secondary Power

Type of secondary power: _____

Location, if remote from the plant: _____

Calculated capacity of secondary power to drive the system:

In standby mode (hours): _____ In alarm mode (minutes): _____

5.2 Control Unit

☐ This system does not have power extender panels

☐ Power extender panels are listed on supplementary sheet A

6. CIRCUITS AND PATHWAYS

Pathway Type	Dual Media Pathway	Separate Pathway	Class	Survivability Level
Signaling Line				
Device Power				
Initiating Device				
Notification Appliance				
Other (specify):				

7. REMOTE ANNUNCIATORS

Type	Location

8. INITIATING DEVICES

Type	Quantity	Addressable or Conventional	Alarm or Supervisory	Sensing Technology
Manual Pull Stations				
Smoke Detectors				
Duct Smoke Detectors				
Heat Detectors				
Gas Detectors				
Waterflow Switches				
Tamper Switches				

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9. NOTIFICATION APPLIANCES

Type	Quantity	Description
Audible		
Visible		
Combination Audible and Visible		

10. SYSTEM CONTROL FUNCTIONS

Type	Quantity
Hold-Open Door Releasing Devices	
HVAC Shutdown	
Fire/Smoke Dampers	
Door Unlocking	
Elevator Recall	
Elevator Shunt Trip	

11. INTERCONNECTED SYSTEMS

☐ This system does not have interconnected systems.

☐ Interconnected systems are listed on supplementary sheet _____ .

12. CERTIFICATION AND APPROVALS

12.1 System Installation Contractor

This system as specified herein has been installed according to all NFPA standards cited herein.

Signed: _____ Printed name: _____ Date: _____

Organization: _____ Title: _____ Phone: _____

12.2 System Operational Test

This system as specified herein has tested according to all NFPA standards cited herein.

Signed: _____ Printed name: _____ Date: _____

Organization: _____ Title: _____ Phone: _____

12.3 Acceptance Test

Date and time of acceptance test: _____

Installing contractor representative: _____

Testing contractor representative: _____

Property representative: _____

AHJ representative: _____

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EMERGENCY COMMUNICATIONS SYSTEMS
SUPPLEMENTARY RECORD OF COMPLETION

This form is a supplement to the System Record of Completion. It includes systems and components specific to emergency communications systems.
This form is to be completed by the system installation contractor at the time of system acceptance and approval.
It shall be permitted to modify this form as needed to provide a more complete and/or clear record.
Insert N/A in all unused lines.

Form Completion Date: _____ Number of Supplemental Pages Attached: _____

1. PROPERTY INFORMATION

Name of property: _____

Address: _____

2. DESCRIPTION OF SYSTEM OR SERVICE

☐ Fire alarm with in-building fire emergency voice alarm communication system (EVAC)

☐ Mass notification system

☐ Combination system, with the following components:

☐ Fire alarm ☐ EVACS ☐ MNS ☐ Two-way, in-building, emergency communications system

☐ Other (specify): _____

NFPA 72 edition: _____ Additional description of system(s): _____

2.1 In-Building Fire Emergency Voice Alarm Communications System

Manufacturer: _____ Model number: _____

Number of single voice alarm channels: _____ Number of multiple voice alarm channels: _____

Number of speakers: _____ Number of speaker circuits: _____

Location of amplification and sound processing equipment:

_____

Location of paging microphone stations:

Location 1: _____

Location 2: _____

Location 3: _____

2.2 Mass Notification System

2.2.1 System Type:

☐ In-building MNS–combination

☐ In-building MNS ☐ Wide-area MNS ☐ Distributed recipient MNS

☐ Other (specify): _____

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2. DESCRIPTION OF SYSTEM OR SERVICE *(continued)*

2.2.2 System Features:

☐ Combination fire alarm/MNS ☐ MNS autonomous control unit ☐ Wide-area MNS to regional national alerting interface

☐ Local operating console (LOC) ☐ Distributed-recipient MNS (DRMNS) ☐ Wide-area MNS to DRMNS interface

☐ Wide-area MNS to high power speaker array (HPSA) interface ☐ In-building MNS to wide-area MNS interface

☐ Other (specify): _____

2.2.3 MNS Local Operating Consoles

Location 1: _____

Location 2: _____

Location 3: _____

2.2.4 High Power Speaker Arrays

Number of HPSA speaker initiation zones: _____

Location 1: _____

Location 2: _____

Location 3: _____

2.2.5 Mass Notification Devices

Combination fire alarm/MNS visual devices: _____ MNS-only visual devices: _____

Textual signs: _____ Other (describe): _____

Supervision class: _____

2.2.6 Special Hazard Notification

☐ This system does not have special suppression predischarge notification.

☐ MNS systems DO NOT override notification appliances required to provide special suppression predischarge notification.

3. TWO-WAY EMERGENCY COMMUNICATIONS SYSTEMS

3.1 Telephone System

Number of telephone jacks installed: _____ Number of warden stations installed: _____

Number of telephone handsets stored on site: _____

Type of telephone system installed: ☐ Electrically powered ☐ Sound powered

3.2 Two-Way Radio Communications Enhancement System

Percentage of area covered by two-way radio service: Critical areas _____ % General building areas _____ %

Amplification component locations: _____

Inbound signal strength _____ dBm Outbound signal strength _____ dBm

Donor antenna isolation is _____ dB above the signal booster gain.

Radio frequencies covered: _____

Radio system monitor panel location: _____

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3. TWO-WAY EMERGENCY COMMUNICATIONS SYSTEMS *(continued)*

3.3 Area of Refuge (Area of Rescue Assistance) Emergency Communications Systems

Number of stations: _____ Location of central control point: _____

Days and hours when central control point is attended: _____

Location of alternate control point: _____

Days and hours when alternate control point is attended: _____

3.4 Elevator Emergency Communications Systems

Number of elevators with stations: _____ Location of central control point: _____

Days and hours when central control point is attended: _____

Location of alternate control point: _____

Days and hours when alternate control point is attended: _____

3.5 Other Two-Way Communications System

Describe: _____

4. CONTROL FUNCTIONS

This system activates the following control functions specific to emergency communications systems:

Type	Quantity
Mass Notification Override of Alarm Signaling Systems or Appliances	

See Main System Record of Completion for additional information, certifications, and approvals.

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POWER SYSTEMS
SUPPLEMENTARY RECORD OF COMPLETION

This form is a supplement to the System Record of Completion. It includes systems and components specific to power systems that incorporate generators, UPS systems, remote battery systems, or other complex power systems. This form is to be completed by the system installation contractor at the time of system acceptance and approval. It shall be permitted to modify this form as needed to provide a more complete and/or clear record. Insert N/A in all unused lines.

Form Completion Date: _____ Number of Supplemental Pages Attached: _____

1. PROPERTY INFORMATION

Name of property: _____

Address: _____

2. SYSTEM POWER

2.1 Control Unit

2.1.1 Primary Power

Input voltage of control panel: _____ Control panel amps: _____

Overcurrent protection: Type: _____ Amps: _____

Location (of primary supply panelboard): _____

Disconnecting means location: _____

2.1.2 Engine-Driven Generator

Location of generator: _____

Location of fuel storage: _____ Type of fuel: _____

2.1.3 Uninterruptible Power System

Equipment powered by UPS system: _____

Location of UPS system: _____

Calculated capacity of UPS batteries to drive the system components connected to it:

In standby mode (hours): _____ In alarm mode (minutes): _____

2.1.4 Batteries

Location: _____ Type: _____ Nominal voltage: _____ Amp/hour rating: _____

Calculated capacity of batteries to drive the system:

In standby mode (hours): _____ In alarm mode (minutes): _____

2.2 In-Building Fire Emergency Voice Alarm Communications System or Mass Notification System

2.2.1 Primary Power

Input voltage of EVACS or MNS panel: _____ EVACS or MNS amps: _____

Overcurrent protection: Type: _____ Amps: _____

Location (of primary supply panelboard): _____

Disconnecting means location: _____

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2. SYSTEM POWER *(continued)*

2.2.2 Engine-Driven Generator

Location of generator: _____

Location of fuel storage: _____ Type of fuel: _____

2.2.3 Uninterruptible Power System

Equipment powered by UPS system: _____

Location of UPS system: _____

Calculated capacity of UPS batteries to drive the system components connected to it:

In standby mode (hours): _____ In alarm mode (minutes): _____

2.2.4 Batteries

Location: _____ Type: _____ Nominal voltage: _____ Amp/hour rating: _____

Calculated capacity of batteries to drive the system:

In standby mode (hours): _____ In alarm mode (minutes): _____

2.3 Notification Appliance Power Extender Panels

☐ This system does not have power extender panels.

2.3.1 Primary Power

Input voltage of power extender panel(s): _____ Power extender panel amps: _____

Overcurrent protection: Type: _____ Amps: _____

Location (of primary supply panelboard): _____

Disconnecting means location: _____

2.3.2 Engine-Driven Generator

Location of generator: _____

Location of fuel storage: _____ Type of fuel: _____

2.3.3 Uninterruptible Power System

Equipment powered by UPS system: _____

Location of UPS system: _____

Calculated capacity of UPS batteries to drive the system components connected to it:

In standby mode (hours): _____ In alarm mode (minutes): _____

2.3.4 Batteries

Location: _____ Type: _____ Nominal voltage: _____ Amp/hour rating: _____

Calculated capacity of batteries to drive the system:

In standby mode (hours): _____ In alarm mode (minutes): _____

See Main System Record of Completion for additional information, certifications, and approvals.

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NOTIFICATION APPLIANCE POWER PANEL
SUPPLEMENTARY RECORD OF COMPLETION

This form is a supplement to the System Record of Completion. It includes a list of types and locations of notification appliance power extender panels.
This form is to be completed by the system installation contractor at the time of system acceptance and approval.
It shall be permitted to modify this form as needed to provide a more complete and/or clear record.
Insert N/A in all unused lines.

Form Completion Date: _____ Number of Supplemental Pages Attached: _____

1. PROPERTY INFORMATION

Name of property: _____

Address: _____

2. NOTIFICATION APPLIANCE POWER EXTENDER PANELS

Make and Model	Location	Area Served	Power Source

See Main System Record of Completion for additional information, certifications, and approvals.

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INTERCONNECTED SYSTEMS
SUPPLEMENTARY RECORD OF COMPLETION

This form is a supplement to the System Record of Completion. It includes a list of types and locations of systems that are interconnected to the main system.
This form is to be completed by the system installation contractor at the time of system acceptance and approval.
It shall be permitted to modify this form as needed to provide a more complete and/or clear record.
Insert N/A in all unused lines.

Form Completion Date: _____ Number of Supplemental Pages Attached: _____

1. PROPERTY INFORMATION

Name of property: _____

Address: _____

2. INTERCONNECTED SYSTEMS

Description	Location	Purpose

See Main System Record of Completion for additional information, certifications, and approvals.

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DEVIATIONS FROM ADOPTED CODES AND STANDARDS
SUPPLEMENTARY RECORD OF COMPLETION

This form is a supplement to the System Record of Completion. It enables the designer and/or installer to document and justify deviations from accepted codes or standards.
This form is to be completed by the system installation contractor at the time of system acceptance and approval.
It shall be permitted to modify this form as needed to provide a more complete and/or clear record.
Insert N/A in all unused lines.

Form Completion Date: _____ Number of Supplemental Pages Attached: _____

1. PROPERTY INFORMATION

Name of property: _____

Address: _____

2. DEVIATIONS FROM ADOPTED CODES OR STANDARDS

Description	Purpose

See Main System Record of Completion for additional information, certifications, and approvals.

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SYSTEM RECORD OF INSPECTION AND TESTING

This form is to be completed by the system inspection and testing contractor at the time of a system test.
It shall be permitted to modify this form as needed to provide a more complete and/or clear record.
Insert N/A in all unused lines.
Attach additional sheets, data, or calculations as necessary to provide a complete record.

Inspection/Test Start Date/Time: _____ Inspection/Test Completion Date/Time: _____

Supplemental Form(s) Attached: _____ (yes/no)

1. PROPERTY INFORMATION

Name of property: _____

Address: _____

Description of property: _____

Name of property representative: _____

Address: _____

Phone: _____ Fax: _____ E-mail: _____

2. TESTING AND MONITORING INFORMATION

Testing organization: _____

Address: _____

Phone: _____ Fax: _____ E-mail: _____

Monitoring organization: _____

Address: _____

Phone: _____ Fax: _____ E-mail: _____

Account number: _____ Phone line 1: _____ Phone line 2: _____

Means of transmission: _____

Entity to which alarms are retransmitted: _____ Phone: _____

3. DOCUMENTATION

On-site location of the required record documents and site-specific software: _____

4. DESCRIPTION OF SYSTEM OR SERVICE

4.1 Control Unit

Manufacturer: _____ Model number: _____

4.2 Software and Firmware

Firmware revision number: _____

4.3 System Power

4.3.1 Primary (Main) Power

Nominal voltage: _____ Amps: _____ Location: _____

Overcurrent protection type: _____ Amps: _____ Disconnecting means location: _____

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4. DESCRIPTION OF SYSTEM OR SERVICE *(continued)*

4.3.2 Secondary Power

Type: _____ Location: _____

Battery type (if applicable): _____

Calculated capacity of batteries to drive the system:

In standby mode (hours): _____ In alarm mode (minutes): _____

5. NOTIFICATIONS MADE PRIOR TO TESTING

Monitoring organization	Contact:	_____	Time:	_____
Building management	Contact:	_____	Time:	_____
Building occupants	Contact:	_____	Time:	_____
Authority having jurisdiction	Contact:	_____	Time:	_____
Other, if required	Contact:	_____	Time:	_____

6. TESTING RESULTS

6.1 Control Unit and Related Equipment

Description	Visual Inspection	Functional Test	Comments
Control unit	☐	☐	
Lamps/LEDs/LCDs	☐	☐	
Fuses	☐	☐	
Trouble signals	☐	☐	
Disconnect switches	☐	☐	
Ground-fault monitoring	☐	☐	
Supervision	☐	☐	
Local annunciator	☐	☐	
Remote annunciators	☐	☐	
Remote power panels	☐	☐	
	☐	☐	

6.2 Secondary Power

Description	Visual Inspection	Functional Test	Comments
Battery condition	☐	☐	
Load voltage	☐	☐	
Discharge test	☐	☐	
Charger test	☐	☐	
Remote panel batteries	☐	☐	

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6. TESTING RESULTS *(continued)*

6.3 Alarm and Supervisory Alarm Initiating Device

Attach supplementary device test sheets for all initiating devices.

6.4 Notification Appliances

Attach supplementary appliance test sheets for all notification appliances.

6.5 Interface Equipment

Attach supplementary interface component test sheets for all interface components.

Circuit Interface / Signaling Line Circuit Interface / Fire Alarm Control Interface

6.6 Supervising Station Monitoring

Description	Yes	No	Time	Comments
Alarm signal	☐	☐		
Alarm restoration	☐	☐		
Trouble signal	☐	☐		
Trouble restoration	☐	☐		
Supervisory signal	☐	☐		
Supervisory restoration	☐	☐		

6.7 Public Emergency Alarm Reporting System

Description	Yes	No	Time	Comments
Alarm signal	☐	☐		
Alarm restoration	☐	☐		
Trouble signal	☐	☐		
Trouble restoration	☐	☐		
Supervisory signal	☐	☐		
Supervisory restoration	☐	☐		

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7. NOTIFICATIONS THAT TESTING IS COMPLETE

Monitoring organization	Contact:	_____	Time:	_____
Building management	Contact:	_____	Time:	_____
Building occupants	Contact:	_____	Time:	_____
Authority having jurisdiction	Contact:	_____	Time:	_____
Other, if required	Contact:	_____	Time:	_____

8. SYSTEM RESTORED TO NORMAL OPERATION

Date: _____ Time: _____

9. CERTIFICATION

This system as specified herein has been inspected and tested according to NFPA 72, 2013 edition, Chapter 14.

Signed: _____ Printed name: _____ Date: _____

Organization: _____ Title: _____ Phone: _____

Qualifications (refer to 10.5.3): _____

10. DEFECTS OR MALFUNCTIONS NOT CORRECTED AT CONCLUSION OF SYSTEM INSPECTION, TESTING, OR MAINTENANCE

_____

_____

_____

_____

_____

_____

_____

10.1 Acceptance by Owner or Owner's Representative:

The undersigned accepted the test report for the system as specified herein:

Signed: _____ Printed name: _____ Date: _____

Organization: _____ Title: _____ Phone: _____

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NOTIFICATION APPLIANCE
SUPPLEMENTARY RECORD OF INSPECTION AND TESTING

This form is a supplement to the System Record of Inspection and Testing.
It includes a notification appliance test record.
This form is to be completed by the system inspection and testing contractor at the time of the inspection and/or test.
It shall be permitted to modify this form as needed to provide a more complete and/or clear record.
Insert N/A in all unused lines.

Inspection/Test Start Date/Time: _____ Inspection/Test Completion Date/Time: _____

Number of Supplemental Pages Attached: _____

1. PROPERTY INFORMATION

Name of property: _____

Address: _____

2. NOTIFICATION APPLIANCE TEST RESULTS

Appliance Type	Location/Identifier	Test Results

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NOTIFICATION APPLIANCE
SUPPLEMENTARY RECORD OF INSPECTION AND TESTING *(continued)*

2. NOTIFICATION APPLIANCE TEST RESULTS *(continued)*

Appliance Type	Location/Identifier	Test Results

See main System Record of Inspection and Testing for additional information, certifications, and approvals.

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Fire Watch Guideline

INSTRUCTIONS:

The owner, manager, or person in charge or control of the building/premises shall assign to the fire watch as many personnel as are required by the Deputy and shall instruct fire watch personnel as to:

- The procedure for notifying the State Fire Marshal
- The area(s) to be patrolled
- Training necessary to insure Fire Watch personnel are capable of activating fire alarm/sprinkler systems when required or necessary
- Any special instructions required by the State Fire Marshal
- Procedures for notifying the building or facility occupants
- A method of calling or notifing the fire service of an emergency

LOG BOOK:

- The owner, manager, person in charge, or in control of the premises shall provide a log book which contains a directory of names, telephone numbers and other information to assist in making emergency calls.

- The log book shall be the official document used to record a history of patrol rounds.

- The log book shall be maintained on the premises and be available for inspection by the Deputy State Fire Marshal.

Fire Watch log

Visually inspect each room and/or space in the facility at _____ minute intervals.

Visually inspect the perimeter (outside) of the facility when directed by the Deputy State Fire Marshal, which may include mechanical/electrical rooms and outbuildings at _____ minute intervals.

DATE	TIME	PERSON COMPLETING INSPECTION (Signature required)	COMMENTS (Upon visual inspection no evidence of a any smok or fire noted)

Fire Watch Guideline

(Complete and return to the Deputy State Fire Marshal)

Assigned fire watch personnel shall:

1. Be thoroughly familiar with the area they are patrolling.
2. Perform patrol operations according to instructions from State Fire Marshal.
3. Utilized the attached fire watch log to document patrol rounds any significant findings.
4. Assigned fire watch personnel shall perform fire watch duties only and have no other responsibility.
5. Relay any special orders or pertinent information to relief personnel and management.

NOTE: The fire watch conditions shall not be terminated without the Deputy State Fire Marshal's written authorization.

FACILITY:

_____

_____

_____

_____

FIRE WATCH FOR ENTIRE BUILDING:

[ ] YES

[ ] NO

SPECIFIC AREAS _____

PERSON RESPONSIBLE TO OVERSEE FIRE WATCH:

Name: _____

Title: _____

Date: _____

DSA IR F-2

FIRE WATCH REQUIREMENTS DURING SCHOOL CONSTRUCTION PROJECTS

Disciplines: Fire & Life Safety, Structural **History:** Issued 12-20-17

PURPOSE: This Interpretation of Regulations (IR) clarifies code requirements based on the California Building Code (CBC), California Fire Code (CFC) and California Code of Regulations (CCR) Title 19 as related to non-operable fire protection/life safety systems requiring a fire watch.

BACKGROUND: 2016 CFC section 901.7 and CCR Title 19 section 1.14 require fire detection and alarm systems, fire hydrant systems, extinguishing systems, mechanical smoke exhaust systems, and smoke and heat vents to be maintained in an operative condition at all times. CFC section 901.7 directs that when a fire protection system is out of service, the fire department and fire code official be notified immediately and the school district shall establish a fire watch. For purposes of application, the Division of the State Architect (DSA) is the fire code official.

SCOPE: During the course of a construction project under the jurisdiction of DSA, DSA is the fire code official. The scope of this IR is confined to those situations where DSA has jurisdiction.

GENERAL: It is the intent of the CFC that fire protection/life safety systems in schools be maintained and fully operable at all times. In the event that a public school (grades K–12 or community colleges) within the jurisdiction of DSA has a fire protection/life safety system that is not operating in a dependable manner, that campus, or the affected portion of the campus, shall be provided a “fire watch.”

A fire watch is intended as a temporary alternate to a fire protection/life safety system and allows a building to be temporarily occupied while the fire protection system is out of service. The purpose of a fire watch is to protect human life and property and transmit an immediate alarm to the building occupants and fire department. 2016 CFC, Chapter 9, Section 901.7, directs that where utilized, fire watches shall be provided with at least one approved means for notifying the fire department. The sole duty of the fire watch shall be dedicated to performing constant patrols of the protected premises and keep watch for evidence of fires such as smoke or flames.

1. REQUIRED FIRE WATCH: When, as part of an alteration or modernization project or construction of a new building a fire protection/life safety system is placed out of service and affects any occupied portion of an existing building undergoing renovation or occupied buildings or portions of the campus, then the school district, DSA, and the Architect/Engineer in general responsible charge of the construction project shall be notified immediately by the project inspector. It will be the school district’s responsibility to establish, instruct and maintain fire watch personnel in/at the affected building(s).

Where a fire alarm system is out of service, warning signs shall be posted at all entrances to any building to inform the occupants (see paragraph 1.3).

FIRE WATCH REQUIREMENTS DURING SCHOOL CONSTRUCTION PROJECTS

Modernizations of existing buildings or construction of new buildings that are not occupied by the public, staff or students during construction, shall not require a fire watch as long as the construction efforts do not affect other occupied areas of the building.

1.1 Fire Watch Plan: The school district shall develop a fire watch plan with the applicable building(s) identified on a site and building plan, and coordinate with the local fire department.

When requested, the school district shall provide a copy of the fire watch plan to the DSA Field Engineer for the region in which the construction is taking place.

A copy of the fire watch plan shall be made available to the local fire authority upon request.

1.2 Requirements of a Fire Watch Plan:

- Include a procedure for notifying the fire department and other contacts deemed necessary by the school district for notification.
- Indicate area(s) to be patrolled and locations of portable fire extinguishers, means of egress and areas of special hazards. If a kitchen hood extinguishing system is included in the non-operable alarm system, the kitchen shall be included in the patrol route during cooking activities.
- The method of sounding an alarm shall be described to initiate the evacuation of building(s). The manner of alarm shall be conveyed to staff and students.
- Determine at least one means of direct communication with the local fire department; a telephone/cell phone is acceptable provided that a test run of the designated routes verifies signal strength of the cell phone at all locations.

1.3 Posting: Signs shall state,

"WARNING, FIRE ALARM SYSTEM IS CURRENTLY INOPERABLE.

A FIRE WATCH IS BEING CONDUCTED.

FIRE WATCH PERSONNEL WILL NOTIFY YOU BY

_____

(State means of notification.)

IN THE EVENT THAT BUILDING EVACUATION IS REQUIRED."

1.4 Fire Watch Personnel: The school district shall designate the fire watch personnel who are familiar with and are able to perform the duties as described in the fire watch plan.

The fire watch personnel shall not perform firefighting duties beyond the scope of an ordinary citizen. (Use of portable fire extinguishers is permitted, provided proper training in the use of fire extinguishers has been received and fire watch personnel feel confident in their ability to suppress a fire.)

1.5 The Fire Watch Personnel Duties: Duties shall include, but not be limited to, the following:

- Fire watch personnel are to be thoroughly familiar with facilities and areas they are patrolling. Route shall be a roving and continuous observation of the entire facility at least once each hour. Where hazardous operations (welding, use of open flame) are occurring, the frequency shall be every thirty minutes.
- Identify any fire, life or property hazards to appropriate contact per the fire watch plan.
- If a fire is discovered, the fire watch shall immediately:
  - Notify the fire department.
  - Notify occupants of the facility of the need to evacuate by a pre-described signal as outlined in 1.2 above. If the horns or public address function of the alarm system are still functional, use them to assist with evacuation of the building.
- Follow the provisions of the fire watch plan.
- Have knowledge of the location and use of fire protection equipment such as fire extinguishers.
- Be familiar with and manually activate fire door releases and/or stage roof vents or stage fire curtain as necessary when, in the judgment of the fire watch personnel, those portions of the building are affected.
- Update the fire watch log at the conclusion of each fire watch route.

1.6 Fire Watch Log: A fire watch log should be maintained at the facility and available to the local fire department and DSA field staff at all times during the fire watch. The school district shall determine the specific hours the fire watch will be on duty. At a minimum, the fire watch shall be on duty during all periods when the building(s) is/are occupied.

The log shall contain a directory of contact names, telephone numbers and other information necessary for making emergency calls.

The log shall indicate the following:

- Address of the facility.
- Name of the person conducting the fire watch.
- Times that the patrol has completed each tour of the facility.
- Record of communication(s) to the fire department.

2. TERMINATION OF FIRE WATCH: Where the fire watch is required due to a fire alarm system installation or modification, the completed or repaired fire alarm system shall be tested per National Fire Protection (NFPA) standard 72 and the system manufacturer's installation requirements. Testing and inspection of the system shall be documented utilizing the NFPA 72 Testing and Inspection Form. The project inspector

shall submit to the school district, A/E in general responsible charge, the local fire authority and DSA, as applicable, copies of the NFPA 72 "Record of Completion."

- It is the school district's responsibility to cancel the fire watch once the fire protection system has been deemed operable as communicated by the project inspector.
- Once the fire watch has been cancelled, the project inspector shall:
  - Notify the local fire department.
  - Notify DSA field engineer.
  - Verify removal of signs.

REFERENCES:

California Code of Regulations Title 19, Section 1.14

California Code of Regulations Title 24

Part 1, California Administrative Code, Section 4-304

Part 9, California Fire Code, Section 901.7

This Interpretation of Regulations (IR) is intended for use by the Division of the State Architect (DSA) staff and by design professionals to promote more uniform statewide criteria for plan review and construction inspection of projects within the jurisdiction of DSA which includes State of California public elementary and secondary schools (grades K–12), community colleges and state-owned or state-leased essential services buildings. This IR indicates an acceptable method for achieving compliance with applicable codes and regulations, although other methods proposed by design professionals may be considered by DSA.

This IR is reviewed on a regular basis and is subject to revision at any time. Please check DSA's website for currently effective IRs. Only IRs listed on the webpage at www.dgs.ca.gov/dsa/Resources/IRManual.aspx at the time of plan submittal to DSA are considered applicable.

LITHONIA LIGHTING®

Catalog Number	
Notes	
Type	

BLT Series LED

2BLT2

2' x 2'
LED



FEATURES & SPECIFICATIONS

INTENDED USE — The BLT Best-in-Value Low Profile LED luminaire features a popular center basket design that offers a clean, versatile style and volumetric distribution. High efficacy LED light engines deliver energy savings and low maintenance compared to traditional sources. An extensive selection of configurations and options make the BLT the perfect choice for many lighting applications including schools, offices and other commercial spaces, retail, hospitals and healthcare facilities. The low profile BLT design (2-3/8") also makes it an excellent choice for renovation projects.

CONSTRUCTION — Prior to fabrication, BLT components are coated with a proprietary paint blend and die-formed for dimensional consistency.

The reflector is finished with a high reflective matte white powder paint for improved aesthetics and increased light diffusion.

End plates contain easy-to-position integral T-bar clips for securely attaching the luminaire to the T-grid. For additional T-grid security, optional screw on T-bar clips are available.

Diffusers are extruded from impact modified acrylic for increased durability.

LED boards and drivers are accessible from the plenum.

OPTICS — Volumetric illumination is achieved by creating an optimal mix of light to walls, partitions and vertical and horizontal work surfaces – rendering the interior space, objects and occupants in a more balanced, complimentary luminous environment. High performance extruded acrylic diffusers conceal LEDs and efficiently deliver light in a volumetric distribution. Four diffuser choices available - curved and square designs with linear prisms or a smooth frosted finish.

ELECTRICAL — Long-life LEDs, coupled with high-efficiency drivers, provide superior quantity and quality of illumination for extended service life. 80% LED lumen maintenance at 60,000 hours (L80/60,000). Color Variation within 3-step MacAdam ellipse (3SDCM).

Non-Configurable BLT: Generic 0-10 volt dimming driver. Dims to 10%

Configurable BLT: available in High Efficiency (HE) versions for applications where a lower wattage (over the standard product) is required. The High Efficiency versions deliver >130 LPW and can be specified via the Lumen Package designations in the Ordering Information below.

eldoLED driver options deliver choice of dimming range, and choices for control, while assuring flicker-free, low-current inrush, 89% efficiency and low EMI.

Optional integrated nLight®controls make each luminaire addressable - allowing them to digitally communicate with other nLight enabled controls such as dimmers, switches, occupancy sensors and photocontrols. Connection to nLight is simple. It can be accomplished with integrated nLight AIR wireless RIO, RES7 sensors, or through standard Cat-5 cabling. nLight offers unique plug-and-play convenience as devices and luminaires automatically discover each other and self-commission. nLight AIR is commissioned easily through an intuitive model app.

Lumen Management: Unique lumen management system (option N80) provides on board intelligence that actively manages the LED light source so that constant lumen output is maintained over the system life, preventing the energy waste created by the traditional practice of over-lighting.

Step-level dimming option allows system to be switched to 50% power for compliance with common energy codes while maintaining fixture appearance.

Driver disconnect provided where required to comply with US and Canadian codes.

SENSOR— Integrated sensor (individual control): Sensor Switch MSD7ADCX ((Passive infrared (PIR)) or MSDPDT7ADCX ((PIR/Microphonics Dual Tech (PDT)) integrated occupancy sensor/automatic dimming photocell allows the luminaire to power off when the space is unoccupied or enough ambient light is entering the space. See page 4 for more details on the integrated sensor.

Integrated Sensor (nLight Wired Networking): This sensor is nLight-enabled, meaning it has the ability to communicate over an nLight network. When wired, using CAT-5 cabling, with other nLight-enabled sensors, power packs, or WallPods, an nLight control zone is created. Once linked to a Gateway, directly or via a Bridge, the zone becomes capable of remote status monitoring and control via SensorView software. See page 4 for the nLight sensor options.

Integrated Smart Sensor (nLight Air Wireless Platform): The RES7 sensor is nLight AIR enabled, meaning it has the ability to communicate over the wireless nLight control platform. It is available with an automatic dimming photocell, and either a digital PIR or a microphonics (PDT) dual technology occupancy sensor. It pairs to other luminaires and wall switches through our mobile app, CL***AIR***ITY, which allows for simple sensor adjustment. See page 4 for more details on the Integrated Smart Sensor.

INSTALLATION — The BLT's low profile design of only 2-3/8" provides increased installation flexibility especially in restrictive plenum applications. The BLT fits into standard 15/16" and narrow 9/16" T-grid ceiling systems.

Suitable for damp location.

For recessed mounting in hard ceiling applications, Drywall Grid Adapters (DGA) are available as an accessory. See Accessories section.

LISTINGS — CSA Certified to meet U.S. and Canadian standards. IC rated.

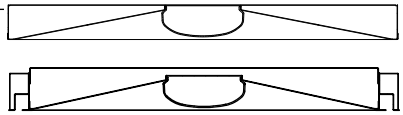
DesignLights Consortium® (DLC) Premium qualified product. Not all versions of this product may be DLC Premium qualified. Please check the DLC Qualified Products List at www.designlights.org/QPL to confirm which versions are qualified.

WARRANTY — 5-year limited warranty. Complete warranty terms located at: www.acuitybrands.com/resources/terms-and-conditions

NOTE: Actual performance may differ as a result of end-user environment and application.
All values are design or typical values, measured under laboratory conditions at 25 °C.
Specifications subject to change without notice.

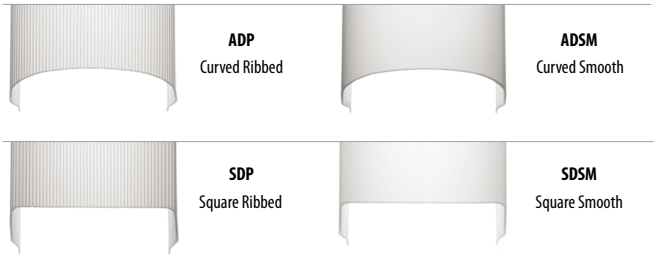
Specifications

Length: 23-3/4 (60.3)
Width: 23-3/4 (60.3)
Depth: 2-3/8 (6.0)
Depth with Air supply/return: 2-3/4 (6.9)



All dimensions are inches (centimeters) unless otherwise specified.

Multiple Diffuser Options



A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is part of an A+ Certified solution for nLight® control networks when ordered with drivers marked by a shaded background*
- This luminaire is part of an A+ Certified solution for nLight control networks, providing advanced control functionality at the luminaire level, when selection includes driver and control options marked by a shaded background*

To learn more about A+, visit www.acuitybrands.com/aplus.

*See ordering tree for details

2BLT Volumetric Recessed Lighting 2'x2'

A+ Capable options indicated by this color background.

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: 2BLT2 33L ADP EZ1 LP835

2BLT2

Series	Air function	Lumens[2]		Diffuser	Voltage	Driver	Color temperature
2BLT2 2X2 BLT	(blank) Static A Air supply/ return[1]	**Standard efficiency[3,4] (>125 LPW)** 20L 2000 33L 3300 40L 4000 48L 4800	**High efficiency[5,6] (>130 LPW)** 20LHE 2000 33LHE 3300 40LHE 4000 48LHE 4800	ADP Curved, linear prisms ADSM Curved, smooth SDP Square, linear prisms SDSM Square, smooth **Includes trim rings to match sensored version** ADPT Curved, linear prisms ADSMT Curved, smooth SDPT Square, linear prisms SDSMT Square, smooth	(blank) MVOLT 120 120V 277 277V 347 347V[7]	EZ1 eldoLED dims to 1% (0-10 volt dimming) GZ1 Dims to 1% (0-10V dimming)[8] GZ10 Dims to 10% (0-10V dimming)[8] SLD Step-level dimming[9]	LP830 82CRI, 3000 K LP835 82CRI, 3500 K LP840 82CRI, 4000 K LP850 82CRI, 5000 K LP930 90CRI, 3000K LP935 90CRI, 3500K LP940 90CRI, 4000K LP950 90CRI, 5000K

nLight Interface

nLight Wired

(blank)	no nLight ® interface
N80	nLight with 80% lumen management
N80EMG	nLight with 80% lumen management For use with generator supply EM power[10]
N100	nLight without lumen management
N100EMG	nLight without lumen management For use with generator supply EM power[10]

nLight Wireless

(blank)	no nLight ® interface
NLTAIR2	nLight AIR Generation 2 enabled[11]

Control[12]

nLight Wired

(blank)	No sensor control
NES7	nLight™ nES 7 PIR integral occupancy sensor[13]
NESPDT7	nLight™ nES PDT 7 dual technology integral occupancy control[13]
NES7ADCX	nLight™ nES 7 ADCX PIR integral occupancy sensor with automatic dimming photocell[13]
NESPDT7ADCX	nLight™ nES PDT 7 dual technology integral occupancy sensor with automatic dimming photocell[13]

nLight Wireless

RES7	nLight AIR PIR integral occupancy sensor with automatic dimming photocell for Networking Capabilities
RES7PDT	nLight AIR microphonics dual technology occupancy sensor with automatic dimming photocell
RIO	nLight AIR radio module without sensor

Individual Control

MSD7ADCX	PIR integral occupancy sensor with automatic dimming control photocell[14]
MSDPDT7ADCX	PDT integral occupancy sensor with automatic dimming control photocell[14]

Options

EL7L	700 lumen battery pack (Noncompliant with CA T20)[15]
EL14L	1400 lumen battery pack (Noncompliant with CA T20)[15]
EL14LSD	1400 lumen battery pack with self-diagnostic testing feature (Noncompliant with CA T20)[15,16]
E10WLCP	EM Self-Diagnostic battery pack, 10W Constant Power, Certified in CA Title 20 MAEDBS[15]
CP	Chicago plenum[17]
BGTD	Bodine Generator Transfer Device[18]
PWS1836	6' pre-wire, 3/8" diameter, 18 gauge, 1 circuit
PWS1846	6' pre-wire, 3/8" diameter, 18 gauge, 2 circuit
PWS1846 PWSLV	Two cables: one 6' pre-wire, 3/8" diameter, 18 gauge, 2 circuits; one 6' pre-wire, 3/8" diameter, 18 gauge, purple and gray[19]
PWS1856LV	6' pre-wire, 3/8" diameter, 18 gauge, 1 circuit w/ low voltage purple and grey wires[19]
GLR	Fast-blowing fuse[20]
GMF	Slow-blowing fuse[20]
NPLT	Narrow pallet
RRL_	RELOC®-ready luminaire[21]
LATC	Earthquake clip
DWAM	Anti-Microbial paint
JP32	Job packaging
IP5X	Gasketed diffuser compartment to meet IP5X rating[22]

Non-Configurable BLT

Stock/MTO	Catalog Description *	UPC	Lumens	Wattage	LPW	Color Temperature	Voltage	Pallet Qty
Stock	2BLT2 33L ADP LP835	00190887529708	3332	26	127	3500K/82 CRI	120-277	52
	2BLT2 33L ADP LP840	00190887529739	3385	26	129	4000K/82CRI	120-277	52
	2BLT2 33L ADP EL14L LP835	00190887529890	3332	26	127	3500K/82CRI	120-277	52
	2BLT2 33L ADP EL14L LP840	00190887529937	3385	26	129	4000K/82CRI	120-277	52
MTO	2BLT2 33L ADP 347 LP835		3332	26	127	3500K/82 CRI	347	52
	2BLT2 33L ADP 347 LP840		3385	26	129	4000K/82CRI	347	52

*Generic 0-10V Dimming to 10%.

Notes and Accessories next page

LED: One Lithonia Way Conyers, GA 30012 Phone: 800-858-7763 www.lithonia.com

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2BLT Volumetric Recessed Lighting 2'x2'

Notes
1 Consult factory for airflow data.
2 Approximate lumen output.
3 All versions may not achieve 125+ LPW. Refer to photometry on www.acuitybrands.com.
4 Air supply/return option, 90 CRI, and versions with integral sensor trim rings may not achieve 125 LPW.
5 All versions may not achieve 130+ LPW. Refer to photometry on www.acuitybrands.com.
6 Air supply/return option, 90 CRI, and versions with integral sensor trim rings may not achieve 130 LPW.
7 Not available with SLD EL7L, or EL14L options.
8 GZ1 and GZ10 not available with any Control or Sensor options
9 Not available with N80, N80EMG, N100, N100EMG, NLTAIR2, or occupancy control.
10 nLight EMG option requires a connection to existing nLight network. Power is provided from a separate N80 or N100 enabled fixture.
11 Must order with RES7, RES7PDT or Rio module. Must order with EZ1 driver.
12 Must specify diffuser with trim rings. See sensor options on page 4.
13 Requires N80, N80EMG, N100, or N100EMG. Must order with EZ1 driver.
14 Only available with EZ1 driver option. 0-10v dimming wires not accessible via access plate.
15 When using pre-wire option, use PWS1846 or PWS1846 PWSLV.
16 For more information, please see the PSSD2 specification sheet.
17 Not available with N80, N80EMG, N100, or N100EMG.
18 Must specify voltage. Requires BSE labeling, voltage specific. Consult factory for options.
19 Not available with nLight wired/wireless network or individual controls.
20 Must specify voltage, 120 or 277, with GLR and GFM fusing.
21 For ordering logic consult RRL_2013.
22 Not available with air supply/return or Wired Networking (NES_) and Individual Control (MSD_) sensors.

Accessories: *Order as separate catalog number.*

DGA22	Drywall grid adapter for 2x2 recessed fixture
2X2SMKSHP	Surface Mount Troffer Kit Pre Paint
2X2SMKSHP PAF	Surface Mount Troffer Kit Post Paint

nLight® Wired Control Accessories:
Order as separate catalog number. Visit www.acuitybrands.com/products/controls/nlight.

WallPod stations	**Model number**	**Occupancy sensors**	**Model number**
On/Off	nPODM [color]	Small motion 360°, ceiling (PIR / dual tech)	nCM 9 RJB / nCM PDT 9 RJB
On/Off & raise/lower	nPODM DX [color]	Large motion 360°, ceiling (PIR / dual tech)	nCM10 RJB / nCM PDT 10 RJB
Graphic touchscreen	nPOD GFX [color]	Wall switch with raise/lower	nWSX PDT LV DX [color]
Photocell controls	**Model number**	**Cat-5 cable (plenum rated)**	**Model number**
Full range dimming	nCM ADCX RJB	10' cable	CAT5 10FT J1
		30' cable	CAT5 30FT J1

nLight® AIR Control Accessories:
Order as separate catalog number. Visit www.acuitybrands.com/products/controls/nlightair.

Wall switches	**Model number**
On/Off single pole	rPODB [color] G2
On/Off two pole	rPODB 2P [color] G2
On/Off & raise/lower single pole	rPODB DX [color] G2
On/Off & raise/lower two pole	rPODB 2P DX [color] G2
On/Off & raise/lower single pole	rPODBZ DX WH G2

rCMS[1] **Example: RCMS PDT 10 AR G2**

Series / Detection	**Power Supply[1]**	**Occupancy Detection**	**Lens (Required)**	**Operating Mode**	**Generation**
RCMS nLight AIR occupancy and daylight sensor	[blank] Power Supply ordered separately PS 150 Standard 150 mA Power Supply	[blank] PIR Detection PDT Dual Tech PIR/ Microphonics	10 Large Motion/ Extended Range 360° 9 Small Motion/ Extended Range 360° 6 High Bay 360° Lens	[BLANK] None AR Auxiliary Relay	G2 Generation 2 compatibility

Replacement Parts: *Order as separate catalog number.*

*247WJV	2DBLT24 ADP LENS ASSEMBLY	2 ft. replacement lens
*249P2P	2DBLT24 SDP LENS ASSEMBLY	2 ft. replacement lens
*249P2W	2DBLT24 ADSM LENS ASSEMBLY	2 ft. replacement lens
*249P32	2DBLT24 SDSM LENS ASSEMBLY	2 ft. replacement lens
*237LT1	2DBLT24 ADPT LENS ASSEMBLY	2 ft. replacement lens
*237LT3	2DBLT24 SDPT LENS ASSEMBLY	2 ft. replacement lens
*237LT5	2DBLT24 ADSMT LENS ASSEMBLY	2 ft. replacement lens
*237LT7	2DBLT24 SDSMT LENS ASSEMBLY	2 ft. replacement lens
*237LT9	2DBLT24 ADPT SENSOR LENS ASSEMBLY	2 ft. replacement lens
*237M4Y	2DBLT24 SDPT SENSOR LENS ASSEMBLY	2 ft. replacement lens
*237M57	2DBLT24 ADSMT SENSOR LENS ASSEMBLY	2 ft. replacement lens
*237M5H	2DBLT24 SDSMT SENSOR LENS ASSEMBLY	2 ft. replacement lens

Notes
1 RCMS requires low voltage power from either RPP20 DS 24V G2 or PS150.

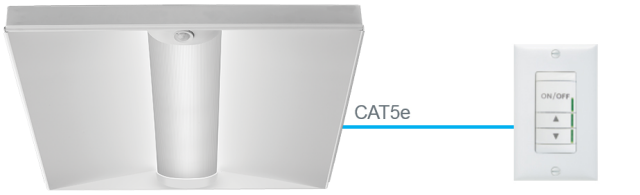


LED: One Lithonia Way Conyers, GA 30012 Phone: 800-858-7763 www.lithonia.com
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2BLT Volumetric Recessed Lighting 2'x2'

Sensor Options					
Option	Automatic Dimming Photocell	Occupancy Sensing		nLight Wired Networking	nLight AIR Networking
		PIR	PDT		
MSD7ADCX	X	X			
MSDPDT7ADCX	X		X		
NES7		X		X	
NES7ADCX	X	X		X	
NESPDT7			X	X	
NESPDT7ADCX	X		X	X	
RES7	X	X			X
RESPDT7	X	X	X		X

Basic nLight Zone



Integrated Sensor with Individual Control

The MSD7ADCX PIR occupancy sensor/automatic dimming photocell is ideal for areas without obstructions and where daylight harvesting may be desired. Suggested applications include, but not limited to, hallways, corridors, storage rooms, and breakrooms or other areas where people are typically moving.

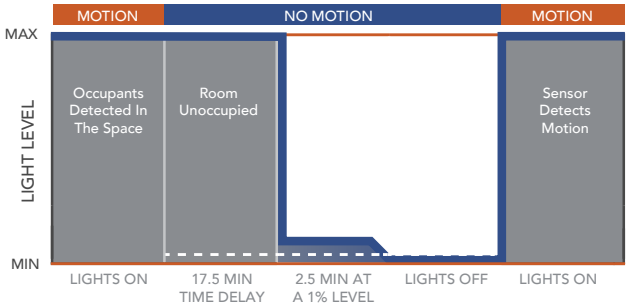
The MSDPDT7ADCX PIR/Microphonics Dual Tech occupancy sensor/automatic dimming photocell is ideal for areas with obstructions and where daylight harvesting is desired. Suggested applications include, but not limited to, open offices, private offices, classrooms, public restrooms, and conference rooms.

nLight Wired Networking

The nES 7 is ideal for small rooms without obstructions or areas with primarily walking motion. Ideal areas include hallways, corridors, storage rooms, and breakrooms. Additionally, the NES7ADCX includes an integrated photocell, which enables daylight harvesting controls.

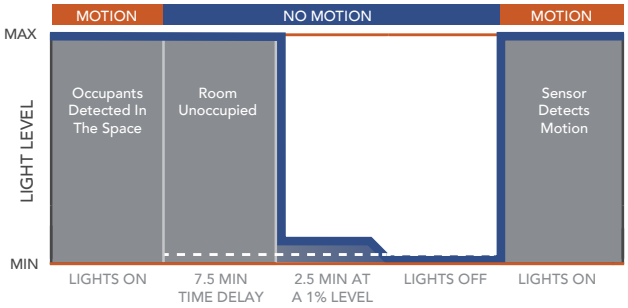
For areas like restrooms, private offices, open offices, conference rooms or any space with obstructions, the nES PDT 7 dual technology sensor is recommended. The nES PDT 7 utilizes both PIR (passive infrared) and Microphonics technologies to detect occupancy. Additionally, the NESPDT7ADCX includes an integrated photocell, which enables daylight harvesting controls which is ideal for areas where windows are present.

Sequence of Operation



*The presetting on the automatic dimming photocell is 5fc.

Sequence of Operation



*The presetting on the automatic dimming photocell is 5fc.

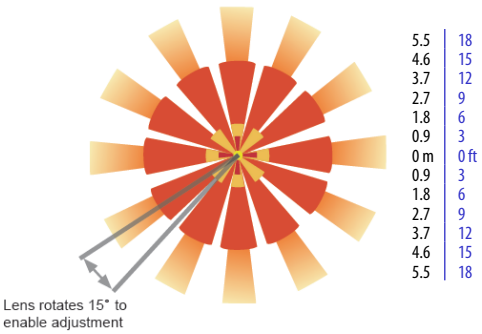
Sensor Coverage Pattern
Mini 360° Lens

- Recommended for walking motion detection from mounting heights between 8 ft (2.44 m) and 20 ft (6.10 m)
- Initial detection of walking motion along sensor axes at distances of 2x the mounting height up to 15 ft (4.57 m) and
- 1.75x up to 20 ft (6.10 m).
- Provides 12 ft (3.66 m) radial detection of small motion when mounted at 9 ft (2.74 m)
- Initial detection will occur earlier when walking across sensor's field of view than when walking directly at sensor

nLight AIR Wireless

nLight AIR is the ideal solution for retrofit or new construction spaces where adding additional wiring can be labor intensive and nLight AIR is available with or without an integral sensor. The integrated RES7 or RES7PDT smart sensors are part of each luminaire in the nLight AIR network, which can be grouped to control multiple luminaires. The granularity of control with the digital PIR occupancy detection and daylight sensing makes a great solution for any application.

9 FT Mounting





Simple as 1,2,3

1. Install the nLight® AIR fixtures with embedded smart sensor
2. Install the wireless battery-powered wall switch
3. With CLAIRITY app, pair the fixtures with the wall switch and if desired, customize the sensor settings for the desired outcome

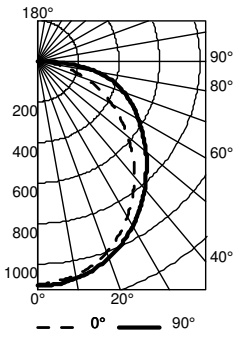


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2BLT Volumetric Recessed Lighting 2'x2'

PHOTOMETRICS

2BLT2 33L ADP LP835, 3332 delivered lumens, test no. ISF36900P19, tested in accordance to IESNA LM-79



CP Summary

	0°	90
0°	1103	1103
5°	1090	1104
15°	1042	1064
25°	946	989
35°	817	881
45°	664	757
55°	500	634
65°	340	517
75°	177	383
85°	40	164
90	1	14

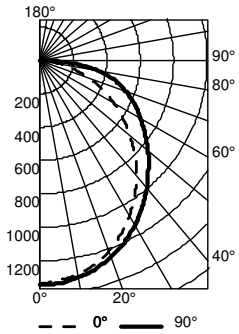
Coefficients of Utilization

RCR	pf 20% pc 80% pw 70%	50%	30%	70%	50%	30%	10%	50%	30%	10%
0	119	119	119	116	116	116	111	111	111
1	108	102	97	100	96	92	96	92	89
2	97	88	81	86	80	74	83	77	72
3	88	77	69	76	68	61	72	66	60
4	81	68	59	67	58	52	64	57	51
5	74	61	51	60	51	44	57	50	44
6	68	55	45	54	45	39	52	44	38
7	63	50	40	49	40	34	47	39	34
8	59	45	36	44	36	30	43	36	30
9	55	41	33	41	33	27	40	32	27
10	52	38	30	38	30	25	37	30	25

Zonal Lumen Summary

Zone	Lumens	% Lamp	% Fixture
0° - 30°	853	25.6	25.6
0° - 40°	1390	41.7	41.7
0° - 60°	2466	74.0	74.0
0° - 90°	3330	100.0	100.0
90° - 120°	2	0.0	0.0
90° - 130°	2	0.0	0.0
90° - 150°	2	0.0	0.0
90° - 180°	2	0.0	0.0
0° - 180°	3332	100.0	100.0

2BLT2 40L ADP LP835, 4041 delivered lumens, test no. ISF36900P35, tested in accordance to IESNA LM-79



CP Summary

	0°	90
0°	1338	1338
5°	1322	1339
15°	1263	1291
25°	1148	1199
35°	991	1069
45°	805	918
55°	607	769
65°	412	627
75°	214	465
85°	48	199
90	1	17

Coefficients of Utilization

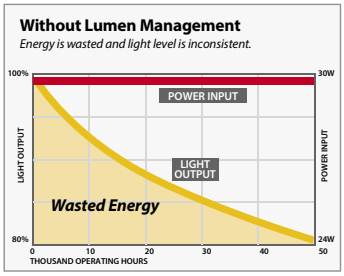
RCR	pf 20% pc 80% pw 70%	50%	30%	70%	50%	30%	10%	50%	30%	10%
0	119	119	119	116	116	116	111	111	111
1	108	102	97	100	96	92	96	92	89
2	97	88	81	86	80	74	83	77	72
3	88	77	69	76	68	61	72	66	60
4	81	68	59	67	58	52	64	57	51
5	74	61	51	60	51	44	57	50	44
6	68	55	45	54	45	39	52	44	38
7	63	50	40	49	40	34	47	39	34
8	59	45	36	44	36	30	43	36	30
9	55	41	33	41	33	27	40	32	27
10	52	38	30	38	30	25	37	30	25

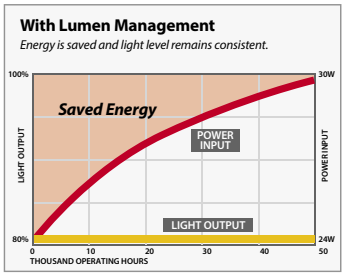
Zonal Lumen Summary

Zone	Lumens	% Lamp	% Fixture
0° - 30°	1035	25.6	25.6
0° - 40°	1686	41.7	41.7
0° - 60°	2991	74.0	74.0
0° - 90°	4039	100.0	100.0
90° - 120°	2	0.0	0.0
90° - 130°	2	0.0	0.0
90° - 150°	2	0.0	0.0
90° - 180°	2	0.0	0.0
0° - 180°	4041	100.0	100.0

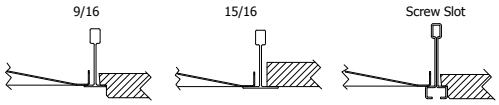
Constant Lumen Management

Enabled by the embedded nLight control, the BLT actively tracks its run-time and manages its light source such that constant lumen output is maintained over the system life. Referred to as lumen management, this feature eliminates the energy waste created by the traditional practice of over-lighting.





MOUNTING DATA	
Ceiling Type	**Appropriate Trim Type**
Exposed grid tee (1' and 9/16")	G
Concealed grid tee	G
Plaster or plasterboard	G*



*DGA accessory available to provide ceiling trim flange and fixture support for plaster or plasterboard ceiling. Recommended rough-in dimensions for DGA installation is 24-3/4" x 24-3/4" (Tolerance is +1/8", -0").

How to Estimate Delivered Lumens in Emergency Mode

Use the formula below to estimate the delivered lumens in emergency mode

Delivered Lumens = 1.25 x P x LPW

P = Ouput power of emergency driver. P = 10W for E10WLCP option.

LPW = Lumen per watt rating of the luminaire. This information is available on the ABL luminaire spec sheet. LPW = Lumen per watt rating of the luminaire. LPW information available in Performance Data section.

LED: One Lithonia Way Conyers, GA 30012 Phone: 800-858-7763 www.lithonia.com

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Performance Data					
Model Number	**Lumens**	**LPW**	**Watts**	**DLC Listing**	**DLC ID**
2BLT2 20L ADP EZ1 (GZ1, GZ10) LP840 [All Options]	2065.45	124.06	16.64	Premium	PM92196A
2BLT2 20L ADP EZ1 (GZ10) LP835 [All Options]	2033	126.58	16.06	Premium	P6445UVD
2BLT2 20L ADP GZ1 LP835 [All Options]	2033	122.11	16.64	standard	PLNK6MX8
2BLT2 20L ADPT EZ1 (GZ10) LP840 [All Options]	2037.91	126.89	16.06	Premium	PYX15QEQ
2BLT2 20L ADPT GZ1 LP835 [All Options]	2005.89	120.49	16.64	standard	P40HQGLB
2BLT2 20L ADPT GZ1 LP840 [All Options]	2037.91	122.41	16.64	standard	PB3HB9AK
2BLT2 33L ADP EZ1 (GZ1, GZ10) LP835 [All Options]	3332	124.92	26.67	Premium	PHSXHE8F
2BLT2 33L ADP EZ1 (GZ1, GZ10) LP840 [All Options]	3385.19	126.91	26.67	Premium	PD18CKQ8
2BLT2 33L ADPT EZ1 (GZ1, GZ10) LP840 [All Options]	3340.05	125.22	26.67	Premium	PF98CZ2H
2BLT2 33L ADPT EZ1 (GZ10) LP835 [All Options]	3287.57	125.14	26.27	Premium	PTKZR9WQ
2BLT2 33L ADPT GZ1 LP835 [All Options]	3287.57	123.25	26.67	standard	PTN5023N
2BLT2 40L ADP EZ1 (GZ1, GZ10) LP835 [All Options]	4041	127.35	31.73	Premium	P1XWW9GV
2BLT2 40L ADP EZ1 (GZ1, GZ10) LP840 [All Options]	4105.51	129.38	31.73	Premium	PHCQ2CQF
2BLT2 40L ADPT EZ1 (GZ1, GZ10) LP835 [All Options]	3987.12	125.65	31.73	Premium	PW6RMMJ4
2BLT2 40L ADPT EZ1 (GZ1, GZ10) LP840 [All Options]	4050.77	127.65	31.73	Premium	P5YYDAA8
2BLT2 48L ADP EZ1 (GZ1, GZ10) LP835 [All Options]	4800	109.9	43.67	standard	PJRH1R1G
2BLT2 48L ADP EZ1 (GZ1, GZ10) LP840 [All Options]	4876.63	111.66	43.67	standard	P8G93YOK
2BLT2 48L ADPT EZ1 (GZ1, GZ10) LP835 [All Options]	4736	108.44	43.67	standard	PITU3V6X
2BLT2 48L ADPT EZ1 (GZ1, GZ10) LP840 [All Options]	4811.61	110.17	43.67	standard	P5X2XU76

DLC information is subject to change, for the most up-to-date information please refer to www.dlc.org. Above listings do not cover 347v or SLD.

HE Performance Data					
Model Number	**Lumens**	**LPW**	**Watts**	**DLC Listing**	**DLC ID**
2BLT2 20LHE ADP EZ1 (GZ1, GZ10) LP835 [All Options]	1948	130.59	14.91	Premium	PUQCZNQI
2BLT2 20LHE ADP EZ1 (GZ1, GZ10) LP840 [All Options]	1979.1	132.67	14.91	Premium	PJCZRW21
2BLT2 20LHE ADPT EZ1 (GZ1, GZ10) LP840 [All Options]	1952.71	130.9	14.91	Premium	PLC4RF4L
2BLT2 33LHE ADP EZ1 (GZ1, GZ10) LP835 [All Options]	3392	137.3	24.7	Premium	PXXZN9PH
2BLT2 33LHE ADP EZ1 (GZ1, GZ10) LP840 [All Options]	3446.15	139.5	24.7	Premium	PKPJYYRF
2BLT2 33LHE ADPT EZ1 (GZ1, GZ10) LP835 [All Options]	3346.77	135.47	24.7	Premium	PZC8BZSS
2BLT2 33LHE ADPT EZ1 (GZ1, GZ10) LP840 [All Options]	3400.2	137.64	24.7	Premium	PM5G8AFU
2BLT2 40LHE ADP EZ1 (GZ1, GZ10) LP835 [All Options]	4118	133.71	30.79	Premium	PJ55XFFP
2BLT2 40LHE ADP EZ1 (GZ1, GZ10) LP840 [All Options]	4183.74	135.85	30.79	Premium	PEGFHPZD
2BLT2 40LHE ADPT EZ1 (GZ1, GZ10) LP835 [All Options]	4063.09	131.93	30.79	Premium	P8E16E9B
2BLT2 40LHE ADPT EZ1 (GZ1, GZ10) LP840 [All Options]	4127.96	134.04	30.79	Premium	PFRSSSVG
2BLT2 48LHE ADP EZ1 (GZ1, GZ10) LP835 [All Options]	4845	128	37.85	Premium	P558XUZP
2BLT2 48LHE ADP EZ1 (GZ1, GZ10) LP840 [All Options]	4922.35	130.04	37.85	Premium	P1863H56
2BLT2 48LHE ADPT EZ1 (GZ1, GZ10) LP835 [All Options]	4780.4	126.29	37.85	Premium	PHPTG5M8
2BLT2 48LHE ADPT EZ1 (GZ1, GZ10) LP840 [All Options]	4856.71	128.31	37.85	Premium	PBKN954Z

DLC information is subject to change, for the most up-to-date information please refer to www.dlc.org. Above listings do not cover 347v or SLD.

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CLASS ROOMS

LITHONIA LIGHTING®

Catalog Number	
Notes	
Type	

BLT Series LED

2BLT4

2' x 4'
LED



FEATURES & SPECIFICATIONS

INTENDED USE —The BLT Best-in-Value Low Profile LED luminaire features a popular center basket design that offers a clean, versatile style and volumetric distribution. High efficacy LED light engines deliver energy savings and low maintenance compared to traditional sources. An extensive selection of configurations and options make the BLT the perfect choice for many lighting applications including schools, offices and other commercial spaces, retail, hospitals and healthcare facilities. The low profile BLT design (2-3/8") also makes it an excellent choice for renovation projects.

CONSTRUCTION — Prior to fabrication, BLT components are coated with a proprietary paint blend and die-formed for dimensional consistency.

The reflector is finished with a high reflective matte white powder paint for improved aesthetics and increased light diffusion.

End plates contain easy-to-position integral T-bar clips for securely attaching the luminaire to the T-grid. For additional T-grid security, optional screw on T-bar clips are available.

Diffusers are extruded from impact modified acrylic for increased durability.

LED boards and drivers are accessible from the plenum.

OPTICS — Volumetric illumination is achieved by creating an optimal mix of light to walls, partitions and vertical and horizontal work surfaces – rendering the interior space, objects and occupants in a more balanced, complimentary luminous environment. High performance extruded acrylic diffusers conceal LEDs and efficiently deliver light in a volumetric distribution. Four diffuser choices available - curved and square designs with linear prisms or a smooth frosted finish.

ELECTRICAL — Long-life LEDs, coupled with high-efficiency drivers, provide superior quantity and quality of illumination for extended service life. 80% LED lumen maintenance at 60,000 hours (L80/60,000). Color Variation within 3-step MacAdam ellipse (3SDCM).

Non-Configurable BLT: Generic 0-10 volt dimming driver. Dims to 10%

Configurable BLT: available in High Efficiency (HE) versions for applications where a lower wattage (over the standard product) is required. The High Efficiency versions deliver >130 LPW and can be specified via the Lumen Package designations in the Ordering Information below.

eldoLED driver options deliver choice of dimming range, and choices for control, while assuring flicker-free, low-current inrush, 89% efficiency and low EMI.

Optional integrated nLight®controls make each luminaire addressable - allowing it to digitally communicate with other nLight enabled controls such as dimmers, switches, occupancy sensors and photocontrols. Connection to nLight is simple. It can be accomplished with integrated nLight AIR wireless RIO, RES7 sensors, or through standard Cat-5 cabling. nLight offers unique plug-and-play convenience as devices and luminaires automatically discover each other and self-commission. nLight AIR is commissioned easily through an intutitive mobile app.

Lumen Management: Unique lumen management system (option N80) provides on board intelligence that actively manages the LED light source so that constant lumen output is maintained over the system life, preventing the energy waste created by the traditional practice of over-lighting.

Step-level dimming option allows system to be switched to 50% power for compliance with common energy codes while maintaining fixture appearance.

Driver disconnect provided where required to comply with US and Canadian codes.

SENSOR— Integrated sensor (individual control): Sensor Switch MSD7ADCX ((Passive infrared (PIR)) or MSDPDT7ADCX ((PIR/Microphonics Dual Tech (PDT)) integrated occupancy sensor/automatic dimming photocell allows the luminaire to power off when the space is unoccupied or enough ambient light is entering the space. See page 4 for more details on the integrated sensor.

Integrated Sensor (nLight Wired Networking): This sensor is nLight-enabled, meaning it has the ability to communicate over an nLight network. When wired, using CAT-5 cabling, with other nLight-enabled sensors, power packs, or WallPods, an nLight control zone is created. Once linked to a Gateway, directly or via a Bridge, the zone becomes capable of remote status monitoring and control via SensorView software. See page 4 for the nLight sensor options.

Integrated Smart Sensor (nLight Air Wireless Platform): The RES7 sensor is nLight AIR enabled, meaning it has the ability to communicate over the wireless nLight control platform. It is available with an automatic dimming photocell, and either a digital PIR or a microphonics (PDT) dual technology occupancy sensor. It pairs to other luminairs and wall switches through our mobile app, CL*AIR*ITY, which allows for simple sensor adjustment. See page 4 for more details on the Integrated Smart Sensor.

INSTALLATION — The BLT's low profile design of only 2-3/8" provides increased installation flexibility especially in restrictive plenum applications. The BLT fits into standard 15/16" and narrow 9/16" T-grid ceiling systems.

Suitable for damp location.

For recessed mounting in hard ceiling applications, Drywall Grid Adapters (DGA) are available as an accessory. See Accessories section.

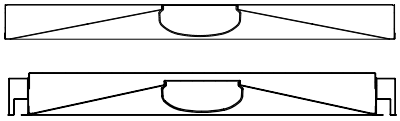
LISTINGS — CSA Certified to meet U.S. and Canadian standards. IC rated.
DesignLights Consortium® (DLC) Premium qualified product. Not all versions of this product may be DLC Premium qualified. Please check the DLC Qualified Products List at www.designlights.org/QPL to confirm which versions are qualified.

WARRANTY — 5-year limited warranty. Complete warranty terms located at:
www.acuitybrands.com/resources/terms-and-conditions

NOTE: Actual performance may differ as a result of end-user environment and application.
All values are design or typical values, measured under laboratory conditions at 25 °C.
Specifications subject to change without notice.

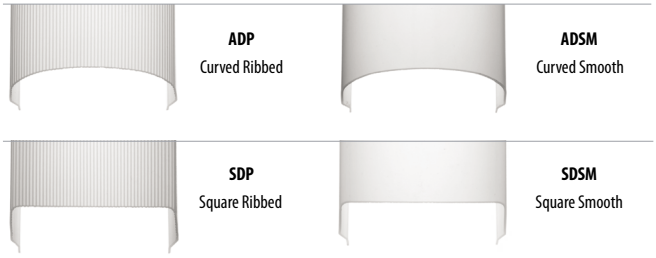
Specifications

Length: 47-3/4 (121.2)
Width: 23-3/4 (60.3)
Depth: 2-3/8 (6.0)
Depth with Air supply/return: 2-3/4 (6.9)



All dimensions are inches (centimeters) unless otherwise specified.

Multiple Diffuser Options



A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is part of an A+ Certified solution for nLight® control networks when ordered with drivers marked by a shaded background*
- This luminaire is part of an A+ Certified solution for nLight control networks, providing advanced control functionality at the luminaire level, when selection includes driver and control options marked by a shaded background*

To learn more about A+, visit www.acuitybrands.com/aplus.

*See ordering tree for details

2BLT Volumetric Recessed Lighting 2'x4'

A+ Capable options indicated by this color background.

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: 2BLT4 40L ADP EZ1 LP840

2BLT4						
Series	**Air function**	**Lumens[2]**	**Diffuser**	**Voltage**	**Driver**	**Color temperature**
2BLT4 2x4 BLT	(blank) Static A Air supply/ return[1]	**Standard efficiency (>100 LPW)** 30L 3000 40L 4000 48L 4800 60L 6000 72L 7200 85L 8500 100L 10000 120L 12000 **High efficiency[3,4] (>130 LPW)** 30LHE 3000 40LHE 4000 48LHE 4800 60LHE 6000 72LHE 7200 85LHE 8500	ADP Curved, linear prisms ADSM Curved, smooth SDP Square, linear prisms SDSM Square, smooth **Includes trim rings to match sensored version** ADPT Curved, linear prisms ADSMT Curved, smooth SDPT Square, linear prisms SDSMT Square, smooth	(blank) MVOLT 120 120V 277 277V 347 347V[5]	EZ1 eldoLED dims to 1% (0-10 volt dimming) GZ1 Dims to 1% (0-10V dimming)[6] GZ10 Dims to 10% (0-10V dimming)[6] SLD Step-level dimming[7]	LP830 82CRI, 3000 K LP835 82CRI, 3500 K LP840 82CRI, 4000 K LP850 82CRI, 5000 K LP930 90CRI, 3000K LP935 90CRI, 3500K LP940 90CRI, 4000K LP950 90CRI, 5000K

nLight Interface	**Control[10]**	**Options**
nLight Wired (blank) no nLight® interface N80 nLight with 80% lumen management N80EMG nLight with 80% lumen management For use with generator supply EM power[8] N100 nLight without lumen management N100EMG nLight without lumen management For use with generator supply EM power[8] **nLight Wireless** (blank) no nLight® interface NLTAIR2 nLight AIR Generation 2 enabled[9]	**nLight Wired** (blank) No sensor control NES7 nLight™ nES 7 PIR integral occupancy sensor[11] NESPDT7 nLight™ nES PDT 7 dual technology integral occupancy control[11] NES7ADCX nLight™ nES 7 ADCX PIR integral occupancy sensor with automatic dimming photocell[11] NESPDT7ADCX nLight™ nES PDT 7 dual technology integral occupancy sensor with automatic dimming photocell[11] **nLight Wireless** RES7 nLight AIR PIR integral occupancy sensor with automatic dimming photocell for Networking Capabilities RES7PDT nLight AIR microphonics dual technology occupancy sensor with automatic dimming photocell RIO nLight AIR radio module without sensor **Individual Control** MSD7ADCX PIR integral occupancy sensor with automatic dimming control photocell[12] MSDPDT7ADCX PDT integral occupancy sensor with automatic dimming control photocell[12]	EL7L 700 lumen battery pack (Noncompliant with CA T20)[13] EL14L 1400 lumen battery pack (Noncompliant with CA T20)[13] EL14LSD 1400 lumen battery pack with self-diagnostic testing feature (Noncompliant with CA T20)[13,14] E10WLCP EM Self-Diagnostic battery pack, 10W Constant Power, Certified in CA Title 20 MAEDBS[13] CP Chicago plenum[15] BGTD Bodine Generator Transfer Device[16] PWS1836 6' pre-wire, 3/8" diameter, 18 gauge, 1 circuit PWS1846 6' pre-wire, 3/8" diameter, 18 gauge, 2 circuit PWS1846 PWSLV Two cables: one 6' pre-wire, 3/8" diameter, 18 gauge, 2 circuits; one 6' pre-wire, 3/8" diameter, 18 gauge, purple and gray[17] PWS1856LV 6' pre-wire, 3/8" diameter, 18 gauge, 1 circuit w/low voltage purple and grey wires[17] GLR Fast-blowing fuse[18] GMF Slow-blowing fuse[18] NPLT Narrow pallet RRL_ RELOC®-ready luminaire[19] LATC Earthquake clip DWAM Anti-Microbial paint JP16 Job packaging IP5X Gasketed diffuser compartment to meet IP5X rating[20]

Accessories next page

Notes

1 Consult factory for airflow data.
2 Approximate lumen output.
3 All versions may not achieve 130+ LPW. Refer to photometry on www.acuitybrands.com.
4 Air supply/return option, 90 CRI, and versions with integral sensor trim rings may not achieve 130 LPW.
5 Not available with SLD, EL7L, EL14L, or E10WLCP options.
6 GZ1 and GZ10 not available with any Control or Sensor options
7 Not available with N80, N80EMG, N100, N100EMG, NLTAIR, or occupancy control.
8 nLight EMG option requires a connection to existing nLight network. Power is provided from a separate N80 or N100 enabled fixture.
9 Must order with RES7, RES7PDT, or RIO module. Only available with EZ1 driver. Not available with 85L, 100L, or 120L options.
10 Must specify diffuser with trim rings. See sensor options on page 4.
11 Requires N80, N80EMG, N100, or N100EMG. Only available with EZ1 driver.
12 Only available with EZ1 driver option. 0-10v dimming wires not accessible via access plate.
13 When using pre-wire option, use PWS1846 or PWS1846 PWSLV.
14 For more information, please see the PSSD2 specification sheet.
15 Not available with N80, N80EMG, N100, or N100EMG.
16 Must specify voltage. Requires BSE labeling, voltage specific. Consult factory for options.
17 Not available with nLight wired/wireless network or individual controls.
18 Must specify voltage, 120 or 277, with GLR and GFM fusing.
19 For ordering logic consult RRL_2013.
20 Not available with air supply/return or Wired Networking (NES_) and Individual Control (MSD_) sensors.

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2BLT Volumetric Recessed Lighting 2'x4'

Non-Configurable BLT								
Stock/MTO	**Catalog Description ***	**UPC**	**Lumens**	**Wattage**	**LPW**	**Color Temperature**	**Voltage**	**Pallet Qty**
Stock	2BLT4 40L ADP LP835	00190887470789	4000	31	129	3500K/82 CRI	120-277	26
	2BLT4 40L ADP LP840	00190887470765	4063	31	131	4000K/82CRI	120-277	26
	2BLT4 48L ADP LP835	00190887468656	4960	38	131	3500K/82 CRI	120-277	26
	2BLT4 48L ADP LP840	00190887468649	5039	38	133	4000K/82CRI	120-277	26
	2BLT4 40L ADP EL14L LP835	00190887470925	4000	31	129	3500K/82 CRI	120-277	26
	2BLT4 40L ADP EL14L LP840	00190887470918	4063	31	131	4000K/82 CRI	120-277	26
	2BLT4 48L ADP EL14L LP835	00190887468670	4960	38	131	3500K/82 CRI	120-277	26
	2BLT4 48L ADP EL14L LP840	00190887468663	5039	38	133	4000K/82 CRI	120-277	26
MTO	2BLT4 40L ADP 347 LP835	00193047562188	4000	31	129	3500K/82 CRI	347	26
	2BLT4 40L ADP 347 LP840	00193047059183	4063	31	131	4000K/82CRI	347	26
	2BLT4 48L ADP 347 LP835	00193047562225	4960	38	131	3500K/82 CRI	347	26
	2BLT4 48L ADP 347 LP840	00193047686426	5039	38	133	4000K/82CRI	347	26

*Generic 0-10V Dimming to 10%.

Accessories: *Order as separate catalog number.*

DGA24	Drywall grid adapter for 2x4 recessed fixture
2X4SMKSHP	Surface Mount Troffer Kit Pre Paint
2X4SMKSHP PAF	Surface Mount Troffer Kit Post Paint

nLight® Wired Control Accessories:
Order as separate catalog number. Visit www.acuitybrands.com/products/controls/nlight.

WallPod stations	**Model number**	**Occupancy sensors**	**Model number**
On/Off	nPODM [color]	Small motion 360°, ceiling (PIR / dual tech)	nCM 9 RJB / nCM PDT 9 RJB
On/Off & raise/lower	nPODM DX [color]	Large motion 360°, ceiling (PIR / dual tech)	nCM10 RJB / nCM PDT 10 RJB
Graphic touchscreen	nPOD GFX [color]	Wall switch with raise/lower	nWSX PDT LV DX [color]
Photocell controls	**Model number**	**Cat-5 cable (plenum rated)**	**Model number**
Full range dimming	nCM ADCX RJB	10' cable	CAT5 10FT J1
		30' cable	CAT5 30FT J1

nLight® AIR Control Accessories:
Order as separate catalog number. Visit www.acuitybrands.com/products/controls/nlightair.

Wall switches	**Model number**
On/Off single pole	rPODB [color] G2
On/Off two pole	rPODB 2P [color] G2
On/Off & raise/lower single pole	rPODB DX [color] G2
On/Off & raise/lower two pole	rPODB 2P DX [color] G2
On/Off & raise/lower single pole	rPODBZ DX WH G2

rCMS — **Example: RCMS PDT 10 AR G2**

Series / Detection	Power Supply[1]	Occupancy Detection	Lens (Required)	Operating Mode	Generation
RCMS nLight AIR occupancy and daylight sensor	[blank] Power Supply ordered separately PS 150 Standard 150 mA Power Supply	[blank] PIR Detection PDT Dual Tech PIR/ Microphonics	10 Large Motion/ Extended Range 360° 9 Small Motion/ Extended Range 360° 6 High Bay 360° Lens	[BLANK] None AR Auxiliary Relay	G2 Generation 2 compatibility

Replacement Parts: *Order as separate catalog number.*

*249P2N	2DBLT48 ADP LENS ASSEMBLY	4 ft. replacement lens
*249P2T	2DBLT48 SDP LENS ASSEMBLY	4 ft. replacement lens
*249P30	2DBLT48 ADSM LENS ASSEMBLY	4 ft. replacement lens
*249P33	2DBLT48 SDSM LENS ASSEMBLY	4 ft. replacement lens
*237LT2	2DBLT48 ADPT LENS ASSEMBLY	4 ft. replacement lens
*237LT4	2DBLT48 SDPT LENS ASSEMBLY	4 ft. replacement lens
*237LT6	2DBLT48 ADSMT LENS ASSEMBLY	4 ft. replacement lens
*237LT8	2DBLT48 SDSMT LENS ASSEMBLY	4 ft. replacement lens
*237LTA	2DBLT48 ADPT SENSOR LENS ASSEMBLY	4 ft. replacement lens
*237M52	2DBLT48 SDPT SENSOR LENS ASSEMBLY	4 ft. replacement lens
*237M5A	2DBLT48 ADSMT SENSOR LENS ASSEMBLY	4 ft. replacement lens
*237M5L	2DBLT48 SDSMT SENSOR LENS ASSEMBLY	4 ft. replacement lens

Notes
1 RCMS requires low voltage power from either RPP20 DS 24V G2 or PS150.

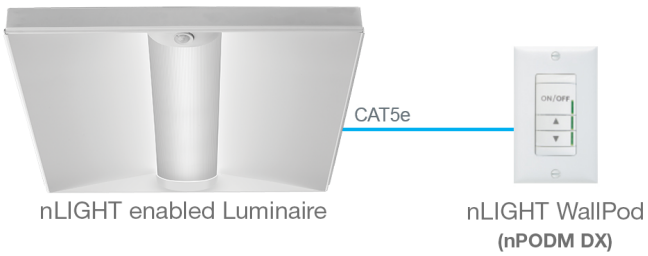


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2BLT Volumetric Recessed Lighting 2'x4'

Sensor Options					
Option	Automatic Dimming Photocell	Occupancy Sensing		nLight Wired Networking	nLight AIR Networking
		PIR	PDT		
MSD7ADCX	X	X			
MSDPDT7ADCX	X		X		
NES7		X		X	
NES7ADCX	X	X		X	
NESPDT7			X	X	
NESPDT7ADCX	X		X	X	
RES7	X	X			X
RESPDT7	X	X	X		X

Basic nLight Zone



Integrated Sensor with Individual Control

The MSD7ADCX PIR occupancy sensor/automatic dimming photocell is ideal for areas without obstructions and where daylight harvesting may be desired. Suggested applications include, but not limited to, hallways, corridors, storage rooms, and breakrooms or other areas where people are typically moving.

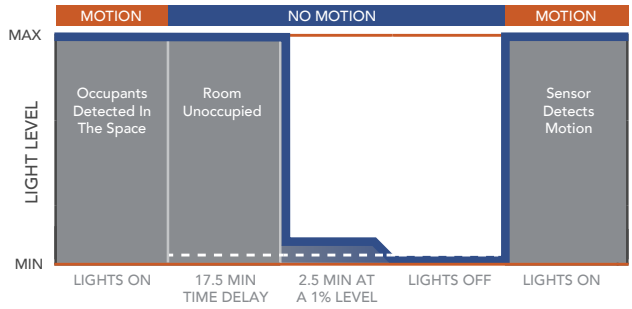
The MSDPDT7ADCX PIR/Microphonics Dual Tech occupancy sensor/automatic dimming photocell is ideal for areas with obstructions and where daylight harvesting is desired. Suggested applications include, but not limited to, open offices, private offices, classrooms, public restrooms, and conference rooms.

nLight Wired Networking

The nES 7 is ideal for small rooms without obstructions or areas with primarily walking motion. Ideal areas include hallways, corridors, storage rooms, and breakrooms. Additionally, the NES7ADCX includes an integrated photocell, which enables daylight harvesting controls.

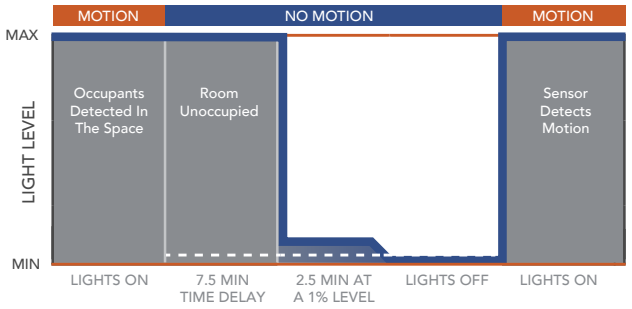
For areas like restrooms, private offices, open offices, conference rooms or any space with obstructions, the nES PDT 7 dual technology sensor is recommended. The nES PDT 7 utilizes both PIR (passive infrared) and Microphonics technologies to detect occupancy. Additionally, the NESPDT7ADCX includes an integrated photocell, which enables daylight harvesting controls which is ideal for areas where windows are present.

Sequence of Operation



*The presetting on the automatic dimming photocell is 5fc.

Sequence of Operation



*The presetting on the automatic dimming photocell is 5fc.

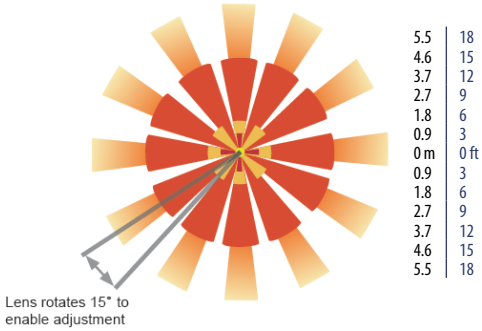
Sensor Coverage Pattern
Mini 360° Lens

- Recommended for walking motion detection from mounting heights between 8 ft (2.44 m) and 20 ft (6.10 m)
- Initial detection of walking motion along sensor axes at distances of 2x the mounting height up to 15 ft (4.57 m) and
- 1.75x up to 20 ft (6.10 m).
- Provides 12 ft (3.66 m) radial detection of small motion when mounted at 9 ft (2.74 m)
- Initial detection will occur earlier when walking across sensor's field of view than when walking directly at sensor

nLight AIR Wireless

nLight AIR is the ideal solution for retrofit or new construction spaces where adding additional wiring can be labor intensive and nLight AIR is available with or without an integral sensor. Integrated RES7 or RES7PDT smart sensors are part of each luminaire in the nLight AIR network, which can be grouped to control multiple luminaires. The granularity of control with the digital PIR occupancy detection and daylight sensing makes a great solution for any application.

9 FT Mounting





Simple as 1,2,3

1. Install the nLight® AIR fixtures with embedded smart sensor
2. Install the wireless battery-powered wall switch
3. With CLAIRITY app, pair the fixtures with the wall switch and if desired, customize the sensor settings for the desired outcome

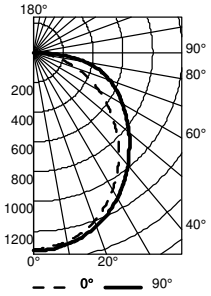


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2BLT Volumetric Recessed Lighting 2'x4'

PHOTOMETRICS

2BLT4 40L ADP LP835, 4000 delivered lumens, test no. ISF36900P109, tested in accordance to IESNA LM-79



CP Summary

	0°	90
0°	1325	1325
5°	1309	1325
15°	1250	1278
25°	1136	1187
35°	981	1058
45°	797	909
55°	601	761
65°	408	621
75°	212	460
85°	48	197
90	1	17

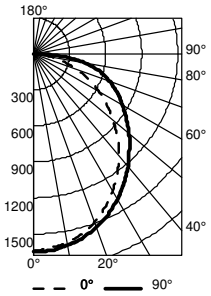
Coefficients of Utilization

	pf	20%								
	pc	80%			70%			50%		
RCR	pw	70%	50%	30%	50%	30%	10%	50%	30%	10%
	0	119	119	119	116	116	116	111	111	111
	1	108	102	97	100	96	92	96	92	89
	2	97	88	81	86	80	74	83	77	72
	3	88	77	69	76	68	61	72	66	60
	4	81	68	59	67	58	52	64	57	51
	5	74	61	51	60	51	44	57	50	44
	6	68	55	45	54	45	39	52	44	38
	7	63	50	40	49	40	34	47	39	34
	8	59	45	36	44	36	30	43	36	30
	9	55	41	33	41	33	27	40	32	27
	10	52	38	30	38	30	25	37	30	25

Zonal Lumen Summary

Zone	Lumens	% Lamp	% Fixture
0° - 30°	1024	25.6	25.6
0° - 40°	1669	41.7	41.7
0° - 60°	2960	74.0	74.0
0° - 90°	3998	100.0	100.0
90° - 120°	2	0.0	0.0
90° - 130°	2	0.0	0.0
90° - 150°	2	0.0	0.0
90° - 180°	2	0.0	0.0
0° - 180°	4000	100.0	100.0

2BLT4 48L ADP LP835, 4960 delivered lumens, test no. ISF 36900P117, tested in accordance to IESNA LM-79



CP Summary

	0°	90
0°	1643	1643
5°	1623	1644
15°	1550	1585
25°	1409	1472
35°	1217	1312
45°	988	1127
55°	745	943
65°	505	769
75°	263	571
85°	59	244
90	1	21

Coefficients of Utilization

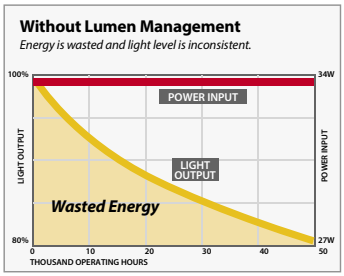
	pf	20%								
	pc	80%			70%			50%		
RCR	pw	70%	50%	30%	50%	30%	10%	50%	30%	10%
	0	119	119	119	116	116	116	111	111	111
	1	108	102	97	100	96	92	96	92	89
	2	97	88	81	86	80	74	83	77	72
	3	88	77	69	76	68	61	72	66	60
	4	81	68	59	67	58	52	64	57	51
	5	74	61	51	60	51	44	57	50	44
	6	68	55	45	54	45	39	52	44	38
	7	63	50	40	49	40	34	47	39	34
	8	59	45	36	44	36	30	43	36	30
	9	55	41	33	41	33	27	40	32	27
	10	52	38	30	38	30	25	37	30	25

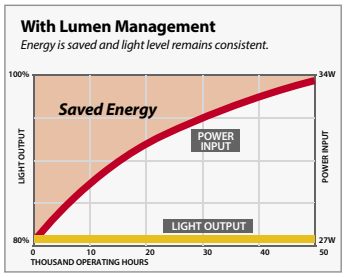
Zonal Lumen Summary

Zone	Lumens	% Lamp	% Fixture
0° - 30°	1270	25.6	25.6
0° - 40°	2070	41.7	41.7
0° - 60°	3671	74.0	74.0
0° - 90°	4957	100.0	100.0
90° - 120°	2	0.0	0.0
90° - 130°	2	0.0	0.0
90° - 150°	2	0.0	0.0
90° - 180°	2	0.0	0.0
0° - 180°	4960	100.0	100.0

Constant Lumen Management

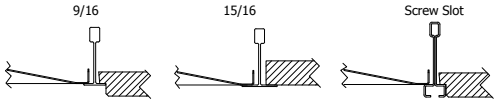
Enabled by the embedded nLight control, the BLT actively tracks its run-time and manages its light source such that constant lumen output is maintained over the system life. Referred to as lumen management, this feature eliminates the energy waste created by the traditional practice of over-lighting.





How to Estimate Delivered Lumens in Emergency Mode
Use the formula below to estimate the delivered lumens in emergency mode
Delivered Lumens = 1.25 x P x LPW
P = Ouput power of emergency driver. P = 10W for E10WLCP option.
LPW = Lumen per watt rating of the luminaire. This information is available on the ABL luminaire spec sheet. LPW = Lumen per watt rating of the luminaire. LPW information available in Performance Data section.

MOUNTING DATA	
Ceiling Type	**Appropriate Trim Type**
Exposed grid tee (1′ and 9/16″)	G
Concealed grid tee	G
Plaster or plasterboard	G*



*DGA accessory available to provide ceiling trim flange and fixture support for plaster or plasterboard ceiling. Recommended rough-in dimensions for DGA installation is 24-3/4" x 48-3/4" (Tolerance is +1/8", -0").

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2BLT **V**olumetric Recessed Lighting 2'x4'

Performance Data					
Model Number	**Lumens**	**LPW**	**Watts**	**DLC Listing**	**DLC ID**
2BLT4 30L ADP EZ1 (GZ1, GZ10) LP835 [All Options]	2962	127.31	23.26	Premium	PWJDEMHS
2BLT4 30L ADP EZ1 (GZ1, GZ10) LP840 [All Options]	3009.28	129.34	23.26	Premium	P18J5GLD
2BLT4 30L ADPT EZ1 (GZ1, GZ10) LP840 [All Options]	2969.16	127.62	23.26	Premium	P3HB2XSG
2BLT4 40L ADP EZ1 (GZ1, GZ10) LP835 [All Options]	4000	126.22	31.69	Premium	PDWKYXFD
2BLT4 40L ADP EZ1 (GZ1, GZ10) LP840 [All Options]	4063.86	128.23	31.69	Premium	PEYXAZWD
2BLT4 40L ADPT EZ1 (GZ1, GZ10) LP835 [All Options]	3946.66	124.53	31.69	Premium	PS63CPK6
2BLT4 40L ADPT EZ1 (GZ1, GZ10) LP840 [All Options]	4009.67	126.52	31.69	Premium	PK79UR9W
2BLT4 48L ADP EZ1 (GZ1, GZ10) LP835 [All Options]	4960	130.5	38	Premium	PJ9CK6C1
2BLT4 48L ADP EZ1 (GZ1, GZ10) LP840 [All Options]	5039.18	132.58	38	Premium	P9W2R5AK
2BLT4 48L ADPT EZ1 (GZ1, GZ10) LP835 [All Options]	4893.86	128.76	38	Premium	PPFKZU3U
2BLT4 48L ADPT EZ1 (GZ1, GZ10) LP840 [All Options]	4971.99	130.82	38	Premium	PC8HMCH9
2BLT4 60L ADP EZ1 (GZ1, GZ10) LP835 [All Options]	6016	126.39	47.59	Premium	PSJ6QERM
2BLT4 60L ADP EZ1 (GZ1, GZ10) LP840 [All Options]	6112.04	128.4	47.59	Premium	PVXQXPUV
2BLT4 60L ADPT EZ1 (GZ1, GZ10) LP835 [All Options]	5935.78	124.7	47.59	Premium	PHT84BW4
2BLT4 60L ADPT EZ1 (GZ1, GZ10) LP840 [All Options]	6030.55	126.69	47.59	Premium	PXV55BC8
2BLT4 72L ADP EZ1 (GZ10) LP840 [All Options]	7360.66	125.3	58.74	Premium	PSCZ22CB
2BLT4 72L ADP GZ1 LP835 [All Options]	7245	119.07	60.84	standard	PISHTCTS
2BLT4 72L ADP GZ1 LP840 [All Options]	7360.66	120.97	60.84	standard	PBERALG7
2BLT4 72L ADPT EZ1 (GZ1, GZ10) LP835 [All Options]	7148.4	117.48	60.84	standard	PDQS3CYK
2BLT4 72L ADPT EZ1 (GZ10) LP840 [All Options]	7262.52	123.63	58.74	Premium	P2KKMMVN
2BLT4 72L ADPT GZ1 LP840 [All Options]	7262.52	119.36	60.84	standard	P10DUPC0
2BLT4 85L ADP EZ1 (GZ1, GZ10) LP835 [All Options]	8567	116.43	73.58	standard	PYD2G06V
2BLT4 85L ADP EZ1 (GZ1, GZ10) LP840 [All Options]	8703.77	118.28	73.58	standard	P8Z4IV4X
2BLT4 85L ADPT EZ1 (GZ1, GZ10) LP835 [All Options]	8452.77	114.87	73.58	standard	PTZEW3QM
2BLT4 85L ADPT EZ1 (GZ1, GZ10) LP840 [All Options]	8587.72	116.71	73.58	standard	P01DMEK9
2BLT4 100L ADP EZ1 (GZ1, GZ10) LP835 [All Options]	9837	103.14	95.36	standard	PGDES20R
2BLT4 100L ADP EZ1 (GZ1, GZ10) LP840 [All Options]	9994.04	104.79	95.36	standard	P007CHGX
2BLT4 100L ADPT EZ1 (GZ1, GZ10) LP835 [All Options]	9705.84	101.77	95.36	standard	PSZUQY7M
2BLT4 100L ADPT EZ1 (GZ1, GZ10) LP840 [All Options]	9860.79	103.39	95.36	standard	P6V6X6HY
2BLT4 120L ADP EZ1 (GZ1, GZ10) LP835 [All Options]	11709	118.18	99.07	standard	PGM4Y7DP
2BLT4 120L ADP EZ1 (GZ1, GZ10) LP840 [All Options]	11895.9	120.07	99.07	standard	P00DDCG2
2BLT4 120L ADPT EZ1 (GZ1, GZ10) LP835 [All Options]	11552.9	116.61	99.07	standard	PXM0FS09
2BLT4 120L ADPT EZ1 (GZ1, GZ10) LP840 [All Options]	11737.3	118.47	99.07	standard	PJ4GEBZM

DLC information is subject to change, for the most up-to-date information please refer to www.dlc.org. Above listings do not cover 347v or SLD.

LED: One Lithonia Way Conyers, GA 30012 Phone: 800-858-7763 www.lithonia.com

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HE Performance Data					
Model Number	**Lumens**	**LPW**	**Watts**	**DLC Listing**	**DLC ID**
2BLT4 30LHE ADP EZ1 (GZ1, GZ10) LP835 [All Options]	3107	135.17	22.98	Premium	P7KEICW5
2BLT4 30LHE ADP EZ1 (GZ1, GZ10) LP840 [All Options]	3156.6	137.33	22.98	Premium	PDOM06BH
2BLT4 30LHE ADPT EZ1 (GZ1, GZ10) LP835 [All Options]	3065.57	133.37	22.98	Premium	P7PZAJDZ
2BLT4 30LHE ADPT EZ1 (GZ1, GZ10) LP840 [All Options]	3114.51	135.5	22.98	Premium	P2N23EBP
2BLT4 40LHE ADP EZ1 (GZ1, GZ10) LP835 [All Options]	4085	138.56	29.48	Premium	P67P6S5Y
2BLT4 40LHE ADP EZ1 (GZ1, GZ10) LP840 [All Options]	4150.21	140.77	29.48	Premium	P95UQD66
2BLT4 40LHE ADPT EZ1 (GZ1, GZ10) LP835 [All Options]	4030.53	136.71	29.48	Premium	PC15DQEC
2BLT4 40LHE ADPT EZ1 (GZ1, GZ10) LP840 [All Options]	4094.88	138.89	29.48	Premium	PGRCSJ2T
2BLT4 48LHE ADP EZ1 (GZ1, GZ10) LP835 [All Options]	4770	138.16	34.52	Premium	PXBJBGN8
2BLT4 48LHE ADP EZ1 (GZ1, GZ10) LP840 [All Options]	4846.15	140.37	34.52	Premium	P5PQ5RRX
2BLT4 48LHE ADPT EZ1 (GZ1, GZ10) LP835 [All Options]	4706.4	136.32	34.52	Premium	P2NK2H33
2BLT4 48LHE ADPT EZ1 (GZ1, GZ10) LP840 [All Options]	4781.53	138.5	34.52	Premium	PK8C1321
2BLT4 60LHE ADP EZ1 (GZ1, GZ10) LP835 [All Options]	5894	135.12	43.61	Premium	PQZN176R
2BLT4 60LHE ADP EZ1 (GZ1, GZ10) LP840 [All Options]	5988.09	137.28	43.61	Premium	PG5CYJUC
2BLT4 60LHE ADPT EZ1 (GZ1, GZ10) LP835 [All Options]	5815.41	133.32	43.61	Premium	PZ72TAWM
2BLT4 60LHE ADPT EZ1 (GZ1, GZ10) LP840 [All Options]	5908.25	135.45	43.61	Premium	PRC4W72B
2BLT4 72LHE ADP EZ1 (GZ1, GZ10) LP835 [All Options]	7149	135.94	52.58	Premium	PUB38GEQ
2BLT4 72LHE ADP EZ1 (GZ1, GZ10) LP840 [All Options]	7263.13	138.11	52.58	Premium	P7GDHZTN
2BLT4 72LHE ADPT EZ1 (GZ1, GZ10) LP835 [All Options]	7053.68	134.12	52.58	Premium	P5CC2VKV
2BLT4 72LHE ADPT EZ1 (GZ1, GZ10) LP840 [All Options]	7166.29	136.26	52.58	Premium	P6P1BKDM
2BLT4 85LHE ADP EZ1 (GZ1, GZ10) LP835 [All Options]	8158	128.96	63.25	Premium	PRTW6BXW
2BLT4 85LHE ADP EZ1 (GZ1, GZ10) LP840 [All Options]	8288.24	131.02	63.25	Premium	P6H1V2D6
2BLT4 85LHE ADPT EZ1 (GZ1, GZ10) LP835 [All Options]	8049.22	127.24	63.25	Premium	P1VG5TA3
2BLT4 85LHE ADPT EZ1 (GZ1, GZ10) LP840 [All Options]	8177.73	129.27	63.25	Premium	PN5BKJ6E

DLC information is subject to change, for the most up-to-date information please refer to www.dlc.org. Above listings do not cover 347v or SLD.

LED: One Lithonia Way Conyers, GA 30012 Phone: 800-858-7763 www.lithonia.com

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LITHONIA LIGHTING®

Catalog Number	PRELIMINARY
Notes	
Type	

SPANL LED

1'x4', 2'x2', and 2'x4'



FEATURES & SPECIFICATIONS

INTENDED USE — The SPANL Series LED Edge-Lit Flat Panel provides volumetric distribution with a fully luminous appearance across the face of the lens. This provides a soft, glare-free solution that is visually comfortable within the space. Suitable for many lighting applications including schools, offices and other commercial spaces, retail, convenience stores, hospitals and healthcare facilities. **Certain airborne contaminants can diminish the integrity of acrylic and/or polycarbonate.** Click here for Acrylic-Polycarbonate Compatibility table for suitable uses.

CONSTRUCTION — Built with regressed aluminum frame for strength, durability, and higher-end architectural appearance. Seamless frame prevents corner light leaks. The satin white lens provides excellent shielding and fully luminous appearance. SPANL's low-profile design provides increased installation flexibility especially in restricted plenum spaces. The back plate includes integral T-bar clips for installation into 9/16" and 15/16" T-grid ceilings. See Accessories section on bottom of page. This must be ordered as a separate item. Fixture may be mounted and wired in continuous rows.

CONTROLS — Optional integrated nLight®controls make each luminaire addressable - allowing it to digitally communicate with other nLight enabled controls such as dimmers, switches, occupancy sensors and photocontrols. Connection to nLight is simple. It can be accomplished with integrated nLight AIR wireless or through standard Cat-5 cabling. nLight offers unique plug-and-play convenience as devices and luminaires automatically discover each other and self-commission, while nLight AIR is commissioned easily through an intuitive mobile app. Also featuring an integrated sensor for occupancy of day-light harvesting photocell control.

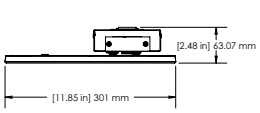
ELECTRICAL — Long-life LEDs, coupled with a high-efficiency driver, provide superior illumination for extended service life. 70% LED lumen maintenance at 60,000 hours (L70/60,000). 0-10V dimming driver, dims to 1% or 10%.

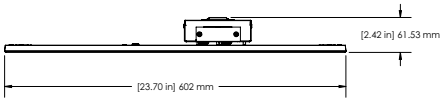
LISTINGS — CSA certified to meet US and Canadian standards. DesignLights Consortium® (DLC) Premium qualified product and DLC qualified product. Not all versions of this product may be DLC Premium qualified or DLC qualified. Please check the DLC Qualified Products List at www.designlights.org/QPL to confirm which versions are qualified. Intended for indoor use only. Damp location listed. IC rated. IP5X rated.

WARRANTY — 5-year limited warranty. Complete warranty terms located at: www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx

Note: Actual performance may differ as a result of end-user environment and application. All values are design or typical values, measured under laboratory conditions at 25 °C. Specifications subject to change without notice.

Configurable fixture dimension





ORDERING INFORMATION Lead times will vary depending on options selected.

Example: SPANL 2X4 4000LM 80CRI 35K MIN1 MVOLT E10WCP NLTAIR2 RIO

Series	Width and Length	Lumens		CRI	Color Temperature	Diffuser	Minimum Dimming Level[1]
		Standard Lumens:	High Efficiency Lumens:				
SPANL LED Flat Panel	1x4 1'x4'	1500LM 1500 Lumens 2000LM 2000 Lumens 3000LM 3000 Lumens 4000LM 4000 Lumens 4800LM 4800 Lumens	1500LMHE 1500 Lumens 2000LMHE 2000 Lumens 3000LMHE 3000 Lumens 4000LMHE 4000 Lumens 4800LMHE 4000 Lumens	80CRI 80 CRI 90CRI 90 CRI	30K 3000K 35K 3500K 40K 4000K 50K 5000K	(Blank) Satin White PSMT Prismatic Low Glare 3DCB 3D Contour Center Basket 3DPFM 3D Picture Frame Mat	MIN1 Dims to 1% MIN10 Dims to 10%[2]
	2x2 2'x2'	2000LM 2000 Lumens 3300LM 3300 Lumens 4000LM 4000 Lumens 4800LM 4800 Lumens	2000LMHE 2000 Lumens 3300LMHE 3300 Lumens 4000LMHE 4000 Lumens				
	2x4 2'x4'	3000LM 3000 Lumens 4000LM 4000 Lumens 4800LM 4800 Lumens 6000LM 6000 Lumens 7200LM 7200 Lumens	3000LMHE 3000 Lumens 4000LMHE 4000 Lumens 4800LMHE 4000 Lumens 6000LMHE 6000 Lumens				

Ordering continued on next page.

ORDERING (continued)

Control Input[3]		Voltage		Step Level Dimming		Emergency Option		nLight Interface		Control	
EZT	eldoLED 0-10V Dimming	MVOLT	120-277V	(Blank)	None	E10WCP	EM Self-Diagnostic battery pack, 10W Constant Power, CEC compliant[7,8,9]	nLight Wired:		nLight Wired:	
ZT	Generic 0-10V Dimming	120	120V	SLD	Step Level Dimming[5,6]	GTD	Generator Transfer Device[10]	(blank)	No constant lumen management	(blank)	no control
NLIGHT	nLight enabled (Wired)	277	277V			EMG	for use with nLight on generator supply EM power[11]	CL80	Constant lumen output 80%[12]		
		347	347V[4]					nLight Wireless:		nLight Wireless:	
								NLTAIR2	nLight AIR Generation 2 enabled[13]	RIO	nLight Air radio module without sensor
								RES7		nLight AIR PIR	integral occupancy sensor with automatic dimming photocell for networking capabilities
								RES7PDT		nLight AIR	microphonics dual technology occupancy sensor with automatic dimming photocell

Options			
GLR	Fast-blowing fuse[14]	PWS1856LV	6' pre-wire, 3/8" diameter, 18 gauge, 1 circuit w/low voltage purple and grey wires[14]
GMF	Slow-blowing fuse[14]	CP	Chicago plenum[16]
PWS1836	6' pre-wire, 3/8" diameter, 18 gauge, 1 circuit	RRL_	RELOC®-ready luminaire
PWS1846	6' pre-wire, 3/8" diameter, 18 gauge, 2 circuit	NPLT	Narrow Pallet
PWS1846 PWSLV	Two cables: one 6' pre-wire, 3/8" diameter, 18 gauge, 2 circuits; one 6' pre-wire, 3/8" diameter, 18 gauge, purple and gray[15]		

Notes:
1. If Step Level Dimming (SLD) is needed please leave this section blank.
2. Not available with EZT or NLIGHT.
3. If Step Level Dimming (SLD) or NLTAIR2 is needed please leave this section blank.
4. Not available with EZT, NLIGHT, SLD, Emergency options or Controls.
5. Not available with BGTD.
6. When using prewire option use PWS1846.
7. When using prewire option use PWS1846 or PWS1846 PWSLV.
8. Please refer to Emergency Battery Estimated Lumen section for lumen estimation. PS1055CP installed with lumen packages > 6000. PS1055LCP installed with lumen packages < 5400.
9. Not available with NLTAIR2 RIO in the 2X2 4800LM and 1X4 or 2X4 6000LM and 6800LM.
10. Requires BSE labeling, voltage must be specified (120, 277). Consult factory for options. Example: BGTD BSE10.
11. nLight EMG option requires a conection to existing nLight network. Power is provided from a separate nLight enabled fixture. Requires NLIGHT.
12. Requires NLIGHT control input.
13. Only available with MIN1 Minimum Dimming Level option.
14. Voltage must be specified (120, 277, 347).
15. Not available with nLight Wired / nLight Wireless
16. Not available with NLIGHT or NLTAIR2 RIO.

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PRELIMINARY

ACCESSORIES

Accessories: *Order as separate catalog number.*	
DGA14	Drywall grid adapter for 1x4 recessed fixture.
DGA22	Drywall grid adapter for 2x2 recessed fixture.
DGA24	Drywall grid adapter for 2x4 recessed fixture.
PS1055CP FMC BRKT	Power Sentry emergency constant power battery pack field installation kit for (T20 CEC Compliant).[1]
2X2SMKSH	2'x2' Surface Mount Troffer Kit[1]
2X4SMKSH	2'x4' Surface Mount Troffer Kit[1]
1X4SMKSH	1'x4' Surface Mount Troffer Kit[1]
1X4PANLACG 36	Adjustable aircraft cable gripper suspension kit with 36" length cables for 1X4 fixture. Includes: suspension cables, mounting hardware, and 5 wire power feed cable (Ground, Hot, Neutral, and Low Voltage Leads).[2]
1X4PANLACG 72	Adjustable aircraft cable gripper suspension kit with 72" length cables for 1X4 fixture. Includes: suspension cables, mounting hardware, and 5 wire power feed cable (Ground, Hot, Neutral, and Low Voltage Leads).[2]
2X2PANLACG 36	Adjustable aircraft cable gripper suspension kit with 36" length cables for 2X2 fixture. Includes: suspension cables, mounting hardware, and 5 wire power feed cable (Ground, Hot, Neutral, and Low Voltage Leads).[2]
2X2PANLACG 72	Adjustable aircraft cable gripper suspension kit with 72" length cables for 2X2 fixture. Includes: suspension cables, mounting hardware, and 5 wire power feed cable (Ground, Hot, Neutral, and Low Voltage Leads).[2]
2X4PANLACG 36	Adjustable aircraft cable gripper suspension kit with 36" length cables for 2X4 fixture. Includes: suspension cables, mounting hardware, and 5 wire power feed cable (Ground, Hot, Neutral, and Low Voltage Leads).[2]
2X4PANLACG 72	Adjustable aircraft cable gripper suspension kit with 72" length cables for 2X4 fixture. Includes: suspension cables, mounting hardware, and 5 wire power feed cable (Ground, Hot, Neutral, and Low Voltage Leads).[2]

Emergency Battery Estimated Lumens

Use the formula below to estimate the delivered lumens in emergency mode

Estimated Lumens = 1.25 x P x LPW

P = Output power of emergency driver (10W for PS1055CP)

LPW = Lumen per watt rating of the luminaire.

SMKSH Accessory



Notes:
1. Cannot be installed with fixture with integrated NLTAIR2 RIO.
2. See Suspension Kits section on bottom of page 6 for additional detail.

nLight® Wired Control Accessories:
Order as separate catalog number. Visit www.acuitybrands.com/products/controls/nlight.

WallPod stations	**Model number**	**Occupancy sensors**	**Model number**
On/Off	nPODM [color]	Small motion 360°, ceiling (PIR / dual tech)	nCM 9 RJB / nCM PDT 9 RJB
On/Off & raise/lower	nPODM DX [color]	Large motion 360°, ceiling (PIR / dual tech)	nCM10 RJB / nCM PDT 10 RJB
Graphic touchscreen	nPOD GFX [color]	Wall switch with raise/lower	nWSX PDT LV DX [color]
Photocell controls	**Model number**	**Cat-5 cable (plenum rated)**	**Model number**
Full range dimming	nCM ADCX RJB	10' cable	CAT5 10FT J1
		30' cable	CAT5 30FT J1

nLight® AIR Control Accessories:
Order as separate catalog number.
Visit www.acuitybrands.com/products/controls/nlightair.

Wall switches	**Model number**
On/Off single pole	rPODB [color] G2
On/Off two pole	rPODB 2P [color] G2
On/Off & raise/lower single pole	rPODB DX [color] G2
On/Off & raise/lower two pole	rPODB 2P DX [color] G2
On/Off & raise/lower single pole	rPODBZ DX WH G2

rCMS[1] — **Example: RCMS PDT 10 AR G2**

Series / Detection	**Power Supply[1]**	**Occupancy Detection**	**Lens (Required)**	**Operating Mode**	**Generation**
RCMS nLight AIR occupancy and daylight sensor	[blank] Power Supply ordered separately	[blank] PIR Detection	10 Large Motion/ Extended Range 360°	[BLANK] None	G2 Generation 2 compatibility
	PS 150 Standard 150 mA Power Supply	PDT Dual Tech PIR/ Microphonics	9 Small Motion/ Extended Range 360°	AR Auxiliary Relay	
			6 High Bay 360° Lens		

Notes
1 RCMS requires low voltage power from either RPP20 DS 24V G2 or PS150.



nLight AIR Wireless

nLight AIR is the ideal solution for retrofit or new construction spaces where adding additional wiring can be labor intensive and costly. The integrated RIO module is part of each luminaire in the nLight AIR network, which can be grouped to control multiple luminaires.



Simple as 1,2,3

1. Install the nLight® AIR fixtures with integrated RIO module.
2. Install the wireless battery-powered wall switch.
3. With CL*AIR*ITY PRO app, pair the fixtures with the wall switch and if desired, add and customize the ceiling mount sensor settings.



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EPANL compatible with Sensor Switch™ WSX-D and SPOD wall switches.



WSX-D



SPOD

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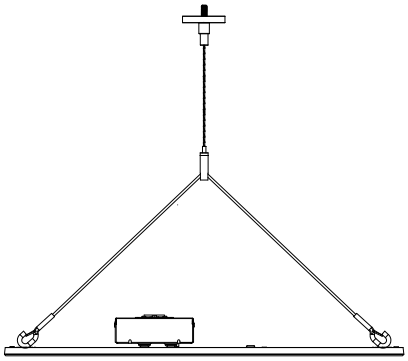
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Suspension Kits

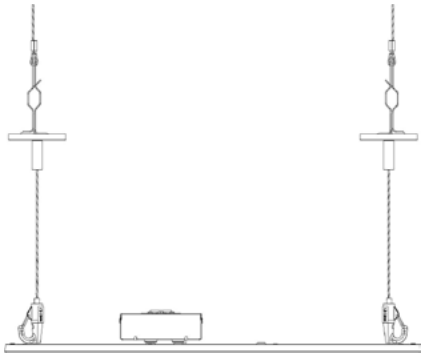
1X4PANLACG



2X2PANLACG



2X4PANLACG



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LITHONIA LIGHTING®

Catalog Number	
Notes	
Type	

PRECISE® COLLECTION

Edge-Lit Exits

LRP

LED LAMPS



NEMA Premium

LED

FEATURES & SPECIFICATIONS

INTENDED USE — Suitable for architectural applications where aesthetics and superior performance are required.

CONSTRUCTION — High-polish, injection-molded virgin acrylic panel, ultrasonically welded to eliminate visible hardware. Graduated depth of molded letters provides uniform light distribution on graphics. Standard housing finish is brushed aluminum.

Precision-molded, textured letters – 6" high with 3/4" stroke, with 100 ft viewing distance rating, based upon UL924 standard. Chevron indicator direction must be specified.

Recessed rough-in section constructed of 20-gauge, die-formed galvanized steel. Extruded aluminum housing trim mounts flush onto wall or ceiling.

Mounting canopy for top mount is constructed of extruded aluminum housing to match housing finish.

OPTICS — LEDs mounted on printed circuit board. The typical life of the exit LED lamp is 10 years.

Low energy consumption – EL N operation: only 2.3W for 120V single-face red sign; 1.7W for 120V single-face green sign. Non-emergency operation: only 1.5W for 120V single-face red sign; 1.2W for 120V single-face green sign.

ELECTRICAL — Dual voltage input capability (120/277V).

Sealed, maintenance-free nickel cadmium battery delivers 90 minutes capacity to lamp. Constant-current series charger, 24-hour recharge after 90-minute discharge.

Polarized battery connector simplifies installation and maintenance; prevents charger damage due to improper connection.

INSTALLATION — Recessed mount – rough-in section for back, ceiling or end mounting. Fits into minimum wall or ceiling opening 13-5/8" L x 4-1/2" W x 3-1/8" D.

Adjustable T-bar hangers adapt mounting tray for mounting in suspended ceilings or variable-size framed openings. Trim ring has 3/4" variable depth adjustment to ensure flush fit against surface of wall or ceiling.

Plug-in wire connections and self-captive mounting screws for mounting panel/trim to rough-in section.

Top Mount (TM) – low-profile mounting canopy attaches exit to J-box. No rough-in section required.

LISTINGS — UL listed. Non-IC recessed mounting. Meets UL 924, NFPA 101 (current Life Safety Code), NEC and OSHA illumination standards, and State of Minnesota requirements for less than 20W energy consumption. NEMA Premium certified.

WARRANTY — 5-year limited warranty, including lamps. Complete warranty terms located at: www.acuitybrands.com/resources/terms-and-conditions

NOTE: Actual performance may differ as a result of end-user environment and application. All values are design or typical values, measured under laboratory conditions at 25°C. Specifications subject to change without notice.

ORDERING INFORMATION

For shortest lead times, configure products using **bolded options.**

Example: LRP 1 RMR LA 120/277 EL N

LRP					
Family	**Housing color**	**Number of faces**	**Letters/background**	**Directional indicators[2]**	**Input voltage**
LRP LED	**(blank)** Brushed aluminum	**1** Single face	RW Red on white	**(blank)** None	**120/277** Dual voltage
	W White	**2** Double face	**RC** Red on clear (single face only)	**LA** Left[3]	
	B Black		**RMR** Red on mirror (simulates mirrored background for double-face exits)	**RA** Right[3]	
	BZ Bronze		GW Green on white	**LRA** Left and right	
	BS Polished Brass[1]		**GC** Green on clear (single face only)	**DA** Double face[4]	
	U Unfinished		**GMR** Green on mirror (simulates clear background for double-face exits)		

Emergency operation	Mounting	Item type	Options[7]
(blank) AC only	**(blank)** Ceiling or back mount	**(blank)** Complete exit panel and rough-in section[7]	FI Fire alarm interface[8]
EL N Nickel cadmium battery	EM Recessed end mount	**PNL** Panel assembly only	F Flashing emergency operation (one flash/second)[8,9]
X2 Lamp boards wired on two separate circuits (specify 120V or 277V)[5]	TM Top mount[6]		

Accessories: *Order as separate items.*

ELA R LRIS 120/277 EL N	Single-face, red LED emergency rough-in section [7,10]
ELA G LRIS 120/277 EL N	Single-face, green LED emergency rough-in section [7,10]
ELA R 2LRIS 120/277 EL N	Double-face, red LED emergency rough-in section [7,10]
ELA G 2LRIS 120/277 EL N	Double-face, green LED emergency rough-in section [7,10]
ELA LCRIS	LED rough-in section (supplied standard with recessed exit unless PNL suffix is specified; order ELA LCRIS only if needed for early installation). Available AC only with no options. [10]
ELA LRIS 277 X2	LED rough-in section (supplied standard with recessed exit unless PNL suffix is specified; order ELA LRIS 277 X2 only if needed for early installation). [7,10]
ELA LRIS 120 X2	LED rough-in section (supplied standard with recessed exit unless PNL suffix is specified; order ELA LRIS 120 X2 only if needed for early installation). [7,10]
ELA US12	12" pendant-mount kit (Top mount exits only). Mounting canopy is brushed aluminum. To order white or black canopy, add W or B to catalog number. Example: ELA W US12. To order 24" or 36" lengths, add 24 or 36 to catalog number. Example: ELA US24. See spec sheet ELA-StemKits.

Notes

1 Not available with EM option.
2 See chart on back for more information.
3 Only available with single face.
4 Only available with double face.
5 Not available with top mount exits (TM) or EL N operation.
6 No Rough-In section required. Attaches directly to J-box. Only available with AC operation.
7 When ordering recessed rough-in separately, all options must be included with rough-in nomenclature. Example: ELA LRIS 277 X2 F.
8 Choice of F or FI, not available with both. Not available with top mount exits.
9 Only available with non-emergency.
10 Rough-in supplied standard with exit unless PNL suffix is specified. Order separately only if needed for early installation.

SPECIFICATIONS

ELECTRICAL EMERGENCY

Primary Circuit

Type	Typical LED life[1]	Supply voltage	Number of faces	Input watts	Max. amps
Red	10 years	120	1	2.3	.093
		277	1	2.7	.095
Red	10 years	120	2	3.2	.084
		277	2	3.9	.094
Green	10 years	120	1	1.7	.07
		277	1	1.9	.07
Green	10 years	120	2	3.7	.14
		277	2	3.8	.14

ELECTRICAL AC ONLY

Primary Circuit

Type	Typical LED life[1]	Supply voltage	Number of faces	Input watts	Max. amps
Red	10 years	120	1	1.5	.087
		277	1	1.8	.089
		347	1	2.2	.107
Red	10 years	120	2	3.1	.178
		277	2	3.4	.180
		347	2	4.1	.220
Green	10 years	120	1	1.2	.064
		277	1	1.3	.062
Green	10 years	120	2	2.0	.06
		277	2	2.3	.06

BATTERY

Sealed Nickel-Cadmium

Typical shelf life [2]	Typical life [2]	Maintenance[3]	Temperature range [4]
3 yrs.	7–9 yrs.	none	32°–100°F (0°-38°C)

Notes

1 Based on continuous operation. The typical life of the exit LED lamp is 10 years.

2 At 77°F (25°C).

3 All life safety equipment, including emergency lighting for path of egress must be maintained, serviced, and tested in accordance with all National Fire Protection Association (NFPA) and local codes. Failure to perform the required maintenance, service, or testing could jeopardize the safety of occupants and will void all warranties.

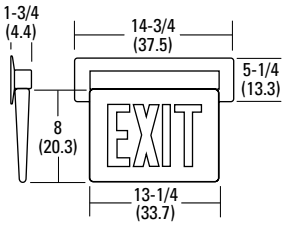
4 Optimum ambient temperature range where unit will provide capacity for 90 minutes. Higher and lower temperatures affect life and capacity.

MOUNTING

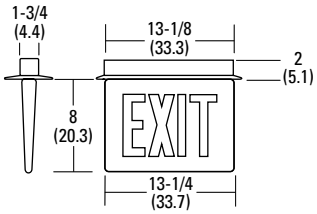
All dimensions are in inches (centimeters).

Shipping weight for panel: 5 lbs. (2.3 kgs.)

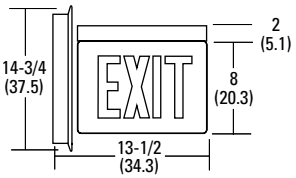
Shipping weight for rough-in section: 5.8 lbs. (2.6 kgs.)



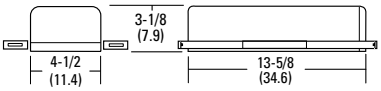
Back Mount (recessed)



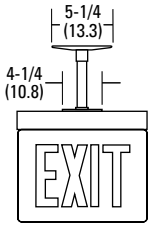
Ceiling Mount (recessed)



End Mount (recessed)



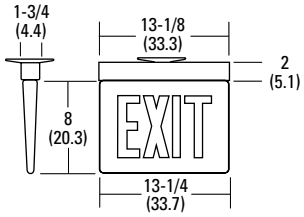
Rough -In Section



With Pendant Mounting kit (TM mounting only)

Directional Indicators

Specification (add to catalog number)	Graphics	
	Back	Front
LA		
RA		
LRA (single face)		
DA		
LRA (double face)		



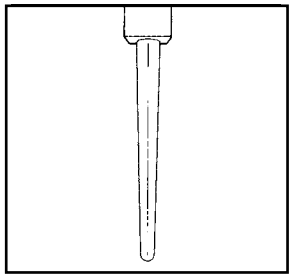
Top Mount (AC only operation)

KEY FEATURES

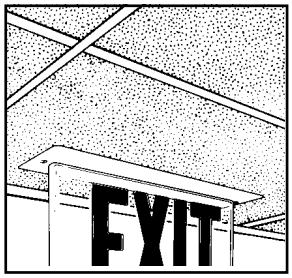


Unengraved with appearance of silk screening.

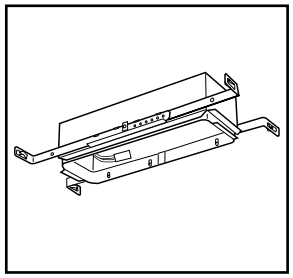
Consult factory for lead times.



Unique wedge-shaped panel design concentrates light for uniform letter illumination.



Trim fits flush against wall or ceiling for clean, attractive appearance.



Small rough-in section.

Emergency operation: contains battery and charger board.

Non-emergency: rough-in section is empty.

EMERGENCY: One Lithonia Way Conyers, GA 30012 Phone: 800.334.8694 Email: techsupport-emergency@acuitybrands.com www.lithonia.com

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LITHONIA LIGHTING®

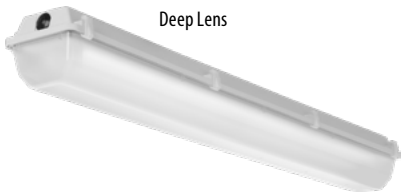
Catalog Number	
Notes	
Type	

Low-Profile Enclosed and Gasketed Industrial

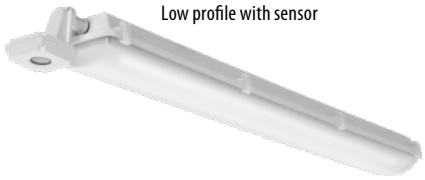
FEM LED

CEILING/ SUSPENDED MOUNT

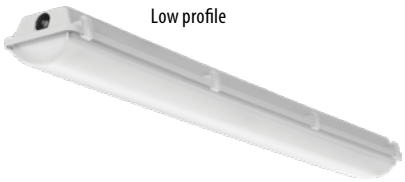
Deep Lens



Low profile with sensor



Low profile



FEATURES & SPECIFICATIONS

INTENDED USE — A general purpose and energy-efficient surface-mounted or suspended LED fixture, suitable for wet, damp and/or cold locations. For vapor-tight demanding environments where moisture or dust is a concern and where relatively low fixture mounting heights and wide fixture spacing are common. Typical applications include industrial facilities, parking garages, retail malls, multi-purpose rooms, garden centers, and food processing. **Certain airborne contaminants can diminish the integrity of acrylic and/or polycarbonate.** **Click here for Acrylic-Polycarbonate Compatibility table for suitable use.**

Certain airborne contaminants may adversely affect the functioning of LEDs and other electronic components, depending on various factors such as concentrations of the contaminants, ventilation, and temperature at the end-user location. **Click here for a list of substances that may not be suitable for interaction with LEDs and other electronic components.**

CONSTRUCTION — One-piece 5VA fiberglass housing with integral perimeter channel utilizing continuous poured-in-place NEMA 4X gasket. Approved as a wireway and for through wiring. Captive polymeric latches are standard. Stainless steel latches (#316) available as an option for food processing or more demanding applications.

Power connection is easily accomplished through pre-drilled holes. Fixture easily mounts to ceilings and other solid structures, or can be suspended with chain, cable or rod using stainless steel mounting brackets (included).

OPTICS — Injection molded, acrylic lens (.080" thick) provides high impact-resistance comparable to 100% DR. For L48 Medium Distribution, a UV stabilized polycarbonate diffuser is available (.080" thick) in clear or frosted for additional impact strength where vandal protection is desired.

Expected service life of 60,000 hours at 80% lumen maintenance (L80); predicted life of more than 100,000 hours.

ELECTRICAL — Utilizes high-efficiency LEDs mounted to core circuit boards. High-efficiency drivers operate 120 thru 277V, 347V and 480V offered with 0-10 volt dimming, allowing granular control when coupled with wireless networking controls. Luminaire Surge Protection Level: Designed to withstand up to 6kV/3kA per ANSI C82.77-5-2015.

INSTALLATION — Fixture can be ceiling or suspended mounted. Pre-punched stainless steel mounting brackets are included (two per luminaire) for easy field-attachment of bolts, screws and other mounting hardware. A covered ceiling is not required to maintain wet location listing or IP rating.

LISTINGS — CSA certified to UL and C-UL standards. Listed for wet locations in ambient temps ranging from -35°C (-31°F) to 25°C (77°F) when fixture is surface mounted or up to 45°C (113°F) when fixture is suspended at least 6" from ceiling. IP65, IP66 and IP67 rated. NSF splash-zone 2 certified and meets FDA/USDA guidelines. Nema 4X rated lens and housing. 1500 PSI hose-down. DesignLights Consortium® (DLC) Premium qualified product and DLC qualified product. Not all versions of this product may be DLC Premium qualified or DLC qualified. Please check the DLC Qualified Products List at www.designlights.org/QPL to confirm which versions are qualified.

WARRANTY — 5-year limited warranty. Complete warranty terms located at: www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx

NOTE: Actual performance may differ as a result of end-user environment and application. All values are design or typical values, measured under laboratory conditions at 25 °C. Specifications subject to change without notice.

Stock configurations are offered for shorter lead times:

Standard Part Number	Stock Part Number
FEM L48 4000LM LPAFL MD MVOLT GZ10 40K 80CRI	**FEM L48 4L MVOLT**
FEM L48 4000LM LPAFL MD MVOLT GZ10 50K 80CRI	**FEM L48 4L MVOLT 5K**

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is part of an A+ Certified solution for nLight® or XPoint™ Wireless control networks marked by a shaded background*

To learn more about A+, visit www.acuitybrands.com/aplus.

*See ordering tree for details

FEM LED Low-Profile Enclosed and Gasketed

A+ Capable options indicated by this color background.

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: FEM L48 4000LM IMAFL WD MVOLT GZ10 40K 80CRI

Series	Length	Nominal Lumens	Diffuser	Distribution	Voltage	Driver	Color temperature	CRI
FEM	L48 48" [1]	3000LM 3,000 lumens 4000LM 4,000 lumens 6000LM 6,000 lumens 8000LM 8,000 lumens 10000LM 10,000 lumens	IMAFL Acrylic, lineal ribbed frosted lens IMACD Acrylic, clear deep lens IMAFD Acrylic, deep frosted lens LPAFL Acrylic, low profile frosted lens[3] LPACL Acrylic, low profile clear lens[3] LPPCL Polycarbonate, low profile clear lens[3] LPPFL Polycarbonate, low profile frosted lens[3]	MD Medium WD Wide [4]	MVOLT MVOLT 120 120V 277 277V 347 347V[5] 480 480V[5]	GZ10 0 - 10V dimming	30K 3000K 35K 3500K 40K 4000K 50K 5000K	80CRI 80 CRI 90CRI 90 CRI
	L96 96" [2]	9000LM 9,000 lumens 12000LM 12,000 lumens 15000LM 15,000 lumens 18000LM 18,000 lumens 20000LM 20,000 lumens						

Options

SF	Single fuse (available with 120, 277, 347)[6]	CS88	6' Brad Harrison 16/3 cord and straight blade plug set[6]	Individual Controls: [12]	
DF	Double Fusing (available with 347, 480V)[6]	CS88L12	12' Brad Harrison 16/3 cord and straight blade plug set[6]	MSI10NWL	Low mount 360° integral motion sensor, wet location, On/Off operation[6]
BSL520	Bodine® emergency LED battery pack for -20°C and up. CA Title 20 Noncompliant [7,8]	CS88R	Brad Harrison receptacle	MSI102L3VWL	Low mount 360° integral motion sensor, wet location, High/Low operation (bi-level)[6]
E15WCP	Emergency battery pack, 15W constant power, Certified in CA Title 20 MAEDBS [6,7,9]	CS89	6' white cord, 16/3, no plug, wet location	MSI10NWL DSCNWL	Low mount 360° integral motion sensor, wet location, On/Off operation for motion sensing, override Off due to daylight[6]
BGTD	Generator transfer device[6,10]	CS89L12	12' white cord, 16/3, no plug, wet location	Xpoint Wireless: [12]	
SPD	Surge protection device, additional 10kV/5kA[6]	TRS	Tamper Resistant Torx® T10 screws	MSI10XAWL DSCXAWL	Xpoint wireless integral motion sensor, On/Off operation for motion sensing, override Off due to daylight[6]
WLF	Wet location fitting (two outboard, top)	DPMB	Dual pendant mounting bracket	XAD	XPoint™ wireless controller, 0-10V dimming[6]
WLFEND	Wet location fitting (one end)	STSL	Stainless steel latches	nLight Air:	
WLFEND2	Wet location fitting (both ends)[11]			NLTAIR2 RSBOR10	nLight AIR generation 2 enabled 306 low mount motion sensor [12]

Accessories: *Order as separate catalog number.*

MHCH 36	Jack chain 36" (pair)
MHHK120	10' single leg air craft cable (ships as pair)
MHHK120SS	10' single leg air craft cable, stainless steel (ships as pair)
RK1 T10BIT W/PIN U	Hex-base driver bit, Torx TX10, for tamper resistant screws with center reject pin
FEMDPMB	Dual pendant mounting bracket (ships as a pair)

Notes

1 Available with 3000LM, 4000LM, 6000LM, 8000LM, and 10000LM lumen packages. Not available with WD when using low profile diffuser.

2 Available with 9000LM, 12000LM, 15000LM, 18000LM, and 20000LM. Not available with low profile diffuser options.

3 Not available with L96. Not available with L48 when ordering WD option.

4 Not availabe with L48 when ordering low-profile lens options.

5 Utilizes step-down transformer. Not available with BGTD.

6 Must specify voltage.

7 Not available with 347 or 480V.

8 For use with ambient temperatures no lower than -20°C.

9 For use in ambient temperatures no lower than -17°C.

10 Available with 120V or 277V only. For use in ambient environments up to 25C. Not available with L48 when ordering 10000LM lumen package. Not available with L96 when ordering 18000LM or 20000LM lumen packages.

11 Not available with Sensor options or cord sets, or MSI controls.

12 Not available with multiple control options - other MSE or Xpoint.

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OPERATIONAL DATA

		Lumen packages	Wattage				Diffusers		
			120v	277v	347v	480v	Acrylic Lineal Frosted (IMAFL)	Frosted (IMAFD, LPAFL, LPPFL)	Clear (IMACD, LPACL, LPPCL)
L48 Medium Distribution *test results reflect less than 1% difference between acrylic (clear/deep/low profile) and polycarbonate (low profile) lens	**Delivered Lumens at 30K 80CRI**	3000LM	23	23	24	25	2972	3032	3071
		4000LM	31	30	31	32	4019	4100	4153
		6000LM	45	44	46	47	5925	6044	6122
		8000LM	69	67	70	71	7593	7746	7845
		10000LM	80	78	81	82	9781	9979	10107
	Delivered Lumens at 35K 80CRI	3000LM	23	23	24	25	3039	3100	3140
		4000LM	31	30	31	32	4109	4192	4246
		6000LM	45	44	46	47	6057	6179	6258
		8000LM	69	67	70	71	7762	7918	8020
		10000LM	80	78	81	82	9999	10201	10332
	Delivered Lumens at 40K 80CRI	3000LM	23	23	24	25	3086	3148	3189
		4000LM	31	30	31	32	4173	4257	4312
		6000LM	45	44	46	47	6151	6275	6356
		8000LM	69	67	70	71	7883	8042	8145
		10000LM	80	78	81	82	10155	10360	10493
	Delivered Lumens at 50K 80CRI	3000LM	23	23	24	25	3200	3264	3306
		4000LM	31	30	31	32	4326	4414	4470
		6000LM	45	44	46	47	6378	6506	6590
		8000LM	69	67	70	71	8173	8338	8445
		10000LM	80	78	81	82	10529	10741	10879

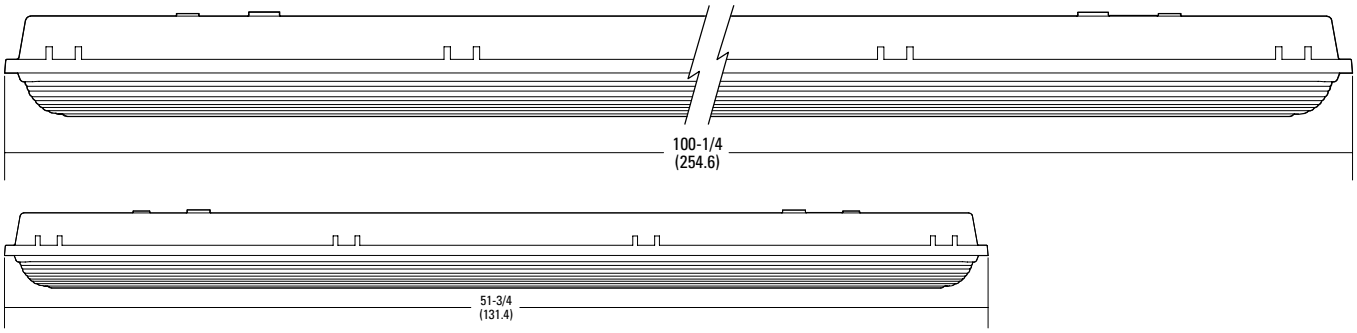
		Lumen packages	Wattage				Diffusers		
			120v	277v	347v	480v	Acrylic Lineal Frosted (IMAFL)	Acrylic Frosted (IMAFD)	Acrylic Clear (IMACD)
L96 Medium Distribution	**Delivered Lumens at 30K 80CRI**	9000LM	65	64	66	67	8718	8959	9072
		12000LM	88	86	89	90	11370	11685	11831
		15000LM	120	118	122	124	14263	14657	14841
		18000LM	145	141	146	148	16863	17330	17547
		20000LM	160	156	162	164	19313	19847	20096
	Delivered Lumens at 35K 80CRI	9000LM	65	64	66	67	8913	9159	9274
		12000LM	88	86	89	90	11624	11945	12095
		15000LM	120	118	122	124	14581	14984	15172
		18000LM	145	141	146	148	17239	17716	17938
		20000LM	160	156	162	164	19743	20289	20544
	Delivered Lumens at 40K 80CRI	9000LM	65	64	66	67	9051	9302	9419
		12000LM	88	86	89	90	11805	12131	12284
		15000LM	120	118	122	124	14808	15218	15409
		18000LM	145	141	146	148	17507	17992	18218
		20000LM	160	156	162	164	20051	20605	20864
	Delivered Lumens at 50K 80CRI	9000LM	65	64	66	67	9385	9644	9765
		12000LM	88	86	89	90	12239	12578	12736
		15000LM	120	118	122	124	15353	15778	15976
		18000LM	145	141	146	148	18152	18654	18888
		20000LM	160	156	162	164	20789	21364	21632

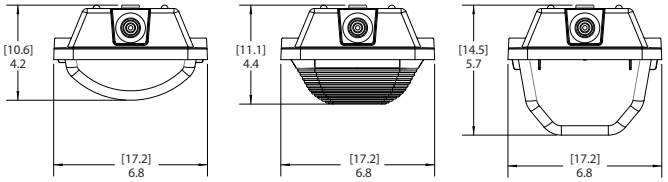
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DIMENSIONS

Specifications subject to change without notice.
All dimensions are inches (centimeters) unless otherwise indicated.

Weight (may vary with options or accessories)
FEM L48: 11.9 lbs (5.397kg)
FEM L96: 24.3 lbs (11.022kg)





Diffuser Type:
LPAFL
LPACL
LPPFL
LPPCL

Diffuser Type:
IMAFL

Diffuser Type:
IMAFD
IMACD

PHOTOMETRICS

See www.lithonia.com for photometry reports.

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LITHONIA LIGHTING®

Catalog Number	
Notes	
Type	

FEATURES & SPECIFICATIONS

INTENDED USE — Recessed LED troffer for general illumination of Cleanroom ISO5-9 (Class 100 – 100,000) environment. Typical applications include healthcare, pharmaceuticals, electronic manufacturing, and other contamination-controlled environments. **Certain airborne contaminants can diminish integrity of acrylic. Click here for Acrylic Environmental Compatibility table for suitable uses.**

Certain airborne contaminants may adversely affect the functioning of LEDs and other electronic components, depending on various factors such as concentrations of the contaminants, ventilation, and temperature at the end-user location. Click here for a list of substances that may not be suitable for interaction with LEDs and other electronic components.

CONSTRUCTION — Housing is made from 20-gauge cold rolled steel. Door frame is .060 painted aluminum and lens is diffused acrylic. Gasket is closed cell silicone.

Finish: All CRS (cold rolled steel) and aluminum parts are finished with electrostatically deposited, thermally set, polyester powder paint after fabrication. Door frame and enclosure finish is NSF-listed.

OPTICS — Long-life LEDs, coupled with high-efficiency drivers, provide extended service life. Lumen maintenance of L80>60,000 hours, L70>100,000 hours.

ELECTRICAL — Thermally protected, resetting, Class TL, UL listed, CSA certified driver is standard.

LED driver delivers dimming from a 0-10V control signal. Dims to 1% standard.

Luminaire Surge Protection Level: Designed to withstand up to 6kV/3kA per ANSI C82.77-5-2015.

INSTALLATION — Lay-in grid or in-ceiling sheet rock installation using swing-arms with range from 1" to 2" grid height. See drawings for other critical dimensions. Additional sealing method required for sheet rock mounted overlap door. Refer to installation instructions for more information. Swing-arms are not intended to secure fixture without additional support. Line voltage supply wiring entrance opening is 7/8".

LISTINGS — CSA certified to meet U.S. and Canadian standards (UL1598 and UL8750) or NOM Certified. IC rated, see footnote 3 for non-compliant configurations. Wet location listed. IP66 with overlap door from below fixture only. Suitable for Bio Levels 1 & 2. EMI filtering option: meets Mil Standard 461F for EMI radiation. Certified for NSF Splash Zone 2. Base configurations for use in ambient temperatures ranging from -20°C (-4°F)to 40°C (104°F) with exception of the following lumen packages (1x4 - 10000LM; 2x2 - 10000LM and 12000LM;
2x4 - 18000LM and 24000LM) and emergency or control options which are 25°C (77°F) max.

WARRANTY — 5-year limited warranty. Complete warranty terms located at:
www.acuitybrands.com/resources/terms-and-conditions

Note: Actual performance may differ as a result of end-user environment and application.
All values are design or typical values, measured under laboratory conditions at 25 °C.
Specifications subject to change without notice.

Cleanroom LED Recessed Luminaire

SRTL



A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is part of an A+ Certified solution for nLight® or XPoint™ Wireless control networks marked by a shaded background*

To learn more about A+, visit www.acuitybrands.com/aplus.

*See ordering tree for details

A+ Capable options indicated by this color background.

ORDERING INFORMATION

Lead times will vary depending on options selected. Consult with your sales representative. **Example:** 2SRTL G L48 18000LM IAW AFL MVOLT EZ1 40K 80CRI DWHXD

Series		Trim type		Length		Nominal Lumens [3]					
SRTL	Recessed wet location troffer, 1' wide[1]	G	Grid (9/16" - 1 1/2" W x 2" H) [2]	L24	24"	1x4:		2x2:		2x4:	
2SRTL	Recessed wet location troffer, 2' wide	F	Flange	L48	48"	3000LM	3,000 lumens	3000LM	3,000 lumens	3000LM	3,000 lumens
						5000LM	5,000 lumens	5000LM	5,000 lumens	5000LM	5,000 lumens
						7000LM	7,000 lumens[4]	7000LM	7,000 lumens	7000LM	7,000 lumens
						10000LM	10,000 lumens[4]	10000LM	10,000 lumens[5]	10000LM	10,000 lumens
								12000LM	12,000 lumens[4]	15000LM	15,000 lumens[5]
										18000LM	18,000 lumens[5,6]
										24000LM	24,000 lumens[4,6]

Door frame		Diffuser type		Voltage		Driver		Color temperature		Color rendering index	
IAW	Inset aluminum, white	AFL	Acrylic, frosted	MVOLT	120-277V	EZ1	eldoLED 0-10V, ECOdrive, dimming to 1% min	30K	3000 K	80CRI	80 CRI
IAN	Inset aluminum, silver			120	120V			35K	3500 K	90CRI	90 CRI
IBSN	Inset brushed stainless steel, natural			208	208V	GZ1	0-10V dimming	40K	4000 K		
OAW	Overlapping aluminum, white			240	240V			50K	5000 K		
OAN	Overlapping aluminum, silver			277	277V						
OBSN	Overlapping brushed stainless steel, natural			347	347V[7]						

Options			Finish	
BGTD	Generator tranfser device[5,8,9]	Individual Controls: [13]		DWAM	Antimicrobial, white
E10WLCP	Emergency battery pack, 10W, Linear Constant Power Certified in CA Title 20 MAEDBS [5,8,10,11]	MSE6NWL	Embedded high mount 360° motion sensor, wet location, On/Off operation[6,14]	DWHXD	Super durable, white
SF	Single fusing[5,8]	MSE62L3VWL	Embedded high mount 360° motion sensor, wet location, High/Low operation (2-level)[6,14]		
DF	Double fusing[5,8,12]	MSE6NWL DSCNWL	Embedded high mount 360° motion sensor, wet location, On/Off operation from motion sensing, Override Off due to daylight[6,14]		
ST3	Constructed with US steel	MSE10NWL	Embedded low mount 360° motion sensor, wet location, On/Off operation[6,14]		
USPOM	Assembled in the USA	MSE102L3VWL	Embedded low mount 360° motion sensor, wet location, High/Low operation (2-level)[6,14]		
		MSE10NWL DSCNWL	Embedded low mount 360° motion sensor, wet location, On/Off operation from motion sensing, Override Off due to daylight[6,14]		
		Xpoint Wireless: [13]			
		MSE6XAWL	XPoint™ wireless high mount 360° motion sensor embedded, on/off, wet location (white only)[6]		
		MSE10XAWL	XPoint™ wireless low mount 360° motion sensor embedded, on/off, wet location (white only)[6]		
		XAD	XPoint™ wireless 0-10V relay[14]		
		XAD924	XPoint™ wireless 0-10V relay with emergency relay		
		nLight: [13]			
		N100	nLight® dimming pack controls, 0-10V eldoLED driver		

CONFIGURATIONS

Lumens	1' X 4'	2' X 2'	2' X 4'
3,000LM	X	X	X
5,000LM	X	X	X
7,000LM	X	X	X
10,000LM	X	X	X
12,000LM		X	
15,000LM			X
18,000LM			X
24,000LM			X

Notes
1 Only available with L48 length.
2 Not available with overlapping doorframe options.
3 Not all lumen packages are available with every length/width combination. See configuration chart for availability.
4 Not available with MVOLT or E10WLCP. Not IC-rated.
5 Not available with MVOLT.
6 Not available with GZ1 driver.
7 347v includes back box.
8 Must specify voltage.
9 Only available with 120 or 277 volt.
10 Not available 347V. See spec sheet PS1055LCP (10W Linear Constant Power) for more information. Meets CA Title 20 compliance.
11 For use in ambient temperatures from 0°C (32°F) to 25°C (77°F).
12 Only available with 208 or 240 volt.
13 Cannot be used with other control options - MSE, Xpoint or nLight.
14 Not available with BGTD.

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SBG EZ – EMBEDDED Motion Sensor (see www.acuitycontrols.com for additional information)

- 360° coverage
- On/Off dim
- Photocell optional
- IP66 rated
- Photocell and 0-10VDC dimming options.

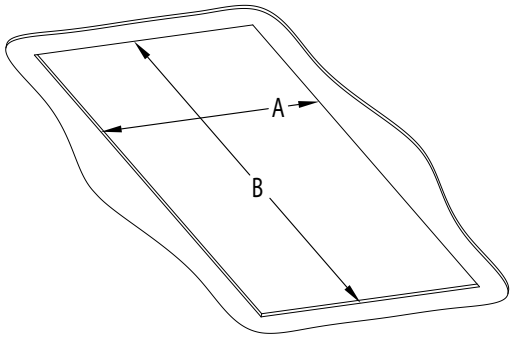


Lithonia nomenclature	Sensor Switch® nomenclature
For shortest lead times use the SBG EZ configurations	
MSE6NWL	SBG 6 EZ WH 0V 10M
MSE62L3VWL	SBG 6 EZ WH 3V
MSE6NWL DSCNWL	SBG 6 EZ P WH 0V 10M
MSE10NWL	SBG 10 EZ WH 0V 10M
MSE102L3VWL	SBG 10 EZ WH 3V
MSE10NWL DSCNWL	SBG 10 EZ P WH 0V 10M

* When ordering silver door frame, sensor will be standard white

MOUNTING DATA

Rough-in



Rough-in dimensions

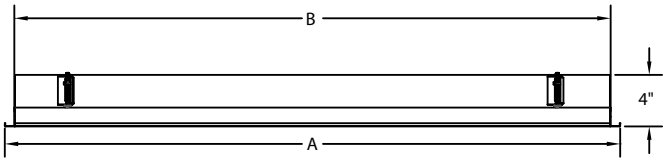
Configuration	A (inches)	B (inches)
1x4	10 1/2	46 1/2
2x2	22 1/2	22 1/2
2x4	22 1/2	46 1/2

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DIMENSIONS

All dimensions are in inches (centimeters) unless otherwise indicated.
Dimensions may vary with options or accessories.
Standard height of fixture is 4". Depending on configuration, a back box may be included which adds 2 5/8" to its height.

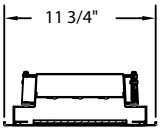
Weight: (may vary with options or accessories)
1x4: 24 lbs (10.9 kg)
2x2: 23 lbs (10.43 kg)
2x4: 45 lbs (20.41 kg)



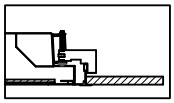
SIDE VIEW

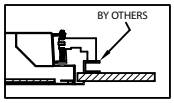


FRONT VIEW
2SRTL



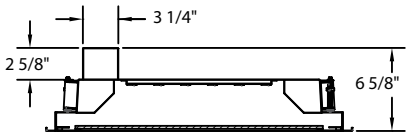
FRONT VIEW
SRTL


GRID MOUNTING
INSET

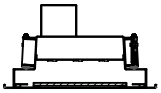


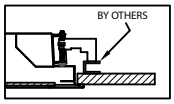
FLANGE MOUNTING
INSET

Series	Length	(A) Flange Length	(B) Housing Length
2SRTL	L48	47-3/4"	46-1/4"
2SRTL	L24	23-3/4"	22-1/4"
SRTL	L48	47-3/4"	46-1/4"

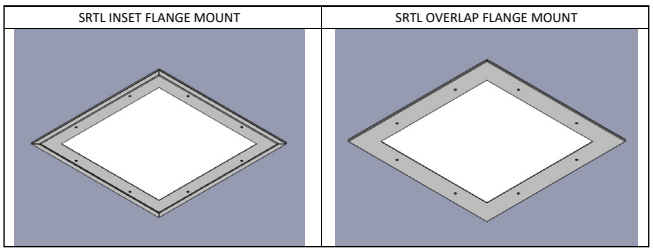


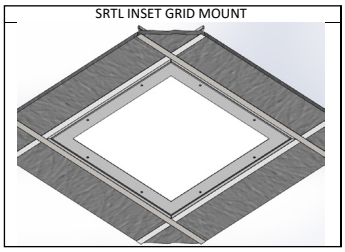
FRONT VIEW
BACK BOX
2SRTL


FRONT VIEW
BACK BOX
SRTL



FLANGE MOUNTING
OVERLAP





PHOTOMETRICS

See www.lithonia.com

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OPERATIONAL DATA

Size	Lumen Package	Input Watts	Color Temp	Acrylic	
				80 CRI	90 CRI
1'x4'	3000LM	27	30K	3140	2560
		27	35K	3210	2650
		27	40K	3260	2700
		27	50K	3380	2760
	5000LM	44	30K	5175	4220
		44	35K	5291	4368
		44	40K	5373	4450
		44	50K	5571	4549
	7000LM	59	30K	6651	5422
		59	35K	6800	5613
		59	40K	6906	5719
		59	50K	7160	5847
	10000LM	88	30K	10043	8188
		88	35K	10267	8476
		88	40K	10427	8636
		88	50K	10811	8828
2'x2'	3000LM	27	30K	2871	2341
		27	35K	2935	2423
		27	40K	2981	2469
		27	50K	3091	2524
	5000LM	42	30K	4563	3720
		42	35K	4665	3851
		42	40K	4737	3923
		42	50K	4912	4011
	7000LM	61	30K	6869	5600
		61	35K	7022	5797
		61	40K	7132	5906
		61	50K	7394	6038
	10000LM	88	30K	9732	7934
		88	35K	9948	8213
		88	40K	10103	8368
		88	50K	10475	8554
	12000LM	110	30K	11835	9649
		110	35K	12099	9988
		110	40K	12287	10176
		110	50K	12739	10403

Size	Lumen Package	Input Watts	Color Temp	Acrylic	
				80 CRI	90 CRI
2'x4'	3000LM	21	30K	2648	2159
		21	35K	2707	2235
		21	40K	2749	2277
		21	50K	2850	2328
	5000LM	39	30K	4670	3807
		39	35K	4774	3941
		39	40K	4848	4015
		39	50K	5027	4105
	7000LM	59	30K	6862	5595
		59	35K	7015	5791
		59	40K	7124	5901
		59	50K	7387	6032
	10000LM	80	30K	9453	7707
		80	35K	9664	7978
		80	40K	9814	8128
		80	50K	10175	8309
	15000LM	121	30K	13984	11401
		121	35K	14295	11801
		121	40K	14518	12024
		121	50K	15052	12291
	18000LM	149	30K	16916	13792
		149	35K	17293	14276
		149	40K	17563	14546
		149	50K	18209	14869
	24000LM	194	30K	22820	18606
		194	35K	23330	19260
		194	40K	23693	19623
		194	50K	24565	20059

Fixture Size	Lumen Output	Number of LED Boards Light up in Emergency Mode
1x4	3000	6
	5000	6
	7000	N/A
	10000	N/A
2x2	3000	3
	5000	3
	7000	2
	10000	3
	12000	N/A
2x4	3000	6
	5000	6
	7000	4
	10000	3
	15000	2
	18000	3
	24000	N/A

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LITHONIA LIGHTING®

Catalog Number
Notes
Type

FEATURES & SPECIFICATIONS

INTENDED USE — The Lithonia Lighting JCBL LED Highbay is the affordable LED solution for users who prefer a luminaire with the look and feel of a round form factor. The JCBL is highly configurable and delivers comfortable and uniform lighting from mounting heights up to 30ft. Gymnasiums, warehouses, packaging facilities and other industrial applications all benefit from JCBL's highly efficient design that saves over traditional sources. **Certain airborne contaminants can diminish the integrity of acrylic and/or polycarbonate. Click here for Acrylic-Polycarbonate Compatibility table for suitable uses.**

Certain airborne contaminants may adversely affect the functioning of LEDs and other electronic components, depending on various factors such as concentrations of the contaminants, ventilation, and temperature at the end-user location. **Click here for a list of substances that may not be suitable for interaction with LEDs and other electronic components.**

CONSTRUCTION — JCBL features an aluminum heat sink to maximize heat dissipation and extend the life of the luminaire by maximizing contact with the LEDs. A glass optical enclosure (IP65 rated) protects the LEDS from dust and other air contaminants. Reflector options including aluminum, prismatic acrylic and polycarbonate ship together and easily mount to the heatsink for quick installation.

OPTICS — Reflector and lens options provide maximum versatility and uniformity. Conical, flat or acrylic drop lenses offer enhanced aesthetics, minimize glare at lower mounting heights when paired with acrylic reflectors.

ELECTRICAL — Utilizes 90°C case temperature for maximum life at high temperatures. Less than 20% THD and PF >90. Luminaire Surge Protection Level: Designed to withstand up to 6kV/3kA per ANSI C82.77-5-2015 with MVOLT. Luminaire Surge Protection Level: Designed to withstand up to 10kV/5kA per ANSI C82.77-5-2015 with HVOLT. Input voltages include 120-277, 347/480 without the use of a step down transformer. 0-10V dimming standard for a dimming range of 100% to 10%. Suitable for 50/60Hz.

WIRELESS NETWORKING — XPoint™ Wireless technology creates a mesh network to ensure communication between fixtures, sensors and wall stations facility-wide. This option provides superior lighting management capabilities including granular control, configuration and custom grouping for increased energy savings.

Integrated Sensor (nLight Wired Networking): This sensor is nLight-enabled, meaning it has the ability to communicate over an nLight network. When wired, using CAT-5 cabling, with other nLight-enabled sensors, power packs, or WallPods, an nLight control zone is created. Once linked to a Gateway, directly or via a Bridge, the zone becomes capable of remote status monitoring and control via SensorView software.

Integrated Smart Sensor (nLight AIR Wireless Platform): The rSBOR sensor is nLight AIR enabled, meaning it has the ability to communicate over the wireless nLight control platform. It is available with an automatic dimming photocell, and either a digital PIR or dual technology occupancy sensor. It pairs to other Luminaires and wall switches through our mobile app, CLAIRITY PRO, which allows for simple sensor adjustment.

INSTALLATION — Mounting options include steel hook & cord or 3/4" NPT threaded hub to accommodate stem or cast hook options.

LISTINGS — UL1598/C SA C22 .2 250, Damp location listed. Suitable for use in ambient temperatures from -40°C up to 55°C .

DesignLights Consortium® (DLC) Premium qualified product and DLC qualified product. Not all versions of this product may be DLC Premium qualified or DLC qualified. Please check the DLC Qualified Products List at www.designlights.org/QPL to confirm which versions are qualified.

WARRANTY — 5-year limited warranty. Complete warranty terms located at: www.acuitybrands.com/resources/terms-and-conditions

Note: Actual performance may differ as a result of end-user environment and application.

All values are design or typical values, measured under laboratory conditions at 25 °C.

Specifications subject to change without notice.



LED Damp Rated High Bay

JCBL

9000, 12000, 15000, 18000, 24000, 30000 or 36000 lumens

High Bay Mixed use/Gym/ Cafeteria

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is part of an A+ Certified solution for nLight® or XPoint™ Wireless control networks marked by a shaded background*

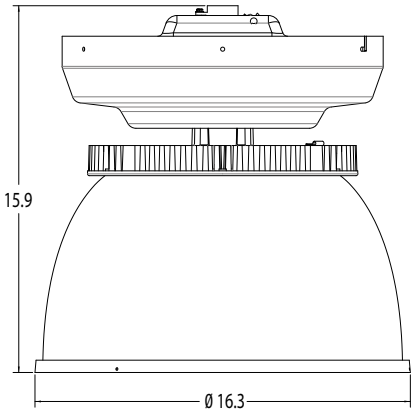
To learn more about A+, visit www.acuitybrands.com/aplus.

*See ordering tree for details

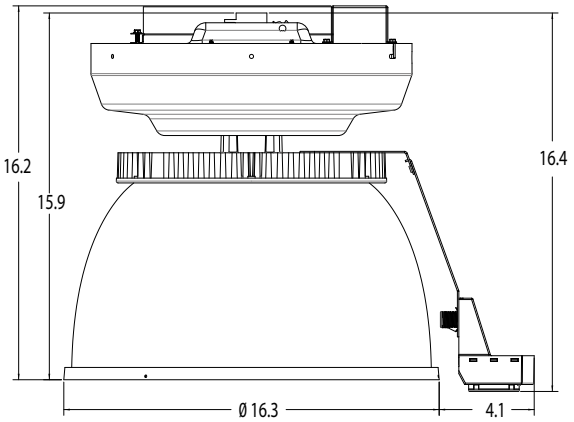
DIMENSIONS

All dimensions are in inches (centimeters) unless otherwise indicated.
Dimensions may vary with options or accessories.

Typical weight:
A cartoned luminaire weighs 23 lbs.;
unboxed it weighs 16 lbs.

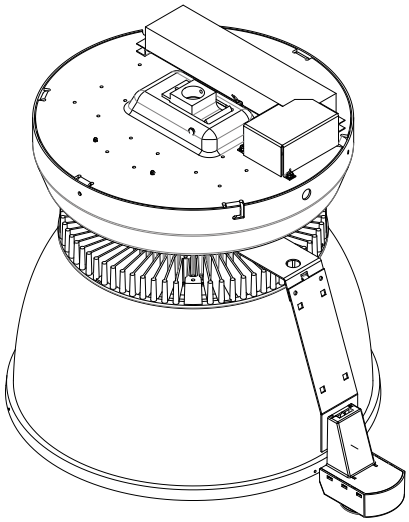


PENDANT MOUNT



PENDANT MOUNT WITH BATTERY & MOTION SENSOR

shown with LSXR motion sensor



INDUSTRIAL: One Lithonia Way, Conyers, GA 30012 Phone: 800-315-4963 techsupport-industrial@acuitybrands.com www.lithonia.com
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JCBL LED Damp Rated High Bay

A+ Capable options indicated by this color background.

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative. **Example**: JCBL 24000LM DALR MVOLT GZ10 40K 80CRI SC6 DWHXD

JCBL				
Series	**Lumens**	**Reflector**	**Lens**[1]	**Voltage**
JCBL	9000LM 9,000 lumens 12000LM 12,000 lumens 15000LM 15,000 lumens 18000LM 18,000 lumens 24000LM 24,000 lumens 30000LM 30,000 lumens 36000LM 36,000 lumens	DALR Diffuse aluminum SALR Specular aluminum ACFR Frosted acrylic ACCR Clear acrylic PLCR Clear polycarbonate	(blank) Open bottom For use with aluminum reflectors ALDRP Drop prismatic ALCON Conical ALFGL Flat prismatic For use with acrylic and polycarbonate reflectors ACRDRP Drop prismatic ACRCON Conical ACRFGL Flat prismatic	MVOLT 120-277V HVOLT 347/480V 120 120V 208 208V 240 240V 277 277V 347 347V 480 480V

GZ10			
Driver	**Color temperature**	**Color rendering index**	**Mounting Configurations**
GZ10 0-10V dimming	30K 3000 K 35K 3500 K 40K 4000 K 50K 5000 K	70CRI 70 CRI 80CRI 80 CRI 90CRI 90 CRI	PM Pendant mount SC6 Steel hook & 6' cord SC6P Steel hook with white 6' cord and NEMA twist lock plug (not available with battery packs)[2,3] SC6PN Steel hook with white 6' straight blade cordset[2,3,4] SCS6G16WSTOW5D Steel hook with white 6' cord, 16/5, no plug, includes low voltage dimming wires SC12 Steel hook & 12' white cord SC12P Steel hook with white 12' cord and NEMA twist lock plug (not available with battery packs)[2,3] SC12PN Steel hook with white 12' straight blade cordset[2,3,4] SCS12G16WSTOW5D Steel hook with white 12' cord, 16/5, no plug, includes low voltage dimming wires

Options				**Super Durable Finishes**	
C6	White 6' cord[5]	LSXBTP	360° Low Mount Occ Sensor, pre-wired; Bluetooth®[2]	DWHXD	White
C12	White 12' cord[5]	LSXBTPHL	360° Low Mount Occ Sensor w/HL Default, pre-wired; Bluetooth®[2]	DNAXD	Natural aluminum
C6PN	White 6' cord with straight blade plug (not available with battery packs)[2,3,4,5]	LSXBTPADC	360° Low Mount Occ Sensor w/ADC Default, prewired; Bluetooth®[2]	DWHGXD	Textured white
CS6G16WSTOW5D	White 6' cord, 16/5, no plug, includes low voltage dimming wires[5]	LSXBTPANL	360° Low Mount Occ Sensor w/ANL Default, prewired; Bluetooth®[2]	DNATXD	Textured natural aluminum
HK455	Safety hook, male, cast aluminum, factory installed[5]	MSI6XADL DSCXADL	360° XPoint™ wireless motion sensor with photocell[2,11]	DBLXD	Black
HC6	White 6' cord with male cast hook, no plug[5,6]	MSI10XADL DSCXADL	360° XPoint™ wireless motion sensor with photocell[2,11]		
HC6P	White 6' cord with male cast hook and NEMA twist lock plug (not available with battery packs)[2,3,5,6]	XAD	Integral factory installed XPoint™ wireless 0-10V dimming relay[2,11]		
HC6PN	White 6' cord with male cast hook and straight blade cord (not available with battery packs)[2,3,4,5,6]	XAD924	Integral factory installed XPoint™ wireless, 0-10V dimming with Emergency relay[2,11]		
HC6P20	White 6' cord with male cast hook and 20-amp plug (not available with battery packs)[2,3,5,6]	NLTAIR2 RKOA	nLight AIR Generation 2 enabled 360°high mount motion sensor[2]		
HCS6G16WSTOW5D	White 6' cord with male cast hook, 16/5, no plug, includes low voltage dimming wires[6]	NLTAIR2 RKOB	nLight AIR Generation 2 enabled 360° low mount motion sensor[2]		
HOCS	Hook, 6' RELOC® OCS[3,5,6,7]	NLTAIR2 rPP20D	nLight AIR Generation 2 dimming and switching module[2,12]		
OCS	6' RELOC® OCS[3,6,7]	NLTAIR2 rPP20DER	nLight AIR Generation 2 dimming and switching module with emergency relay (not available with battery pack or BGTD)[2,12]		
E10WCP	EM Self-diagnostics battery pack, 10W, constant power, certified in CA title 20 MAEDBS[2,8]	NPP16D	nLight® switching/dimming module[2,13]		
BGTD	Generator transfer device (120 or 277 only)[2]	NPP16DER	nLight® switching/dimming module with emergency relay (not available with battery pack or BGTD)[2,13]		
WG	Wire guard for open bottom reflectors (ships separately)				
FWG	Full wire guard (ships separately)				
AO	Adjustable output[9]				
LCOZU	Aisle motion sensor, pre-wired[2,10]				
LCHOSZU	Aisle motion sensor, pre-wired; programmable dimming[2,10]				
LCPZU	Aisle motion sensor with photocell; pre-wired[2,10]				
LAOZU	360° motion sensor, pre-wired[2,10]				
LAHOSZU	360° motion sensor, pre-wired; programmable dimming[2,10]				
LAPZU	360° motion sensor with photocell, pre-wired[2,10]				

Accessories and Notes next page.

INDUSTRIAL: One Lithonia Way, Conyers, GA 30012 Phone: 800-315-4963 techsupport-industrial@acuitybrands.com www.lithonia.com
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Accessories: *Order as separate catalog number.*	
HK455	Safety hook, male, cast aluminum
JCBLHKF	Hook, female
JCBLSC120	Safety cable 120"
JCBLSC240	Safety cable 240"
JCBLSTEM12 XXX	Swivel stem kit, 12", silver finish standard
JCBLSTEM24 XXX	Swivel stem kit, 24", silver finish standard
JCBLSTEM36 XXX	Swivel stem kit, 36", silver finish standard
WGJCBL	Wire guard for use with open bottom reflectors
FWGJCBL	Full wire guard
PS1055CP	FMC Emergency battery pack, 15W, CEC compliant, for remote mount only

Notes
1 Lensed fixtures are suitable for use in ambient temperatures up to 40°C.
2 Must specify voltage. Not available MVOLT or HVOLT.
3 120-277V utilizes a 15-amp plug, 347-480 utilizes a 20-amp plug (standard).
4 Not available with 480V.
5 PM option required.
6 Ships standard with HK455 option.
7 When reloc is selected fixture bears a dry location label.
8 Available 120-277 only. Four conductor cordset ships standard when product is ordered with cord. Utilizes PS1055CP.
9 Not available with any other controls options.
10 Not available with XAD or XAD924.
11 Not available with 30,000LM at 347V or 480V.
12 NOt available HVOLT, 347 or 480V.
13 Available with 120-347V only.

OPERATIONAL DATA

Lumen Package	Input Watts	Ambient Rating	Reflector	Lens	Delivered Lumens											
					3000K CCT, 70CRI	3500K CCT, 70CRI	4000K CCT, 70CRI	5000K CCT, 70CRI	3000K CCT, 80CRI	3500K CCT, 80CRI	4000K CCT, 80CRI	5000K CCT, 80CRI	3000K CCT, 90CRI	3500K CCT, 90CRI	4000K CCT, 90CRI	5000K CCT, 90CRI
9000LM	63	-40°F (-40°C) - 135°F (55°C)	ACCR	-	9628	10046	10186	10256	9418	9418	9558	10046	7814	8023	8163	8581
			ACFR	-	9602	10020	10159	10229	9394	9394	9533	10020	7793	8002	8141	8559
			DALR	-	8045	8395	8511	8569	7870	7870	7987	8395	6529	6704	6821	7170
			PLCR	-	8967	9357	9487	9552	8772	8772	8902	9357	7277	7472	7602	7992
			SALR	-	8811	9194	9322	9385	8619	8619	8747	9194	7151	7342	7470	7853
			ACCR	ACRCON	9014	9405	9536	9601	8818	8818	8948	9405	7315	7511	7642	8034
			ACFR	ACRCON	9069	9463	9594	9660	8872	8872	9003	9463	7360	7557	7689	8083
			PLCR	ACRCON	8422	8789	8911	8972	8239	8239	8361	8789	6836	7019	7141	7507
			ACCR	ACRDRP	8900	9287	9416	9480	8706	8706	8835	9287	7223	7416	7545	7932
			ACFR	ACRDRP	9082	9477	9608	9674	8884	8884	9016	9477	7371	7568	7700	8095
			PLCR	ACRDRP	8350	8713	8834	8894	8168	8168	8289	8713	6777	6958	7079	7442
			ACCR	ACRFGL	9042	9435	9566	9632	8845	8845	8976	9435	7338	7535	7666	8059
			ACFR	ACRFGL	9102	9498	9630	9696	8904	8904	9036	9498	7387	7585	7717	8113
			PLCR	ACRFGL	8378	8742	8864	8924	8196	8196	8317	8742	6800	6982	7103	7467
			DALR	ALCON	7787	7895	7949	7462	7300	7300	7408	7787	6056	6219	6327	6651
			SALR	ALCON	8529	8648	8707	8174	7996	7996	8115	8529	6634	6812	6930	7286
			DALR	ALDRP	7778	7886	7940	7453	7291	7291	7399	7778	6049	6211	6319	6643
			SALR	ALDRP	8580	8699	8758	8222	8043	8043	8162	8580	6673	6852	6971	7328
			DALR	ALFGL	7613	7719	7772	7296	7138	7138	7243	7613	5922	6080	6186	6503
			SALR	ALFGL	8564	8683	8743	8207	8029	8029	8148	8564	6661	6839	6958	7315
12000LM	84	-40°F (-40°C) - 135°F (55°C)	ACCR	-	12418	12958	13138	13228	12148	12148	12328	12958	10079	10349	10529	11069
			ACFR	-	12386	12924	13104	13193	12116	12116	12296	12924	10052	10321	10501	11039
			DALR	-	10377	10828	10978	11053	10151	10151	10301	10828	8422	8647	8798	9249
			PLCR	-	11566	12069	12236	12320	11314	11314	11482	12069	9387	9638	9806	10309
			SALR	-	11365	11859	12023	12106	11118	11118	11282	11859	9223	9471	9635	10129
			ACCR	ACRCON	11626	12132	12300	12384	11373	11373	11542	12132	9436	9688	9857	10362
			ACFR	ACRCON	11697	12206	12375	12460	11443	11443	11613	12206	9493	9748	9917	10426
			PLCR	ACRCON	10864	11336	11493	11572	10628	10628	10785	11336	8817	9053	9211	9683
			ACCR	ACRDRP	11479	11978	12145	12228	11230	11230	11396	11978	9316	9566	9732	10231
			ACFR	ACRDRP	11714	12223	12393	12478	11459	11459	11629	12223	9507	9762	9932	10441
			PLCR	ACRDRP	10770	11238	11394	11472	10536	10536	10692	11238	8741	8975	9131	9599
			ACCR	ACRFGL	11663	12170	12339	12423	11409	11409	11578	12170	9465	9719	9888	10395
			ACFR	ACRFGL	11740	12251	12421	12506	11485	11485	11655	12251	9528	9784	9954	10464
			PLCR	ACRFGL	10806	11276	11433	11511	10572	10572	10728	11276	8770	9005	9162	9632
			DALR	ALCON	10044	10183	10253	9625	9416	9416	9555	10044	7812	8021	8160	8579
			SALR	ALCON	11002	11155	11231	10543	10314	10314	10467	11002	8557	8786	8939	9397
			DALR	ALDRP	10032	10171	10241	9614	9405	9405	9544	10032	7803	8012	8151	8569
			SALR	ALDRP	11066	11220	11297	10605	10375	10375	10528	11066	8607	8838	8991	9452
			DALR	ALFGL	9820	9956	10025	9411	9206	9206	9343	9820	7638	7842	7979	8388
			SALR	ALFGL	11047	11200	11277	10586	10356	10356	10510	11047	8592	8822	8975	9436

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OPERATIONAL DATA (continued)

Lumen Package	Input Watts	Ambient Rating	Reflector	Lens	Delivered Lumens											
					3000K CCT, 70CRI	3500K CCT, 70CRI	4000K CCT, 70CRI	5000K CCT, 70CRI	3000K CCT, 80CRI	3500K CCT, 80CRI	4000K CCT, 80CRI	5000K CCT, 80CRI	3000K CCT, 90CRI	3500K CCT, 90CRI	4000K CCT, 90CRI	5000K CCT, 90CRI
15000LM	103	-40°F (-40°C) - 135°F (55°C)	ACCR	-	14899	15547	15763	15871	14575	14575	14791	15547	12092	12416	12632	13280
			ACFR	-	14860	15506	15721	15829	14537	14537	14752	15506	12060	12383	12598	13244
			DALR	-	12449	12991	13171	13261	12179	12179	12359	12991	10104	10375	10555	11096
			PLCR	-	13876	14479	14681	14781	13575	13575	13776	14479	11262	11563	11765	12368
			SALR	-	13635	14228	14425	14524	13338	13338	13536	14228	11066	11362	11560	12153
			ACCR	ACRCON	13948	14555	14757	14858	13645	13645	13847	14555	11321	11624	11826	12432
			ACFR	ACRCON	14034	14644	14847	14949	13729	13729	13932	14644	11390	11695	11898	12508
			PLCR	ACRCON	13034	13600	13789	13884	12750	12750	12939	13600	10578	10861	11050	11617
			ACCR	ACRDRP	13772	14371	14571	14670	13473	13473	13672	14371	11177	11477	11676	12275
			ACFR	ACRDRP	14054	14665	14869	14971	13749	13749	13952	14665	11406	11712	11915	12526
			PLCR	ACRDRP	12921	13483	13670	13764	12640	12640	12828	13483	10487	10768	10955	11517
			ACCR	ACRFGL	13992	14601	14804	14905	13688	13688	13891	14601	11356	11660	11863	12471
			ACFR	ACRFGL	14085	14698	14902	15004	13779	13779	13983	14698	11432	11738	11942	12554
			PLCR	ACRFGL	12965	13529	13717	13811	12683	12683	12871	13529	10522	10804	10992	11556
			DALR	ALCON	12050	12217	12301	11548	11297	11297	11464	12050	9372	9623	9791	10293
			SALR	ALCON	13199	13383	13474	12649	12374	12374	12558	13199	10266	10541	10725	11274
			DALR	ALDRP	12036	12203	12286	11534	11283	11283	11451	12036	9361	9612	9779	10281
			SALR	ALDRP	13277	13461	13553	12724	12447	12447	12631	13277	10326	10603	10787	11341
			DALR	ALFGL	11782	11945	12027	11291	11045	11045	11209	11782	9164	9409	9573	10064
			SALR	ALFGL	13253	13437	13529	12701	12425	12425	12609	13253	10308	10584	10768	11320
18000LM	125	-40°F (-40°C) - 135°F (55°C)	ACCR	-	18253	19047	19311	19443	17856	17856	18121	19047	14814	15211	15475	16269
			ACFR	-	18205	18996	19260	19392	17809	17809	18073	18996	14775	15171	15434	16226
			DALR	-	15252	15915	16136	16247	14920	14920	15141	15915	12378	12710	12931	13594
			PLCR	-	17000	17739	17985	18109	16630	16630	16877	17739	13797	14167	14413	15152
			SALR	-	16704	17430	17672	17794	16341	16341	16583	17430	13557	13920	14162	14888
			ACCR	ACRCON	17088	17831	18079	18203	16717	16717	16965	17831	13869	14240	14488	15231
			ACFR	ACRCON	17193	17941	18190	18314	16819	16819	17068	17941	13954	14328	14577	15324
			PLCR	ACRCON	15968	16662	16894	17009	15621	15621	15852	16662	12959	13307	13538	14232
			ACCR	ACRDRP	16873	17606	17851	17973	16506	16506	16750	17606	13694	14060	14305	15039
			ACFR	ACRDRP	17218	17966	18216	18341	16844	16844	17093	17966	13974	14348	14598	15346
			PLCR	ACRDRP	15830	16518	16748	16862	15486	15486	15715	16518	12847	13192	13421	14109
			ACCR	ACRFGL	17142	17888	18136	18260	16770	16770	17018	17888	13913	14285	14534	15279
			ACFR	ACRFGL	17256	18006	18257	18382	16881	16881	17131	18006	14005	14380	14630	15381
			PLCR	ACRFGL	15884	16574	16805	16920	15538	15538	15769	16574	12891	13236	13467	14157
			DALR	ALCON	14762	14967	15070	14147	13840	13840	14045	14762	11482	11789	11995	12610
			SALR	ALCON	16171	16395	16508	15497	15160	15160	15385	16171	12577	12914	13139	13813
			DALR	ALDRP	14745	14950	15052	14131	13824	13824	14028	14745	11468	11776	11980	12595
			SALR	ALDRP	16266	16492	16605	15588	15249	15249	15475	16266	12651	12990	13216	13894
			DALR	ALFGL	14434	14634	14735	13833	13532	13532	13732	14434	11226	11527	11728	12329
			SALR	ALFGL	16237	16462	16575	15560	15222	15222	15447	16237	12628	12967	13192	13869

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OPERATIONAL DATA (continued)

Lumen Package	Input Watts	Ambient Rating	Reflector	Lens	Delivered Lumens											
					3000K CCT, 70CRI	3500K CCT, 70CRI	4000K CCT, 70CRI	5000K CCT, 70CRI	3000K CCT, 80CRI	3500K CCT, 80CRI	4000K CCT, 80CRI	5000K CCT, 80CRI	3000K CCT, 90CRI	3500K CCT, 90CRI	4000K CCT, 90CRI	5000K CCT, 90CRI
24000LM	160	-40°F (-40°C) - 135°F (55°C)	ACCR	-	23693	24723	25066	25238	23178	23178	23521	24723	19229	19744	20087	21118
			ACFR	-	23630	24658	25000	25171	23117	23117	23459	24658	19178	19692	20034	21062
			DALR	-	19797	20658	20945	21089	19367	19367	19654	20658	16067	16498	16785	17646
			PLCR	-	22066	23026	23346	23505	21587	21587	21906	23026	17909	18389	18708	19668
			SALR	-	21682	22625	22939	23096	21211	21211	21525	22625	17597	18069	18383	19326
			ACCR	ACRCON	22181	23146	23467	23628	21699	21699	22021	23146	18002	18484	18806	19770
			ACFR	ACRCON	22317	23287	23611	23773	21832	21832	22155	23287	18112	18598	18921	19891
			PLCR	ACRCON	20727	21628	21928	22078	20276	20276	20577	21628	16822	17272	17573	18474
			ACCR	ACRDRP	21901	22853	23171	23329	21425	21425	21742	22853	17775	18251	18568	19520
			ACFR	ACRDRP	22349	23321	23645	23807	21863	21863	22187	23321	18138	18624	18948	19920
			PLCR	ACRDRP	20548	21441	21739	21888	20101	20101	20399	21441	16676	17123	17421	18314
			ACCR	ACRFGL	22251	23219	23541	23702	21767	21767	22090	23219	18059	18543	18865	19833
			ACFR	ACRFGL	22399	23373	23697	23860	21912	21912	22237	23373	18179	18666	18990	19964
			PLCR	ACRFGL	20617	21514	21813	21962	20169	20169	20468	21514	16733	17181	17480	18376
			DALR	ALCON	19162	19428	19561	18364	17964	17964	18231	19162	14904	15303	15569	16368
			SALR	ALCON	20990	21282	21427	20115	19678	19678	19970	20990	16326	16763	17054	17929
			DALR	ALDRP	19140	19405	19538	18342	17943	17943	18209	19140	14886	15285	15551	16348
			SALR	ALDRP	21113	21407	21553	20234	19794	19794	20087	21113	16421	16861	17155	18034
			DALR	ALFGL	18736	18996	19126	17955	17565	17565	17825	18736	14572	14962	15223	16003
			SALR	ALFGL	21076	21368	21515	20197	19758	19758	20051	21076	16392	16831	17124	18002
30000LM	204	-40°F (-40°C) - 135°F (50°C)	ACCR	-	29714	31006	31437	31652	29068	29068	29499	31006	24116	24762	25193	26484
			ACFR	-	29636	30924	31354	31569	28992	28992	29421	30924	24052	24696	25126	26414
			DALR	-	24829	25908	26268	26448	24289	24289	24649	25908	20151	20691	21051	22130
			PLCR	-	27674	28878	29279	29479	27073	27073	27474	28878	22460	23062	23463	24666
			SALR	-	27193	28375	28769	28966	26602	26602	26996	28375	22070	22661	23055	24237
			ACCR	ACRCON	27819	29028	29431	29633	27214	27214	27617	29028	22577	23182	23585	24795
			ACFR	ACRCON	27989	29206	29611	29814	27380	27380	27786	29206	22716	23324	23730	24947
			PLCR	ACRCON	25994	27124	27501	27690	25429	25429	25806	27124	21097	21662	22039	23169
			ACCR	ACRDRP	27467	28661	29059	29258	26870	26870	27268	28661	22292	22889	23287	24482
			ACFR	ACRDRP	28029	29248	29654	29857	27420	27420	27826	29248	22748	23358	23764	24982
			PLCR	ACRDRP	25770	26890	27264	27450	25209	25209	25583	26890	20915	21475	21848	22969
			ACCR	ACRFGL	27906	29119	29524	29726	27299	27299	27704	29119	22648	23255	23660	24873
			ACFR	ACRFGL	28092	29313	29720	29924	27481	27481	27888	29313	22799	23410	23817	25038
			PLCR	ACRFGL	25857	26982	27356	27544	25295	25295	25670	26982	20986	21548	21922	23047
			DALR	ALCON	24032	24366	24533	23031	22530	22530	22864	24032	18692	19192	19526	20527
			SALR	ALCON	26325	26690	26873	25228	24679	24679	25045	26325	20475	21023	21389	22486
			DALR	ALDRP	24004	24337	24504	23004	22504	22504	22837	24004	18670	19170	19503	20503
			SALR	ALDRP	26479	26847	27031	25376	24824	24824	25192	26479	20595	21147	21514	22618
			DALR	ALFGL	23497	23823	23987	22518	22029	22029	22355	23497	18276	18765	19091	20070
			SALR	ALFGL	26432	26799	26982	25330	24780	24780	25147	26432	20558	21109	21476	22577

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OPERATIONAL DATA (continued)

Lumen Package	Input Watts	Ambient Rating	Reflector	Lens	Delivered Lumens											
					3000K CCT, 70CRI	3500K CCT, 70CRI	4000K CCT, 70CRI	5000K CCT, 70CRI	3000K CCT, 80CRI	3500K CCT, 80CRI	4000K CCT, 80CRI	5000K CCT, 80CRI	3000K CCT, 90CRI	3500K CCT, 90CRI	4000K CCT, 90CRI	5000K CCT, 90CRI
36000LM	249	-40°F (-40°C) - 135°F (45°C)	ACCR	-	34589	36093	36594	36845	33837	33837	34338	36093	28072	28824	29325	30829
			ACFR	-	34497	35997	36497	36747	33747	33747	34247	35997	27998	28748	29248	30748
			DALR	-	28902	30158	30577	30787	28274	28274	28692	30158	23457	24085	24504	25760
			PLCR	-	32214	33615	34082	34315	31514	31514	31981	33615	26145	26845	27312	28713
			SALR	-	31654	33030	33489	33718	30966	30966	31424	33030	25690	26378	26837	28213
			ACCR	ACRCON	32382	33790	34259	34494	31678	31678	32147	33790	26281	26985	27454	28862
			ACFR	ACRCON	32580	33997	34469	34705	31872	31872	32344	33997	26442	27150	27622	29039
			PLCR	ACRCON	30259	31574	32013	32232	29601	29601	30039	31574	24558	25215	25654	26970
			ACCR	ACRDRP	31973	33363	33826	34058	31278	31278	31741	33363	25949	26644	27107	28498
			ACFR	ACRDRP	32627	34046	34519	34755	31918	31918	32391	34046	26480	27189	27662	29081
			PLCR	ACRDRP	29997	31301	31736	31953	29345	29345	29780	31301	24345	24998	25432	26737
			ACCR	ACRFGL	32484	33896	34367	34602	31778	31778	32249	33896	26364	27070	27541	28953
			ACFR	ACRFGL	32700	34122	34595	34832	31989	31989	32463	34122	26539	27250	27724	29145
			PLCR	ACRFGL	30099	31408	31844	32062	29445	29445	29881	31408	24428	25083	25519	26827
			DALR	ALCON	27974	28363	28557	26809	26226	26226	26614	27974	21758	22341	22729	23895
			SALR	ALCON	30643	31069	31281	29366	28728	28728	29153	30643	23833	24472	24897	26174
			DALR	ALDRP	27941	28329	28524	26777	26195	26195	26583	27941	21732	22314	22702	23867
			SALR	ALDRP	30823	31251	31465	29539	28896	28896	29325	30823	23973	24615	25044	26328
			DALR	ALFGL	27352	27732	27922	26212	25642	25642	26022	27352	21274	21843	22223	23363
			SALR	ALFGL	30768	31195	31409	29486	28845	28845	29272	30768	23930	24571	24999	26281

UPLIGHT PERCENTAGES (*Based on 24,000LM 40K 80CRI)

Reflector Option	Flat Lens	Conical Lens	Drop Lens	L/Lens
ACFR	18.0%	17.0%	17.4%	13.1%
ACCR	7.2%	5.8%	7.4%	2.7%
PLCR	6.6%	5.0%	6.8%	2.2%
SALR	0.1%	0.1%	1.7%	0.0%
DALR	0.1%	0.1%	1.8%	0.1%

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OPERATIONAL DATA (continued)

LUMEN MAINTENANCE TABLE

Lumen Package	25,000	35,000	50,000	60,000
9000LM	0.97	0.96	0.95	0.94
12000LM	0.97	0.96	0.95	0.94
15000LM	0.96	0.95	0.94	0.93
18000LM	0.96	0.95	0.94	0.93
24000LM	0.96	0.95	0.93	0.93
30000LM	0.95	0.94	0.93	0.92
36000LM	0.95	0.93	0.91	0.90

LAT TABLE VS. AMBIENT TEMPERATURE (C)

Lumen Package	25	30	35	40	45	50	55
9000LM	1.00	1.00	0.99	0.99	0.98	0.98	0.97
12000LM	1.00	1.00	0.99	0.98	0.98	0.97	0.97
15000LM	1.00	0.99	0.99	0.98	0.98	0.97	0.96
18000LM	1.00	0.98	0.98	0.97	0.96	0.96	0.95
24000LM	1.00	0.99	0.99	0.98	0.97	0.97	0.96
30000LM	1.00	0.99	0.99	0.98	0.97	0.97	
36000LM	1.00	0.99	0.99	0.98			

REFLECTORS AND LENSES



Aluminum reflector
Available specular (SALR) or diffuse (DALR)



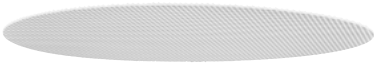
Acrylic frosted reflector (ACFR)



Clear acrylic (ACCR) or polycarbonate reflector (PLCR)



Acrylic drop lens (ACRDRP)

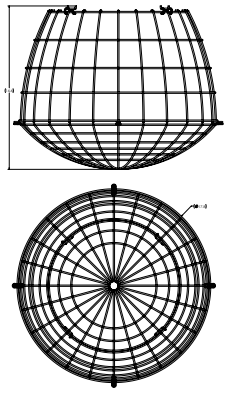


Flat prismatic lens (ALFGL)

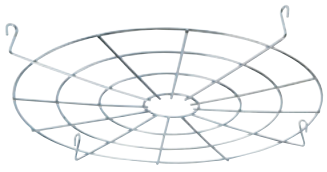


Conical lens (ALCON)

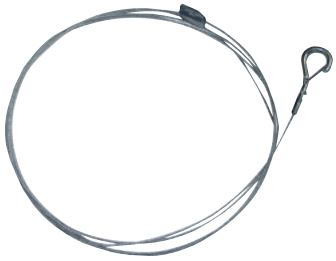
OPTIONS AND ACCESSORIES



Full Wire Guard (FWG)
All dimensions are in inches.



Wire Guard (WG)



Safety Cable (JCBLSC120 or JCBLSC240)



Cast Hook Female (JCBLHKF)

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SELECTIONS BELOW WILL EXTEND ORDER LEAD TIME. CONSULT YOUR SALES REPRESENTATIVE FOR DETAILS.

SINGLE RELAY

ORDERING INFORMATION

Example: LAH0SZU

Series	Lens option	Dimming/Photocell	Max. dim level	Min. dim level	Temp/Humidity	Default occupancy time delay
L LSXR passive infrared indoor occupancy sensor	A High mount, 360° B Low mount, 360° C High mount aisleway	0 None[1] H High/low occupancy operation P Switching photocell (on/off)[1] M Dimming and switching photocell G Dimming and switching photocell with high/low occupancy operation	0 10 VDC 9 9 VDC 8 8 VDC 7 7 VDC	S Minimum dim level of ballast 1 1 VDC 2 2 VDC 3 3 VDC 4 4 VDC 5 5 VDC 6 6 VDC	Z None T Low temperature[2]	I 30 sec D 2.5 min X 5.0 min R 7.5 min U 10.0 min (with minimum 15 minute on time) V 15.0 min W 20.0 min Y 30.0 min

Notes

1 Max and min dim levels not applicable with this option.

2 Ambient temperature rating of -4°F (-20°C) to 131°F (55°C).

Example: LENS 50 J100

Replacement lenses: *Order as separate catalog number.*

Series	Lens type	Package quantity
LENS	6 High mount 360° 10 Low mount 360° 50 High mount aisleway	[blank] Single Lens J10 10-pack J100 100-pack

Bluetooth Sensor

Model	Default Operation	LSXR Equivalent	Occupancy Time Delay	Photocell Mode	Photocell Set-point	Low Trim	High Trim	Dim to Off Time Delay
LSXBTP	On/Off Occupancy Only Disabled	LSXR 10 LT or LB00STU	10 minutes	Disabled	n/a	n/a	100%	Disabled
LSXBTPHL	Occupancy w/ 0-10V Dimming (High/Low/Off)	LSXR 10 HL LT or LBH0STU	10 minutes	Disabled	n/a	10%	100%	2.5 minutes
LSXBTPADC	Occupancy w/ Dim & Switch Photocell	LSXR 10 ADC LT or LBM0STU	10 minutes	On/Off & Auto Dim	50 fc	10%	100%	0 seconds
LSXBTPANL	Dim & Switch Photocell with High/Low Occupancy Operation	LSXR 10 ANL LT or LBG0STU	10 minutes	On/Off & Auto Dim	50 fc	10%	100%	Stay Dim/Never Off

SBG BTP Wireless Sensor: Web Page | Presentation
VLP Mobile App: Web Page | Sell Sheet | FAQ | User Guide | Configuration Video

PHOTOMETRICS

See www.lithonia.com.

INDUSTRIAL: One Lithonia Way, Conyers, GA 30012 Phone: 800-315-4963 techsupport-industrial@acuitybrands.com www.lithonia.com

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High Bay Linear Mixed use/Gym/ Cafeteria

LITHONIA LIGHTING®

Catalog Number	
Notes	
Type	

FEATURES & SPECIFICATIONS

INTENDED USE — Ideal one-for-one replacement of conventional HID and fluorescent high bay systems. Applications include warehousing, manufacturing, gymnasiums, and other large indoor spaces with mounting heights up to 60'. **Certain airborne contaminants can diminish the integrity of acrylic and/or polycarbonate.** Click here for Acrylic-Polycarbonate Compatibility table for suitable uses.

Certain airborne contaminants may adversely affect the functioning of LEDs and other electronic components, depending on various factors such as concentrations of the contaminants, ventilation, and temperature at the end-user location. Click here for a list of substances that may not be suitable for interaction with LEDs and other electronic components.

CONSTRUCTION — Structural elements such as the channel and end caps are fabricated from steel for maximum rigidity. Wireguard attachment points provided. For high ambient (HA) option, lightweight aluminum heat sink designed to perform in ambient temperatures up to 55 ° C for maximum naturally convective cooling.

OPTICS — General, narrow, wide and focus distributions available to meet both horizontal and vertical light level requirements. Injection molded refractors for repeatable photometry. Diffuse lens standard to provide glare control and LED protection. Optics are IP5X rated.

ELECTRICAL — L88 at 60,000 hours, L70>100,000 hours. Utilizes a 90°C case temperature driver for maximum life at high temperatures. 0.90 power factor. Luminaire Surge Protection Level: Designed to withstand up to 6kV/3kA per ANSI C82.77-5-2015. Luminaire Surge Protection Level: Designed to withstand up to 10kV/5kA per ANSI C82.77-5-2015, optional. Available as 120-277V or 347-480V input.

0-10V dimming standard for a dimming range of 100% to 10%.

WIRELESS NETWORKING — nLight® AIR is the ideal solution for retrofit or new construction spaces where adding additional wiring can be labor intensive and nLight AIR is available with or without an integral sensor. Integrated smart sensors or dimming and switching modules must be part of each luminaire in the nLight AIR network, which can be grouped to control multiple luminaires. The granularity of control with the digital PIR occupancy detection and daylight sensing makes this a great solution for any application.

INSTALLATION — Suitable for suspension by chain, cable, surface-mounting bracket (THUN accessory), hook monopoint or single (pendant) monopoint. Surface mounting not recommended without optional surface mounting bracket. To maintain ambient listing, fixture should be mounted at a minimum plenum height of 18".

LISTINGS — CSA certified to US and Canadian safety standards. Damp location listed. Suitable for ambient temperatures from -40°F (-40°C) to 113°F (45°C) when suspended 18" from ceiling. High ambient option available (HA), suitable for ambient temperatures -40°F (-40°C) to131°F (55°C) when suspended 18" from ceiling. The Bluetooth® word mark and logos are registered trademarks owned by Bluetooth SIG, Inc. and any use of such marks by Acuity Brands is under license. Other trademarks and trade names are those of their respective owners.

DesignLights Consortium® (DLC) Premium qualified product and DLC qualified product. Not all versions of this product may be DLC Premium qualified or DLC qualified. Please check the DLC Qualified Products List at www.designlights.org/QPL to confirm which versions are qualified.

Stock configurations are offered for shorter lead times:

Standard Part Number	Stock Part Number	DLC QPL Product ID	DLC Premium?
IBG 12000LM SEF AFL GND MVOLT GZ10 40K 80CRI DWH	IBG 12L MVOLT	PAMMN2VX	√
IBG 15000LM SEF AFL GND MVOLT GZ10 40K 80CRI DWH	IBG 15L MVOLT	P3G6HADN	√
IBG 18000LM SEF AFL GND MVOLT GZ10 40K 80CRI DWH	IBG 18L MVOLT	P851GVEP	√
IBG 24000LM SEF AFL GND MVOLT GZ10 40K 80CRI DWH	IBG 24L MVOLT	PZBJQY5S	√
IBG 12000LM SEF AFL GND HVOLT GZ10 40K 80CRI DWH	IBG 12L HVOLT	PQ5BU878	√
IBG 15000LM SEF AFL GND HVOLT GZ10 40K 80CRI DWH	IBG 15L HVOLT	PSWUYJP8	√
IBG 18000LM SEF AFL GND HVOLT GZ10 40K 80CRI DWH	IBG 18L HVOLT	PRVPPS9D	√
IBG 24000LM SEF AFL GND HVOLT GZ10 40K 80CRI DWH	IBG 24L HVOLT	P2UE1ZS4	√
IBG 12000LM SEF AFL GND MVOLT GZ10 50K 80CRI DWH	IBG 12L MVOLT 5K	P7TZZ4ZV	√
IBG 15000LM SEF AFL GND MVOLT GZ10 50K 80CRI DWH	IBG 15L MVOLT 5K	PMXBGZJS	√
IBG 18000LM SEF AFL GND MVOLT GZ10 50K 80CRI DWH	IBG 18L MVOLT 5K	P85EZXU7	√
IBG 24000LM SEF AFL GND MVOLT GZ10 50K 80CRI DWH	IBG 24L MVOLT 5K	PQ5CSK48	√
IBG 12000LM SEF AFL GND HVOLT GZ10 50K 80CRI DWH	IBG 12L HVOLT 5K	PFRXRQKT	√
IBG 15000LM SEF AFL GND HVOLT GZ10 50K 80CRI DWH	IBG 15L HVOLT 5K	PV4M2BP5	√
IBG 18000LM SEF AFL GND HVOLT GZ10 50K 80CRI DWH	IBG 18L HVOLT 5K	PA36YXUT	√
IBG 24000LM SEF AFL GND HVOLT GZ10 50K 80CRI DWH	IBG 24L HVOLT 5K	P5H22E5M	√

LED High Bay

IBG



WARRANTY — 5-year limited warranty. Complete warranty terms located at: www.acuitybrands.com/resources/terms-and-conditions

Note: Actual performance may differ as a result of end-user environment and application. All values are design or typical values, measured under laboratory conditions at 25 °C. Specifications subject to change without notice.

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is part of an A+ Certified solution for nLight® or XPoint™ Wireless control networks marked by a shaded background*

To learn more about A+, visit www.acuitybrands.com/aplus.

*See ordering tree for details

A+ Capable options indicated by this color background.

ORDERING INFORMATION

Lead times will vary depending on options selected. Consult with your sales representative.

Example: IBG 24000LM SEF AFL GND MVOLT GZ10 40K 80CRI DWH

Series	Nominal lumens		Performance package	Lens	Distribution	Voltage	Driver	Color temperature
IBG	8000LM 8,000 lumens[2]	30000LM 30,000 lumens	SEF Standard efficiency	AFL Acrylic, frosted	WD Wide	MVOLT 120-277V	GZ10 0-10V dimming[7]	30K 3000 K
IBGN[1]	12000LM 12,000 lumens	36000LM 36,000 lumens	HEF Premium efficiency	ACL Clear acrylic	GND General	HVOLT 347-480V[3]	AZ10 0-10V dimming, aux. output[8]	35K 3500 K
	15000LM 15,000 lumens	48000LM 48,000 lumens		PCL Clear polycarbonate	ND Narrow	120 120V		40K 4000 K
	18000LM 18,000 lumens	60000LM 60,000 lumens		PFL Semi-diffuse polycarbonate	FD Focus	208 208V		50K 5000 K
	24000LM 24,000 lumens			L/LENS Less lens		240 240V		
						277 277V		
						347 347V[4,5]		
						480 480V[4,5,6]		

Coloring rendering index	Options			Finish
70CRI 70 CRI	HA	High ambient[9]	Individual Controls:[23]	DNA Natural aluminum
80CRI 80 CRI	SPD	Surge protection device[10]	HLN360	Haleon 360° High Mount Occ Sensor, pre-wired; Bluetooth®[24]	DWH Gloss white
90CRI 90 CRI	BPK	Fixture backpack[11]	HLN360HL	Haleon 360° High Mount Occ Sensor w/HL Default, pre-wired; Bluetooth®[24]	
	PS1050	Emergency battery pack 10W, CA Title 20 Noncompliant[12]	HLN360ADC	Haleon 360° High Mount Occ Sensor w/ADC Default, pre-wired; Bluetooth®[24]	
	PS10250	Emergency battery pack 10W, Title 20 Noncompliant[13]	HLN360ANL	Haleon 360° High Mount Occ Sensor w/ANL Default, pre-wired; Bluetooth®[24]	
	PS10250BC	Emergency battery pack 10W, Certified in CA Title 20 MAEDBS[13]	HLNASL	Haleon High Mount Aisleway Occ Sensor, pre-wired; Bluetooth®[24]	
	PS30250	Emergency battery pack, 30W, Title 20 Noncompliant[14]	HLNASLHL	Haleon High Mount Aisleway Occ Sensor w/HL Default, pre-wired; Bluetooth®[24]	
	BGTD	Generator transfer device[15]	HLNASLADC	Haleon High Mount Aisleway Occ Sensor w/ADC Default, pre-wired; Bluetooth®[24]	
	SF	Single fuse[16]	HLNASLANL	Haleon High Mount Aisleway Occ Sensor w/ANL Default, pre-wired; Bluetooth®[24]	
	DF	Double fuse[17]	LAOZU	360° high mount motion sensor, pre-wired[25]	
	OUTCTR	Wiring leads pulled through back center of fixture[18]	LAH0SZU	360° high mount motion sensor with dimming, pre-wired[25]	
	OCS	RELOC® OnePass® selectable cable 6' installed[20,21]	LAPZU	360° high mount motion sensor with photocell, pre-wired[25]	
	OCU___	RELOC® OnePass® unselectable cable 6' installed (must specify tap position)[19,21]	LAM0SZU	360° high mount motion sensor, dimming & switching photocell, pre-wired[25]	
	IMP	Integrated modular plug[22]	C6D0SUEM	360° high mount motion sensor, dimming only (photocell disabled), pre-wired; UL924 listed (not available with battery pack or BGTD)[26,27]	
	RRL_	RELOC®-Ready luminaire. (Not available with Haleon sensor options) See page 11 for ordering information	C10D0SUEM	360° low mount motion sensor, dimming only (photocell disabled), pre-wired; UL924 listed (not available with battery pack or BGTD)[26,28]	
	WGX	Standard wire guard, installed (not available with Haleon sensor)	nLight wired:[29]		
	Cord sets:		nPP16D	nLight® dimming & switching module	
	CS1W	Straight plug, 120V[19]	nPP16DER	nLight® dimming & switching module with emergency relay (not available with battery pack or BGTD)	
	CS3W	Twist-lock, 120V[19]	nMSI	nLight® high mount aisleway motion sensor, pre-wired[30]	
	CS7W	Straight plug, 277V[19]	nMSI360	nLight® 360° high mount motion sensor, pre-wired[31]	
	CS11W	Twist-lock, 277V[19]	nMSID	nLight® high mount aisleway motion sensor with dimming, pre-wired[32]	
	CS25W	Twist-lock, 347V[19]	nMSI360D	nLight® 360° high mount motion sensor with dimming, pre-wired[33]	
	CS97W	Twist-lock, 480V[19]	nLight wireless:		
	CS93W	600 SO white cord, no plug (no voltage required)	NLTAIR2 RKOA	nLight AIR Generation 2 enabled 360°high mount motion sensor	
	CS93W4C	600V SO 4 - conductor white cord, no plug (for use when unswitched hot is required for battery pack)	NLTAIR2 RKOB	nLight AIR Generation 2 enabled 360° low mount motion sensor	
	CS93W5CD	600 SO 5-conductor white cord, no plug (no voltage required)	NLTAIR2 rPP20D	nLight AIR Generation 2 dimming and switching module[34]	
			NLTAIR2 rPP20DER	nLight AIR Generation 2 dimming and switching module with emergency relay (not available with battery pack or BGTD)[34]	
			X-Point wireless:		
			MSI6XADL DSCXADL	XPoint™ Wireless 360° high mount motion sensor with photocell	
			XPW	XPoint™ Wireless 0-10V relay, external (utilizes XPA CMRB0) 55°C max ambient	
			XAD	XPoint™ Wireless 0-10V relay, internal, lower max ambient (not available with Haleon sensor)[33]	
			XPWEM	XPoint™ Wireless 0-10V relay, external (utilizes XPACMRB0EM) 55°C max ambient, meets UL924 (not available with battery pack or BGTD)	
			XAD924	XPoint™ Wireless 0-10V relay, internal, lower max ambient, meets UL924 (not available with battery pack or BGTD)[35]	

See Accessories and footnotes on next page

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Accessories: *Order as separate catalog number.*

Mounting:

IBAC120 M100	Aircraft cable 10' with hook (one pair)
IBAC240 M75	Aircraft cable 20' with hook (one pair)
IBHMP	Hook monopoint
HBBS36	Chain hanger with chain, 36" (one pair)
IBGACVH	Aircraft 10' V hanger (one pair)
IBGPMPHB	Pendant monopoint splice box, includes side covers (3/4" hub) for use with OUTCTR option, not available with BPK option
THUN	Tong hanger bracket (order 2 per fixture) [36]

Cord sets and sensors for IMP option:

CS1WIMP	Straight plug, 120V
CS3WIMP	Twist-lock, 120V
CS7WIMP	Straight plug, 277V
CS11WIMP	Twist-lock, 277V
CS25WIMP	Twist-lock 347V
CS93WIMP	600V SO white cord, no plug (no voltage required)
CS97WIMP	Twist-lock 480V
MSIIMPIBG	Aisle sensor for use with IMP option
MSI360IMPIBG	360° sensor for use with IMP option

Wire guards (not available with Haleon sensor):

WGIBG22	Wire guard for IBG 8000LM; gloss white
WGIBG24	Wire guard for IBG 12000/15000LM; gloss white
WGIBG26	Wire guard for IBG 18000/24000/30000LM; gloss white
WGIBG42	Wire guard for all IBGN lumen packages; gloss white
WGIBG46	Wire guard for IBG 36000/48000/60000LM; gloss white
WGIBG22DNA	Wire guard for IBG 8000LM; natural aluminum
WGIBG24DNA	Wire guard for IBG 12000/15000LM; natural aluminum
WGIBG26DNA	Wire guard for IBG 18000/24000/30000LM; natural aluminum
WGIBG42DNA	Wire guard for all IBGN lumen packages; natural aluminum
WGIBG46DNA	Wire guard for IBG 36000/48000/60000LM; natural aluminum

1 Available with 18000LM, 24000LM, 30000LM and 36000LM only.
2 8,000LM not available with HVOLT, 347, 480, or Haleon sensor controls.
3 Not available with 8000LM. Not available with BTGD, nPP16D, nPP16DER, PS1050, PS10250, PS30250, NLTAIR2 RPP20D, NLTAIR2 RPP20DER or XAD options.
4 When ordered with 8000LM or Xpoint controls voltage selected utilizes the fixture back pack.
5 Not available with NLTAIR2 RPP20D and NLTAIR2 RPP20DER options.
6 Not available with nPP16D or nPP16DER.
7 Not available with Haleon sensor control options.
8 Required with Haleon sensor control options.
9 55 C when suspended, 45 C when surface mounted. Not available with BGTD, PS1050, PS10250, PS30250 or XAD.
10 Standard with HVOLT, 347, or 480V - only specify for MVOLT, 120, 208, 240, or 277V when additional surge protection is needed. Standard with Motion sensors/ controls, BGTD & Power Sentry battery options.
11 Required with PS1050, PS10250, PS30250, BGTD. Required with 8000LM when ordered with 347/480V. Required with Xpoint controls when ordered with 347/480V. Not available with nLight. Not for use with THUN mount (surface).
12 Requires BPK option. Available 120-277V only. Available with 8000LM only. Not available with IMP. See spec sheet PS1050 for more information. For use in ambient temperatures 32° F to 113° F.
13 Requires BPK option. Available 120-277V only. Not available with 8000LM. Not available with IMP. Only available for factory installation. See spec sheet PS10250 for more information. For use in ambient temperatures 50°F to 113° F.
14 Requires BPK option. 120 or 277V only. Not available with 8000LM. Not available with IMP. See spec sheet PS30250 for more information. For use in ambient temperatures 32°F to 112°F.
15 Requires BPK option. 120 or 277V only. Not available with PS1050, PS10250, PS30250 or HA. Not available with 347 or 480V when ordered in combination with XAD or XPW. For ambient temperatures up to 104°F (40°C).
16 Available on 120, 277, 347V. Not available with MVOLT or HVOLT.
17 Available on 208, 240, 480V and Haleon sensors. Not available with MVOLT or HVOLT.
18 Not available with BPK option. Requires IBGPMPHB accessory to mount fixture. Not available with Cord Set options.
19 Must specify voltage.
20 Cannot be used in dimming applications, must use RRLC12S.
21 Fixture will bear dry location label.
22 Not available with BPK, nPP16D, nPP16DER, nMSI, nMSI360, PS1050, PS10250, or PS30250.
23 Must specify voltage. Refer to page 7 for Haleon sensor default settings matrix. Refer to page 9 for additional LSXR ordering options. Refer to page 10 for additional C6D0SUEM and C10D0SUEM information.
24 RRL option not available. Not available with OUTCTR.
25 This sensor configuration is suitable for minimum ambient temperature of 14°F (-10°C). See page 9 for low temperature option providing -4°F (-20°C) minimum ambient temperature.
26 Daylight harvesting functionality not enabled by default. See page 10 for default sequence of operation.
27 Utilizes XPA CMRB6.
28 Utilizes XPA CMRB10.
29 Not available with 208, 240, or 480V. Not available with HA option.
30 nMSI options utilizes a nPP16 and nCMB 50 sensor, CAT5e connector cable also included.
31 nMSI360 options utilizes a nPP16 and nCMB 6 sensor, CAT5e connector cable also included.
32 nMSID options utilizes a nPP16D and nCMB 50 sensor CAT5e connector cable also included.
33 nMSI360D options utilizes a nPP16D and nCMB 6 sensor, CAT5e connector cable also included.
34 NLTAIR2 RPP20D and NLTAIR2 RPP20DER not available with BPK, battery pack options, BGTD, 347, or 480V. Not available with HA.
35 Not available with HVOLT. When ordered with 347V or 480V, BPK option is required. Not available with HA option.
36 Maximum ambient temperature of standard fixture mounted with THUN is 95°F (35°C). With HA option 113°F (45°C). Not available with MSIIMPIBG or MSI360IMPIBG options.

POWER SENTRY EMERGENCY BATTERY PACKS

PS1050:	http://www.acuitybrands.com/products/detail/369448/Power-Sentry/PS1050/Reduced-Profile-LED-Emergency-Battery-Pack/-/media/products/Power_Sentry/369448/document/PS1050_pdf.pdf
PS10250:	http://www.acuitybrands.com/products/detail/604737/Power-Sentry/PS10250/Emergency-LED-Battery-Backup/-/media/products/Power_Sentry/604737/document/PS10250_pdf.pdf
PS30250:	http://www.acuitybrands.com/products/detail/604739/Power-Sentry/PS30250/Emergency-LED-Battery-Backup/-/media/products/Power_Sentry/604739/document/PS30250_pdf.pdf

EMERGENCY LUMENS AFL GND (5000K 70CRI)

Delivered lumens calculation provided on battery spec sheet does not represent emergency lumen output on IBG product. Forward voltage does not match constant current design in all cases. See chart below for IBG lumen output in emergency mode.

Fixture	IBG			IBGN
Lumen package	8000LM (PS1050 only)	12000LM - 15000LM	18000LM - 60000LM	18000LM - 36000LM
PS1050/PS10250	1600	1300	1900	1200
PS30250	N/A	4000	2400	3800

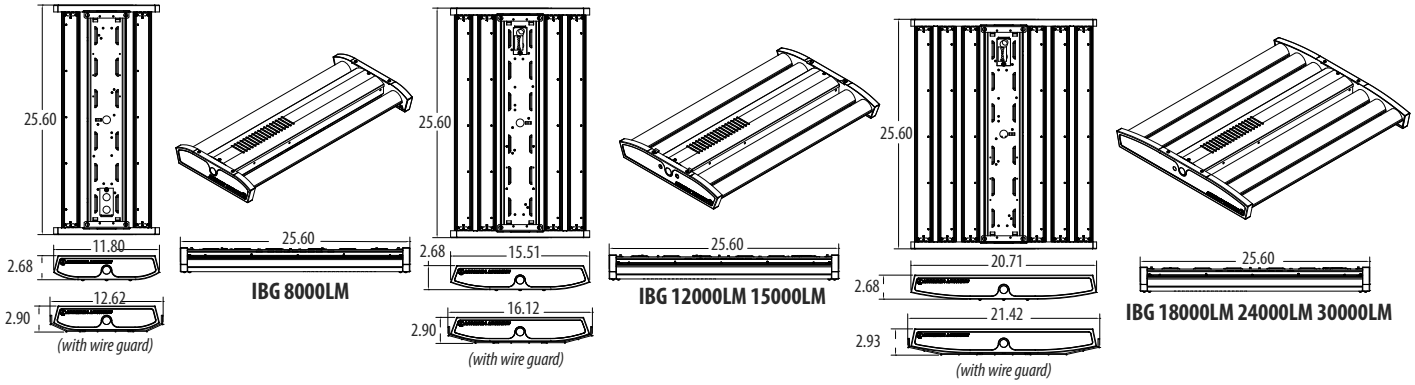
Note: For emergency lumen output of specific model, please consult factory.

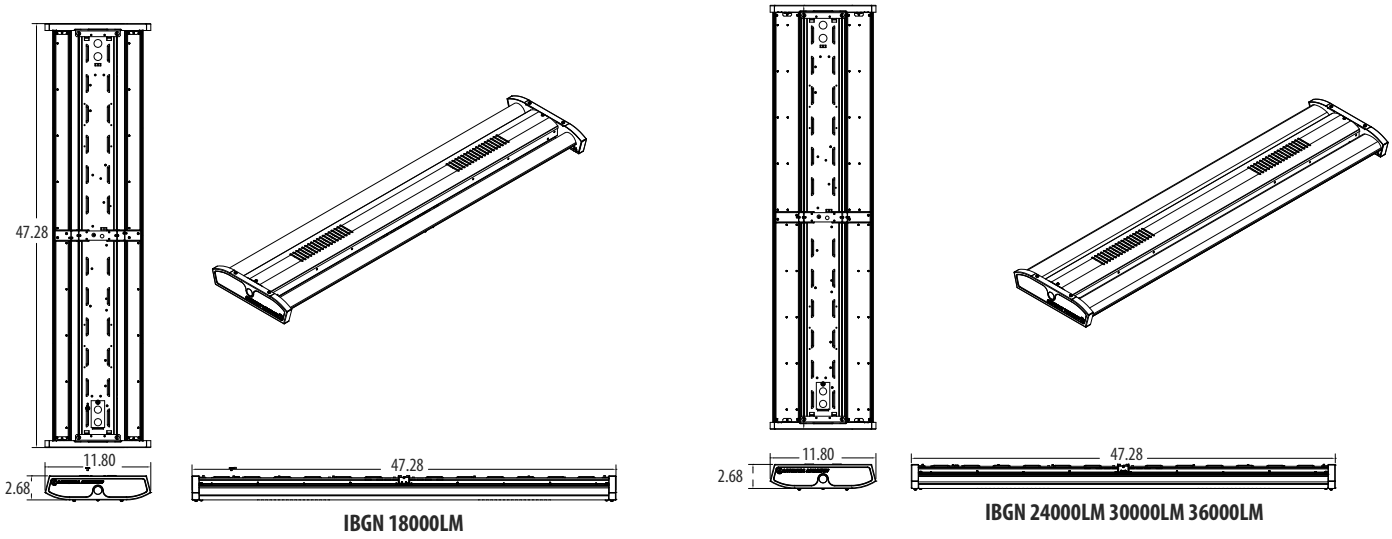
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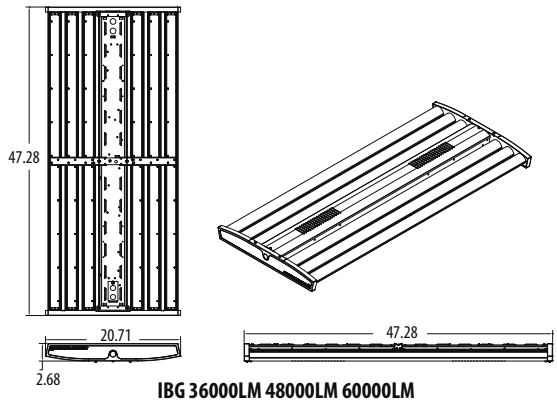
DIMENSIONS

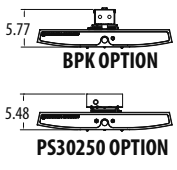
All dimensions are in inches (centimeters) unless otherwise indicated.
Dimensions may vary with options or accessories.

Weight: (may vary with options or accessories)
8L: 7.75 lbs (3.515Kg)
12L/15L: 10.5 lbs (4.762Kg)
18L/24L/30L: 15.9 lbs (7.212Kg)
18L/24L/30L/36L: 4' Narrow - 16.25 lbs (7.370Kg)
36L/48L/60L: 4' - 6' Mod - 21.75 lbs (9.865Kg)









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IBG OPERATIONAL DATA

	Lumen package	Efficiency level	Lens/distribution			
			Acrylic frosted/ general	Clear acrylic/narrow	Clear acrylic/wide	Clear acrylic/focus
Delivered lumens 4000K, 80CRI	8000LM	SEF	7594	7145	7384	7364
		HEF	7842	7378	7625	7604
	12000LM	SEF	11580	10895	11260	11228
		HEF	11746	11051	11421	11390
	15000LM	SEF	14458	13603	14059	14019
		HEF	14824	13947	14415	14374
	18000LM	SEF	17329	16303	16850	16803
		HEF	17752	16702	17262	17214
	24000LM	SEF	23000	21639	22365	22303
		HEF	23612	22215	22960	22896
	30000LM	SEF	27344	25727	26589	26515
		HEF	29577	27827	28760	28680
	36000LM	SEF	33203	31239	34547	32197
		HEF	35528	33426	34547	34450
	48000LM	SEF	45973	43253	44704	44579
		HEF	47254	44458	45949	45821
	60000LM	SEF	55453	52172	53922	53771
		HEF	57027	53653	55452	55298
Delivered lumens 5000K, 80CRI	8000LM	SEF	7873	7408	7656	7635
		HEF	8082	7604	7859	7837
	12000LM	SEF	12006	11296	11674	11642
		HEF	12106	11390	11771	11739
	15000LM	SEF	14990	14103	14576	14536
		HEF	15278	14374	14856	14815
	18000LM	SEF	17966	16904	17470	17422
		HEF	18296	17214	17791	17741
	24000LM	SEF	23847	22436	23188	23123
		HEF	24366	22896	23664	23598
	30000LM	SEF	28351	26674	27568	27491
		HEF	30483	28680	29641	29559
	36000LM	SEF	34221	32196	35605	33183
		HEF	36616	34450	35605	35506
	48000LM	SEF	47665	44845	46349	46220
		HEF	48702	45820	47357	47225
	60000LM	SEF	57494	54093	55906	55751
		HEF	58774	55297	57151	56992

PHOTOMETRICS

See www.lithonia.com.

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IBG CHARACTERISTICS

Lumen package	Wattage								Length	Width	Depth	Comparable Light Source
	Standard efficiency				High efficiency							
	120V	277V	347V	480V	120V	277V	347V	480V	Dimensions are shown in inches (centimeters) unless otherwise noted.			
8000LM	55	54	58	61	50	49	51	54	25.6	11.75	2.75	100W MH, 4-lamp T8 NBF
12000LM	79	77	77	76	70	69	68	67	25.6	15.52	2.75	175W MH, 4-lamp T8 HBF, 2-lamp T5HO
15000LM	97	95	97	96	87	86	86	86	25.6	15.52	2.75	200W MH, 6-lamp T8 NBF
18000LM	114	112	114	115	102	100	102	103	25.6	20.65	2.75	250W MH, 6-lamp T8 HBF, 4-lamp T5HO
24000LM	154	150	150	150	136	133	135	135	25.6	20.65	2.75	400W MH, 6-lamp T5HO
30000LM	193	186	188	188	176	171	173	173	25.6	20.65	2.75	575W MH, 10-lamp T8 HBF
36000LM	225	221	227	229	200	197	203	206	47.29	20.65	2.75	750W MH, 8-lamp T5HO
48000LM	301	293	301	302	267	261	269	270	47.29	20.65	2.75	875W MH, 10-lamp T5HO
60000LM	385	374	378	377	332	323	330	330	47.29	20.65	2.75	1000W MH

IBGN OPERATIONAL DATA

	Lumen package	Efficiency level	Lens/distribution			
			Acrylic frosted/ general	Clear acrylic/narrow	Clear acrylic/wide	Clear acrylic/focus
Delivered lumens 4000K, 80CRI	18000LM	SEF	17036	16028	16566	16520
		HEF	17776	16724	17285	17237
	24000LM	SEF	22727	21383	22100	22038
		HEF	24123	22696	23457	23392
	30000LM	SEF	28642	26948	27851	27773
		HEF	29493	27748	28679	28599
	36000LM	SEF	34336	32305	33388	33295
		HEF	34912	32846	33948	33853
Delivered lumens 5000K, 80CRI	18000LM	SEF	17663	16618	17175	17128
		HEF	18320	17237	17814	17765
	24000LM	SEF	23564	22170	22913	22849
		HEF	24862	23391	24176	24108
	30000LM	SEF	29696	27940	28876	28796
		HEF	30397	28599	29558	29475
	36000LM	SEF	35600	33494	34617	34520
		HEF	35982	33853	34988	34890

IBGN CHARACTERISTICS

Lumen package	Wattage								Length	Width	Depth
	Standard efficiency				High efficiency						
	120V	277V	347V	480V	120V	277V	347V	480V	Dimensions are shown in inches (centimeters) unless otherwise noted.		
18000LM	117	114	115	114	104	102	101	101	47.29	11.75	2.75
24000LM	172	170	167	167	152	150	153	153	47.29	11.75	2.75
30000LM	209	205	208	207	183	180	179	178	47.29	11.75	2.75
36000LM	246	240	242	243	207	203	202	201	47.29	11.75	2.75

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PROJECTED LUMEN MAINTENANCE

IBG 2ft & 4ft						
Operating hours	0	15,000	30,000	45,000	60,000	100,000
Lumen maintenance factor	1	0.97	0.95	0.93	0.91	0.86
IBGN						
Operating hours	0	15,000	30,000	45,000	60,000	100,000
Lumen maintenance factor	1	0.97	0.93	0.90	0.87	0.81

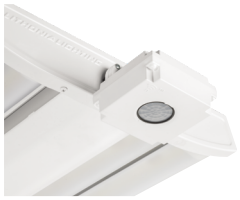
AMBIENT TEMPERATURE RATINGS

Mounting	Suspended	Surface
Standard temperature rating	113°F (45°C)	95°F (35°C)
HA option temperature rating	131°F (55°C)	113°F (45°C)

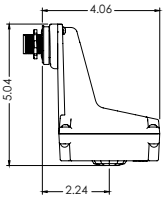
LUMENS VS. AMBIENT TEMPERATURE

Ambient °C	Ambient °F	Lumen Multiplier
0	32	1.04
5	41	1.03
10	50	1.02
20	68	1.01
25	77	1.00
30	86	0.99
35	95	0.99
40	104	0.98
45	113	0.97
50	122	0.96
55	131	0.96

nLIGHT® AIR Dimming and Photo Sensor



See rSBOR spec sheet for additional information.



Drawing for dimensional information only. Fixture will ship with snap mount option and not threaded nipple.

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HALEON - Integrated Occupancy Sensor with Bluetooth® Programmability

- Programmable sensor settings over Bluetooth® with Acuity VLP smartphone app.
- Default programming options to service various application spaces - occupancy detection, 0-10V dimming and daylight harvesting.
- 360° High Mount and High Mount Aiselway lens detection options for mounting heights up to 40 ft.
- Integrated retractable lens mask included to block unwanted detection.
- Sensor ambient temperature rating of -40°F (-40°C) to 158°F (70°C).



Bluetooth®

Haleon Default Programming

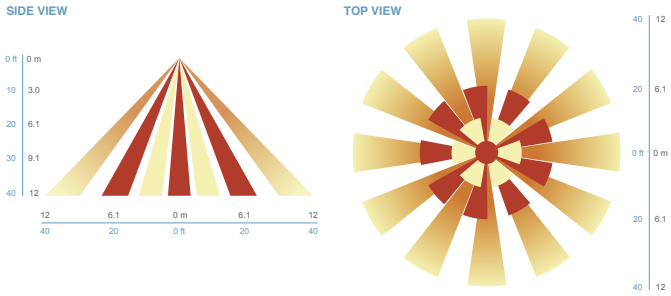
Model	Default Operation	LSXR Equivalent	Occupancy Time Delay	Photocell Mode	Photocell Set-point	Low Trim	High Trim	Dim to Off Time Delay
HLNxxx	On/Off Occupancy Only	LSXR 6 LT or LAOOSTU	10 minutes	Disabled	n/a	n/a	100%	Disabled
HLNxxxHL	Occupancy w/ 0-10V Dimming (High/Low/Off)	LSXR 6 HL LT or LAHOSTU	10 minutes	Disabled	n/a	10%	100%	2.5 minutes
HLNxxxADC	Occupancy w/ Dim & Switch Photocell	LSXR 6 ADC LT or LAMOSTU	10 minutes	On/Off & Auto Dim	50 fc	10%	100%	0 seconds
HLNxxxANL	Dim & Switch Photocell with High/Low Occupancy Operation	LSXR 6 ANL LT or LAGOSTU	10 minutes	On/Off & Auto Dim	50 fc	10%	100%	Stay Dim/ Never Off

Note: Lens detection noted in place of 'xxx'

HALEON COVERAGE PATTERNS

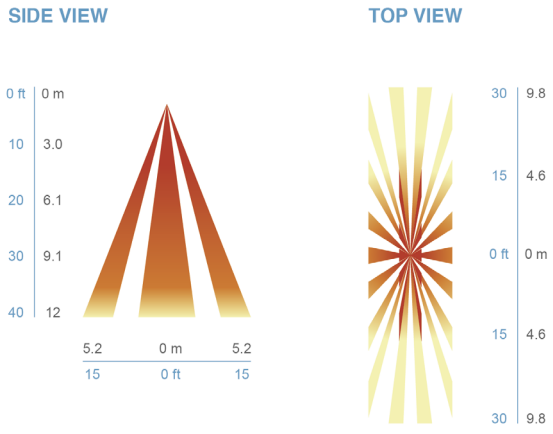
HIGH MOUNT 360°

- Optimized full coverage pattern for 10 – 40 ft. (3.1 – 12 m)
- Reliable detection of large motion (e.g. pedestrian walking traffic) up to 30 ft. (9.1 m) mounting height
- Reliable detection of extra-large motion (e.g. forklift traffic) up to 40 ft. (12 m) mounting height
- Stow-able rotating lens shield can be utilized to mask areas in which detection is not desired



HIGH MOUNT AISLEWAY

- Optimized bi directional coverage pattern for aisleways with 10 – 40 ft. (3.1 – 12 m) mounting heights
- 1.2X's mounting height equals approximate detection range
- Reliable detection of large motion (e.g. pedestrian walking traffic) up to 30 ft. (9.1 m) mounting height
- Reliable detection of extra-large motion (e.g. forklift traffic) up to 40 ft. (12 m) mounting height
- Stow-able rotating lens shield can be utilized to mask areas in which detection is not desired



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LSXR – Fixture Mount Occupancy Sensor (see www.AcuityControls.com for additional information)

- Three interchangeable lens options to satisfy multiple mounting heights and coverage pattern requirements.
- Integrated mounting bracket drops lens down 3" from chase nipple.
- Single or dual relay versions — designed with robust protection from the harsh switching requirements of T5 and LED loads.
- Photocell and 0-10VDC dimming options.
- No PIR field calibration or sensitivity adjustments required.
- Sensor ambient temperature rating of 14°F (-10°C) to 131°F (55°C).

LSXR configuration	Comparable CMRB sensor	Old style sensor nomenclature
For shortest lead times use one of the following LSXR configurations		
LC0ZU	CMRB 50	MSI
LCH0SZU	CMRB 50 D	MSID
LCPZU	CMRB 50 P	MSIPED
LA0ZU	CMRB 6	MSI360
LAH0SZU	CMRB 6 D	MSI360D
LAPZU	CMRB 6 P	MSI360PED



SELECTIONS BELOW WILL EXTEND ORDER LEAD TIME. CONSULT YOUR SALES REPRESENTATIVE FOR DETAILS.

SINGLE RELAY

ORDERING INFORMATION

Example: LAH0SZU

Series	Lens option	Dimming/Photocell	Max. dim level	Min. dim level	Temp/Humidity	Default occupancy time delay
L LSXR passive infrared indoor occupancy sensor	A High mount, 360° B Low mount, 360° C High mount aisleway	0 None[1] H High/low occupancy operation P Switching photocell (on/off)[1] M Dimming and switching photocell G Dimming and switching photocell with high/low occupancy operation	0 10 VDC 9 9 VDC 8 8 VDC 7 7 VDC	S Minimum dim level of ballast 1 1 VDC 2 2 VDC 3 3 VDC 4 4 VDC 5 5 VDC 6 6 VDC	Z None T Low temperature[2]	I 30 sec D 2.5 min X 5.0 min R 7.5 min U 10.0 min (with minimum 15 minute on time) V 15.0 min W 20.0 min Y 30.0 min

Notes

1 Max and min dim levels not applicable with this option.

2 Ambient temperature rating of -4°F (-20°C) to 131°F (55°C).

DUAL RELAY (Available with 120, 277, and 347V only)

ORDERING INFORMATION

Example: LA2KZU

Series	Lens option	Poles	Operating mode	Temp/Humidity	Default occupancy time delay
L LSXR passive infrared indoor occupancy sensor	A High mount, 360° B Low mount, 360° C High mount aisleway	2 Dual relay	J None K Alternating off relays (promotes even lamp wear) O Alternating off relays w/photocell P Switching photocell(on/off) E Photocell on/off (pole 1 only) F Photocell on/off - both poles (dual set-point)	Z None T Low temperature[1]	I 30 sec D 2.5 min X 5.0 min R 7.5 min U 10.0 min (with minimum 15 minute on time) V 15.0 min W 20.0 min Y 30.0 min

Notes

1 Ambient temperature rating of -4°F (-20°C) to 131°F (55°C).

Example: LENS 50 J100

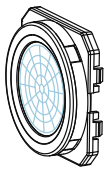
Replacement lenses: *Order as separate catalog number.*

Series	Lens type	Package quantity
LENS	6 High mount 360° 10 Low mount 360° 50 High mount aisleway	[blank] Single Lens J10 10-pack J100 100-pack

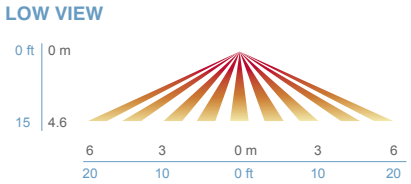
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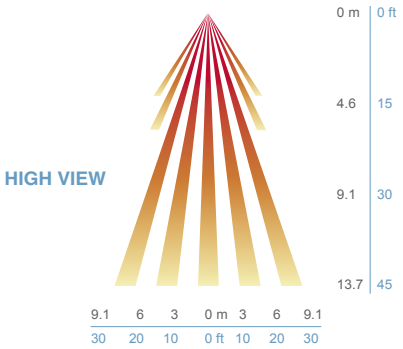
LSXR COVERAGE PATTERNS

HIGH MOUNT 360º LENS (#6)

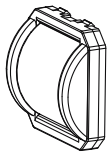


- Best choice for 15 to 45 ft (4.57 to 13.72 m) mounting heights
- 15 to 20 ft (4.57 to 6.10 m) radial coverage overlaps area lit by a typical high bay fixture
- Excellent detection of large motion (e.g. walking) up to a 35 ft (10.76 m) mounting height
- Excellent detection of extra large motion (e.g. forklifts) up to a 45 ft (13.72 m) mounting height

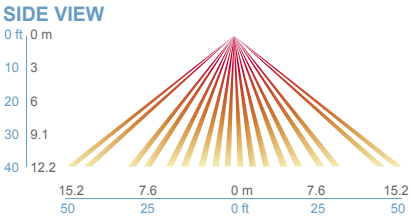


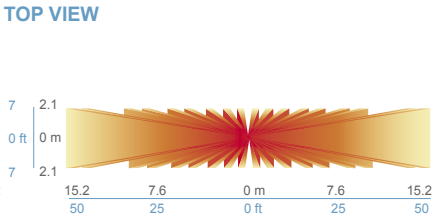


HIGH MOUNT AISLEWAY LENS (#50)

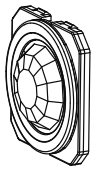


- Provides a bi-directional coverage pattern ideal for warehouse racking
- 1.2x mounting height equals approximate detection range in either direction
- Typical 40 ft (12.19 m) mounting detects 50 ft (15.24 m) in either direction
- Superior aisleway coverage compared to a masked 360º lens

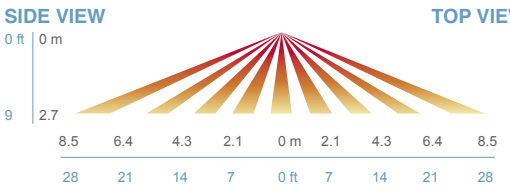


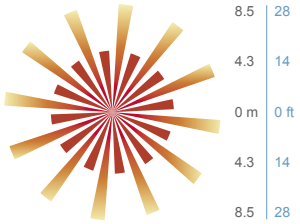


LOW MOUNT 360º LENS (#10)



- Best choice for large motion detection (e.g. walking)
- 360º conical shaped pattern
- Provides ~24 ft (7.32 m) radial coverage (~2000 ft2) when mounted at 9 ft (2.74 m)
- 7 to 15 ft (2.13 to 4.57 m) mounting heights provide 16 to 36 ft (4.88 to 10.97 m) radial coverage
- Detection range improves when walking across beams compared to into beams





C6D0SUEM & C10D0SUEM - UL924 Listed Sensors

SENSOR DEFAULT SEQUENCE OF OPERATION

- The occupied light level is full output.
- The unoccupied light level is approximately 30%.
- The time delay following sensor vacancy is 5 minutes, with an additional 5 minute slow ramp from the occupied light level to the unoccupied light level.
- **The onboard daylight sensor is not enabled by default - sensor will not respond to changing daylight conditions.**

Daylight sensor settings can be enabled and programmed by a trained technician after installation.

EGRESS MODE SEQUENCE OF OPERATION

The UL924 C6D0SUEM & C10D0SUEM controls are designed to provide fully tuned light output for 90 minutes following power loss or interruption, ignoring automatic dimming/occupancy/daylight control signals during this time.

- Typical sequence upon power loss: Backup power source activates, transfer switch moves the emergency circuit powering the sensor onto the backup source, and sensor regains power. This sensor is programmed to detect any power interruption or transfer > 30 ms
- The sensor then ignores occupancy & daylight status and controls the luminaire to full light output for 90 minutes.
- The device resumes normal dimming & occupancy controls after 90 minutes.
- This sensor should not be used with online power backup systems or any transfer devices with < 30 ms transfer time.

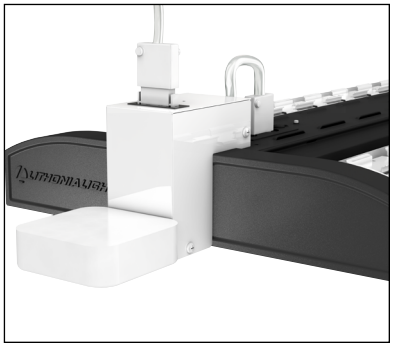
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IMP - Integrated Modular Plug

- The integrated modular plug (IMP) option allows the installer to plug and play a multitude of accessories.
- Cord sets connect quickly to any fixture with IMP option.
- IMP accessories include occupancy sensors, photocells, X-point relays.

IMP compatible cord sets[1]	
CS1WIMP	Straight plug, 120V
CS3WIMP	Twist-lock, 120V
CS7WIMP	Straight plug, 277V
CS11WIMP	Twist-lock, 277V
CS25WIMP	Twist-lock, 347V
CS93WIMP	600V SEOOW white cord, no plug
CS97WIMP	Twist-lock, 480V

IMP compatible sensors	
MSIIMP	Aisle sensor
MSI360IMP	360° sensor



Notes

1 Cord set required for fixture operation. All cord sets are 18/3, 6' white.

RRL - RELOC®-Ready Luminaire

- RRL connectors to be used with the OnePass system.
- Load side of connector factory installed to luminaire.
- 4-pole mating connector with push-in terminations allows for simple installation.
- Touch-safe design on both halves meets UL/CSA requirement.
- Wiping contact design allows safe disconnect under load.



ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative. **Example**: RRLA

Series		Wiring instructions	
RRL	RELOC®-ready luminaire	A	Hot conductor wired to position #1 (phase A); non-dimming
		B	Hot conductor wired to position #2 (phase B); non-dimming
		AE	Hot conductor wired to position #1 (phase A), hot conductor #2 wired to position #2 (phase B); non-dimming[1]
		C12S	Hot conductor in position #1 (phase A), low voltage conductor #1 in position #2,low voltage conductor #2 in position #3; dimming[2]

Compatible RELOC® Cables for Industrial Luminaires (ordered and shipped separately)

(click to view RELOC product page for more information)



OCS



OCU



OD

Notes

1 AE commercial fixtures should disconnect the TSPL before unplugging the RRL so it does not go into discharge mode. Requires fixture to have battery option.

2 C12S option is used with the OnePass for 0-10V/DALI applications.

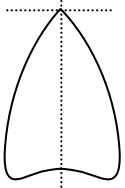
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LED Down light Cylinder

gotham®

Luminaire Type:
Catalog Number (autopopulated):





Gotham Architectural Downlighting
LED Downlights

6" Evo®
Cylinder

Solid-State Lighting

ENERGY STAR

A+ CAPABLE

FEATURES

OPTICAL SYSTEM
- Self-flanged semi-specular, matte-diffuse or finishing trim
- Patented Bounding Ray™ optical design (U.S. Patent No. 5,800,050)
- 45° cutoff to source and source image
- Top-down flash characteristic
- Polycarbonate lens integral to light engine

MECHANICAL SYSTEM
- Heavy-gauge aluminum construction
- Ceiling mount and wall mount for direct installation to 4" octagonal or square junction box
- Pendant mount entry for 3/8" National Pipe Thread stem; wires supplied by others
- Unique mounting mechanism at top of cylinders for easy one-person installation
- EDXB driver includes 3-foot DMX signal cable when ordered with FCM or WM mounting option. Fixture includes 10-foot DMX signal cable when ordered with PM or ACC mounting option.
- ACC180 provided with 15' 5-wire cord for power and 0-10V dimming

ELECTRICAL SYSTEM
- Fully serviceable and upgradeable LED light engine
- 70% lumen maintenance at 60,000 hours
- Tested according LM-79 and LM-80 standards
- 2.5 SDCM; 85 CRI typical, 90+ CRI optional
- Overload and short circuit protected
- Dimming wires supplied by others

LISTINGS
- Fixtures are CSA certified to meet US and Canadian standards; wet location, covered ceiling. ENERGY STAR® certified product.

WARRANTY
- 5-year limited warranty. Complete warranty terms located at: www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx

Note: Actual performance may differ as a result of end user environment and application. All values are design or typical values, measured under laboratory conditions at 25° C.

ORDERING INFORMATION

A+ Capable options indicated by this color background.

EXAMPLE: EVO CYL 35/10 6AR MWD LSS MVOLT EZ1 FCM DWHG

Series	Type	Color temperature	Nominal lumen values	Aperture/ Trim color	Trim type	Distribution[2]	Finish
EVO	**CYL**	**27/** 2700 K **30/** 3000 K **35/** 3500 K **40/** 4000 K **50/** 5000 K	**10** 1000 lumens **15** 1500 lumens **20** 2000 lumens **25** 2500 lumens **30** 3000 lumens **35** 3500 lumens **40** 4000 lumens **45** 4500 lumens	**6AR** Clear **6PR** Pewter **6WTR** Wheat **6GR** Gold **6WR**[1] White **6BR**[1] Black **6WRAMF**[1] White anti-microbial	(blank) Downlight **W** Wallwash	**VND** Very narrow (0.5 s/mh) **ND** Narrow (0.7 s/mh) **MD** Medium (0.9 s/mh) **MWD** Medium wide (1.0 s/mh) **WD** Wide (1.2 s/mh)	**LSS** Semi-specular **LD** Matte-diffuse **LS** Specular

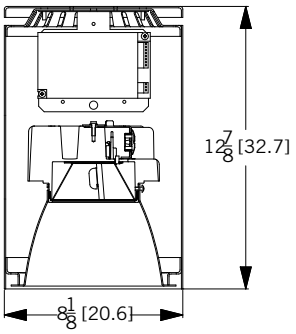
Voltage	Driver[3]		Mounting	Options		Architectural Colors - Powder Paint[11]	
MVOLT	**GZ10**	0-10V driver dims to 10%	**FCM** Ceiling mount	**SF**	Single fuse. Specify voltage.	**DWHG**	Matte white (standard)
120	**GZ1**	0-10V driver dims to 1%	**WM**[7] Wall mount	**CRI90**	High CRI (90+)	**DDB**	Dark bronze
277	**EZ10**	eldoLED 0-10V ECOdrive. Linear dimming to 10% min.	**PM** Pendant 3/8" thread mount	**NPP16D**[9]	nLight® network power/relay pack with 0-10V dimming for non-eldoLED drivers (GZ10, GZ1).	**DBL**	Black
	EZ1	eldoLED 0-10V ECOdrive. Linear dimming to 1% min.	**ACC**[8] 10ft aircraft cable and cord mount	**NPP16DER**[9]	nLight® network power/relay pack with 0-10V dimming for non-eldoLED drivers (GZ10, GZ1). ER controls fixtures on emergency circuit.	**DWH**	Gloss white
	EZB	eldoLED 0-10V SOLOdrive. Logarithmic dimming to <1%.	**ACC180**[8] 15ft aircraft cable and cord mount	**NPS80EZ**[9,10]	Sensor Switch® nLight® dimming pack controls 0-10V eldoLED drivers (EZ_).	**DMB**	Medium bronze
	EDAB[4]	eldoLED SOLOdrive DALI. Logarithmic dimming to <1%.		**NPS80EZER**[9,10]	Sensor Switch® nLight® dimming pack controls 0-10V eldoLED drivers. ER controls fixtures on emergency circuit operation (EZ_).	**DNA**	Natural aluminum
	EDXB[4]	eldoLED POWERdrive DMX with RDM (remote device management). Square Law dimming to <1%. Includes termination resistor. Refer to DMXR Manual.				**DSS**	Sandstone
	EXA1[5]	XPoint Wireless, eldoLED 0-10V ECOdrive. Linear dimming to 1%. Refer to XPoint tech sheet.				**DGC**	Charcoal grey
	EXAB[5]	XPoint Wireless, eldoLED 0-10V SOLOdrive. Logarithmic dimming to <1%. Refer to XPoint tech sheet.				**DTG**	Tennis green
	ECOS2[4,6]	Lutron® Hi-Lume® 2-wire forward-phase driver. 120V only. Minimum dimming level 1%. Minimum lumen 1000/Maximum lumen 3000.				**DBR**	Bright red
	ECOS3[4]	Lutron® Hi-Lume® 3-wire or EcoSystem® dimming driver. Minimum dimming level 1%. Minimum lumen 1000/ Maximum lumen 4500.				**DSB**	Steel blue

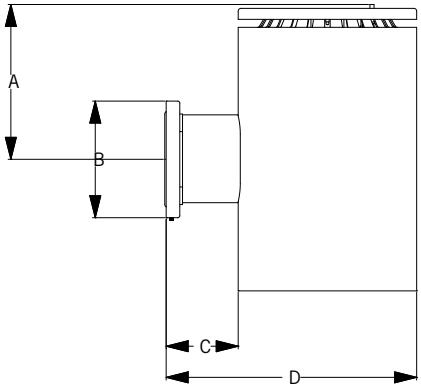
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DIMENSIONAL DATA

All dimensions are inches (centimeters) unless otherwise noted.





Reflector aperture: 6-1/4 (15.9)
Housing diameter: 8-1/8 (20.3)

Wall mount dimensions
A = 7-3/4 (19.7)
B = 5-5/16 (13.5)
C = 3-1/4 (8.3)
D = 10-7/8 (27.6)

ELECTRICAL

WATTAGE CONSUMPTION MATRIX			
LUMENS	**LM ACTUAL**	**WATTAGE**	**LUMENS per WATT**
1000	1,059	11.8	90.1
1500	1,572	18.5	85.0
2000	2,058	23.2	88.9
2500	2,612	29.5	88.5
3000	3,077	36.6	84.1
3500	3,591	42.1	85.3
4000	4,046	48.1	84.2
4500	4,555	46.9	97.1

ACCESSORIES

ACCESSORIES order as separate catalog numbers (shipped separately)

CYS[12]	3/8" stem and canopy with 5° "hang straight" swivel	**CRSX**[12]	3/8" stem and canopy with 45° swivel. Use this nomenclature when ordering EDXB driver
CRS[12]	3/8" stem and canopy with 45° swivel	**SDT 347/120 75VA**[13]	347V Step-down transformer
CYSX[12]	3/8" stem and canopy with 5° "hang straight" swivel. Use this nomenclature when ordering EDXB driver		

NOTES

ORDERING NOTES

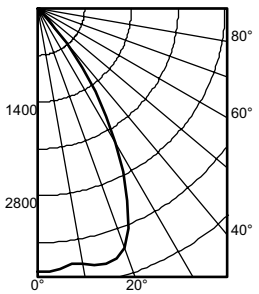
1. Not available with finishes.
2. Not available with wallwash trim type.
3. Refer to TECH-240 for compatible dimmers.
4. Not available with nLight® and XPoint options.
5. XPoint® CMRB ships separately.
6. Specify voltage 120V.
7. Access panel (supplied by others) recommended for use with nLight® and XPoint®.
8. White cord with white housings. All others black cord.
9. Specify voltage. For use with generator supply EM power. Will require an emergency hot feed and normal hot feed.
10. Interface remote mounted.
11. Additional architectural colors available; see www.lithonia.com/archcolors.
12. Color and length of stem must be specified (from 6" to 240" in even increments in maximum sections of 48"). Ex.: CYS06 DWHG. Ceiling attachment for interior use. Consult factory for exterior use. Wire not included.
13. Transformer must be field-installed to an accessible remote-mounted junction box.

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Distribution Curve	Distribution Data	Output Data	Coefficient of Utilization	Illuminance: Single Luminaire 30" Above Floor

EVO 35/40 6AR LS

INPUT WATTS: 48.1, DELIVERED LUMENS: 4046, LM/W=84.1 , 1.03 S/MH, TEST NO. LTL27768



	Ave	Lumens
0	3935	
5	3901	371
15	3944	1106
25	3172	1427
35	1508	926
45	221	203
55	6	10
65	2	2
75	1	1
85	0	0
90	0	

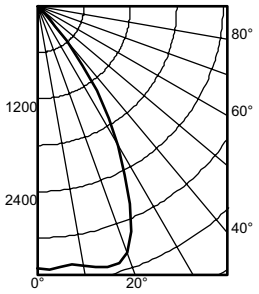
Zone	Lumens	% Lamp
0° - 30°	2904.3	71.8
0° - 40°	3830.0	94.7
0° - 60°	4043.4	99.9
0° - 90°	4046.3	100.0
90° - 180°	0.0	0.0
0° - 180°	4046.3	*100.0
*Efficiency		

pf	80%			20%			50%		
pc	70%								
pw	50%	30%	10%	50%	30%	10%	50%	30%	10%
0	119	119	119	116	116	116	111	111	111
1	111	108	106	109	106	104	105	103	101
2	103	99	96	101	98	95	98	95	93
3	96	91	87	95	90	87	92	88	85
4	90	84	80	89	84	80	87	82	79
5	84	78	74	83	78	74	81	77	73
6	79	73	69	78	73	68	77	72	68
7	74	68	64	73	68	64	72	67	63
8	70	64	60	69	63	60	68	63	59
9	66	60	56	65	60	56	64	59	56
10	62	56	52	62	56	52	61	56	52

Mounting Height	Inital FC Center Beam	50% beam - 54.4° Diameter	50% beam - 54.4° FC	10% beam - 78.1° Diameter	10% beam - 78.1° FC
8.0	130.1	5.7	65.1	8.9	13.0
10.0	70.0	7.7	35.0	12.2	7.0
12.0	43.6	9.8	21.8	15.4	4.4
14.0	29.8	11.8	14.9	18.7	3.0
16.0	21.6	13.9	10.8	21.9	2.2

EVO 35/35 6AR LS

INPUT WATTS: 42.1, DELIVERED LUMENS: 3591, LM/W=85.3, 1.05 S/MH, TEST NO. LTL27767



	Ave	Lumens
0	3400	
5	3390	324
15	3497	981
25	2830	1274
35	1335	820
45	193	177
55	5	9
65	2	2
75	1	1
85	1	1
90	1	

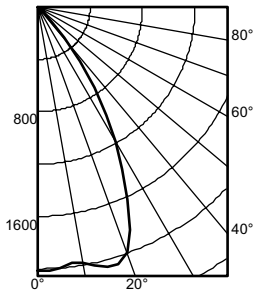
Zone	Lumens	% Lamp
0° - 30°	2579.3	71.8
0° - 40°	3399.8	94.7
0° - 60°	3586.3	99.9
0° - 90°	3590.5	100.0
90° - 180°	0.0	0.0
0° - 180°	3590.5	*100.0
*Efficiency		

pf	80%			20%			50%		
pc	70%								
pw	50%	30%	10%	50%	30%	10%	50%	30%	10%
0	119	119	119	116	116	116	111	111	111
1	111	108	106	109	106	104	105	103	101
2	103	99	96	101	98	95	98	95	93
3	96	91	87	95	90	87	92	88	85
4	90	84	80	89	84	80	87	82	79
5	84	78	74	83	78	74	81	77	73
6	79	73	69	78	72	68	77	72	68
7	74	68	64	73	68	64	72	67	63
8	70	64	60	69	63	59	68	63	59
9	66	60	56	65	60	56	64	59	55
10	62	56	52	62	56	52	61	56	52

Mounting Height	Inital FC Center Beam	50% beam - 55.2° Diameter	50% beam - 55.2° FC	10% beam - 78.2° Diameter	10% beam - 78.2° FC
8.0	112.4	5.7	56.2	8.9	11.2
10.0	60.4	7.8	30.2	12.2	6.0
12.0	37.7	9.9	18.8	15.4	3.8
14.0	25.7	12.0	12.9	18.7	2.6
16.0	18.7	14.1	9.3	21.9	1.9

EVO 35/20 6AR LS

INPUT WATTS: 23.2, DELIVERED LUMENS: 2058, LM/W=88.7, 1.02 S/MH, TEST NO. LTL27777



	Ave	Lumens
0	2018	
5	1997	190
15	2053	576
25	1618	733
35	749	459
45	105	94
55	3	5
65	1	1
75	0	0
85	0	0
90	0	

Zone	Lumens	% Lamp
0° - 30°	1498.5	72.8
0° - 40°	1958.0	95.1
0° - 60°	2056.6	99.9
0° - 90°	2058.3	100.0
90° - 180°	0.0	0.0
0° - 180°	2058.3	*100.0
*Efficiency		

pf	80%			20%			50%		
pc	70%								
pw	50%	30%	10%	50%	30%	10%	50%	30%	10%
0	119	119	119	116	116	116	111	111	111
1	111	108	106	109	107	105	105	103	101
2	103	99	96	102	98	95	98	95	93
3	96	92	88	95	91	87	92	89	86
4	90	85	81	89	84	80	87	83	79
5	84	79	74	83	78	74	82	77	73
6	79	73	69	78	73	69	77	72	68
7	74	68	64	74	68	64	72	67	64
8	70	64	60	69	64	60	68	63	60
9	66	60	56	66	60	56	65	60	56
10	62	57	53	62	56	53	61	56	53

Mounting Height	Inital FC Center Beam	50% beam - 54.2° Diameter	50% beam - 54.2° FC	10% beam - 77.3° Diameter	10% beam - 77.3° FC
8.0	66.7	5.6	33.4	8.8	6.7
10.0	35.9	7.7	17.9	12.0	3.6
12.0	22.4	9.7	11.2	15.2	2.2
14.0	15.3	11.8	7.6	18.4	1.5
16.0	11.1	13.8	5.5	21.6	1.1

LUMEN OUTPUT MULTIPLIER - CRI	
CRI	**FACTOR**
80 CRI	1
90 CRI	0.79

LUMEN OUTPUT MULTIPLIER - CCT	
CRI	**FACTOR**
5000 K	1.101
4000 K	1.035
3500 K	1
3000 K	0.973
2700 K	0.938

LUMEN OUTPUT MULTIPLIER - TRIM FINISH						
FINISH	**CLEAR (AR)**	**PEWTER (PR)**	**WHEAT (WTR)**	**GOLD (GR)**	**WHITE (WR/WRAMF)**	**BLACK (BR)**
Specular (LS)	1.00	0.88	0.83	0.95	N/A	N/A
Semi-specular (LSS)	0.95	0.84	0.79	0.90	N/A	N/A
Matte-diffuse (LD)	0.85	0.73	0.69	0.80	N/A	N/A
Paint	N/A	N/A	N/A	N/A	0.87	0.73

PHOTOMETRY NOTES

- Tested in accordance with IESNA LM-79-08.
- Tested to current IES and NEMA standards under stabilized laboratory conditions.
- CRI: 85 typical.

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CONTROLS

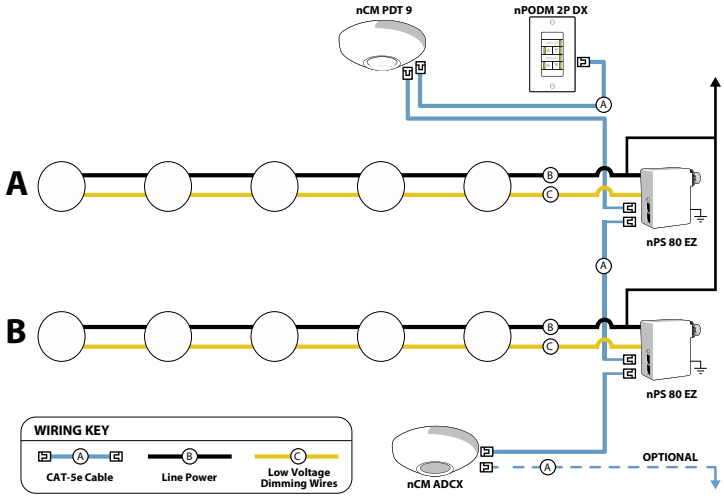
Choose Wall Controls.
nLIGHT o ers multiple styles of wall controls – each with varying features and user experience.



Push-Button WallPod
Traditional tactile buttons and LED user feedback



Graphic WallPod
Full color touch screen provides a sophisticated look and feel



EXAMPLE
Group Fixture Control*
*Application diagram applies for fixtures with eldoLED drivers only.

nPS 80 EZ Dimming/Control Pack (qty 2 required)
nPODM 2P DX Dual On/Off/Dim Push-Button WallPod
nCM ADCX Daylight Sensor with Automatic Dimming Control
nCM PDT 9 Dual Technology Occupancy Sensor

Description: This design provides a dual on/off/dim wall station that enables manual control of the fixtures in Row A and Row B separately. Additionally, a daylight harvesting sensor is provided so the lights in row B can be configured to dim automatically when daylight is available. An occupancy sensor turns off all lights when the space is vacant.

nLight® Control Accessories:
Order as separate catalog number. Visit www.sensorswitch.com/nLight for complete listing of nLight controls.

WallPod stations	Model number
On/Off	nPODM [color]
On/Off & Raise/Lower	nPODM DX [color]
Graphic Touchscreen	nPOD GFX [color]
Photocell controls	**Model number**
Dimming	nCM ADCX

Occupancy sensors	Model number
Small motion 360°, ceiling (PIR / dual tech)	nCM 9 / nCM PDT 9
Large motion 360°, ceiling (PIR / dual tech)	nCM 10 / nCM PDT 10
Wide view (PIR / dual tech)	nWV 16 / nWV PDT 16
Wall Switch w/ Raise/Lower (PIR / dual tech)	nWSX LV DX / nWSX PDT LV DX
Cat-5 cables (plenum rated)	**Model number**
10', CAT5 10FT	CAT5 10FT J1
15', CAT5 15FT	CAT5 15FT J1

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is part of an A+ Certified solution for nLight® control networks when ordered with drivers marked by a shaded background*
- This luminaire is part of an A+ Certified solution for nLight control networks, providing advanced control functionality at the luminaire level, when selection includes driver and control options marked by a shaded background*

To learn more about A+, visit www.acuitybrands.com/aplus.

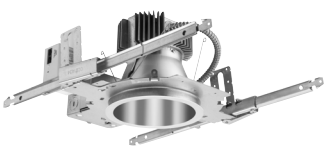
*See ordering tree for details

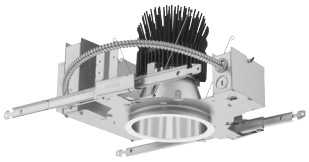
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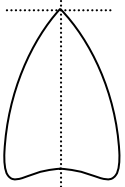
LED Down lights

gotham®

Luminaire Type:
Catalog Number:







SHOWN: 4500LM (LEFT), 17,500LM (RIGHT)

Gotham Architectural Downlighting
LED Downlights

6" Evo®
Downlight

Solid-State Lighting

FEATURES

OPTICAL SYSTEM
- Patented Bounding Ray™ optical design (U.S. Patent No. 5,800,050)
- 45° cutoff to source and source image
- Top-down flash characteristic
- Polycarbonate lens integral to light engine

MECHANICAL SYSTEM
- 16-gauge galvanized steel construction; maximum 1-1/2" ceiling thickness
- Telescopic mounting bars maximum of 32", preinstalled, 4" vertical adjustment
- Toolless adjustments post installation
- Junction box capacity: 8 (4 in, 4 out) 12AWG rated for 90°C
- Light engine and driver accessible through aperture

ELECTRICAL SYSTEM
- Fully serviceable and upgradeable lensed LED light engine
- 70% lumen maintenance at 60,000 hours
- Tested according to LM-79 and LM-80 standards
- Overload and short circuit protected
- 2.5 SDCM; 85 CRI typical, 90+ CRI optional

LISTINGS
- Fixtures are CSA certified to meet US and Canadian standards; wet location, covered ceiling. ENERGY STAR® certified product.

WARRANTY
5-year limited warranty. Complete warranty terms located at:
www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx

Note:
Actual performance may differ as a result of end user environment and application.
All values are design or typical values, measured under laboratory conditions at 25 °C.

WATTAGE CONSUMPTION MATRIX			
NOMINAL LUMENS	DELIVERED LUMENS*	WATTAGE	LUMENS per WATT
1000	1074	11.8	91.4
1500	1595	18.5	86.2
2000	2064	23.2	89.2
2500	2660	29.5	90.2
3000	3077	36.6	84.1
3500	3665	42.1	87.1
4000	4050	48.1	84.2
4500	4623	46.9	98.6
5000	5256.3	48.66	108.0
6000	6371.4	57.61	110.6
8000	8246.7	74.89	110.1
10000	10636.5	97.13	109.5
12000	12332	115.0	107.2
15000	15776	150.9	104.5
17500	17801	175.3	101.5

*Lumen Output for CRI80 - 3500K - MWD - Clear LS Reflector

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is part of an A+ Certified solution for nLight® control networks when ordered with drivers marked by a shaded background*
- This luminaire is part of an A+ Certified solution for nLight® control networks, providing advanced control functionality at the luminaire level, when selection includes driver and control options marked by a shaded background*

To learn more about A+, visit www.acuitybrands.com/aplus.

*See ordering tree for details

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ORDERING INFORMATION

A+ Capable options indicated by this color background.

Design2Ship Quick Ship Program: Options in green text qualify for Design2Ship — 5 business days from order entry to ship. Refer to Design2Ship Brochure for complete program details. **Maximum Order Quantity: 100 units; 50 for Chicago Plenum.**

EXAMPLE: EVO 35/150 6AR MWD LSS MVOLT EZ1

Series	Color temperature	Nominal lumen values	Reflector/Flange color	Trim Style	Distribution
EVO	**27/** 2700 K **30/** 3000 K **35/** 3500 K **40/** 4000 K **50/** 5000 K	**10** 1000 lumens **15** 1500 lumens **20** 2000 lumens **25** 2500 lumens **30** 3000 lumens **35** 3500 lumens **40** 4000 lumens **45** 4500 lumens **50** 5000 lumens **60** 6000 lumens **80** 8000 lumens **100** 10000 lumens **120** 12000 lumens **150** 15000 lumens **175** 17500 lumens	**6AR** Clear **6PR** Pewter **6WTR** Wheat **6GR** Gold **6WR**[1] White **6BR**[1] Black **6WRAMF**[1] White anti-microbial	**(blank)** Self-flanged **FL** Flangeless	**VND** Very narrow (0.5 s/mh) **ND** Narrow (0.7 s/mh) **MD** Medium (0.9 s/mh) **MWD** Medium wide (1.0 s/mh) **WD** Wide (1.2 s/mh)

Finish	Voltage	Driver[3]
LSS Semi-specular **LD** Matte-diffuse **LS** Specular	MVOLT 120 277 347[2]	**GZ10** 0-10V driver dims to 10% **GZ1** 0-10V driver dims to 1% **EZ10** 0-10V eldoLED driver with smooth and flicker-free deep dimming performance down to 10% **EZ1** 0-10V eldoLED driver with smooth and flicker-free deep dimming performance down to 1% **EZB** 0-10V eldoLED driver with smooth and flicker-free deep dimming performance to dark **EDAB**[4] DALI eldoLED driver with smooth and flicker-free deep dimming performance to dark **EDXB**[4,5] DMX with RDM (remote device management) eldoLED driver with smooth and flicker-free deep dimming performance to dark. Refer to DMXR Manual. **EXA1** XPoint Wireless, 0-10V eldoLED driver with smooth and flicker-free deep dimming performance down to 1% **EXAB** XPoint Wireless, 0-10V eldoLED driver with smooth and flicker-free deep dimming performance to dark **ECOS2**[4,5,6] Lutron® Hi-Lume® 2-wire forward-phase driver. Minimum dimming level 1% **ECOS3**[4,5,] Lutron® Hi-Lume® 3-wire or EcoSystem® driver. Minimum dimming level 1%

Options

SF	Single fuse. Specify 120V or 277V.
TRW[7]	White painted flange
TRBL[8]	Black painted flange
EL[9]	Emergency battery pack with integral test switch
ELR[9]	Emergency battery pack with remote test switch
ELSD[9]	Emergency battery pack with self-diagnostics, integral test switch. (4500lm max)
ELRSD[9]	Emergency battery pack with self-diagnostics, remote test switch. (4500lm max)
E10WCP[9]	Emergency battery pack, 10W Constant Power, CA Title 20 compliant with integral test switch. (4500lm max)
E10WCPR[9]	Emergency battery pack, 10W Constant Power, CA Title 20 compliant with remote test switch. (4500lm max)
NPP16D[10]	nLight® network power/relay pack with 0-10V dimming for non-eldoLED drivers (GZ10, GZ1).
NPP16DER[10]	nLight® network power/relay pack with 0-10V dimming for non-eldoLED drivers (GZ10, GZ1). ER controls fixtures on emergency circuit.
NPS80EZ[10]	nLight® dimming pack controls 0-10V eldoLED drivers.
NPS80EZER[10]	nLight® dimming pack controls 0-10V eldoLED drivers. ER controls fixtures on emergency circuit.
N80[11]	nLight® Lumen Compensation
BGTD	Bodine generator transfer device. Specify 120V or 277V.
CRI90	High CRI (90+)
CP[12]	Chicago plenum. Specify 120V or 277V.
RRL__	RELOC®-ready luminaire connectors enable a simple and consistent factory installed option across all ABL luminaire brands. Refer to RRL for complete nomenclature.
HAO[13]	HAO High ambient option (40C)
NLTAIR2[14]	nLight® Air enabled
NLTAIRER2[14]	nLight® AIR Dimming Pack Wireless Controls. Controls fixtures on emergency circuit

ACCESSORIES order as separate catalog numbers (shipped separately)

SCA6	Sloped ceiling adapter. Degree of slope must be specified (5D, 10D, 15D, 20D, 25D, 30D). Ex: SCA6 10D. Refer to TECH-190.
CTA4-8 YKHL	Ceiling thickness adapter for 10,000lm and above (extends mounting frame to accommodate ceiling thickness up to 5"). Adds ~4" to fixture height.
CTA4-8 YK	Ceiling thickness adapter for 8,000lm and below (extends mounting frame to accommodate ceiling thickness up to 5"). Adds ~4" to fixture height.
GVRT	Vandal-resistant trim accessory. Refer to TECH-200.
ISD BC	0-10V wallbox dimmer. Refer to ISD-BC.

ORDERING NOTES

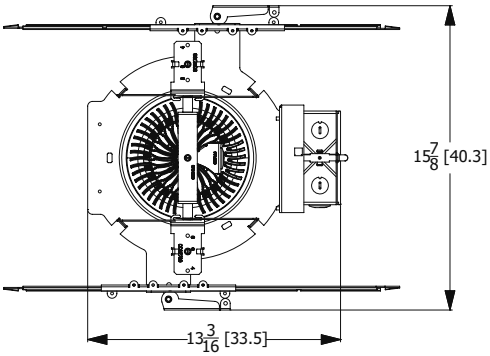
1. Not available with finishes.
2. Not available with emergency batterypack options.
3. Refer to TECH-240 for compatible dimmers.
4. Not available with nLight® and Xpoint options.
5. Not available 17,500lm.
6. Specify voltage 120V.
7. Not applicable with WR or FL option.
8. Not applicable with BR or FL option.
9. For dimensional changes, refer to TECH-140.
10. Specify voltage. ER for use with generator supply power. Will require an emergency hot feed and normal hot feed.
11. Fixture begins at 80% light level. Must be specified with NPS80EZ or NPS80EZ ER. Only available with EZ10 and EZ1 drivers.
12. 12,000lm max with EL or nLight® options. 5,000lm max with Lutron drivers combined with EL. Not available with ELR, HAO, EXA1, or EXAB options.
13. Only available 5000lm -15,000lm with eldoLED drivers.
14. Not available DALI or DMX drivers. Not available with CP, NPS80EZ, NPS80EZER, NPP16D, NPP16DER or N80 options. Not recommended for metal ceiling installations.

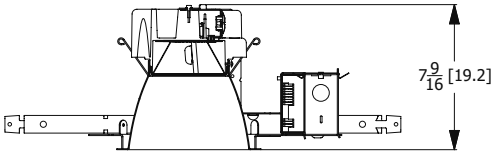
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DIMENSIONAL DATA

All dimensions are inches unless otherwise noted.

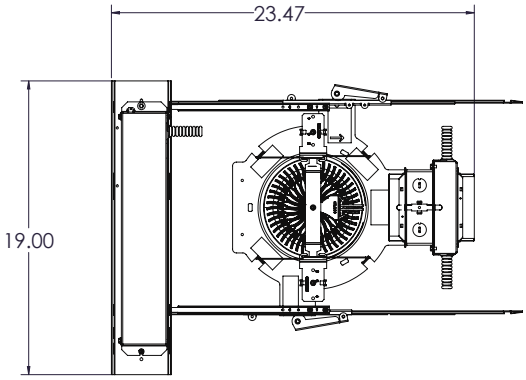
1000LM-4500LM STANDARD

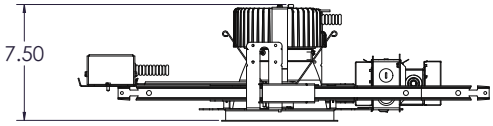




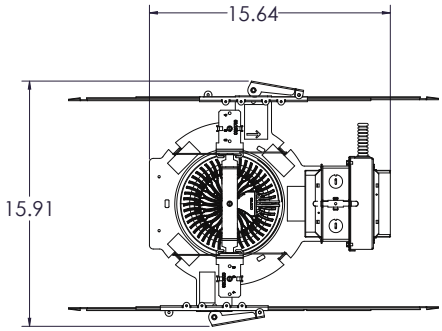
Aperture: 6-1/4" (15.9)
Ceiling Opening: 7-1/8" (18.1) self-flanged
7-1/4" (18.4) flangeless
Overlap trim: 7-1/2" (19.1)

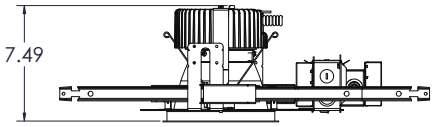
1000LM-4500LM BATTERYPACK



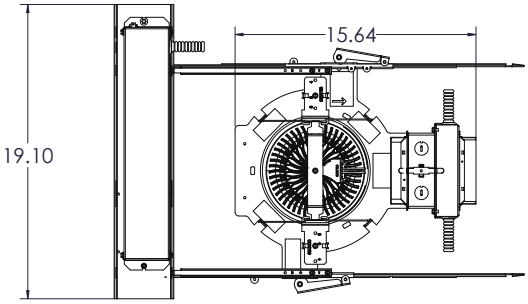


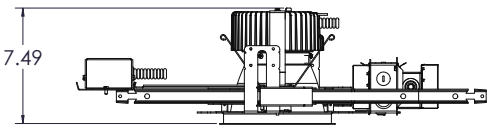
5000LM-8000LM STANDARD





5000LM-8000LM BATTERYPACK



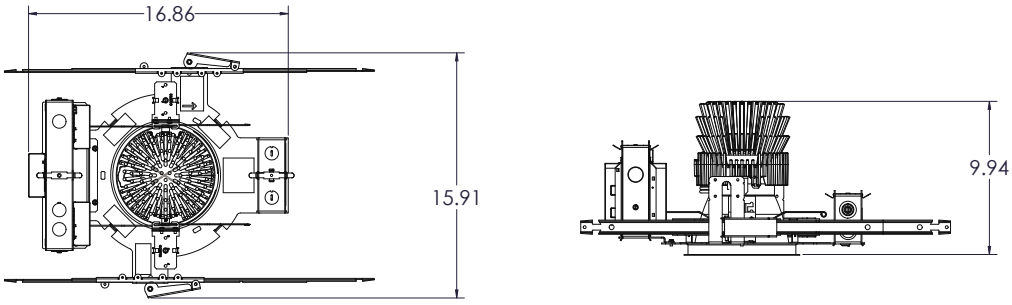


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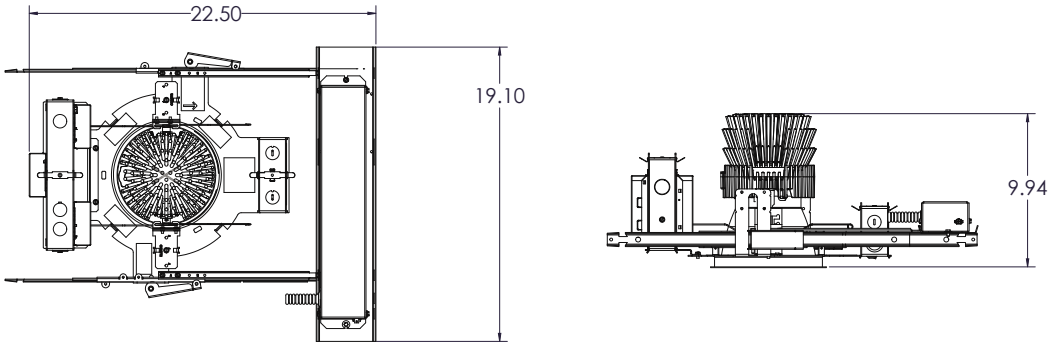
DIMENSIONAL DATA

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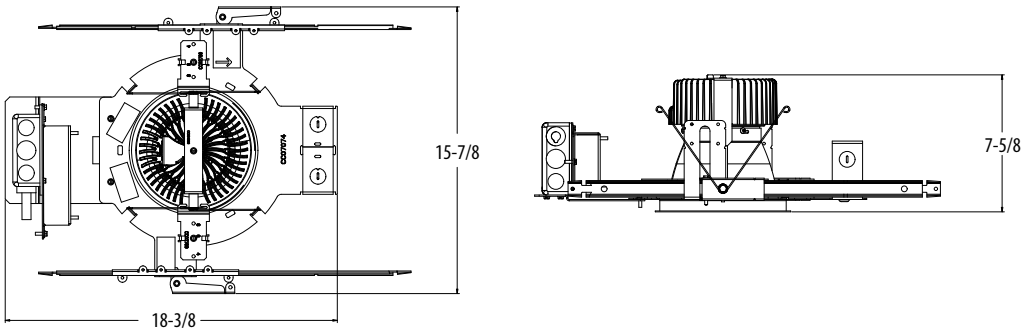
10,000LM-17,500LM STANDARD



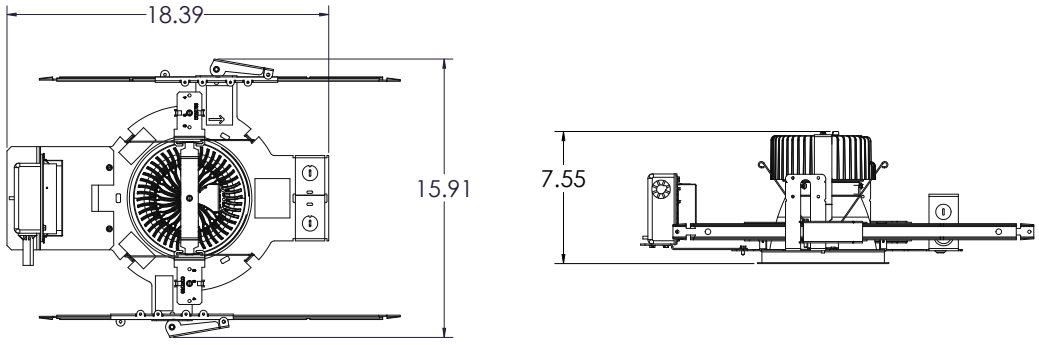
10,000LM-17,500LM BATTERYPACK



1000LM-4500LM CHICAGO PLENUM



5000 LUMEN ECO/SOLO DRIVE OPEN FRAME CP

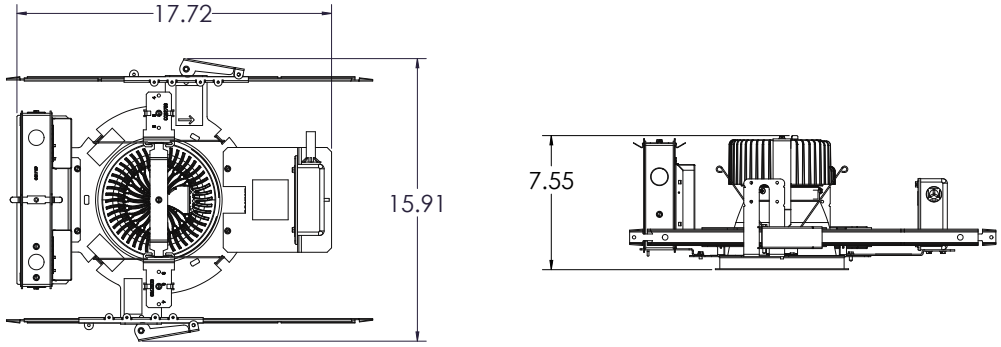


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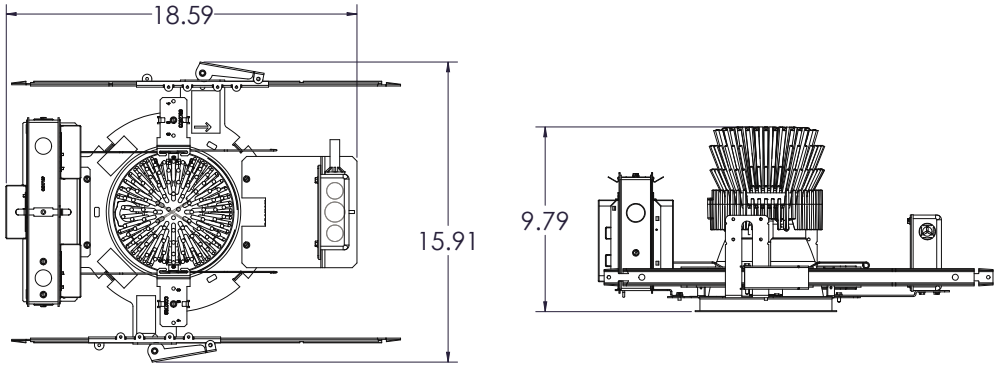
DIMENSIONAL DATA

All dimensions are inches unless otherwise noted.

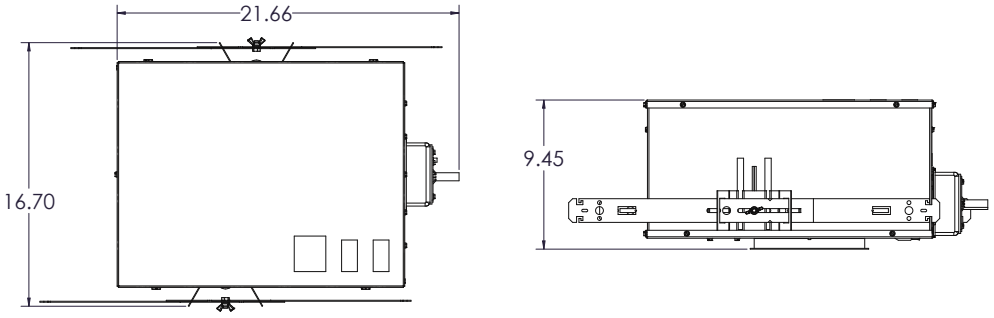
5000 (LUTRON & POWER DRIVE ONLY), 6000 & 8000 LUMEN OPEN FRAME CP



10000 - 17,500 LUMEN OPEN FRAME CP



5000 & 6000 LUMEN CP (WITH NLIGHT® OR BATTERY PACK)



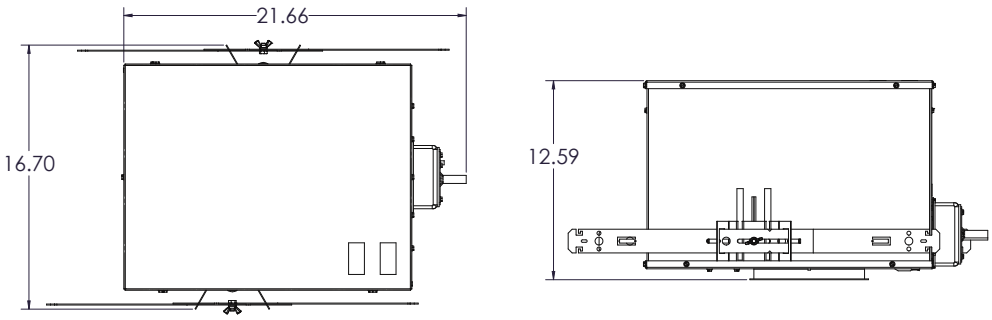
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gotham®

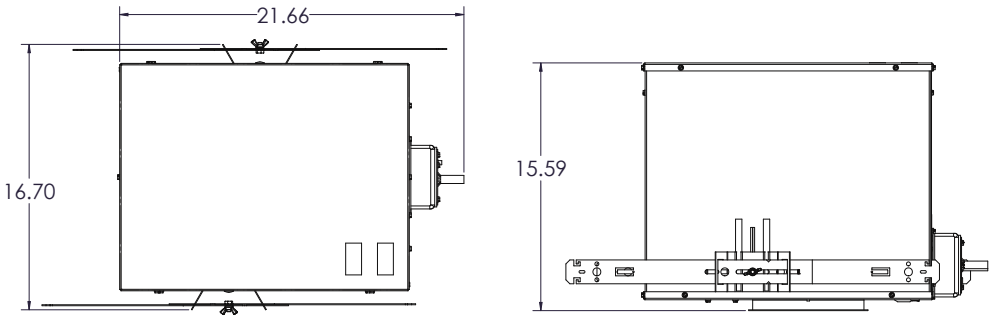
DIMENSIONAL DATA

All dimensions are inches unless otherwise noted.

8000 LUMEN CP (WITH NLIGHT® OR BATTERY PACK)



10K & 12K LUMEN CP (WITH NLIGHT® OR BATTERY PACK)



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ELECTRICAL

MARKED SPACINGS IN INCHES - 25°C AMBIENT			
Lumen Package	**Fixture Center to Center MIN**	**Fixture Center to Building Member MIN**	**Space above Fixture**
500-5000	None	None	None
6000	24	12	5
8000	36	18	11
10000	36	18	9
12000			
15000			
17500	72	36	9

MARKED SPACINGS - CHICAGO PLENUM OPEN FRAME IN INCHES - 25°C AMBIENT			
Lumen Package	**Fixture Center to Center MIN**	**Fixture Center to Building Member MIN**	**Space above Fixture**
500-5000	None	None	None
6000	24	12	5
8000	36	18	11
10000	36	18	9
12000			
15000			
17500	72	36	9

MARKED SPACINGS - CHICAGO PLENUM ENCLOSURE IN INCHES - 25°C AMBIENT			
Lumen Package	**Fixture Center to Center MIN**	**Fixture Center to Building Member MIN**	**Space above Fixture**
500-6000	None	None	None
8000	36	18	6
10000	48	24	3
12000			

MARKED SPACINGS IN INCHES - 40°C AMBIENT			
Lumen Package	**Fixture Center to Center MIN**	**Fixture Center to Building Member MIN**	**Space above Fixture**
5000	24	12	5
6000			
8000	48	24	9
10000			
12000			
15000	72	36	9

EVO - ELDOLED DRIVER DEFAULT DIMMING CURVE		
	Curve	**Minimum Dimming**
EZ10	Linear	10%
EZ1	Linear	1%
EZB	Logarithmic	<1%
EDAB	Logarithmic	<1%
EDXB	Square Law	<1%
EXA1	Linear	1%
EXAB	Logarithmic	<1%

HOW TO ESTIMATE DELIVERED LUMENS IN EMERGENCY MODE

Use the formula below to estimate the delivered lumens in emergency mode

Delivered Lumens = 1.25 x P x LPW

P = Ouput power of emergency driver. P = 10W for PS1055CP

LPW = Lumen per watt rating of the luminaire. This information is available on the ABL luminaire spec sheet.
The LPW rating is also available at Designlight Consortium.

LUMEN OUTPUT MULTIPLIER - CCT		
CRI	CCT	**Multiplier**
80	**2700K**	0.916
	3000K	0.948
	3500K	1
	4000K	1.032
	5000K	1.1
90	**2700K**	0.748
	3000K	0.8
	3500K	0.838
	4000K	0.845
	5000K	0.945

Reflector Finish	Multiplier
LS-Specular	1
LSS- Semi Specular	0.956
WR - White	0.87
LD - Mat Diffuse	0.85
BR - Black	0.73

Distribution	Beam Angle	Field Angle
VND	30.2	63.7
ND	44.1	68.8
MD	54.2	81.6
MWD	66.8	88.9
WD	71.1	92.1

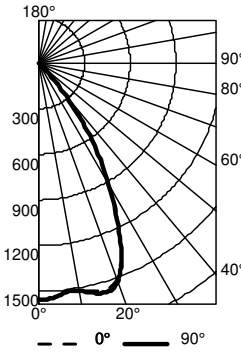
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PHOTOMETRY

Distribution Curve	Distribution Data	Output Data	Coefficient of Utilization	Illuminance: Single Luminaire 30" Above Floor

EVO 35/15 6AR MWD LS

INPUT WATTS: 18.5, DELIVERED LUMENS: 1595LM, LM/W=86.2 , 1.03 S/MH, TEST NO. LTL27782P1115



CP Summary

	0°	90
0°	1552	1552
5°	1528	1535
15°	1549	1564
25°	1257	1261
35°	597	584
45°	90	84
55°	3	3
65°	1	1
75°	1	1
85°	0	0
90	0	0

Coefficients of Utilization

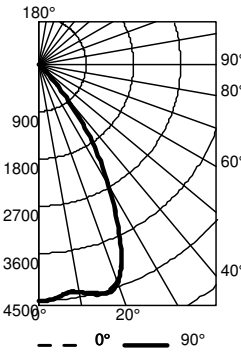
RCR	pf 20%	80%			70%			50%		
	pc									
	pw	70%	50%	30%	50%	30%	10%	50%	30%	10%
0		119	119	119	116	116	116	111	111	111
1		114	111	108	109	106	104	105	103	101
2		108	103	99	101	98	95	98	95	93
3		103	96	91	95	90	87	92	88	85
4		97	90	84	89	84	80	87	82	79
5		93	84	78	83	78	74	81	77	73
6		88	79	73	78	73	69	77	72	68
7		83	74	68	74	68	64	72	67	63
8		79	70	64	69	64	60	68	63	59
9		75	66	60	65	60	56	64	59	56
10		72	62	56	62	56	52	61	56	52

Zonal Lumen Summary

Zone	Lumens	% Lamp	% Fixture
0° - 30°	1151	72.2	72.2
0° - 40°	1511	94.7	94.7
0° - 60°	1593	99.9	99.9
0° - 90°	1595	100.0	100.0
90° - 180°	0	0.0	0.0
0° - 180°	1595	100.0	100.0

EVO 35/45 6AR MWD LS

INPUT WATTS: 46.9, DELIVERED LUMENS: 4623LM, LM/W=98.5 , 1.03 S/MH, TEST NO. LTL27782P1241



CP Summary

	0°	90
0°	4499	4499
5°	4429	4448
15°	4490	4534
25°	3643	3655
35°	1731	1694
45°	260	243
55°	9	8
65°	2	3
75°	2	2
85°	0	0
90	0	0

Coefficients of Utilization

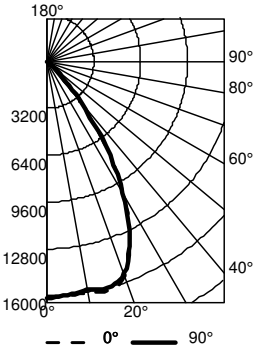
RCR	pf 20%	80%			70%			50%		
	pc									
	pw	70%	50%	30%	50%	30%	10%	50%	30%	10%
0		119	119	119	116	116	116	111	111	111
1		114	111	108	109	106	104	105	103	101
2		108	103	99	101	98	95	98	95	93
3		103	96	91	95	90	87	92	88	85
4		97	90	84	89	84	80	87	82	79
5		93	84	78	83	78	74	81	77	73
6		88	79	73	78	73	69	77	72	68
7		83	74	68	74	68	64	72	67	63
8		79	70	64	69	64	60	68	63	59
9		75	66	60	65	60	56	64	59	56
10		72	62	56	62	56	52	61	56	52

Zonal Lumen Summary

Zone	Lumens	% Lamp	% Fixture
0° - 30°	3336	72.2	72.2
0° - 40°	4380	94.7	94.7
0° - 60°	4619	99.9	99.9
0° - 90°	4623	100.0	100.0
90° - 180°	0	0.0	0.0
0° - 180°	4623	100.0	100.0

EVO 35/175 6AR MWD LS

INPUT WATTS: 175.3, DELIVERED LUMENS: 17801LM, LM/W=101.5 , 1.06 S/MH, TEST NO. ISF 34035P268



CP Summary

	0°	90
0°	16146	16146
5°	16095	16027
15°	16214	16013
25°	13435	13347
35°	6981	7024
45°	1397	1491
55°	93	100
65°	34	36
75°	13	13
85°	2	2
90	0	0

Coefficients of Utilization

RCR	pf 20%	80%			70%			50%		
	pc									
	pw	70%	50%	30%	50%	30%	10%	50%	30%	10%
0		119	119	119	116	116	116	111	111	111
1		113	111	108	108	106	104	104	103	101
2		108	103	98	101	97	94	98	95	92
3		102	95	90	94	89	86	91	87	84
4		97	89	83	88	82	78	85	81	77
5		91	83	77	82	76	72	80	75	71
6		87	77	71	77	71	67	75	70	66
7		82	73	66	72	66	62	71	65	61
8		78	68	62	67	62	57	66	61	57
9		74	64	58	63	58	54	62	57	53
10		70	60	54	60	54	50	59	54	50

Zonal Lumen Summary

Zone	Lumens	% Lamp	% Fixture
0° - 30°	12002	67.4	67.4
0° - 40°	16291	91.5	91.5
0° - 60°	17746	99.7	99.7
0° - 90°	17801	100.0	100.0
90° - 120°	0	0.0	0.0
90° - 130°	0	0.0	0.0
90° - 150°	0	0.0	0.0
90° - 180°	0	0.0	0.0
0° - 180°	17801	100.0	100.0

PHOTOMETRY NOTES

- Tested in accordance with IESNA LM-79-08.
- Tested to current IES and NEMA standards under stabilized laboratory conditions.
- CRI: 85 typical.

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CONTROLS

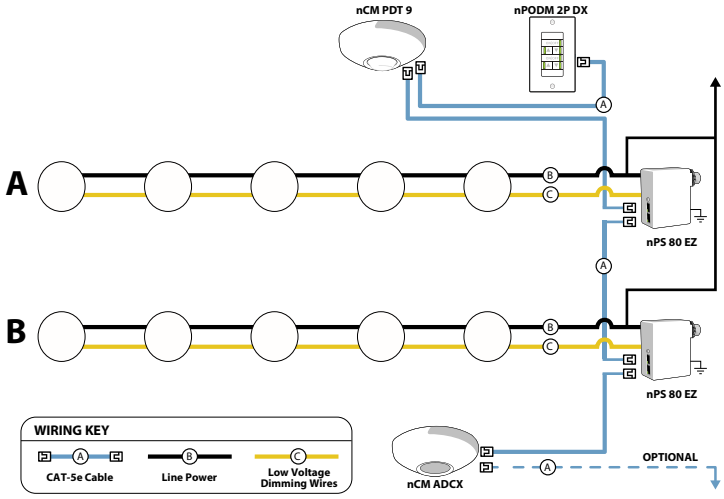
Choose Wall Controls.
nLIGHT o ers multiple styles of wall controls – each with varying features and user experience.



Push-Button WallPod
Traditional tactile buttons and LED user feedback



Graphic WallPod
Full color touch screen provides a sophisticated look and feel



EXAMPLE
Group Fixture Control*
*Application diagram applies for fixtures with eldoLED drivers only.

nPS 80 EZ Dimming/Control Pack (qty 2 required)
nPODM 2P DX Dual On/Off/Dim Push-Button WallPod
nCM ADCX Daylight Sensor with Automatic Dimming Control
nCM PDT 9 Dual Technology Occupancy Sensor

Description: This design provides a dual on/off/dim wall station that enables manual control of the fixtures in Row A and Row B separately. Additionally, a daylight harvesting sensor is provided so the lights in row B can be configured to dim automatically when daylight is available. An occupancy sensor turns off all lights when the space is vacant.

nLight® Control Accessories:
Order as separate catalog number. Visit www.sensorswitch.com/nLight for complete listing of nLight® controls.

WallPod stations	Model number	Occupancy sensors	Model number
On/Off	nPODM [color]	Small motion 360°, ceiling (PIR / dual tech)	nCM 9 / nCM PDT 9
On/Off & Raise/Lower	nPODM DX [color]	Large motion 360°, ceiling (PIR / dual tech)	nCM 10 / nCM PDT 10
Graphic Touchscreen	nPOD GFX [color]	Wide view (PIR / dual tech)	nWV 16 / nWV PDT 16
Photocell controls	**Model number**	Wall Switch w/ Raise/Lower (PIR / dual tech)	nWSX LV DX / nWSX PDT LV DX
Dimming	nCM ADCX	**Cat-5 cables (plenum rated)**	**Model number**
		10', CAT5 10FT	CAT5 10FT J1
		15', CAT5 15FT	CAT5 15FT J1

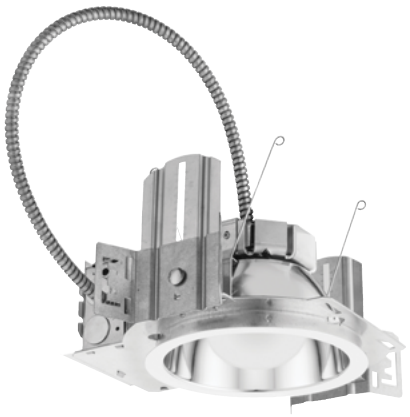
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LITHONIA LIGHTING®

Catalog Number	
Notes	
Type	

LDN6

6" OPEN and WALLWASH LED
Non-IC
New Construction Downlight



FEATURES & SPECIFICATIONS

INTENDED USE — Typical applications include corridors, lobbies, conference rooms and private offices.

CONSTRUCTION — Galvanized steel mounting/plaster frame; galvanized steel junction box with bottom-hinged access covers and spring latches. Reflectors are retained by torsion springs.

Vertically adjustable mounting brackets with commercial bar hangers provide 3-3/4" total adjustment.

Two combination ½"-3/4" and four ½" knockouts for straight-through conduit runs. Capacity: 8 (4 in, 4 out). No. 12 AWG conductors, rated for 90°C.

Accommodates 12"-24" joist spacing.

Passive cooling thermal management for 25°C standard; high ambient (40°C) option available. Light engine and drivers are accessible from above or below ceiling.

Max ceiling thickness 1-1/2".

OPTICS — LEDs are binned to a 3-step SDCM; 80 CRI minimum.

LED light source concealed with diffusing optical lens.

General illumination lighting with 1.0 S/MH and 55° cutoff to source and source image.

Self-flanged anodized reflectors in specular, semi-specular, or matte diffuse finishes. Also available in white and black painted reflectors.

ELECTRICAL — Multi-volt (120-277V, 50/60Hz) 0-10V dimming drivers mounted to junction box, 10% or 1% minimum dimming level available.

0-10V dimming fixture requires two (2) additional low-voltage wires to be pulled.

70% lumen maintenance at 50,000 hours.

LISTINGS — Certified to US and Canadian safety standards. Damp location standard (wet location, covered ceiling optional). ENERGY STAR® certified product.

WARRANTY — 5-year limited warranty. Complete warranty terms located at: www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx

Note: Actual performance may differ as a result of end-user environment and application.

All values are design or typical values, measured under laboratory conditions at 25 °C.

Specifications subject to change without notice.

battery pack

A+ Capable options indicated by this color background.

ORDERING INFORMATION

Lead times will vary depending on options selected. Consult with your sales representative.

Example: LDN6 35/15 LO6AR LSS MVOLT EZ10

LDN6							
Series	**Color temperature**	**Lumens[1]**		**Aperture/Trim Color**		**Finish**	**Voltage**
LDN6 6" round	27/ 2700K 30/ 3000K 35/ 3500K 40/ 4000K 50/ 5000K	05 500 lumens 10 1000 lumens 15 1500 lumens 20 2000 lumens	25 2500 lumens 30 3000 lumens 40 4000 lumens 50 5000 lumens	LO6 Downlight LW6 Wallwash	AR Clear WR[2] White BR[2] Black	LSS Semi-specular LD Matte diffuse LS Specular	MVOLT Multi-volt 120 120V 277 277V 347[3] 347V

Driver	
GZ10	0-10V driver dims to 10%
GZ1	0-10V driver dims to 1%
EZ10	0-10V eldoLED driver with smooth and flicker-free deep dimming performance down to 10%
EZ1	0-10V eldoLED driver with smooth and flicker-free deep dimming performance down to 1%

Options	
SF[4]	Single fuse
TRW[5]	White painted flange
TRBL[5]	Black painted flange
EL	Emergency battery pack with integral test switch. Not Certified in CA Title 20 MAEDBS
ELR	Emergency battery pack with remote test switch. Not Certified in CA Title 20 MAEDBS
ELSD	Emergency battery pack with self-diagnostics, integral test switch. Not Certified in CA Title 20 MAEDBS
ELRSD	Emergency battery pack with self-diagnostics, remote test switch. Not Certified in CA Title 20 MAEDBS
E10WCP	Emergency battery pack, 10W Constant Power with integral test switch. Certified in CA Title 20 MAEDB
E10WCPR	Emergency battery pack, 10W Constant Power with integral test switch. Certified in CA Title 20 MAEDB
NPP16D[6]	nLight® network power/relay pack with 0-10V dimming for non-eldoLED drivers (GZ10, GZ1).
NPP16DER[6]	nLight® network power/relay pack with 0-10V dimming for non-eldoLED drivers (GZ10, GZ1). ER controls fixtures on emergency circuit.
N80[7]	nLight™ Lumen Compensation
NPS80EZ[6]	nLight® dimming pack controls 0-10V eldoLED drivers (EZ10, EZ1).
NPS80EZER[6]	nLight® dimming pack controls 0-10V eldoLED drivers (EZ10, EZ1). ER controls fixtures on emergency circuit.
HAO[10]	High ambient option
CP[11]	Chicago Plenum
WL	Wet Location, specify for exterior use applications
RRL___	RELOC®-ready luminaire connectors enable a simple and consistent factory installed option across all ABL luminaire brands. Refer to RRL for complete nomenclature. Available only in RRLA, RRLB, RRLAE, and RRLC12S.
NLTAIR2[8,9]	nLight® Air enabled
NLTAIRER2[8,9]	nLight® AIR Dimming Pack Wireless Controls. Controls fixtures on emergency circuit
USPOM	US point of manufacture

Accessories: *Order as separate catalog number.*

EAC ISSM 375	Compact interruptible emergency AC power system
EAC ISSM 125	Compact interruptible emergency AC power system
GRA68 JZ	Oversized trim ring with 8" outside diameter [1]
SCA6	Sloped ceiling adapter. Refer to TECH-SCA for more options.

Notes

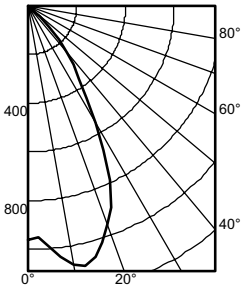
1. Overall height varies based on lumen package; refer to dimensional chart on page 3.
2. Not available with finishes.
3. Not available with emergency options.
4. Must specify voltage 120V or 277V.
5. Available with clear (AR) reflector only.
6. Specify voltage. ER for use with generator supply EM power. Will require an emergency hot feed and normal hot feed.
7. Fixture begins at 80% light level. Must be specified with NPS80EZ or NPS80EZ ER. Only available with EZ10 and EZ1 drivers.
8. Not available with CP, NPS80EZ, NPS80EZER, NPP16D, NPP16DER or N80 options.
9. NLTAIR2 and NLTAIRER2 not recommended for metal ceiling installations.
10. Fixture height is 6.5" for all lumen packages with HAO.
11. Must specify voltage for 3000lm. 5000lm with marked spacing 24 L x 24 W x 14 H. Not available with emergency battery pack option.

LDN6

PHOTOMETRY

Distribution Curve | **Distribution Data** | **Output Data** | **Coefficient of Utilization** | **Illuminance Data at 30" Above Floor for a Single Luminaire**

LDN6 35/10 LO6AR, input watts: 12.75, delivered lumens: 1082, LM/W = 84.86, spacing criterion at 0= 1.02, test no. ISF 30716P31.



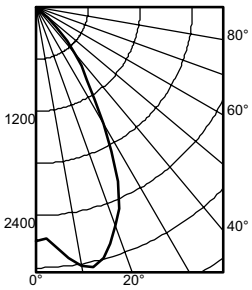
	Ave	Lumens
0	961	
5	992	98
15	1064	295
25	789	353
35	362	235
45	121	96
55	2	4
65	1	1
75	0	0
85	0	0
90	0	

Zone	Lumens	% Lamp
0° - 30°	746.1	69.0
0° - 40°	981.1	90.7
0° - 60°	1080.9	99.9
0° - 90°	1082.0	100.0
90° - 120°	0.0	0.0
90° - 130°	0.0	0.0
90° - 150°	0.0	0.0
90° - 180°	0.0	0.0
0° - 180°	1082.0	*100.0
*Efficiency		

pf / pc / pw	80% 50%	80% 30%	80% 10%	20% 70% 50%	20% 70% 30%	20% 70% 10%	50% 50%	50% 30%	50% 10%
0	119	119	119	116	116	116	111	111	111
1	111	108	106	109	106	104	104	103	101
2	103	99	95	101	97	94	98	95	92
3	96	91	87	94	90	86	92	88	85
4	89	84	79	88	83	79	86	81	78
5	83	77	73	82	77	73	81	76	72
6	78	72	68	77	72	67	76	71	67
7	73	67	63	73	67	63	71	66	62
8	69	63	59	68	62	58	67	62	58
9	65	59	55	64	59	55	63	58	54
10	61	55	51	61	55	51	60	55	51

Mounting Height	Inital FC Center Beam	50% beam - 54.5° Diameter	50% beam - 54.5° FC	10% beam - 82.2° Diameter	10% beam - 82.2° FC
8.0	31.8	5.7	15.9	9.6	3.2
10.0	17.1	7.7	8.5	13.1	1.7
12.0	10.6	9.8	5.3	16.6	1.1
14.0	7.3	11.8	3.6	20.1	0.7
16.0	5.3	13.9	2.6	23.6	0.5

LDN6 35/30 LO6AR, input watts: 34.69, delivered lumens: 3033.9, LM/W = 87.45, spacing criterion at 0= 1.02, test no. ISF 30716P22.



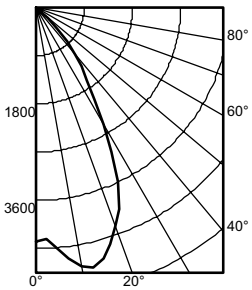
	Ave	Lumens
0	2693	
5	2782	274
15	2984	827
25	2212	991
35	1014	659
45	339	268
55	4	12
65	2	2
75	1	1
85	0	0
90	0	

Zone	Lumens	% Lamp
0° - 30°	2092.2	69.0
0° - 40°	2751.0	90.7
0° - 60°	3030.8	99.9
0° - 90°	3033.9	100.0
90° - 120°	0.0	0.0
90° - 130°	0.0	0.0
90° - 150°	0.0	0.0
90° - 180°	0.0	0.0
0° - 180°	3033.9	*100.0
*Efficiency		

pf / pc / pw	80% 50%	80% 30%	80% 10%	20% 70% 50%	20% 70% 30%	20% 70% 10%	50% 50%	50% 30%	50% 10%
0	119	119	119	116	116	116	111	111	111
1	111	108	106	109	106	104	104	103	101
2	103	99	95	101	97	94	98	95	92
3	96	91	87	94	90	86	92	88	85
4	89	84	79	88	83	79	86	81	78
5	83	77	73	82	77	73	81	76	72
6	78	72	68	77	72	67	76	71	67
7	73	67	63	73	67	63	71	66	62
8	69	63	59	68	62	58	67	62	58
9	65	59	55	64	59	55	63	58	54
10	61	55	51	61	55	51	60	55	51

Mounting Height	Inital FC Center Beam	50% beam - 54.5° Diameter	50% beam - 54.5° FC	10% beam - 82.2° Diameter	10% beam - 82.2° FC
8.0	89.0	5.7	44.5	9.6	8.9
10.0	47.9	7.7	23.9	13.1	4.8
12.0	29.8	9.8	14.9	16.6	3.0
14.0	20.4	11.8	10.2	20.1	2.0
16.0	14.8	13.9	7.4	23.6	1.5

LDN6 35/50 LO6AR, input watts: 55.56, delivered lumens: 4922.1, LM/W = 88.59, spacing criterion at 0= 1.02, test no. ISF 30716P40.



	Ave	Lumens
0	4370	
5	4513	445
15	4841	1341
25	3589	1608
35	1645	1069
45	550	435
55	7	19
65	3	3
75	2	2
85	0	0
90	0	

Zone	Lumens	% Lamp
0° - 30°	3394.2	69.0
0° - 40°	4463.2	90.7
0° - 60°	4917.1	99.9
0° - 90°	4922.1	100.0
90° - 120°	0.0	0.0
90° - 130°	0.0	0.0
90° - 150°	0.0	0.0
90° - 180°	0.0	0.0
0° - 180°	4922.1	*100.0
*Efficiency		

pf / pc / pw	80% 50%	80% 30%	80% 10%	20% 70% 50%	20% 70% 30%	20% 70% 10%	50% 50%	50% 30%	50% 10%
0	119	119	119	116	116	116	111	111	111
1	111	108	106	109	106	104	104	103	101
2	103	99	95	101	97	94	98	95	92
3	96	91	87	94	90	86	92	88	85
4	89	84	79	88	83	79	86	81	78
5	83	77	73	82	77	73	81	76	72
6	78	72	68	77	72	67	76	71	67
7	73	67	63	73	67	63	71	66	62
8	69	63	59	68	62	58	67	62	58
9	65	59	55	64	59	55	63	58	54
10	61	55	51	61	55	51	60	55	51

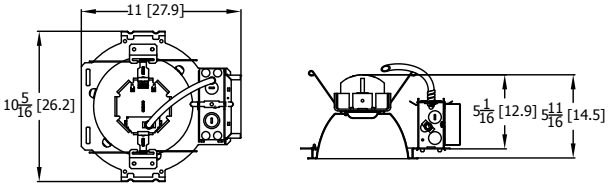
Mounting Height	Inital FC Center Beam	50% beam - 54.5° Diameter	50% beam - 54.5° FC	10% beam - 82.2° Diameter	10% beam - 82.2° FC
8.0	144.4	5.7	72.2	9.6	14.4
10.0	77.7	7.7	38.8	13.1	7.8
12.0	48.4	9.8	24.2	16.6	4.8
14.0	33.0	11.8	16.5	20.1	3.3
16.0	24.0	13.9	12.0	23.6	2.4

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LDN6

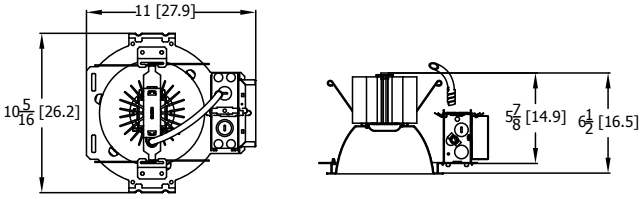
* All dimensions are inches (centimeters) unless otherwise noted.

LDN6 500-1500 LUMEN



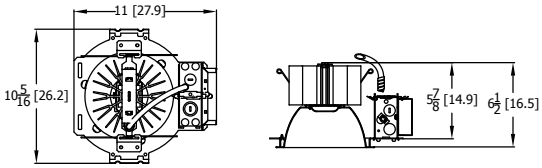
Aperture: 6-1/4 (15.9)
Ceiling Opening: 7-1/8 (18.1)
Overlap trim: 7-1/2 (19.1)

LDN6 2000-3000 LUMEN



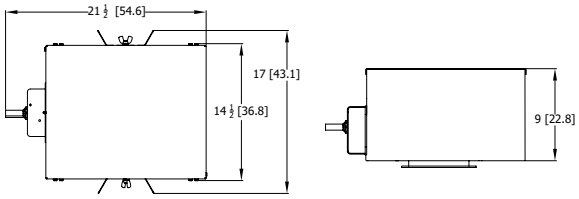
Aperture: 6-1/4 (15.9)
Ceiling Opening: 7-1/8 (18.1)
Overlap trim: 7-1/2 (19.1)

LDN6 4000-5000 LUMEN



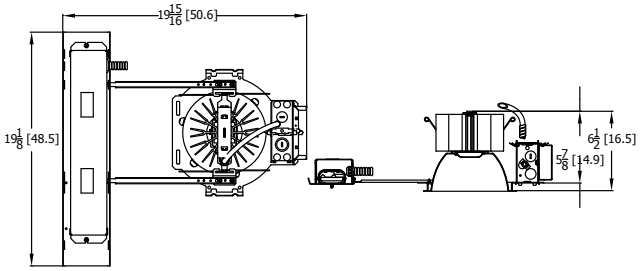
Marked Spacing: 24 x 24 x 10
Aperture: 6-1/4 (15.9)
Ceiling Opening: 7-1/8 (18.1)
Overlap trim: 7-1/2 (19.1)

LDN6 CP



Aperture: 6-1/4" (15.9)
Ceiling Opening: 7-1/8" (18.1)
Overlap trim: 7-1/2" (19.1)

LDN6 EL-ELR



Marked Spacing above 3000 lumen: 24 x 24 x 10
Aperture: 6-1/4 (15.9)
Ceiling Opening: 7-1/8 (18.1)
Overlap trim: 7-1/2 (19.1)

LDN6			
Target Lumen	**Lumens @ 3500K**	**Wattage**	**LPW**
500	662.2	7.6	87.1
1000	1082.0	12.8	84.5
1500	1606.0	20.5	78.3
2000	2023.0	22.6	89.5
2500	2529.5	27.1	93.3
3000	3034.0	34.7	87.4
4000	3977.5	44.1	90.2
5000	4922.2	55.5	88.7

HOW TO ESTIMATE DELIVERED LUMENS IN EMERGENCY MODE

Use the formula below to estimate the delivered lumens in emergency mode

Delivered Lumens = 1.25 x P x LPW

P = Ouput power of emergency driver. P = 10W for PS1055CP

LPW = Lumen per watt rating of the luminaire. This information is available on the ABL luminaire spec sheet.
The LPW rating is also available at Designlight Consortium.

LUMEN OUTPUT MULTIPLIERS - FINISH			
	Clear (AR)	**White (WR)**	**Black (BR)**
Specular (LS)	1.0	N/A	N/A
Semi-specular (LSS)	0.950	N/A	N/A
Matte diffuse (LD)	0.85	N/A	N/A
Painted	N/A	0.87	0.73

LUMEN OUTPUT MULTIPLIERS - CCT					
	2700K	**3000K**	**3500K**	**4000K**	**5000K**
80CRI	0.950	0.966	1.000	1.025	1.101

Notes

- Tested in accordance with IESNA LM-79-08.
- Tested to current IES and NEMA standards under stabilized laboratory conditions.
- CRI: 80 typical.

DOWNLIGHTING: One Lithonia Way Conyers, GA 30012 Phone: 800-315-4935 Fax: 770-860-3129 www.lithonia.com

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ADDITIONAL DATA

COMPATIBLE 0-10V WALL-MOUNT DIMMERS		
MANUFACTURER	PART NO.	POWER BOOSTER AVAILABLE
Lutron®	Diva® DVTV	
	Diva® DVSCTV	
	Nova T® NTFTV	
	Nova® NFTV	
Leviton®	AWSMT-7DW	CN100
	AWSMG-7DW	PE300
	AMRMG-7DW	
	Leviton Centura Fluorescent Control System	
	IllumaTech® IP7 Series	
Synergy®	ISD BC	RDMFC
	SLD LPCS	
	Digital Equinox (DEQ BC)	
Douglas Lighting Controls	WPC-5721	
Entertainment Technology	Tap Glide TG600FAM120 (120V)	
	Tap Glide Heatsink TGH1500FAM120 (120V)	
	Oasis 0A2000FAMU	
Honeywell	EL7315A1019	EL7305A1010 (optional)
	EL7315A1009	
HUNT Dimming	Preset slide: PS-010-IV and PS-010-WH	
	Preset slide: PS-010-3W-IV and PS-010-3W-WH	
	Preset slide, controls FD-010: PS-IFC-010-IV and PS-IFC-010-WH-120/277V	
	Preset slide, controls FD-010: PS-IFC-010-3W-IV and PS-IFC-010-3W-WH-120/277V	
	Remote mounted unit: FD-010	
Lehigh Electronic Products	Solitaire	PBX
PDM Electrical Products	WPC-5721	
Starfield Controls	TR61 with DALI interface port	RT03 DALInet Router
WattStopper®	LS-4 used with LCD-101 and LCD-103	

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is part of an A+ Certified solution for nLight® control networks when ordered with drivers marked by a shaded background*
- This luminaire is part of an A+ Certified solution for nLight control networks, providing advanced control functionality at the luminaire level, when selection includes driver and control options marked by a shaded background*

To learn more about A+, visit www.acuitybrands.com/aplus.

*See ordering tree for details

DOWNLIGHTING: One Lithonia Way Conyers, GA 30012 Phone: 800-315-4935 Fax: 770-860-3129 www.lithonia.com

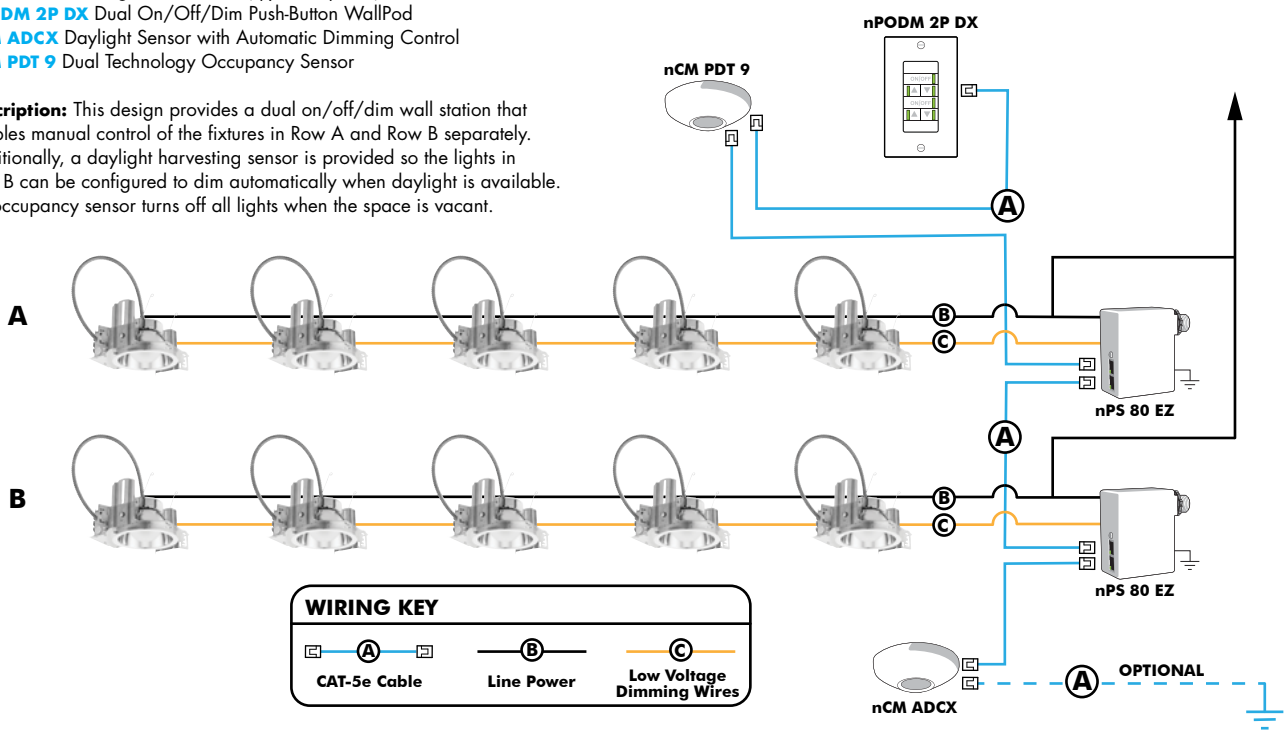
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LDN6

EXAMPLE
Group Fixture Control*
*Appiication diagram applies for fixtures with eldoLED drivers only.

nPS 80 EZ Dimming/Control Pack (qty: 2 required)
nPODM 2P DX Dual On/Off/Dim Push-Button WallPod
nCM ADCX Daylight Sensor with Automatic Dimming Control
nCM PDT 9 Dual Technology Occupancy Sensor

Description: This design provides a dual on/off/dim wall station that enables manual control of the fixtures in Row A and Row B separately. Additionally, a daylight harvesting sensor is provided so the lights in Row B can be configured to dim automatically when daylight is available. An occupancy sensor turns off all lights when the space is vacant.



Choose Wall Controls
nLight offers multiple styles of wall controls - each with varying features and user experience.



Push-Button Wallpod
Traditional tactile buttons and LED user feedback



Graphic Wallpod
Full color touch screen provides a sophisticated look and feel

nLight® Wired Controls Accessories:			
Order as separate catalog number. Visit www.acuitybrands.com/products/controls/nlight for complete listing of nLight controls.			
WallPod Stations	**Model number**	**Occupancy sensors**	**Model Number**
On/Off	nPODM (Color)	Small motion 360º, ceiling (PIR/dual Tech)	nCM 9 / nCM PDT 9
On/Off & Raise/Lower	nPOD DX (Color)	Large motion 360º, ceiling (PIR/dual tech)	nCM 10 / nCM PDT 10
Graphic Touchscreen	nPOD GFX (Color)	Wide View (PIR/dual tech)	nWV 16 / nWV PDT 16
Photocell controls	**Model Number**	Wall Switch w/ Raise/Lower (PIR/dual tech)	nWSX LV DX / nWSX PDT LV DX
Dimming	nCM ADCX	**Cat-5 cables (plenum rated)**	**Model Number**
		10', CAT5 10FT	CAT5 10FT J1
		15, CAT5 15FT	CAT5 15FT J1

nLight® AIR Control Accessories: *Order as separate catalog number. Visit www.acuitybrands.com/products/controls/nlightair.*	
Wall switches	**Model number**
On/Off single pole	rPODB [color]
On/Off two pole	rPODB 2P [color]
On/Off & raise/lower single pole	rPODB DX [color]
On/Off & raise/lower two pole	rPODB 2P DX [color]
On/Off & raise/lower single pole	rPODBZ DX WH[1]

Notes
1 Can only be ordered with the RES7Z zone control sensor version.

nLight AIR
nLight AIR is the ideal solution for retrofit or new construction spaces where adding communication is cost prohibitive. The integrated nLight AIR rPP20 Power Pack is part of each Lithonia LDN Luminaire. These individually addressable controls offer the ultimate in flexibility during initial setup and for space repurposing.



Simple as 1,2,3

1. Install the nLight® AIR fixtures with embedded smart sensor
2. Install the wireless battery-powered wall switch
3. With CLAIRITY app, pair the fixtures with the wall switch and if desired, customize the sensor settings for the desired outcome



DOWNLIGHTING: One Lithonia Way Conyers, GA 30012 Phone: 800-315-4935 Fax: 770-860-3129 www.lithonia.com
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Rev. 01/22/19

Linear LED pendant - Offices

LITHONIA LIGHTING®

Catalog Number	
Notes	
Type	

GRAD LINEAR



I/D, Direct

FEATURES & SPECIFICATIONS

INTENDED USE —The GRAD is a linear suspended product for commercial indoor, education and healthcare applications.

CONSTRUCTION — Nominal 8-1/4" x 1-3/4" rectangular housing is formed from cold-rolled steel.

End caps are mechanically attached with no exposed fasteners.

Color for housing and end caps is white or painted aluminum. Consult factory for custom colors.

OPTICS — Four LED lumen packages and three available color temperature options (3000K, 3500K and 4000K) — all within 2.5 MacAdam ellipses.

ELECTRICAL — LED light engine — consisting of modular LED boards and dimming driver — is rated for >60,000 hours (L80) at 25° C ambient temperature. Specify 120V or 277V. Pre-wired with 16AWG fixture wire. For special circuiting or wire gauge, consult factory. Plug-in electrical connectors included.

MIN1 option provides "natural dimming" with smooth, continuous and flicker-free dimming. Syncing for controls: 2mA max. THD: < 20%. Insignificant inrush current at 120 and 277VAC. FCC Class A and B tested for EMI and RFI. Controls and system networking options. For wired networking via Cat-5e, choose an integrated nLight® module. For daylight dimming and/or dual technology occupancy detection, see Page 3 for integrated sensor options. One control module per 4' section or 40' maximum row.

INSTALLATION — 4' and 8' lengths in a single section for exact suspension spacing of 4' and 8'. For total luminaire length, add 1/16" for each flat end cap. Using internal joiners, 4' and 8' sections can be joined to form longer rows.

Ambient operating temperature between 0° C and 25° C.

LISTINGS — CSA/CUS listed. LM-79 tested. Individual sections meet FCC Part 15 requirements. Lighting Facts partner. CSA tested to UL 1598 standards.

DesignLights Consortium® (DLC) Premium qualified product and DLC qualified product. Not all versions of this product may be DLC Premium qualified or DLC qualified. Please check the DLC Qualified Products List at www.designlights.org/QPL to confirm which versions are qualified.

WARRANTY — 5-year limited warranty. Complete warranty terms located at: www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx

Note: Actual performance may differ as a result of end-user environment and application. All values are design or typical values, measured under laboratory conditions at 25 °C. Specifications subject to change without notice.

ORDERING INFORMATION

Lead times will vary depending on options selected. Consult with your sales representative.

Example: GRD LLP 16FT MSL4 80CRI 30K ID1000LMF 80/20 MIN1 ZT 120 SCT F1/24A C110

Luminaire	Linear length plan	Total run length	Maximum section length	LED color rendering	LED color temperature	Indirect/direct LED output	Indirect/direct intensity ratio
GRD	LLP Linear longest possible LSL Linear same length	___FT Indicate luminaire row length in 4' increments. Ex: 12FT	MSL4 4' section(s) MSL8 8' section(s)	80CRI 80+ CRI	27K 2700K 30K 3000K 35K 3500K 40K 4000K 50K 5000K	ID800LMF 800 nominal lumens per foot ID1000LMF 1000 nominal lumens per foot ID1300LMF 1300 nominal lumens per foot ID1500LMF 1500 nominal lumens per foot	80/20 Std. 80% up/ 20% down 20/80 20% up/ 80% down 0/100 0% up/ 100% down

Minimum dimming level	Control input	Voltage	Wiring option	Emergency options[8]
MIN1 Constant current, dimming to 1% MIN10[1] Constant current, dimming to 10%	ZT 0-10V[2] NLIGHT nLight enabled[3] ECO Lutron Ecosystem[4]	120 120V 277 277V	SCT Single circuit	(blank) None 1EC (1) Emergency circuit module 2EC (2) Emergency circuit modules __EC ___ Emergency circuit modules _E10WLCP _10 Watt battery pack, constant power with self diagnostics. CEC Certified

Primary Sensor[5]	Secondary Sensor[5]	Mounting type /	Overall suspension	
(blank) No factory-installed, integrated sensor PDT_ Dual technology occupancy sensor. PIR & microphonics sensor ADC_ Daylight Dimming Sensor APD_ Dual technology occupancy sensor and daylight dimming sensor	(blank) No factory-installed, integrated sensor SPDT_ Dual technology occupancy sensor. PIR & microphonics sensor SADC_ Daylight Dimming Sensor SAPD_ Dual technology occupancy sensor and daylight dimming sensor	F1/ T-bar ceiling (universal mounting bracket) F1A/ T-bar ceiling (UMB with integrated J-box) F2/ Hard ceiling (horizontal J-box)	12F 12" fixed 18F 18" fixed 24F 24" fixed 24A 24" adjustable 36A 36" adjustable 48A 48" adjustable	72A 72" adjustable 96A 96" adjustable 144A 144" adjustable 192A 192" adjustable 240A 240" adjustable

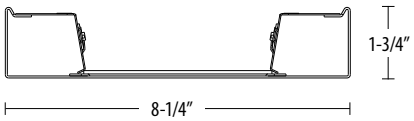
Color	Fusing	Territory compliance	Cover	Canopy	Junction box	Slope
C110 Painted aluminum (low gloss) C210 White white (fine textured) C202[6] Black (fine textured) C099 Custom color	(blank) None GLR Fast blow GMF Slow blow	(blank) None CSA[7] Manufactured to Canadian standards	(blank) None DU Dust cover	(blank) None MCS Matching canopy at support for aesthetics MCSJ Matching canopy for J-box mounting at non-power feed support locations BLK[6] Black cord, cord manager and canopy	(blank) None OJB Offset J-box at feed	(blank) None SLP Sloped ceiling

Notes

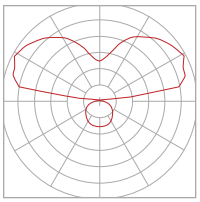
1 Not available with NLIGHT or Sensors.
2 0-10V will use linear dimming curve.
3 Will use logarithmic dimming curve.
4 Only available with MIN1
5 Only available with ZT or NLIGHT.
6 Will use white cord and canopy unless BLK canopy option is selected.
7 When chosen with EC entire section must be EC. EX: MSL8 section would need to be 2EC for entire section.
8 Separate feed required.

DIMENSIONS

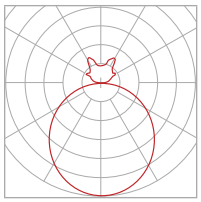
All dimensions are inches (centimeters) unless otherwise specified.



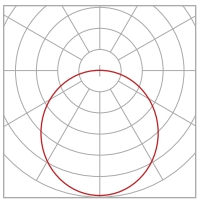
PHOTOMETRICS



ID800LMF 80/20 80CRI 35K
137 lm/W
3401 delivered lumens per 4' section



ID800LMF 20/80 80CRI 35K
105 lm/W
2621 delivered lumens per 4' section



ID800LMF 0/100 80CRI 35K
94 lm/W
2335 delivered lumens per 4' section

Fixture Performance

	3000K				3500K				4000K			
	800LMF	1000LMF	1300LMF	1500LMF	800LMF	1000LMF	1300LMF	1500LMF	800LMF	1000LMF	1300LMF	1500LMF
Lumen Output	3303	4033	4843	5841	3401	4153	4987	6015	3456	4220	5067	6111
Input Watts	25	32	40	51	25	32	40	51	25	32	40	51
Lumens/Watt	133	125	121	115	137	129	124	119	139	131	126	121

*AT 80/20 Indirect/Direct Intensity Ratio

How to Calculate Delivered Lumens in Emergency Mode

Use the formula below to determine the delivered lumens in emergency mode

Delivered Lumens = 1.25 x P x LPW

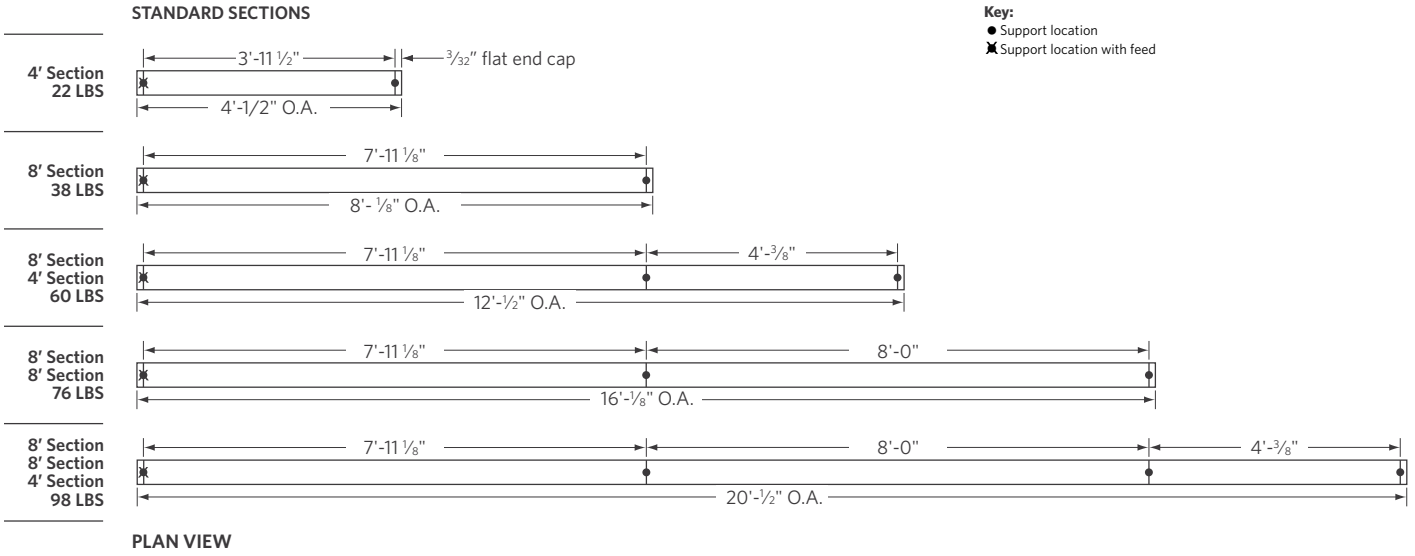
P = Ouput power of emergency driver. P = 10W for E10WLCP option.

LPW = Lumen per watt rating of the luminaire. This information is available on the ABL luminaire spec sheet. LPW = Lumen per watt rating of the luminaire. LPW information available in Performance Data section.

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Weights and Support Spacing

Suspension spacing equals section length. Default location shown. Consult factory for stem mounting suspension spacing and alternate locations.



Linear Plan:

Lithonia Lighting offers the ability to provide a continuous run plan to suit your requirements by optionally offering three different methods of configuration.

LSL- Linear Same Length:
In this configuration, each segment is the same length and is standardized based on the longest length available and is the only option provided. Because it is dependent on one segment length there are mathematical limitations on what overall row lengths can be achieved. Example: 20 FT row would be achieved with 5, 4 FT long segments equaling 20 FT (nominal).

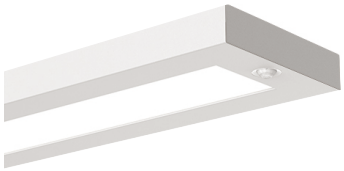
LCB- Linear Center Balanced:
This configuration incorporates the longest center segment(s) along with any additional lengths required to fill the run length, added to the run ends. Example: 20 FT run would have 2, 4 FT segments (one at each end) and 1, 8 FT segment in the center.

LLP- Linear Longest Possible
In this configuration, the longest length available is optimized, resulting in the fewest segments and mounting locations. Caution, should be used where balanced appearance is a concern. Example: 20 FT run would have 2, 8 FT segment and 1, 4 FT segment at the end of the run.

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INTEGRATED SENSOR OPTIONS

Dimming Driver	Integrated Sensor	Daylight Dimming	Daylight Dimming and/or Occupancy Detection	nLight Wired Networking	nLight Wireless Networking	Link to Spec Sheet
NLIGHT	ADC	X		X		https://www.acuitybrands.com/products/detail/147312/nLight/nES-ADCX/Dimming-Photocell-Embedded-Low-Volt/-/media/products/nLight/147312/document/nES_ADCX-Form_pdf.pdf
NLIGHT	PDT		X	X		https://www.acuitybrands.com/products/detail/147187/nLight/nES-7-Family/Micro-360176-Embedded-Low-Volt-PIR/-/media/products/nLight/147187/document/nes_7-Form_pdf.pdf
NLIGHT	APD	X	X	X		https://www.acuitybrands.com/products/detail/147187/nLight/nES-7-Family/Micro-360176-Embedded-Low-Volt-PIR/-/media/products/nLight/147187/document/nes_7-Form_pdf.pdf
ZT	ADC	X				https://www.acuitybrands.com/products/detail/147312/nLight/nES-ADCX/Dimming-Photocell-Embedded-Low-Volt/-/media/products/nLight/147312/document/nES_ADCX-Form_pdf.pdf
ZT	PDT		X			https://www.acuitybrands.com/products/detail/147187/nLight/nES-7-Family/Micro-360176-Embedded-Low-Volt-PIR/-/media/products/nLight/147187/document/nes_7-Form_pdf.pdf
ZT	APD	X	X			https://www.acuitybrands.com/products/detail/147187/nLight/nES-7-Family/Micro-360176-Embedded-Low-Volt-PIR/-/media/products/nLight/147187/document/nes_7-Form_pdf.pdf



Daylight harvesting deactivated by default and field programmed per sequence of operations for PDT sensor options.

Luminaires specified with nLight system networking ship with one RJ-45 connector integrated into the luminaire, 10' of Cat-5e cable and a splitter to control the entire luminaire row (depending on wattage/voltage limitations). For multiple zones, please contact TechSupport@PeerlessLighting.com.

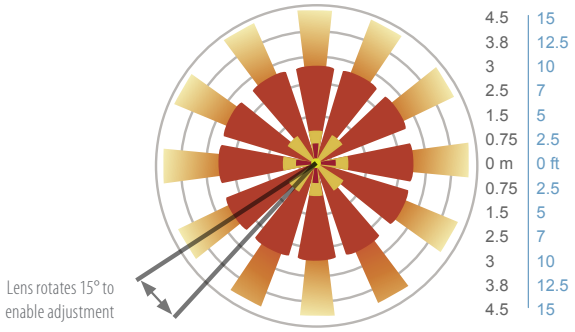
OCCUPANCY DETECTION COVERAGE

At the 7.5 ft (2.9 m) hanging height of a typical pendant mount fixture the sensor provides 10 ft (3.05 m) radial detection of small motion. At a 9 ft (2.74 m) hanging height the radius is 12 ft (3.66 m) for small motion.

Adequate for walking motion detection from mounting heights between 7.5 ft (2.29 m) and 20 ft (6.10 m).

Initial detection will occur earlier when walking across sensor's field of view than when walking directly at sensor.

Initial detection of walking motion into long coverage segment will occur at distances of 2x the mounting height up to 15 ft (4.57 m) and 1.75x up to 20 ft (6.10 m). Lens assembly rotates 15° to enable adjustment in order to line up long segments.

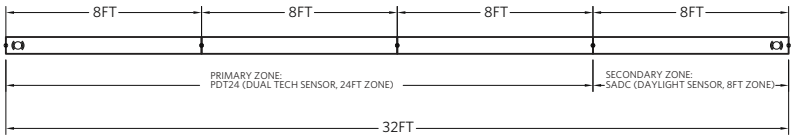


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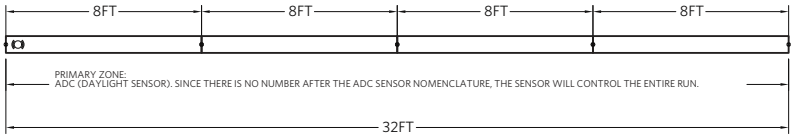
INTEGRATED SENSOR LAYOUT

CORRECT:

32FT MSL8 RUN WITH 2 SENSORS WITH PRIMARY ZONE 24FT AND SECONDARY ZONE 8FT -- PDT24 SADC8

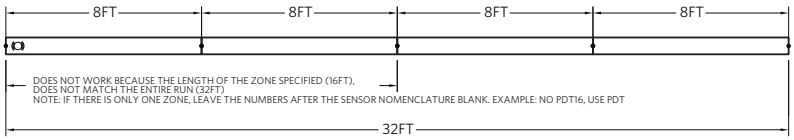


32FT MSL8 RUN WITH 1 SENSOR ALL ONE ZONE -- ADC

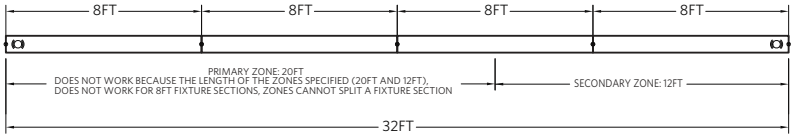


INCORRECT:

32FT MSL8 RUN WITH 1 SENSOR ALL ONE ZONE -- PDT16



32FT MSL8 RUN WITH 2 SENSORS WITH PRIMARY ZONE 20FT AND SECONDARY ZONE 12FT -- PDT20 SADC12



Notes:
- Only one sensor per zone
- At the most, the entire run can only have 2 sensors (thus 2 sensors zones at the most)
- Sensor zone can not split fixture sections
- No overlapping zones

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Most Common Mounting Types and Options

Options available for this specific luminaire are checked in the boxes below.

Mounting Type

F1/ For use with most T-Bar and screw slot grid ceilings. Designed for on-grid and off-grid applications.

F2/ For use with recessed or surface mount horizontal J-box applications.

F1A/ For use with most T-Bar and screw slot grid ceilings. Designed for on-grid and off-grid applications. Comes complete with vertical J-box with built-in wire way. See also CP.

Mounting Options

MCS Matching canopy at support for aesthetics.

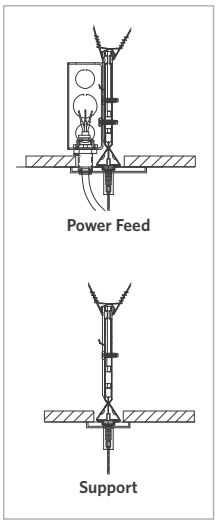
MCSJ Matching canopy for J-box mounting at non-power feed support locations.

OJB Offset J-box at feed.

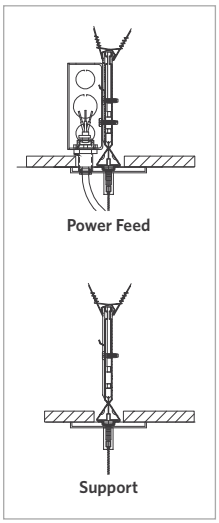
SLP OJB Sloped ceiling couplers and offset J-box option at feed.

For more detailed mounting drawings and information, see PeerlessLighting.com/MountingOptions

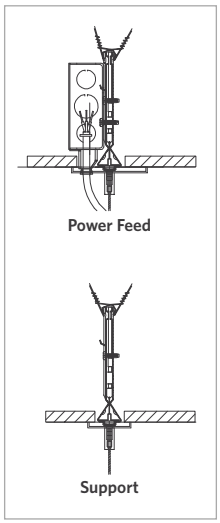
☑ F1/



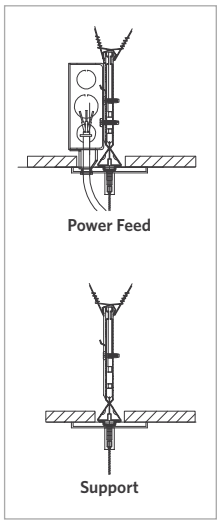
☑ F1/MCS



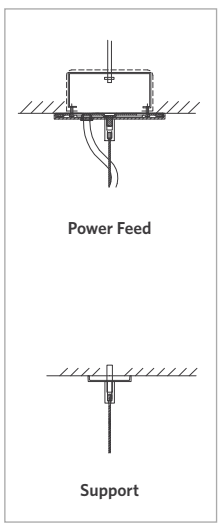
☑ F1A/



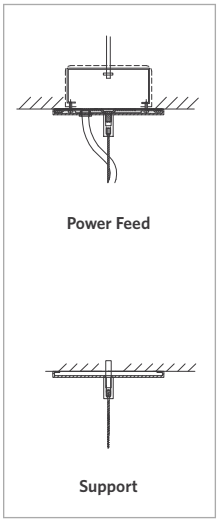
☑ F1A/MCS



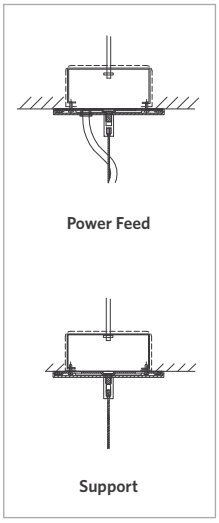
☑ F2/



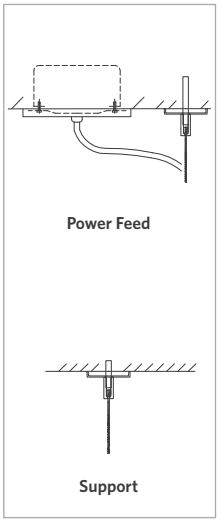
☑ F2/MCS



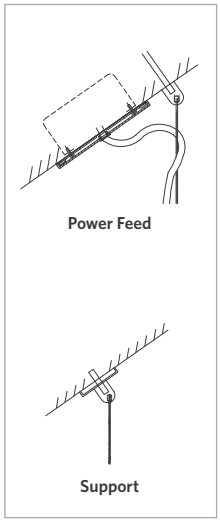
☑ F2/MCSJ



☑ F2/OJB



☑ F2/SLP OJB



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LITHONIA LIGHTING®

Catalog Number	
Notes	
Type	

FEATURES & SPECIFICATIONS

INTENDED USE — The CLX is a linear lighting solution that is available in multiple lengths, lumen packages and distributions. Designed for versatility, the CLX can address virtually any indoor lighting need. The CLX is also offered in standard and high efficacy configurations and capable of being continuous row mounted or installed as a stand-alone fixture. Ideal for uplight and downlight in commercial, retail, manufacturing, warehouse, and display applications. **Certain airborne contaminants can diminish the integrity of acrylic and/or polycarbonate.** Click here for Acrylic-Polycarbonate Compatibility table for suitable uses.

CONSTRUCTION — Channel and cover are formed from code-gauge cold-rolled steel. Housing and lens endcaps are injection molded plastic to provide a more architectural look and feel. The endcaps come standard with a 7/8" knock out for continuous mounting but can be ordered without.

Finish: Paint options include high-gloss, baked white polyester (WH), galvanized (GALV), matte black (MB) and smoke gray (SKGY). Five-stage iron phosphate pre-treatment ensures superior paint adhesion and rust resistance.

OPTICS — Offered with acrylic lens and less lens configurations. Provides a choice of optical distributions including, wide, narrow, and aisle.

ELECTRICAL — Utilizes high-output LEDs integrated on a two-layer circuit board, ensuring cool-running operation. Optional internal pluggable wiring harness for reduced labor cost in row mounting applications. (See PLR_ ordering information on page 15.) Electronic LED driver is multi-volt input and 0-10V dimming standard (see Operational Data on page 12 for actual wattage consumption). This fixture is designed to withstand a maximum line surge of 2.5kV at 0.75kA combination wave for indoor locations, for applications requiring higher level of protection additional surge protection must be provided.

L70>100,000 hours at 25˚C.

LEDs provide nominal 80 CRI or 90CRI at 3000 K, 3500 K,4000 K, or 5000 K.

Lumen output up to 2,500 lumens per foot.

INSTALLATION — Fixture may be ceiling or wall mounted (with or without THCLX hanger or angle mounted with CLXANGBRT), pendant or stem mounted with appropriate mounting options.

WARNING — Removing the lens and opening the fixture during installation exposes the LEDs, putting them at risk for damage.

If you plan to surface mount the fixture, we recommend using the THCLX. This eliminates the need to open the fixture.

If you plan to continuous row mount, we recommend using the PLR wiring harness option. This eliminates the need to open the fixture.

Damage to the LEDs caused during installation will not be covered under the warranty.

LISTINGS — CSA certified to US and Canadian safety standards. For use in damp locations between -4°F (-20°C) and 104°F (40°C). Optional High Ambient (HA) ranging to 122°F(50°C) available on certain lumen packages (See ambient temperature chart for additional information).
DesignLights Consortium® (DLC) Premium qualified product and DLC qualified product. Not all versions of this product may be DLC Premium qualified or DLC qualified. Please check the DLC Qualified Products List at www.designlights.org/QPL to confirm which versions are qualified.

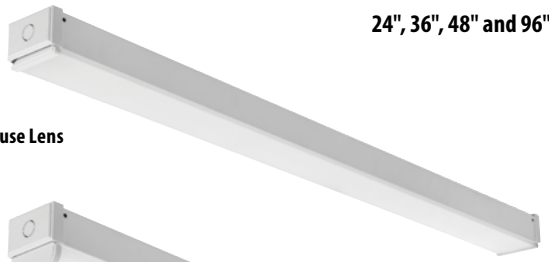
WARRANTY — 5-year limited warranty. Complete warranty terms located at:
www.acuitybrands.com/resources/terms-and-conditions

Note: Actual performance may differ as a result of end-user environment and application.
All values are design or typical values, measured under laboratory conditions at 25 °C.
Specifications subject to change without notice.

LED Linear

CLX

24", 36", 48" and 96" Lengths



Flat Diffuse Lens



Round Diffuse Lens



Wide Diffuse Lens

Stock configurations are offered for shorter lead times:

Stock Part Number	UPC	DLC QPL Product ID	DLC Premium
CLX L48 3000LM SEF FDL MVOLT GZ10 40K 80CRI WH	00191723525816	PJANKZR4	Yes
CLX L48 3000LM SEF FDL MVOLT GZ10 50K 80CRI WH	00191723525885	PKW32VKL	Yes
CLX L48 5000LM SEF FDL MVOLT GZ10 40K 80CRI WH	00191723525939	P77I8Z20	Yes
CLX L48 5000LM SEF FDL MVOLT GZ10 50K 80CRI WH	00191723525908	P8A42C1H	Yes
CLX L96 6000LM SEF FDL MVOLT GZ10 40K 80CRI WH	00191723525861	PPFTGRBV	Yes
CLX L96 6000LM SEF FDL MVOLT GZ10 50K 80CRI WH	00191723525915	PW6250TE	Yes
CLX L96 10000LM SEF FDL MVOLT GZ10 40K 80CRI WH	00191723525922	PYKOC7EW	Yes
CLX L96 10000LM SEF FDL MVOLT GZ10 50K 80CRI WH	00191723525830	PKYPL35K	Yes
CLX L48 3000LM SEF RDL MVOLT GZ10 40K 80CRI WH	00191723525960	PJANKZR4	Yes
CLX L48 3000LM SEF RDL MVOLT GZ10 50K 80CRI WH	00191723525892	PKW32VKL	Yes
CLX L48 5000LM SEF RDL MVOLT GZ10 40K 80CRI WH	00191723525854	P77I8Z20	Yes
CLX L48 5000LM SEF RDL MVOLT GZ10 50K 80CRI WH	00191723525946	P8A42C1H	Yes
CLX L96 6000LM SEF RDL MVOLT GZ10 40K 80CRI WH	00191723525878	PPFTGRBV	Yes
CLX L96 6000LM SEF RDL MVOLT GZ10 50K 80CRI WH	00191723525823	PD0SSIAD	Yes
CLX L96 10000LM SEF RDL MVOLT GZ10 40K 80CR WH	00191723525953	PYKOC7EW	Yes
CLX L96 10000LM SEF RDL MVOLT GZ10 50K 80CRI WH	00191723525847	PKYPL35K	Yes

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is part of an A+ Certified solution for nLight® or XPoint™ Wireless control networks marked by a shaded background*

To learn more about A+, visit www.acuitybrands.com/aplus.

*See ordering tree for details

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: CLX L48 5000LM SEF WDL MVOLT GZ10 40K 80CRI WH

Series	Length	Nominal lumens	Performance package	Louver	Lens
CLX LED linear	L24 24"[1,2]	1500LM 1,500 lumens 2000LM 2,000 lumens 2500LM 2,500 lumens 3500LM 3,500 lumens 4500LM 4,500 lumens 5000LM 5,000 lumens[3,4]	SEF Standard efficiency[5] HEF Premium efficiency	(Blank) Less louver SBLW Straight blade louver, white[6] SBLMB Straight blade louver, matte black[6] SBLGV Straight blade louver, galvanized[6] SBLSKGY Straight blade louver, smoke gray[6]	L/Lens Less lens FDL Flat diffuse[7,8] RDL Round diffuse[7,8] WDL Wide diffuse[7,8]
	L36 36"[2]	2250LM 2,250 lumens 3000LM 3,000 lumens 3750LM 3,750 lumens 5250LM 5,250 lumens 6750LM 6,750 lumens 7500LM 7,500 lumens[3,4]			
	L48 48"	3000LM 3,000 lumens 4000LM 4,000 lumens 5000LM 5,000 lumens 7000LM 7,000 lumens[2] 9000LM 9,000 lumens[2] 10000LM 10,000 lumens[2,4]			
	L96 96"	6000LM 6,000 lumens 8000LM 8,000 lumens 10000LM 10,000 lumens 14000LM 14,000 lumens[2,4] 18000LM 18,000 lumens[2,4] 20000LM 20,000 lumens[2,4]			

Distribution	Voltage		Driver[14]	Color temperature	Coloring rendering index
(Blank) General	MVOLT 120-277V[10]	277 277V	GZ10 0 -10V dimming[15]	30K 3000 K	80CRI 80 CRI
ND Narrow[8,9]	120 120V	347 347V[12,13]	EZ1 Dimming to 1%[2]	35K 3500 K	90CRI 90 CRI
WD Wide[8,9]	208 208V[11]	480 480V[12,13]		40K 4000 K	
AD2 Aisle, 24° off center[8,9]	240 240V[11]			50K 5000 K	

Options

PS1050	Emergency battery pack, 10W, CA Title 20 Noncompliant[2,11,13,16,17]
E10WLCP	Emergency battery pack, 10W Linear Constant Power, Certified in CA Title 20 MAEDBS[2,11,13,16,17]
BGTD	Generator transfer device, not avaialble with PS1050[13,16,18]
OCS	5', 18/3 Reloc selectable One Pass cable[16]
HA	High ambient, for use in ambient temperatures up to 50°C[11]
EPNKO	Decorative endplate, no knock out[19]
OUTCTR	Wiring leads pulled through back center of fixture[20]
OUTEND	Wiring leads pulled through end of fixture[21]
Cord Sets:	
CS1W	Staight blade plug, 120V[10,16]
CS3W	NEMA twist-lock plug, 120V[10,16]
CS7W	Staight blade plug, 277V[10,16]
CS11W	NEMA twist-lock plug, 277V[10,16]
CS25W	NEMA twist-lock plug, 347V[10,16]
CS97W	NEMA twist-lock plug, 480V[10,16]
CS93W	600V SEOOW white cord, no plug (no voltage required)
CS6G16ST0WD5D	6' white cord, 16/5, no plug, includes low voltage dimming wires (no voltage required)[15]
PLR___	Plug-in wiring, see page 16 for ordering information
PLR1LVG	Plug-in wiring,low voltage dimming[22]
RRL___	RELOC®-ready luminaire. See page 15 for ordering information
SPD	Surge protection device, provides up to 6kV protection[16,20]
USPOM	Assembled in the United States
nLight® Wireless:[23,24]	
NLTAIR2 RES7	nLight® Generation 2 enabled PIR integral occupancy sensor with automatic dimming photocell
NLTAIR2 RES7PDT	nLight AIR Generation 2 enabled dual technology integral occupancy sensor with automatic dimming photocell
NLTAIR2 RIO	No sensor control
nLight® Wired:[23,25,26]	
N100	nLight® without lumen management
NES7	nLight® nES 7 PIR integral occupancy sensor[27]
NESPDT7	nLight® nES PDT 7 dual technology integral occupancy control[27]
NES7ADCX	nLight® nES 7 ADCX PIR integral occupancy sensor with automatic dimming photocell[27]
NESPDT7ADCX	nLight® nES PDT 7 dual technology integral occupancy sensor with automatic dimming photocell[27]
Individual controls:[23,25]	
MSD7	PIR integral occupancy sensor
MSDPDT7	PDT 7 dual technology integral occupancy control
MSD7ADC	PIR integral occupancy sensor with automatic dimming control photocell
MSDPDT7ADC	PDT integral occupancy sensor with automatic dimming control photocell

Finish

WH	White
GALVW	Galvanized with white lens end caps
GALVB	Galvanized with black lens end caps
MB	Matte black
SKGYW	Smoke gray with white lens end caps
SKGYB	Smoke gray with black lens end caps

See Accessories and footnotes on next page

INDUSTRIAL: One Lithonia Way, Conyers, GA 30012 Phone: 800-315-4963 www.lithonia.com

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Accessories: *Order as separate catalog number.*

Mounting:

ZACVH	Aircraft cable 120" (one pair)
ZAC120	One adjustable aircraft cable with canopy 120" [28]
ZACFP120	One adjustable aircraft cable with feed (3 conductor) and canopy, 120" [28]
ZACFPD120	One adjustable aircraft cable with feed (5 conductor) and canopy 120" [28]
ZAC240	One adjustable aircraft cable with canopy 240" [28]
ZACFP240	One adjustable aircraft cable with feed (3 conductor) and canopy, 240" [28]
ZACFPD240	One adjustable aircraft cable with feed (5 conductor) and canopy 240" [28]
SQ_	Stem kit, 2" increments up to 48" [28]

THCLX __	Tong hanger (Must specify color) (one pair) [29]
CLXANGBKT ____	Angle bracket, (Must specify color) (one pair) [29]
HC36	Hanger chain, 36" (one pair)

Sensors & Controls:

LSXR	Sensor Switch ® LSXR occupancy sensor [30]
NPP16D	nLight® switching/dimming module
NPP16DER	nLight® switching/dimming module with emergency relay
rPP20D	nLight® air dimming/switching module
XPA CMRB0	XPoint™ Wireless 0-10V relay, external, 55°C max ambient

Reflectors:

CLXRW24___	Wide decorative 24" reflector, (Must specify color) [31]
CLXRW36___	Wide decorative 36" reflector, (Must specify color) [31]
CLXRW48___	Wide decorative 48" reflector, (Must specify color) [31]
CLXRW96___	Two wide decorative 48" reflectors, (Must specify color) [31]
CLXRWU24___	Wide decorative 24" reflector with uplight, (Must specify color) [31]
CLXRWU36___	Wide decorative 36" reflector with uplight, (Must specify color) [31]
CLXRWU48___	Wide decorative 48" reflector with uplight, (Must specify color) [31]
CLXRWU96___	Two wide decorative 48" reflectors with uplight, (Must specify color) [31]
CLXRN24	Narrow 24" reflector, (Must specify color) [32]
CLXRN36	Narrow 36" reflector, (Must specify color) [32]
CLXRN48	Narrow 48" reflector, (Must specify color) [32]
CLXRN96___	Two narrow 48" reflectors, (Must specify color) [32]

Wireguards:

WGCLX24___	24" wireguard, (Must specify color) [33]
WGCLX36___	36" wireguard, (Must specify color) [33]
WGCLX48___	48" wireguard, XX, (Must specify color) 96" fixture requires two [33]

Notes

1 Not available with OUTCTR option.
2 Not available with HA option.
3 Not available with SEF when ordered in combination with EZ1.
4 Not available with NLTAIR2 RES7, NLTAIR2 RES7PDT, or NLTAIR2 RIO.
5 Not available with EZ1 when ordered with L24 with 5000LM or L36 with 7500LM.
6 When ordered with L24 only available with 1500LM or 2000LM in combination with GZ10 driver. Not for use with THCLX, CLXANGBKT, CLX reflectors or WGCLX accessories. Not available with RDL lens options.
7 Only available with general distribution.
8 Not available with CLXRN accessories.
9 Available L/LENS only.
10 Not available with PS1050, E10WLCP, or BGTD.
11 Not available with BGTD option.
12 Voltage selected utilizes a step-down transformer. Not available with L24 when ordered with N100.Not available with PS1050, E10WLCP or BGTD option.
13 Requires SPD option.
14 When continuous row mounting, fixtures must all have the same driver selection.
15 Not available with Individual controls, nLight wired networking, nLight wireless networking, nLight wireless zone control options.
16 Must specify voltage.
17 Not available with L24 or L36. Not available with L48 in combination with N100.
18 Available with L48 or L96 only. 20 Not available with PS1050 or E10WLCP options. Not available with 208 or 240V. Not available Individual controls, NLight Wired, or NLight Wireless options.
19 Not available OUTEND.
20 Required with PS1050, E10WLCP, BGTD, XAD, or XAD924.
21 Not available with PLR options.
22 Not available with XPoint, Individual controls, NLight Wired, or NLight Wireless options.
23 Sensor housing will be the same color as lens end caps.
24 Not available with L24 in combination with 5000LM, not available with L36 in combination with 7500LM, not available with L48 in combination with 10000LM, and not available with L96 in combination with 14000LM, 18000LM, or 20000LM. Not available with PLRs containing low voltage dimming wires.
25 Not available with any other control option. Requires EZ1.
26 Only available in WDL.
27 Requires N100 option.
28 Ships standard as white.
29 Not available with louver, wireguards, wide reflectors.
30 More configurations on LSXR Specification Sheet.
31 L24 reflector is 22.65", L36 reflector is 34.01", L48 reflector is 46.80", L96 comes with two L48 reflectors.
32 For use with L/LENS fixtures only. L24 reflector is 22.75", L36 reflector is 34.20", L48 reflector is 46.85", L96 comes with two L48 reflectors.
33 Not for use with CLX wide reflector accessories.

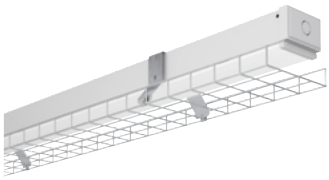
OPTIONS AND ACCESSORIES



Narrow reflector
Ships separtely from fixture.
Order as:
CLXRN24___
CLXRN36___
CLXRN48___
CLXRN96___



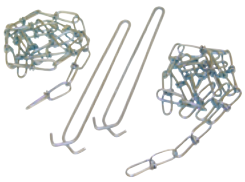
Wide decorative reflector
Ships separtely from fixture.
Order as:
CLXRW24___
CLXRW36___
CLXRW48___
CLXRW96___



Wireguard
Ships separately from fixture:
96" fixture requires two WGCLX48.
Order as:
WGCLX24___
WGCLX36___
WGCLX48___



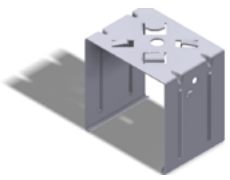
Aircraft Cable with Canopy
Available in 120" or 240"
Order as:
ZAC120
ZAC240



HANGER CHAIN
36" chain with Y hanger. ships as a pair
Order as:
HC36



ZACVH HANGER
10' Aircraft cable with Y hanger.
Order as:
ZACVH



Tong hanger
Ships as a pair
Order As:
THCLX___

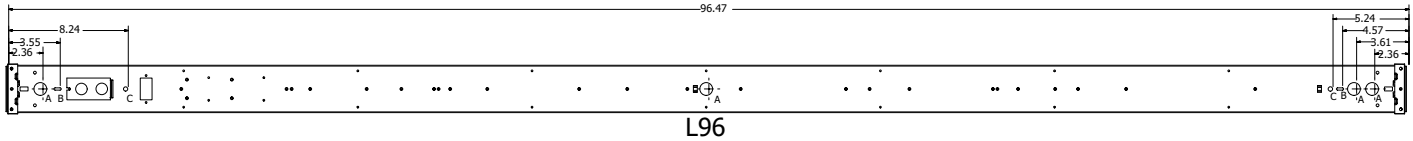
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DIMENSIONS

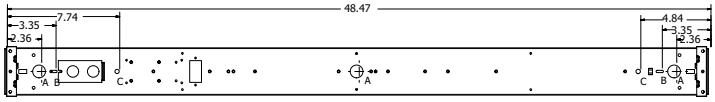
All dimensions are in inches (centimeters) unless otherwise indicated.
Dimensions may vary with options or accessories.

INTEGRATED SENSOR ADDS 2.0 INCHES TO STANDALONE FIXTURE LENGTH
HOUSING END CAP ADDS 0.236 INCHES TO FIXTURE LENGTH PER SIDE. DIMENSIONS BELOW INCLUDE ENDCAPS.

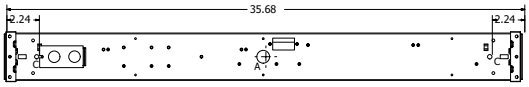
A - 7/8" KNOCK OUT
B - 0.5" by 0.16" SLOT
C - 0.3" DIA HOLE



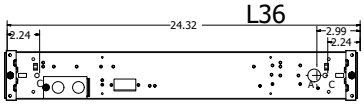
L96



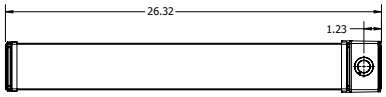
L48



L36



L24

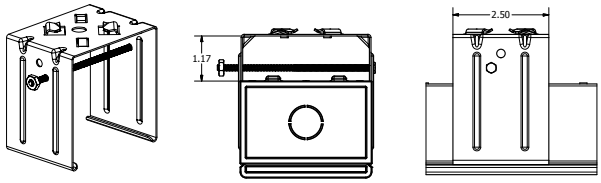


L24 WITH SENSOR

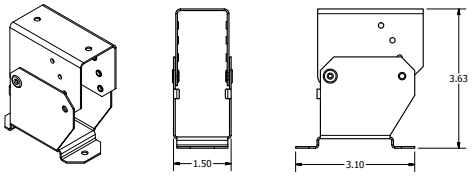
PALLET DIMENSIONS

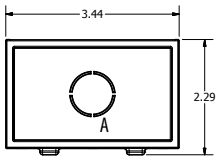
Length	Approx Weight	Fixtures per pallet	Pallet Dims (L X W X H)
L24	4 lb	100	54x46x37
L36	5 lb	80	54x46x37
L48	7.5 lb	64	54x46x37
L96	14 lb	64	98x46x37

THCLX - SHIPS TWO PER ORDER,
UTILIZES A #8 HEX HEAD SCREW AND NUT
FIXTURE SITS 1.3 INCHES FROM STRUCTURE WHEN MOUNTED

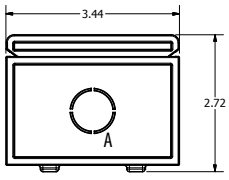


CLXANGBKT - SHIPS TWO PER ORDER
HOLES TO MOUNTING STRUCTURE ARE 0.175" DIA, 2.5" APART
FIXTURE SITS APPROXIMATELY 3.5" FROM STRUCTURE
WHEN MOUNTED HORIZONTAL TO STRUCTURE

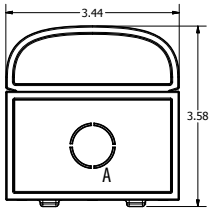




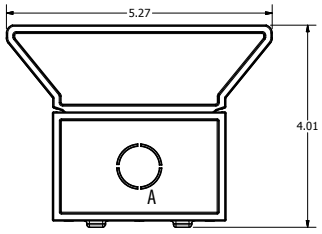
L/LENS



FDL



RDL



WDL

PHOTOMETRICS

See www.lithonia.com.

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POWER SENTRY EMERGENCY BATTERY PACKS

		SEF Emergency Lumens	HEF Emergency Lumens
PS1050	Factory installable	1400	1500
E10WLCP	Factory installable	1400	1500
PS1555LCP	Field installable, remote mount only	2000	2100

Note: For emergency lumen output of specific model, please consult factory. One board will be illuminated during emergency operation.

CLX CHARACTERISTICS

Nominal Lumen Package	Length	Wattage								Length	Width	Depth	Comparable Light Source
		Standard efficiency				High efficiency							
		120V	277V	347V	480V	120V	277V	347V	480V	Dimensions are shown in inches			
2500LM	24"	19.9	19.9	25.9	25.9	18.5	18.5	24.5	24.5	24	3.5	3.75	1-lamp 32WT8, 1-lamp 54W T5HO, 50W HID
5000LM	24"	41.9	41.9	47.9	47.9	37.9	37.9	43.9	43.9	24	3.5	3.75	2-lamp 32WT8, 1-lamp 54W T5HO, 70W HID
3750LM	36"	28.1	28.1	34.1	34.1	27.0	27.0	33.0	33.0	36	3.5	3.75	1-lamp 32WT8, 1-lamp 54W T5HO, 50W HID
7500LM	36"	62.9	62.9	68.9	68.9	56.8	56.8	62.8	62.8	36	3.5	3.75	2-lamp 32WT8, 1-lamp 54W T5HO, 70W HID
5000LM	48"	35.4	35.4	41.4	41.4	32.9	32.9	38.9	38.9	48	3.5	3.75	2-lamp 32WT8, 1-lamp 54W T5HO, 70W HID
10000LM	48"	77.1	77.1	83.1	83.1	70.4	70.4	76.4	76.4	48	3.5	3.75	3 -lamp 32WT8, 2-lamp 54W T5HO, 100W HID
10000LM	96"	70.8	70.8	76.8	76.8	65.8	65.8	71.8	71.8	96	3.5	3.75	3 -lamp 32WT8, 2-lamp 54W T5HO, 100W HID
20000LM	96"	154.2	154.2	160.2	160.2	140.8	140.8	146.8	146.8	96	3.5	3.75	6 - lamp 32WT8, 4 -lamp 54T5HO, 200W HID

AMBIENT TEMPERATURE RATINGS

Driver Package		GZ10			EZ1 or EOHN			Any Driver	
Length	Lumen package	Direct Surface	THCLX/ Suspended	HA Option (Direct or Suspended)	Direct Surface	THCLX	Suspended 18"	Xpoint/ BGTD Direct Surface	PS1050 Suspended
L24	1500LM	40C	40C	N/A	35C	35C	35C	N/A	N/A
	2000LM	40C	40C		35C	35C	35C		
	2500LM	40C	40C		35C	35C	35C		
	3000LM	40C	40C		40C	40C	40C		
	4500LM	40C	40C		35C	35C	40C		
	5000LM	40C	40C		25C	30C	35C		
L36	2250LM	40C	40C		40C	40C	40C		
	3000LM	40C	40C		40C	40C	40C		
	3750LM	40C	40C		40C	40C	40C		
	5250LM	40C	40C		35C	35C	40C		
	6750LM	30C	40C		35C	35C	40C		
	7500LM	30C	40C		25C	30C	35C		
L48	3000LM	40C	40C	50C	40C	40C	40C	35C	25C
	4000LM	40C	40C	50C	40C	40C	40C		
	5000LM	40C	40C	50C	35C	35C	40C		
	7000LM	30C	40C	N/A	35C	35C	40C		
	9000LM	30C	40C		25C	30C	35C		
	10000LM	30C	40C		25C	30C	35C		
L96	6000LM	40C	40C	50C	35C	35C	40C		
	8000LM	30C	40C	50C	35C	35C	40C		
	10000LM	30C	40C	50C	25C	30C	35C		
	14000LM	40C	40C	N/A	35C	35C	40C		
	18000LM	30C	40C		25C	30C	35C		
	20000LM	30C	40C		25C	30C	35C		

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CLX OPERATIONAL DATA

	Length	Nominal lumen package	Performance package	CRI	Delivered Lumens				Wattage
					Color Temperature				
					3000K	3500K	4000K	5000K	
L/Lens	L24	1500LM	SEF	80	1497	1540	1582	1619	10.85
				90	1305	1333	1371	1441	10.85
			HEF	80	1493	1514	1582	1586	10.39
				90	1220	1237	1301	1301	10.39
		2000LM	SEF	80	2066	2125	2183	2235	14.48
				90	1801	1840	1892	1989	14.48
			HEF	80	2060	2089	2183	2189	13.46
				90	1684	1708	1796	1796	13.46
		2500LM	SEF	80	2616	2689	2763	2829	18.41
				90	2279	2329	2394	2517	18.41
			HEF	80	2607	2644	2763	2771	17.42
				90	2132	2161	2273	2273	17.42
		3500LM	SEF	80	3518	3617	3716	3804	25.83
				90	3065	3132	3220	3385	25.83
			HEF	80	3506	3556	3716	3726	25.04
				90	2867	2907	3057	3057	25.04
		4500LM	SEF	80	5040	5182	5325	5451	38.7
				90	4392	4487	4614	4851	38.7
			HEF	80	5024	5096	5325	5339	34.8
				90	4108	4165	4380	4380	34.8
		5000LM	SEF	80	5355	5506	5657	5791	41.48
				90	4667	4767	4902	5153	41.48
			HEF	80	5338	5414	5657	5672	38.11
				90	4364	4425	4653	4653	38.11
	L36	2250LM	SEF	80	2411	2547	2101	2207	16.36
				90	2479	2607	2146	2320	16.36
			HEF	80	2437	2554	1965	2095	15.47
				90	2547	2403	1992	2095	15.47
		3000LM	SEF	80	3221	3388	2730	2868	20.8
				90	3310	3133	2789	3015	20.8
			HEF	80	3167	3319	2553	2722	19.98
				90	3310	3123	2589	2722	19.98
		3750LM	SEF	80	4123	4337	3495	3671	26.47
				90	4236	4010	3570	3859	26.47
			HEF	80	4054	4248	3268	3485	25.09
				90	4236	3997	3314	3485	25.09
		5250LM	SEF	80	5545	5833	4700	4937	39.9
				90	5698	5393	4801	5190	39.9
			HEF	80	5452	5713	4396	4687	34.3
				90	5698	5376	4457	4687	34.3
		6750LM	SEF	80	7081	7448	6001	6303	54.85
				90	7275	6886	6131	6627	54.85
			HEF	80	6962	7294	5613	5984	47.97
				90	7275	6864	5691	5984	47.97
		7500LM	SEF	80	7756	8158	6574	6905	62.6
				90	7969	7543	6716	7260	62.6
			HEF	80	7626	7991	6148	6555	54.02
				90	7969	7519	6234	6555	54.02

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CLX OPERATIONAL DATA (continued)

	Length	Nominal lumen package	Performance package	CRI	Delivered Lumens				Wattage
					Color Temperature				
					3000K	3500K	4000K	5000K	
L/Lens	L48	3000LM	SEF	80	3019	3104	3190	3265	20.32
				90	2631	2688	2764.	2906.	20.32
			HEF	80	3010	3052	3190	3198	19.01
				90	2461	2495	2624	2624	19.01
		4000LM	SEF	80	4034	4148	4262	4363	27.58
				90	3515	3591	3693	3882	27.58
			HEF	80	4021	4078	4262	4273	24.75
				90	3288	3334	3505	3505	24.75
		5000LM	SEF	80	5047	5189	5332	5458	34.8
				90	4398	4493	4620	4857	34.8
			HEF	80	5031	5102	5332	5346	31.77
				90	4113	4171	4386	4386	31.77
		7000LM	SEF	80	7311	7517	7724	7907	49.05
				90	6371	6509	6692	7036	49.05
			HEF	80	7288	7391	7724	7744	44.67
				90	5959	6042	6353	6353	44.67
		9000LM	SEF	80	9215	9475	9735	9967	63.99
				90	8031	8204	8435	8869	63.99
			HEF	80	9186	9317	9735	9762	58.58
				90	7511	7615	8008	8008	58.58
		10000LM	SEF	80	10299	10590	10880	11139	73.37
				90	8975	9169	9427	9912	73.37
			HEF	80	10266	10412	10880	10910	66.27
				90	8394	8511	8950	8950	66.27
	L96	6000LM	SEF	80	5942	6110	6278	6427	38.15
				90	5178	5290	5439	5719	38.15
			HEF	80	5923	6008	6278	6294	35.54
				90	4843	4911	5164	5164	35.54
		8000LM	SEF	80	7929	8153	8376	8575	52.32
				90	6910	7059	7258	7631	52.32
			HEF	80	7903	8016	8376	8399	48.5
				90	6462	6552	6890	6890	48.5
		10000LM	SEF	80	9808	10085	10362	10608	66.47
				90	8548	8732	8978	9439	66.47
			HEF	80	9777	9916	10362	10390	60.89
				90	7994	8106	8523	8523	60.89
		14000LM	SEF	80	14323	14727	15131	15491	94.78
				90	12482	12752	13111	13784	94.78
			HEF	80	14277	14480	15131	15172	85.96
				90	11674	11836	12447	12447	85.96
		18000LM	SEF	80	18458	18979	19500	19963	128.98
				90	16086	16433	16896	17764	128.98
			HEF	80	18399	18661	19500	19552	116.92
				90	15044	15254	16040	16040	116.92
		20000LM	SEF	80	20386	20962	21537	22048	146.83
				90	17766	18150	18661	19619	146.83
			HEF	80	20321	20610	21537	21595	131.6
				90	16616	16847	17716	17716	131.6

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CLX OPERATIONAL DATA (continued)

	Length	Nominal lumen package	Performance package	CRI	Delivered Lumens				Wattage
					Color Temperature				
					3000K	3500K	4000K	5000K	
RDL	L24	1500LM	SEF	80	1359	1397	1436	1470	10.85
				90	1184	1210	1244	1308	10.85
			HEF	80	1355	1374	1436	1439	10.39
				90	1107	1123	1181	1181	10.39
		2000LM	SEF	80	1875	1928	1981	2028	14.48
				90	1634	1670	1717	1805	14.48
			HEF	80	1869	1896	1981	1987	13.46
				90	1528	1550	1630	1630	13.46
		2500LM	SEF	80	2374	2441	2508	2567	18.41
				90	2069	2113	2173	2284	18.41
			HEF	80	2366	2400	2508	2514	17.42
				90	1935	1962	2063	2063	17.42
		3500LM	SEF	80	3192	3282	3372	3452	25.83
				90	2782	2842	2922	3072	25.83
			HEF	80	3182	3227	3372	3381	25.04
				90	2602	2638	2774	2774	25.04
		4500LM	SEF	80	4574	4703	4832	4947	38.7
				90	3986	4072	4187	4402	38.7
			HEF	80	4560	4624	4832	4845	34.8
				90	3728	3780	3975	3975	34.8
		5000LM	SEF	80	4860	4997	5134	5256	41.48
				90	4235	4327	4448	4677	41.48
			HEF	80	4844	4913	5134	5148	38.11
				90	3961	4016	4223	4223	38.11
	L36	2250LM	SEF	80	2188	2250	2311	2366	16.36
				90	1907	1948	2003	2106	16.36
			HEF	80	2181	2212	2311	2318	15.47
				90	1783	1808	1901	1901	15.47
		3000LM	SEF	80	2843	2924	3004	3075	20.8
				90	2478	2531	2603	2736	20.8
			HEF	80	2834	2875	3004	3012	19.98
				90	2317	2350	2471	2471	19.98
		3750LM	SEF	80	3639	3742	3845	3936	26.47
				90	3171	3240	3331	3502	26.47
			HEF	80	3628	3679	3845	3855	25.09
				90	2966	3007	3162	3162	25.09
		5250LM	SEF	80	4895	5033	5171	5294	39.9
				90	4265	4357	4480	4710	39.9
			HEF	80	4879	4948	5171	5185	34.3
				90	3989	4045	4253	4253	34.3
		6750LM	SEF	80	6250	6426	6602	6759	54.85
				90	5446	5564	5721	6014	54.85
			HEF	80	6230	6318	6602	6620	47.97
				90	5094	5165	5431	5431	47.97
		7500LM	SEF	80	6846	7039	7232	7404	62.6
				90	5966	6095	6266	6588	62.6
			HEF	80	6824	6921	7232	7252	54.02
				90	5580	5657	5949	5949	54.02

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CLX OPERATIONAL DATA (continued)

	Length	Nominal lumen package	Performance package	CRI	Delivered Lumens				Wattage
					Color Temperature				
					3000K	3500K	4000K	5000K	
RDL	L48	3000LM	SEF	80	2740	2817	2895	2963	20.32
				90	2388	2439	2508	2637	20.32
			HEF	80	2731	2770	2895	2902	19.01
				90	2233	2264	2381	2381	19.01
		4000LM	SEF	80	3661	3764	3868	3959	27.58
				90	3190	3259	3351	3523	27.58
			HEF	80	3649	3701	3868	3878	24.75
				90	2984	3025	3181	3181	24.75
		5000LM	SEF	80	4580	4710	4839	4954	34.8
				90	3992	4078	4193	4408	34.8
			HEF	80	4566	4631	4839	4852	31.77
				90	3733	3785	3980	3980	31.77
		7000LM	SEF	80	6635	6822	7009	7176	49.05
				90	5782	5907	6073	6385	49.05
			HEF	80	6614	6708	7009	7028	44.67
				90	5408	5483	5766	5766	44.67
		9000LM	SEF	80	8363	8599	8835	9045	63.99
				90	7288	7446	7655	8049	63.99
			HEF	80	8336	8455	8835	8859	58.58
				90	6816	6911	7268	7268	58.58
		10000LM	SEF	80	9347	9611	9874	10109	73.37
				90	8145	8321	8556	8995	73.37
			HEF	80	9317	9450	9874	9901	66.27
				90	7618	7724	8122	8122	66.27
	L96	6000LM	SEF	80	5393	5545	5697	5832	38.15
				90	4700	4801	4936	5190	38.15
			HEF	80	5375	5452	5697	5712	35.54
				90	4395	4457	4686	4686	35.54
		8000LM	SEF	80	7196	7399	7602	7782	52.32
				90	6271	6406	6587	6925	52.32
			HEF	80	7173	7275	7602	7622	48.5
				90	5865	5946	6253	6253	48.5
		10000LM	SEF	80	8902	9153	9404	9627	66.47
				90	7757	7925	8148	8567	66.47
			HEF	80	8873	8999	9404	9429	60.89
				90	7255	7356	7735	7735	60.89
		14000LM	SEF	80	12999	13366	13732	14058	94.78
				90	11328	11573	11899	12510	94.78
			HEF	80	12957	13142	13732	13769	85.96
				90	10594	10742	11296	11296	85.96
		18000LM	SEF	80	16751	17224	17697	18117	128.98
				90	14598	14913	15334	16121	128.98
			HEF	80	16698	16936	17697	17744	116.92
				90	13653	13843	14557	14557	116.92
		20000LM	SEF	80	18501	19023	19545	20009	146.83
				90	16123	16471	16935	17805	146.83
			HEF	80	18442	18705	19545	19598	131.6
				90	15079	15290	16078	16078	131.6

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CLX OPERATIONAL DATA (continued)

	Length	Nominal lumen package	Performance package	CRI	Delivered Lumens				Wattage
					Color Temperature				
					3000K	3500K	4000K	5000K	
FDL	L24	1500LM	SEF	80	1320	1358	1395	1428	10.85
				90	1151	1175	1208	1271	10.85
			HEF	80	1316	1335	1395	1399	10.39
				90	1076	1091	1147	1147	10.39
		2000LM	SEF	80	1822	1874	1925	1971	14.48
				90	1588	1622	1668	1754	14.48
			HEF	80	1816	1842	1925	1930	13.46
				90	1485	1506	1583	1583	13.46
		2500LM	SEF	80	2306	2371	2436	2494	18.41
				90	2010	2053	2111	2219	18.41
			HEF	80	2299	2332	2436	2443	17.42
				90	1880	1906	2004	2004	17.42
		3500LM	SEF	80	3102	3189	3277	3354	25.83
				90	2703	2761	2839	2985	25.83
			HEF	80	3092	3136	3277	3285	25.04
				90	2528	2563	2695	2695	25.04
		4500LM	SEF	80	4444	4570	4695	4807	38.7
				90	3873	3957	4068	4277	38.7
			HEF	80	4430	4493	4695	4708	34.8
				90	3622	3673	3862	3862	34.8
		5000LM	SEF	80	4722	4855	4988	5107	41.48
				90	4115	4204	4322	4544	41.48
			HEF	80	4707	4774	4988	5002	38.11
				90	3848	3902	4103	4103	38.11
	L36	2250LM	SEF	80	2126	2186	2246	2299	16.36
				90	1852	1892	1946	2046	16.36
			HEF	80	2119	2149	2246	2252	15.47
				90	1732	1757	1847	1847	15.47
		3000LM	SEF	80	2762	2840	2918	2988	20.8
				90	2407	2459	2529	2659	20.8
			HEF	80	2754	2793	2918	2926	19.98
				90	2251	2283	2401	2401	19.98
		3750LM	SEF	80	3536	3636	3735	3824	26.47
				90	3081	3148	3237	3403	26.47
			HEF	80	3525	3575	3735	3745	25.09
				90	2882	2922	3073	3073	25.09
		5250LM	SEF	80	4755	4890	5024	5143	39.9
				90	4144	4234	4353	4577	39.9
			HEF	80	4740	4808	5024	5037	34.3
				90	3876	3930	4132	4132	34.3
		6750LM	SEF	80	6072	6243	6415	6567	54.85
				90	5292	5406	5558	5844	54.85
			HEF	80	6053	6139	6415	6432	47.97
				90	4949	5018	5276	5276	47.97
		7500LM	SEF	80	6651	6839	7027	7194	62.6
				90	5796	5922	6088	6401	62.6
			HEF	80	6630	6725	7027	7046	54.02
				90	5421	5497	5780	5780	54.02

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CLX OPERATIONAL DATA (continued)

	Length	Nominal lumen package	Performance package	CRI	Delivered Lumens				Wattage
					Color Temperature				
					3000K	3500K	4000K	5000K	
FDL	L48	3000LM	SEF	80	2662	2737	2812	2879	20.32
				90	2320	2370	2437	2562	20.32
			HEF	80	2654	2691	2812	2820	19.01
				90	2170	2200	2313	2313	19.01
		4000LM	SEF	80	3557	3657	3758	3847	27.58
				90	3100	3167	3256.	3423	27.58
			HEF	80	3546	3596	3758	3768	24.75
				90	2899	2939	3091	3091	24.75
		5000LM	SEF	80	4450	4576	4701	4813	34.8
				90	3878	3962	4073	4283	34.8
			HEF	80	4436	4499	4701	4714	31.77
				90	3627	3678	3867	3867	31.77
		7000LM	SEF	80	6446	6628	6810	6972	49.05
				90	5618	5739	5901	6204	49.05
			HEF	80	6426	6517	6810	6829	44.67
				90	5254	5327	5602	5602	44.67
		9000LM	SEF	80	8126	8355	8584	8788	63.99
				90	7081	7234	7438	7820	63.99
			HEF	80	8100	8215	8584	8607	58.58
				90	6623	6715	7061	7061	58.58
		10000LM	SEF	80	9081	9338	9594	9822	73.37
				90	7914	8085	8313	8740	73.37
			HEF	80	9052	9181	9594	9620	66.27
				90	7402	7505	7892	7892	66.27
	L96	6000LM	SEF	80	5240	5387	5535	5667	38.15
				90	4566	4665	4796	5042	38.15
			HEF	80	5223	5297	5535	5550	35.54
				90	4270	4330	4553	4553	35.54
		8000LM	SEF	80	6991	7189	7386	7561	52.32
				90	6093	6224	6400	6728	52.32
			HEF	80	6969	7068	7386	7406	48.5
				90	5698	5778	6075	6075	48.5
		10000LM	SEF	80	8649	8893	9137	9354	66.47
				90	7537	7700	7917	8323	66.47
			HEF	80	8621	8744	9137	9161	60.89
				90	7049	7147	7516	7516	60.89
		14000LM	SEF	80	12630	12986	13342	13659	94.78
				90	11006	11244	11561	12154	94.78
			HEF	80	12589	12768	13342	13378	85.96
				90	10293	10437	10975	10975	85.96
		18000LM	SEF	80	16276	16735	17194	17602	128.98
				90	14184	14490	14898	15663	128.98
			HEF	80	16223	16454	17194	17240	116.92
				90	13265	13450	14143	14143	116.92
		20000LM	SEF	80	17976	18483	18990	19441	146.83
				90	15665	16004	16454	17300	146.83
			HEF	80	17918	18173	18990	19041	131.6
				90	14651	14855	15621	15621	131.6

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CLX OPERATIONAL DATA (continued)

	Length	Nominal lumen package	Performance package	CRI	Delivered Lumens				Wattage
					Color Temperature				
					3000K	3500K	4000K	5000K	
WDL	L24	1500LM	SEF	80	1377	1415	1454	1489	10.85
				90	1200	1226	1260	1325	10.85
			HEF	80	1372	1392	1454	1458	10.39
				90	1122	1138	1196	1196	10.39
		2000LM	SEF	80	1900	1953	2007	2055	14.48
				90	1656	1691	1739	1828	14.48
			HEF	80	1894	1921	2007	2012	13.46
				90	1548	1570	1651	1651	13.46
		2500LM	SEF	80	2405	2472	2540	2601	18.41
				90	2095	2141	2201	2314	18.41
			HEF	80	2397	2431	2540	2547	17.42
				90	1960	1987	2090	2090	17.42
		3500LM	SEF	80	3234	3325	3416	3497	25.83
				90	2818	2879	2960	3112	25.83
			HEF	80	3223	3269	3416	3426	25.04
				90	2636	2672	2810	2810	25.04
		4500LM	SEF	80	4634	4765	4895	5012	38.7
				90	4038	4125	4242	4459	38.7
			HEF	80	4619	4685	4895	4908	34.8
				90	3777	3829	4027	4027	34.8
		5000LM	SEF	80	4923	5062	5201	5324	41.48
				90	4290	4383	4506	4738	41.48
			HEF	80	4907	4977	5201	5215	38.11
				90	4012	4068	4278	4278	38.11
	L36	2250LM	SEF	80	2216	2279	2341	2397	16.36
				90	1931	1973	2029	2133	16.36
			HEF	80	2209	2241	2341	2348	15.47
				90	1806	1832	1926	1926	15.47
		3000LM	SEF	80	2880	2962	3043	3115	20.8
				90	2510	2564	2636	2772	20.8
			HEF	80	2871	2912	3043	3051	19.98
				90	2347	2380	2503	2503	19.98
		3750LM	SEF	80	3687	3791	3895	3987	26.47
				90	3213	3282	3375	3548	26.47
			HEF	80	3675	3727	3895	3905	25.09
				90	3005	3047	3204	3204	25.09
		5250LM	SEF	80	4958	5098	5238	5362	39.9
				90	4321	4414	4539	4772	39.9
			HEF	80	4942	5013	5238	5252	34.3
				90	4041	4097	4309	4309	34.3
		6750LM	SEF	80	6331	6510	6688	6847	54.85
				90	5517	5636	5795	6093	54.85
			HEF	80	6311	6401	6688	6706	47.97
				90	5160	5232	5502	5502	47.97
		7500LM	SEF	80	6935	7131	7326	7500	62.6
				90	6044	6174	6348	6674	62.6
			HEF	80	6913	7011	7326	7346	54.02
				90	5652	5731	6027	6027	54.02

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CLX OPERATIONAL DATA (continued)

	Length	Nominal lumen package	Performance package	CRI	Delivered Lumens				Wattage
					Color Temperature				
					3000K	3500K	4000K	5000K	
WDL	L48	3000LM	SEF	80	2776	2854	2932	3002	20.32
				90	2419	2471	2541	2671	20.32
			HEF	80	2767	2806	2932	2940	19.01
				90	2262	2294	2412	2412	19.01
		4000LM	SEF	80	3709	3813	3918	4011	27.58
				90	3232	3302	3395	3569	27.58
			HEF	80	3697	3749	3918	3929	24.75
				90	3023	3065	3223	3223	24.75
		5000LM	SEF	80	4640	4771	4902	5018	34.8
				90	4044	4131	4247	4465	34.8
			HEF	80	4625	4691	4902	4915	31.77
				90	3782	3834	4032	4032	31.77
		7000LM	SEF	80	6721	6911	7101	7269	49.05
				90	5857	5984	6152	6469	49.05
			HEF	80	6700	6795	7101	7120	44.67
				90	5478	5554	5841	5841	44.67
		9000LM	SEF	80	8472	8711	8950	9163	63.99
				90	7383	7543	7755	8154	63.99
			HEF	80	8445	8565	8950	8974	58.58
				90	6905	7001	7362	7362	58.58
		10000LM	SEF	80	9469	9736	10003	10240	73.37
				90	8252	8430	8667	9112	73.37
			HEF	80	9438	9573	10003	10030	66.27
				90	7717	7825	8228	8228	66.27
	L96	6000LM	SEF	80	5463	5617	5771	5908	38.15
				90	4761	4864	5001	5258	38.15
			HEF	80	5445	5523	5771	5787	35.54
				90	4452	4515	4747	4747	35.54
		8000LM	SEF	80	7289	7495	7701	7884	52.32
				90	6353	6490	6672	7015	52.32
			HEF	80	7266	7370	7701	7722	48.5
				90	5941	6024	6334	6334	48.5
		10000LM	SEF	80	9017	9272	9526	9752	66.47
				90	7858	8028	8254	8678	66.47
			HEF	80	8988	9117	9526	9552	60.89
				90	7349	7452	7836	7836	60.89
		14000LM	SEF	80	13168	13540	13911	14241	94.78
				90	11476	11723	12054	12673	94.78
			HEF	80	13126	13313	13911	13949	85.96
				90	10732	10882	11443	11443	85.96
		18000LM	SEF	80	16970	17448	17927	18353	128.98
				90	14788	15108	15533	16331	128.98
			HEF	80	16915	17156	17927	17975	116.92
				90	13831	14024	14746	14746	116.92
		20000LM	SEF	80	18742	19271	19800	20270	146.83
				90	16333	16686	17156	18037	146.83
			HEF	80	18682	18948	19800	19853	131.6
				90	15276	15489	16287	16287	131.6

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RRL - RELOC®-Ready Luminaire

- RRL connectors can be used with Quick-Flex®, System 820 and OnePass® systems.
- Load side of connector factory installed to luminaire.
- 4-pole mating connector with push-in terminations allows for simple installation.
- Touch-safe design on both halves meets UL/CSA requirement.
- Wiping contact design allows safe disconnect under load.



ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: RRLA

Series		Wiring instructions	
RRL	RELOC®-ready luminaire	A	Hot conductor wired to position #1 (phase A)
		B	Hot conductor wired to position #2 (phase B)
		C	Hot conductor wired to position #3 (phase C) [1]

Compatible RELOC® Cables for Industrial Luminaires (ordered and shipped separately)



OCS



OCU



OD



DC



PT

Notes

1 C, ABE, and C12S options are not used with Quick-Flex QFC, QSFC, QPT, and QD.

PRODUCT INFORMATION

Advanced plug-in system with two-circuit capability. Available on industrial and strip products and a variety of architectural products mounted in continuous rows. 1, 2, 3 and 4-lamp fixtures. PLR22 (2-circuit) and crossover harness switches hot circuit serving next fixture in row. Reduces fixture types on job for alternating circuit applications (see example below.)

Easy one-step installation, saves up to 35% on labor costs. Expanded switching flexibility helps save energy.

Rows can be 50% longer with two-circuit systems. Polarized, lock-together nylon connectors prevent miswiring in the field. #12 THHN conductor, rated 600V, 90°C. White neutral wire included. Grounding accomplished by fixture in-row connectors.

CSA certified systems available with up to 2 circuits. G ground required.

Note: Specifications subject to change without notice.



Wiring

PLR

Advanced 1 or 2-Circuit Plug-In

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Series	Number of hot wires		Branch circuits				Dimming		Ground	
			Circuits to which ballast is connected		Emergency circuit connected					
PLR	(blank)	Not required for 22	(blank)	Not required for 22	(blank)	No emergency circuit	LV	Low-voltage dimming	G	Ground
PLR22	1	Black	A	Black wire	ELA	Emergency circuit wired to black wire				
	2	Black and red	B	Red wire	ELB	Emergency circuit wired to red wire				

Typical Applications

- Multiple-circuit and single-circuit for longer continuous rows
- Multiple-circuit with alternating fixtures on separate circuits and 2-circuit (PLR 22)
- Multiple circuit with night-lights located along row as desired

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Linear Wrap

LITHONIA LIGHTING®

Catalog Number	
Notes	
Type	

ST SERIES

Surface Volumetric

STL4



4'

LED

INDUSTRY RECOGNITION/AWARDS

NGL'12

2012 BEST IN CLASS

pia11

2011 ARCHITECTURAL SSL PRODUCT INNOVATION AWARD

FEATURES & SPECIFICATIONS

INTENDED USE — The STL combines digital LED lighting and controls technologies with high-performance optical design to offer the most advanced surface-mount luminaire for general ambient lighting applications. High-efficacy light engine delivers long life and excellent color, ensuring a superior quality lighting installation that is highly efficient and sustainable.

CONSTRUCTION — Housing is roll formed from code-gauge steel.

Impact modified linear-faceted refractor with light diffusing film. Refractor attaches to die cast ends by simple hook and pin design with controlled tension provided by sonically welded end plate, providing secure installation and easy maintenance.

Decorative die-cast end caps provide added durability.

Finish: All metal parts are post-painted in white polyester powder coat for smooth, finished edges and uniform light distribution. Natural aluminum finish available on end caps (see Options).

Injection-molded plastic light traps prevent light leaks between shielding and end plates and centers diffuser on channel.

OPTICS — Volumetric illumination is achieved by creating an optimal mix of light to vertical and horizontal work surfaces, rendering interior space, objects and occupants in a more balanced luminous environment.

Light distribution is carefully controlled at high angles, providing just enough luminous flux to create the volumetric effect.

Angled mounting surface combined with crescent-shape linear faceted refractor system obscures and integrates individual LED images and uniformly washes fixture surface with light.

ELECTRICAL — Long-life LEDs, coupled with high-efficiency drivers, provide superior quantity and quality of illumination for extended service life. STL is rated to deliver L90 performance at 60,000 hours. The LEDs have a CRI of 82.

eldoLED driver options deliver choice of dimming range and choices for control, while assuring flicker-free, low-current inrush, 89% efficiency and low EMI.

Optional nLight® embedded controls continuously monitor system performance, allow for constant lumen management / compensation function, facilitate simple "plug-and-play" network and controls upgrading via Cat-5 cable. Ballast disconnect provided where required to comply with US and Canadian codes.

LISTINGS — CSA certified to meet U.S. and Canadian standards.

DesignLights Consortium® (DLC) qualified product. Not all versions of this product may be DLC qualified. Please check the DLC Qualified Products List at www.designlights.org/QPL to confirm which versions are qualified.

Patents pending. Damp listed.

WARRANTY — 5-year limited warranty. Complete warranty terms located at www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx

Note: Actual performance may differ as a result of end-user environment and application.
All values are design or typical values, measured under laboratory conditions at 25 °C.
Specifications subject to change without notice.

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is part of an A+ Certified solution for nLight® control networks when ordered with drivers marked by a shaded background*
- This luminaire is part of an A+ Certified solution for nLight control networks, providing advanced control functionality at the luminaire level, when selection includes driver and control options marked by a shaded background*

To learn more about A+, visit www.acuitybrands.com/aplus.

*See ordering tree for details

STL4 LED Surface Volumetric

A+ Capable options indicated by this color background.

ORDERING INFORMATION

Lead times will vary depending on options selected. Consult with your sales representative.

Example: STL4 20L EZ1 LP840

STL4							
Series	**Lumens**[1]	**Voltage**	**Driver**	**Color temperature**	**Control**	**Options**	**Finish**[6]
STL4 4' surface volumetric LED	20L 30L 40L 48L 60L	(blank) MVOLT (120-277) 347 347V[2]	EZ1 eldoLED dims to 1%, 0-10V EZB eldoLED dims to dark, 0-10V SLD Step-level dimming[3] EXA1 Dims to 1%, XPoint wireless enabled[3,4] EXAB Dims to dark, XPoint wireless enabled[3,4] GZ10 Dims to 10% (0-10V dimming)[7]	LP830 3000K LP835 3500K LP840 4000K LP850 5000K	(blank) No controls N80 nLight with 80% (L80) lumen management N80EMG nLight with 80% (L80) lumen management for use with generator supply EM power N100 nLight without lumen management N100EMG nLight without lumen management for use with generator supply EM power LSXRHL Sensor Switch® fixture mount sensor with High/Low occupancy operation[5] LSXR10 Sensor Switch® fixture mount sensor with On/Off occupancy operation	EL7L 700 nominal lumen battery pack (Noncompliant with CA T20) EL14L 1400 nominal lumen battery pack (Noncompliant with CA T20) E10WLCP EM Self-Diagnostic battery pack, 10W Constant Power, Certified in CA Title 20 MAEDBS SC1 Surface conduit end cap provisions for one endcap SC2 Surface conduit end cap provisions for both end caps	(blank) White DNA Natural aluminum MB Matte Black

Accessories: *Order as separate catalog number.*

STCR	Continuous row connector (see mounting data)
STACG___	ST adjustable aircraft cable gripper suspension kit (specify length as 36 or 72 inches) (specify ceiling type F1 or F2 - see mounting data)
STACGF___	ST adjustable aircraft cable gripper with power feed (specify length as 36 or 72 inches) (specify ceiling type F1 or F2 - see mounting data)
STACGE___	ST adjustable aircraft cable gripper with emergency power feed (specify length as 36 or 72 inches) (specify ceiling type F1 or F2 - see mounting data)

Notes

1. Approximate lumen output.
2. Not available with EL battery packs or SLD driver.
3. Not available with controls options
4. Gateway not included. Requires on-site commissioning. Visit www.lightingcontrols.com/XPointWireless for more information.
5. Requires SC1 option. Dims to approximately 10% light output when unoccupied. See sensor details on next page.
6. For additional paint finishes refer to: Architectural Colors.
7. GZ10 drivers not available with any Controls or sensor options.

Performance Data

Lumen Package	Input Watts[1]	Lumens	LPW
30L LP830	26.7	2904	108.8
30L LP835	26.7	3049	114.2
30L LP840	26.7	3195	119.7
30L LP850	26.7	3282	122.9
40L LP830	34.9	3688	105.7
40L LP835	34.9	3834	109.9
40L LP840	34.9	3979	114.0
40L LP850	34.9	4124	118.2
48L LP830	45.2	4615	102.1
48L LP835	45.2	4850	107.3
48L LP840	45.2	5088	112.6
48L LP850	45.2	5184	114.7
60L LP830	53.2	5294	99.5
60L LP835	53.2	5559	104.5
60L LP840	53.2	5811	109.2
60L LP850	53.2	5954	111.9



Sensor Switch LSXR Sensor

Lens type:	**10** - Low Mount 360°
Dimming:	**HL** - High/Low Occupancy operation
Min Dim Level:	**3V** - approximately 10% light output when unoccupied
Time Delay:	**5M** - 5 minutes

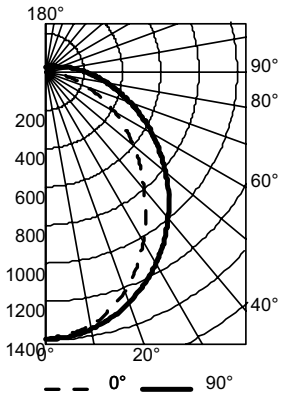
How to Calculate Delivered Lumens in Emergency Mode
Use the formula below to determine the delivered lumens in emergency mode
Delivered Lumens = 1.25 x P x LPW
P = Ouput power of emergency driver. P = 10W for E10WLCP option.
LPW = Lumen per watt rating of the luminaire. LPW information available in Performance Data section.

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STL4 LED Surface Volumetric

PHOTOMETRICS

STL4 40L EZ1 LP840, 3979 delivered lumens, test no. LTL25690, tested in accordance to IESNA LM-79.



CP Summary

	0°	90
0°	1395	1395
5°	1374	1389
15°	1289	1329
25°	1126	1221
35°	911	1080
45°	699	910
55°	507	729
65°	322	553
75°	158	393
85°	38	260
90	3	207

Coefficients of Utilization

	pf			20%								
	pc		80%			70%			50%		
	pw	70%	50%	30%	50%	30%	10%	50%	30%	10%
RCR	0	117	117	117	114	114	114	107	107	107
	1	106	101	97	98	94	90	93	89	86
	2	97	88	81	86	79	74	81	76	71
	3	88	77	69	75	68	61	71	65	60
	4	81	69	60	67	59	52	63	56	51
	5	74	61	52	60	52	45	57	50	44
	6	69	55	46	54	46	40	52	44	39
	7	64	50	42	49	41	35	47	40	34
	8	59	46	38	45	37	31	43	36	31
	9	56	42	34	41	34	28	40	33	28
	10	52	39	31	38	31	26	37	30	25

Zonal Lumen Summary

Zone	Lumens	% Lamp	% Fixture
0° - 30°	1043	26.2	26.2
0° - 40°	1668	41.9	41.9
0° - 60°	2829	71.1	71.1
0° - 90°	3703	93.1	93.1
90° - 120°	175	4.4	4.4
90° - 130°	207	5.2	5.2
90° - 150°	252	6.3	6.3
90° - 180°	276	6.9	6.9
0° - 180°	3979	100.0	100.0

MOUNTING DATA

Suspension Kit Ceiling Types: F1 for use with most T-bar and screw slot grid ceiling applications. Designed for on-grid and off-grid installations.

F2 for use with recessed or surface-mount horizontal J-box applications.

For unit or row installation; surface or suspend mounting.

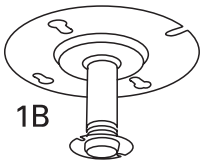
Individual installation — One double-stem or two single-stem hangers required.

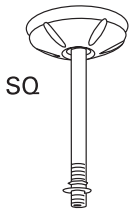
For aircraft cable, one STACG_, STACGF_, or STACGE_ required for each suspension point.

Row installation — Order one (1) STCR accessory per fixture for continuous row applications. Not required for last fixture in row. One hanger per fixture plus one per row required.

Note: 2' configurations with emergency option cannot be stem mounted.

See ACCESSORIES below for hanging devices.





DIMENSIONS

All dimensions are inches (centimeters) unless otherwise noted.

Specifications

Length: 46-3/8 (117.8)

Width: 10-1/8 (25.7)

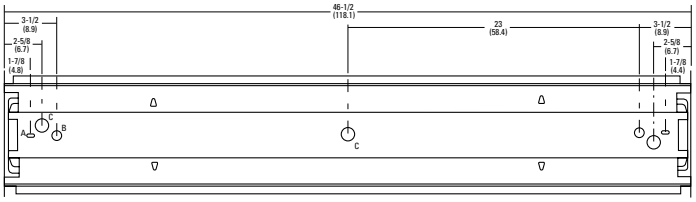
Depth: 3-7/8 (9.8)

Weight: 13LB

A = 1/4 x 1/2 (.635 x 1.27) Oval Hole

B = 11/16 (1.75) Dia. K.O.

C = 7/8 (2.22) Dia.K.O.



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d-series

D-Series Size 1
LED Flood Luminaire

Catalog Number

Notes

Type

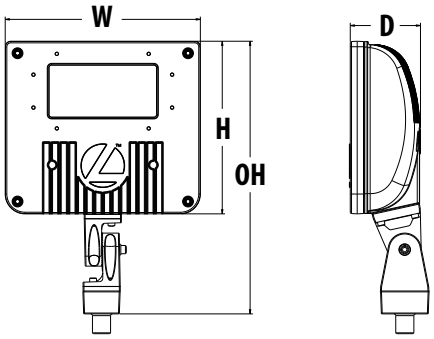
Hit the Tab key or mouse over the page to see all interactive elements.

Introduction

D-Series Size 1 Flood features advanced optics and precision illumination in a sleek and compact form that seamlessly blends with the environment. State of the art reflector design with cutting edge chip-on-board LED technology produces excellent uniformity using precision beam patterns. Provides long-life replacement for 70-150W metal halide floodlights offering up to 77% energy savings with expected service life of over 100,000 hours.

Specifications

EPA:	0.6 ft² *(0.05 m²)*
Depth:	3-1/8″ *(8.0 cm)*
Width:	8-7/8″ *(22.4 cm)*
Height:	7-3/4″ *(19.8 cm)*
Overall Height	12″ *(30.5 cm)*
Weight:	7.2 lbs *(3.3 kg)*



Ordering Information

EXAMPLE: DSXF1 LED P1 40K MSP MVOLT THK DDBXD

DSXF1 LED								
Series	**Performance Package**	**Color Temperature**	**Distribution**	**Voltage**	**Mounting**	**Options**	**Finish** *(required)*
DSXF1 LED	P1 P2	30K 3000K 40K 4000K 50K 5000K	NSP Narrow spot MSP Medium spot MFL Medium flood FL Flood WFL Wide flood WFR Wide flood, rectangular HMF Horizontal flood	MVOLT [1] 120 [2] 208 [2] 240 [2] 277 [2] 347 [2]	**Shipped included** THK Knuckle with 1/2″ NPS threaded pipe IS Integral slipfitter (fits 2-3/8″ O.D. tenon) YKC62 Yoke with 16-3 SO cord **Shipped separately** [3] DSXF1/2TS Tenon slipfitter (2-3/8″ O.D. THK required) FTS CG6 Tenon Slipfitter (fits 2-3/8″ to 2-7/8″ O.D. tenon. YKC62 required)	**Shipped installed** PE Photocontrol, button style [4,5] PEX Photocontrol external threaded adjustable [5] SF Single fuse (120, 277, 347V) [2] DF Double fuse (208, 240) [2] DMG 0-10v dimming wires pulled outside fixture (for use with an external control, ordered separately) **Shipped separately** [3] UBV Upper/bottom visor (universal) FV Full visor VG Vandal guard	DDBXD Dark bronze DBLXD Black DNAXD Natural aluminum DWHXD White

Accessories

Ordered and shipped separately.

DSXF1/2TS DDBXD U	Slipfitter for 1-1/4″ to 2-3/8″ OD tenons; mates with 1/2″ threaded knuckle (specify finish)
FRWB DDBXD U	Radius wall bracket, 2-3/8″ OD tenon (specify finish)
FSPB DDBXD U	Steel square pole bracket, 2-3/8″ OD tenon (specify finish)
DSXF1UBV DDBXD U	Upper/bottom visor accessory (specify finish)
DSXF1FV DDBXD U	Full visor accessory (specify finish)
DSXF1VG U	Vandal guard accessory

For more mounting options, visit our Floodlighting Accessories pages.

Stock configurations are offered for shorter lead times:

Standard Part Number	Stock Part Number	CI Code
DSXF1 LED P1 40K WFL MVOLT THK DDBXD	**DSXF1 LED P1 40K**	***240TJH**
DSXF1 LED P1 50K WFL MVOLT THK DDBXD	**DSXF1 LED P1 50K**	***240TJG**
DSXF1 LED P1 40K WFL MVOLT YKC62 DDBXD	**DSXF1 LED P1 40K YK**	***263KL9**
DSXF1 LED P1 50K WFL MVOLT YKC62 DDBXD	**DSXF1 LED P1 50K YK**	***263UJE**
DSXF1 LED P2 40K WFL MVOLT THK DDBXD	**DSXF1 LED P2 40K**	***240TJL**
DSXF1 LED P2 50K WFL MVOLT THK DDBXD	**DSXF1 LED P2 50K**	***240TJJ**
DSXF1 LED P2 40K WFL MVOLT YKC62 DDBXD	**DSXF1 LED P2 40K YK**	***263KLA**
DSXF1 LED P2 50K WFL MVOLT YKC62 DDBXD	**DSXF1 LED P2 50K YK**	***263UJG**
DSXF1/2 Slip-fitter Tenon Accessory DDBXD	**DSXF1/2TS DDBXD U**	***216G5K**

NOTES

1. MVOLT driver operates on line voltage from 120-277V.
2. Single fuse (SF) requires 120V, 277V or 347V. Double fuse (DF) requires 208V, 240V or 480V.
3. Also available as accessories; see Accessories information at left.
4. Rated 25C maximum ambient for performance package P2. Specify PEX for higher ambient temperatures.
5. Photocontrol (PE, PEX) requires 120, 208, 240, 277 or 347 voltage option.
6. Must specify 120, 277 or 347 voltage option.

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Performance Data

Lumen Output

Lumen values are from photometric tests performed in accordance with IESNA LM-79-08. Data is considered to be representative of the configurations shown, within the tolerances allowed by Lighting Facts. Actual performance may differ as a result of end-user environment and application. Actual wattage may differ by +/- 8% when operating between 120-480V +/- 10%. Contact factory for performance data on any configurations not shown here.

Performance Package	System Watts	Dist. Type	Field Angle		Beam Angle		30K (3000K, 70 CRI)			40K (4000K, 70 CRI)			50K (5000K, 70 CRI)		
			°H	°V	°H	°V	Max Cd	Lumens	LPW	Max Cd	Lumens	LPW	Max Cd	Lumens	LPW
P1	21W	NSP	37	38	18	19	16,316	2,601	124	18,039	2,876	137	18,039	2,876	137
		MSP	51	51	27	28	9,908	2,578	123	10,954	2,850	136	10,954	2,850	136
		MFL	60	60	46	45	4,027	2,435	116	4,452	2,692	128	4,452	2,692	128
		FL	84	91	59	72	2,255	2,682	128	2,494	2,965	141	2,494	2,965	141
		WFL	109	101	86	85	1,494	2,766	132	1,652	3,058	146	1,652	3,058	146
		WFR	103	92	80	71	1,809	2,794	133	2,000	3,089	147	2,000	3,089	147
		HMF	124	63	100	48	2,001	2,329	111	2,212	2,575	123	2,212	2,575	123
P2	42W	NSP	37	38	18	19	29,740	4,741	113	32,881	5,242	125	32,881	5,242	125
		MSP	51	51	27	28	18,060	4,699	112	19,967	5,195	124	19,967	5,195	124
		MFL	60	50	46	45	7,340	4,439	106	8,115	4,908	117	8,115	4,908	117
		FL	84	91	59	72	4,111	4,889	116	4,545	5,406	129	4,545	5,405	129
		WFL	109	101	86	85	2,568	4,753	113	3,011	5,573	133	3,011	5,573	133
		WFR	103	92	80	71	3,297	5,094	121	3,645	5,631	134	3,645	5,632	134
		HMF	124	63	100	48	3,647	4,245	101	4,032	4,693	112	4,032	4,693	112

IF REPLACING OLD BELOW	USE NEW BELOW	RECOMMENDED	ALSO CONSIDER
DSXF1 LED 1	DSXF1 LED P1	Summary, customer gets ~ 900 more lumens* at slightly higher watts	---
DSXF1 LED 2	DSXF1 LED P2	Summary, customer gets ~ 1500 more lumens* at higher watts	Consider dropping down to DSXF1 LED P1, however 900 lumens less VS. older design, but at half the watts
DSXF2 LED 3	DSXF1 LED P2	Summary, use size 1-P2 at lower watts, roughly same lumens	If staying with size two, same watts, but 2000 more lumens
DSXF2 LED 4	DSXF2 LED P1	Summary, use size 2-P1 at lower watts, roughly same lumens	---

Lumen Ambient Temperature (LAT) Multipliers

Use these factors to determine relative lumen output for average ambient temperatures from 0-40°C (32-104°F).

Ambient	
0°C	32°F
10°C	50°F
20°C	68°F
25°C	**77°F**
30°C	86°F
40°C	104°F

Projected LED Lumen Maintenance

Data references the extrapolated performance projections for the **DSXF1 LED P2** platform noted in a 25C ambient, based on 10,000 hours of LED testing (tested per IESNA LM-80-08 and projected per IESNA TM-21-11).

To calculate LLF, use the lumen maintenance factor that corresponds to the desired number of operating hours below. For other lumen maintenance values, contact factory.

Operating Hours	0	25,000	50,000	100,000
Lumen Maintenance Factor	1.0	0.97	0.96	0.95

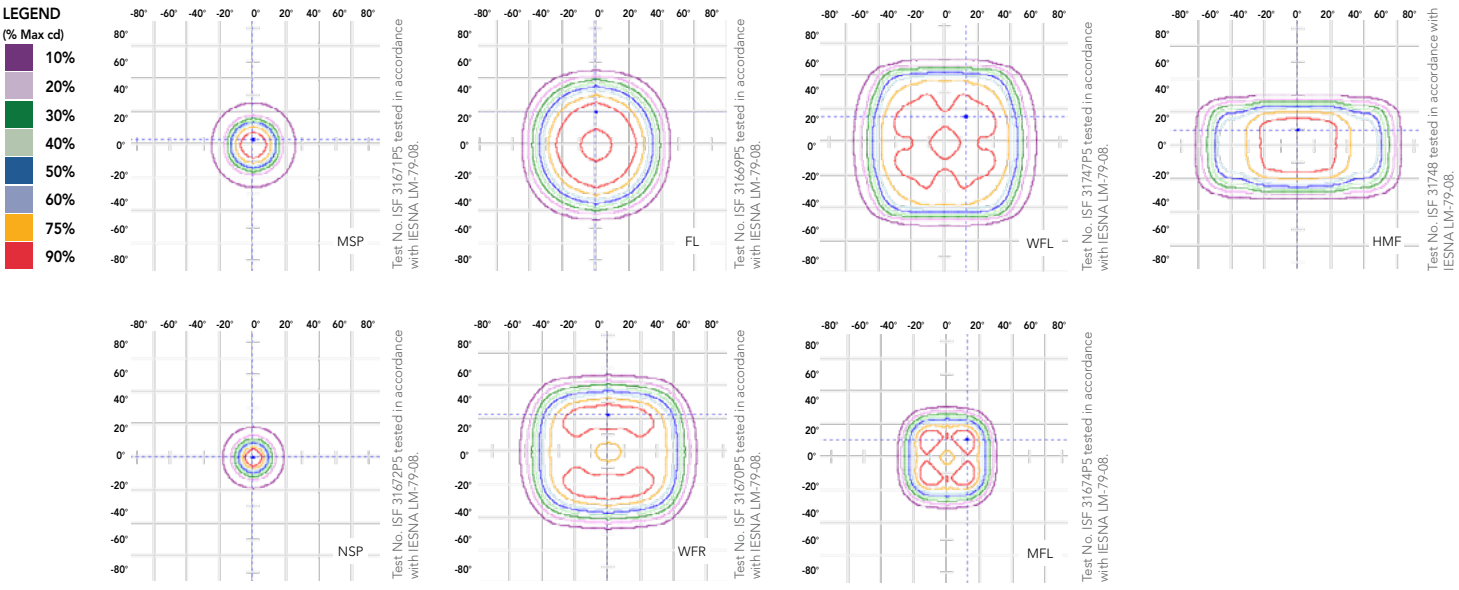
Electrical Load

Light Engines	System Watts	Current (A)					
		120	208	240	277	347	480
P1	21W	0.18	0.1	0.09	0.08	0.07	-
P2	42W	0.35	0.20	0.18	0.15	0.12	-

Photometric Diagrams

To see complete photometric reports or download .ies files for this product, visit Lithonia Lighting's D-Series Flood Size 1 homepage.

Isocandela plots for the DSXF1 LED P2 40K.



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Mounting, Options and Accessories



THK - Knuckle with 1/2" NPS threaded pipe



YKC62 - Yoke with SO cord
H= 4-1/4" (10.7 cm)
D= 2-1/4" (5.7 cm)



IS – Integral slipfitter
H= 2-1/2" (6.3 cm)
ID= 2-3/8" (6.0 cm)
OD= 3-1/2" (8.8 cm)



UBV – Upper/bottom visor
W= 5-1/4" (13.3 cm)
H= 2-1/2" (6.3 cm)
D= 3" (7.6 cm)



FV – Full visor
W= 5-1/4" (13.3 cm)
H= 2-1/2" (6.3 cm)
D= 3" (7.6 cm)



VG – Vandal guard
W= 6-1/2" (16.5 cm)
H= 4" (10.1 cm)

FEATURES & SPECIFICATIONS

INTENDED USE
The sleek design of the D-Series Size 1 Flood reflects the embedded high performance LED technology. It is ideal for landscape, signage and accent lighting in many commercial and residential applications.

CONSTRUCTION
Die-cast aluminum housing has integral heat sink fins to optimize thermal management through conductive and convective cooling. The LED driver is mounted in direct contact with the casting to promote low operating temperature and long life. Housing is completely sealed against moisture and environmental contaminants using a tempered glass lens(IP66). Low EPA (0.6 ft^2) for optimized wind loading.

FINISH
Exterior parts are protected by a zinc-infused Super Durable TGIC thermoset powder coat finish that provides superior resistance to corrosion and weathering. A tightly controlled multi-stage process ensures a minimum 3 mils thickness for a finish that can withstand extreme climate changes without cracking or peeling.

OPTICS
A variety of precision-molded vacuum-metallized specular reflectors are engineered for superior target illumination, uniformity and spacing. Light engines are available in 3000K (70 CRI min.), 4000K (70 CRI min.) or 5000K (70 CRI min.) configurations. Optional visors offer additional versatility.

ELECTRICAL
Light engine(s) consist of chip-on-board (COB) LEDs directly coupled to the housing to maximize heat dissipation and promote long life (100,000 hrs, L80). Single-engine unit uses a Class 2 electronic driver; dual-engine unit uses a Class 1 electronic driver. Both drivers have a power factor >90%, THD <20%, and an expected life of 100,000 hours. Standard 6KV surge protection meets a minimum Category C Low operation (per ANSI/IEEE C62.41.2).

INSTALLATION
Integral adjustable knuckle with 1/2-14NPS threaded pipe, tenon slipfitter, or integral slipfitter, facilitates quick and easy installation to a variety of mounting accessories. This secure connection enables the D-Series Size 1 to withstand up to a 1.5 G vibration load rating per ANSI C136.31.

LISTINGS
CSA certified to U.S. and Canadian standards. Luminaire is IP66 rated. Rated for -40°C minimum ambient.

DesignLights Consortium® (DLC) Premium qualified product and DLC qualified product. Not all versions of this product may be DLC Premium qualified or DLC qualified. Please check the DLC Qualified Products List at www.designlights.org/QPL to confirm which versions are qualified.

WARRANTY
5-year limited warranty. Complete warranty terms located at:
www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx.

Note: Actual performance may differ as a result of end-user environment and application. All values are design or typical values, measured under laboratory conditions at 25 °C. Specifications subject to change without notice.

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d"series

D-Series Size 2
LED Flood Luminaire

Catalog Number

Notes

Type

Hit the Tab key or mouse over the page to see all interactive elements.

Introduction

D-Series Size 2 Flood features advanced optics and precision illumination in a sleek and compact form that seamlessly blends with the environment. State of the art reflector design with cutting edge chip-on-board LED technology produces excellent uniformity using precision beam patterns. Provides long-life replacement for 150-250W metal halide floodlights offering up to 74% energy savings with expected service life of over 100,000 hours.

Specifications

EPA: 0.8 ft² *(0.05 m²)*

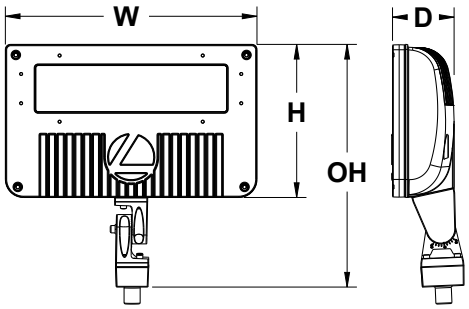
Depth: 3-1/8" *(8.0 cm)*

Width: 12-7/8" *(32.6 cm)*

Height: 7-3/4" *(19.8 cm)*

Overall Height 12" *(30.5 cm)*

Weight: 10.5 lbs *(4.8 kg)*



Ordering Information

EXAMPLE: DSXF2 LED P1 40K MSP MVOLT THK DDBXD

DSXF2 LED

Series	Performance Package	Color Temperature	Distribution	Voltage	Mounting	Options	Finish *(required)*
DSXF2 LED	P1 P2 P3[1,2,3]	30K 3000K 40K 4000K 50K 5000K	NSP Narrow spot MSP Medium spot MFL Medium flood FL Flood WFL Wide flood WFR Wide flood, rectangular HMF Horizontal flood	MVOLT[4] 120[5] 208[5] 240[5] 277[5] 347[5] 480[5,6]	**Shipped included** THK Knuckle with 1/2" NPS threaded pipe YKC62 Yoke with 16-3 SO cord IS Integral slipfitter (fits 2-3/8" O.D. tenon) **Shipped separately** DSXF1/2TS Tenon slipfitter (2-3/8" O.D. THK required)[7] FTS CG6 Tenon slipfitter (2-7/8" O.D. YKC62 required)[7]	**Shipped installed** PE Photocontrol, button style[8,9] PEX Photocontrol external threaded adjustable[9] DMG 0-10v dimming wires pulled outside fixture (for use with an external control, ordered separately) SF Single fuse (120, 277, 347V)[5] DF Double fuse (208, 240, 480V)[5] SPD10KV Separate surge protection[10] **Shipped separately**[7] UBV Upper/bottom visor (universal) FV Full visor VG Vandal guard	DDBXD Dark bronze DBLXD Black DNAXD Natural aluminum DWHXD White

Accessories

Ordered and shipped separately.

DSXF1/2TS DDBXD U	Slipfitter for 1-1/4" to 2-3/8" OD tenons; mates with 1/2" threaded knuckle (specify finish)
FTS CG6 DDBXD U	Slipfitter for 2-3/8" to 2-7/8" OD tenons; mates with yoke mount (specify finish)
FRWB DDBXD U	Radius wall bracket, 2-3/8" OD tenon (specify finish)
FSPB DDBXD U	Steel square pole bracket, 2-3/8" OD tenon (specify finish)
DSXF2UBV DDBXD U	Upper/bottom visor accessory (specify finish)
DSXF2FV DDBXD U	Full visor accessory (specify finish)
DSXF2VG U	Vandal guard accessory

For more mounting options, visit our Floodlighting Accessories pages.

Stock configurations are offered for shorter lead times:

Standard Part Number	Stock Part Number	CI Code
DSXF2 LED P1 40K WFL MVOLT THK DDBXD	DSXF2 LED P1 40K	*240TJ9
DSXF2 LED P1 50K WFL MVOLT THK DDBXD	DSXF2 LED P1 50K	*240TJ8
DSXF2 LED P1 40K WFL MVOLT YKC62 DDBXD	DSXF2 LED P1 40K YK	*263KLF
DSXF2 LED P1 50K WFL MVOLT YKC62 DDBXD	DSXF2 LED P1 50K YK	*263UJK
DSXF2 LED P2 40K WFL MVOLT THK DDBXD	DSXF2 LED P2 40K	*240THT
DSXF2 LED P2 50K WFL MVOLT THK DDBXD	DSXF2 LED P2 50K	*240TJC
DSXF2 LED P2 40K WFL MVOLT YKC62 DDBXD	DSXF2 LED P2 40K YK	*263KLG
DSXF2 LED P2 50K WFL MVOLT YKC62 DDBXD	DSXF2 LED P2 50K YK	*263UJM
DSXF1/2 Slip-fitter Tenon Accessory DDBXD	DSXF1/2TS DDBXD U	*216G5K

NOTES

1. Performance package P3 rated 35C maximum ambient.
2. Not available with PE (use PEX).
3. Rated 25C maximum ambient with SPD10KV.
4. MVOLT driver operates on line voltage from 120-277V.
5. Single fuse (SF) requires 120V, 277V or 347V. Double fuse (DF) requires 208V, 240V or 480V.
6. Not available with PE and PEX.
7. Also available as accessories; see accessories information at left.
8. Rated 25C maximum ambient for performance package P2. Not available in performance package P3. Specify PEX for higher ambient temperatures.
9. Photocontrol (PE, PEX) requires 120, 208, 240, 277 or 347 voltage option.
10. Cannot exceed 25°C maximum ambient when used with P3 performance package.

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Performance Data

Lumen Output

Lumen values are from photometric tests performed in accordance with IESNA LM-79-08. Data is considered to be representative of the configurations shown, within the tolerances allowed by Lighting Facts. Actual performance may differ as a result of end-user environment and application. Actual wattage may differ by +/- 8% when operating between 120-480V +/- 10%. Contact factory for performance data on any configurations not shown here.

Performance Package	System Watts	Dist. Type	Field Angle		Beam Angle		30K (3000K, 70 CRI)			40K (4000K, 70 CRI)			50K (5000K, 70 CRI)		
			°H	°V	°H	°V	Max Cd	Lumens	LPW	Max Cd	Lumens	LPW	Max Cd	Lumens	LPW
P1	54W	NSP	39	39	19	18	43,427	7,337	136	45,662	7,715	143	45,662	7,715	143
		MSP	52	51	28	28	26,563	7,010	130	27,930	7,370	136	27,930	7,370	136
		MFL	59	59	45	46	11,831	7,058	131	12,440	7,421	137	12,440	7,421	137
		FL	87	87	62	68	6,258	7,309	135	6,581	7,686	142	6,581	7,686	142
		WFL	114	101	87	83	3,991	7,412	137	4,197	7,793	144	4,197	7,793	144
		WFR	107	92	81	71	4,827	7,427	138	5,076	7,810	145	5,076	7,810	145
		HMF	123	64	89	50	6,580	6,764	125	6,919	7,102	132	6,919	7,102	132
P2	78W	NSP	39	39	19	18	59,506	10,054	129	62,568	10,571	136	62,568	10,571	136
		MSP	52	51	28	28	36,397	9,605	123	38,271	10,099	129	38,271	10,099	129
		MFL	59	59	45	46	16,211	9,671	124	17,046	10,169	130	17,046	10,169	130
		FL	87	87	62	68	8,575	10,016	128	9,017	10,531	135	9,017	10,531	135
		WFL	114	101	87	83	5,469	10,156	130	5,751	10,678	137	5,751	10,678	137
		WFR	107	92	81	71	6,615	10,177	131	6,955	10,701	137	6,955	10,701	137
		HMF	123	64	89	50	9,017	9,254	119	9,481	9,731	125	9,481	9,731	125
P3	102W	NSP	39	39	19	18	70,481	11,908	117	74,109	12,521	123	74,109	12,521	123
		MSP	52	51	28	28	43,111	11,377	112	45,330	11,962	117	45,330	11,962	117
		MFL	59	59	45	46	19,011	11,455	112	20,190	12,044	118	20,190	12,044	118
		FL	87	87	62	68	10,157	11,863	116	10,680	12,474	122	10,680	12,474	122
		WFL	114	101	87	83	6,198	11,508	113	6,811	12,648	124	6,811	12,648	124
		WFR	107	92	81	71	7,835	12,054	118	8,238	12,675	124	8,238	12,675	124
		HMF	123	64	89	50	10,680	10,961	107	11,230	11,526	113	11,230	11,526	113

IF REPLACING OLD BELOW	USE NEW BELOW	RECOMMENDED	ALSO CONSIDER
DSXF1 LED 1	DSXF1 LED P1	Summary, customer gets ~ 900 more lumens* at slightly higher watts	---
DSXF1 LED 2	DSXF1 LED P2	Summary, customer gets ~ 1500 more lumens* at higher watts	Consider dropping down to DSXF1 LED P1, however 900 lumens less VS. older design, but at half the watts
DSXF2 LED 3	DSXF1 LED P2	Summary, use size 1-P2 at lower watts, roughly same lumens	If staying with size two, same watts, but 2000 more lumens
DSXF2 LED 4	DSXF2 LED P1	Summary, use size 2-P1 at lower watts, roughly same lumens	---

Lumen Ambient Temperature (LAT) Multipliers

Use these factors to determine relative lumen output for average ambient temperatures from 0-40°C (32-104°F).

Ambient	
0°C	32°F
10°C	50°F
20°C	68°F
25°C	**77°F**
30°C	86°F
40°C	104°F

Projected LED Lumen Maintenance

Data references the extrapolated performance projections for the DSXF LED P3 platform noted in a 25C ambient, based on 10,000 hours of LED testing (tested per IESNA LM-80-08 and projected per IESNA TM-21-11).

To calculate LLF, use the lumen maintenance factor that corresponds to the desired number of operating hours below. For other lumen maintenance values, contact factory.

Operating Hours	0	25,000	50,000	100,000
Lumen Maintenance Factor	1.0	0.95	0.95	0.95

Electrical Load

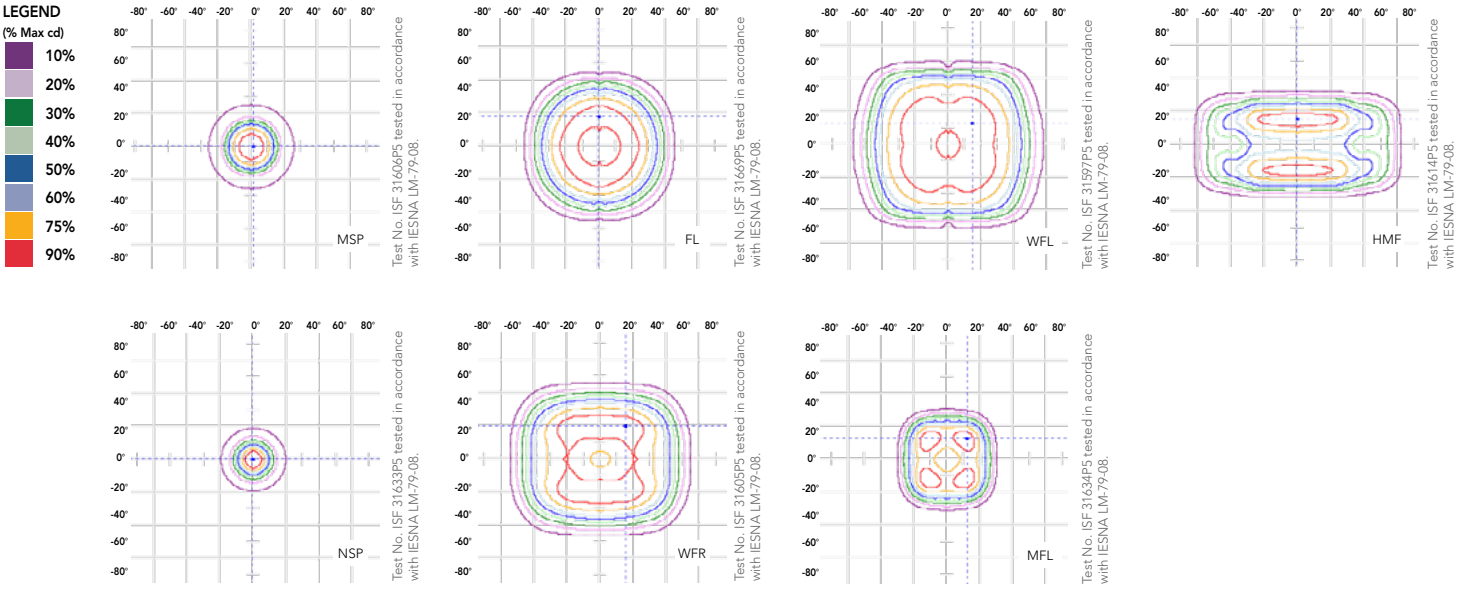
		Current (A)					
Light Engines	System Watts*	120	208	240	277	347	480
P1	54W	0.45	0.26	0.23	0.2	0.16	0.13
P2	78W	0.65	0.37	0.33	0.29	0.23	0.18
P3	102W	0.88	0.49	0.43	0.39	0.31	0.23

* Systems Watts for 347-480V; P1: 56W, P2: 80W, P3:103W.

Photometric Diagrams

To see complete photometric reports or download .ies files for this product, visit Lithonia Lighting's D-Series Flood Size 2 homepage.

Isocandela plots for the DSXF2 LED P2 40K.



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Mounting, Options and Accessories



THK - Knuckle with 1/2" NPS threaded pipe



YKC62 - Yoke with SO cord
W= 4-3/4" (12.0 cm)
H= 4-1/4" (10.7 cm)
D= 2-1/4" (5.7 cm)



IS – Integral slipfitter
H= 2-1/2" (6.3 cm)
ID= 2-3/8" (6.0 cm)
OD= 3-1/2" (8.8 cm)



UBV – Upper/bottom visor
W= 10" (25.4 cm)
H= 2-1/2" (6.3 cm)
D= 3" (7.6 cm)



FV – Full visor
W= 10" (25.4 cm)
H= 2-1/2" (6.3 cm)
D= 3" (7.6 cm)



VG – Vandal guard
W= 10-1/2" (26.6cm)
H= 4" (10.1cm

FEATURES & SPECIFICATIONS

INTENDED USE
The sleek design of the D-Series Size 2 Flood reflects the embedded high performance LED technology. It is ideal for larger signage, facade and flagpole lighting in many commercial and residential applications.

CONSTRUCTION
Die-cast aluminum housing has integral heat sink fins to optimize thermal management through conductive and convective cooling. The LED driver is mounted in direct contact with the casting to promote low operating temperature and long life. Housing is completely sealed against moisture and environmental contaminants using a tempered glass lens (IP66). Low EPA (0.8 ft^2) for optimized wind loading.

FINISH
Exterior parts are protected by a zinc-infused Super Durable TGIC thermoset powder coat finish that provides superior resistance to corrosion and weathering. A tightly controlled multi-stage process ensures a minimum 3 mils thickness for a finish that can withstand extreme climate changes without cracking or peeling.

OPTICS
A variety of precision-molded vacuum-metallized specular reflectors are engineered for superior target illumination, uniformity and spacing. Light engines are available in 3000K (70 CRI min.), 4000K (70 CRI min.) or 5000K (70 CRI min.) configurations. Optional visors offer additional versatility.

ELECTRICAL
Light engine(s) consist of chip-on-board (COB) LEDs directly coupled to the housing to maximize heat dissipation and promote long life (100,000 hrs, L80). Class 1 electronic driver has a power factor >90%, THD <20%, and has an expected life of 100,000 hours with <1% failure rate. Standard 6KV surge protection meets a minimum Category C Low operation (per ANSI/IEEE C62.41.2).

INSTALLATION
Integral adjustable knuckle with 1/2-14 NPS threaded pipe, tenon slipfitter, or yoke mounting, facilitates quick and easy installation to a variety of mounting accessories. This secure connection enables the D-Series Size 2 to withstand up to a 1.5 G vibration load rating per ANSI C136.31.

LISTINGS
CSA certified to U.S. and Canadian standards. Luminaire is IP66 rated. Rated for -40°C minimum ambient.

DesignLights Consortium® (DLC) Premium qualified product and DLC qualified product. Not all versions of this product may be DLC Premium qualified or DLC qualified. Please check the DLC Qualified Products List at www.designlights.org/QPL to confirm which versions are qualified.

WARRANTY
5-year limited warranty. Complete warranty terms located at:
www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx.

Note: Actual performance may differ as a result of end-user environment and application. All values are design or typical values, measured under laboratory conditions at 25 °C. Specifications subject to change without notice.

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D-Series Size 3
LED Flood Luminaire

d-series

Catalog Number

Notes

Type

Hit the Tab key or mouse over the page to see all interactive elements.

Specifications

EPA: 1.4 ft² (0.13 m²)

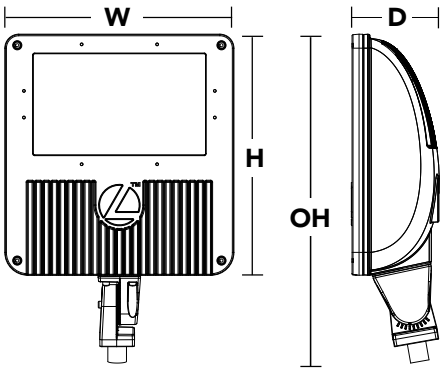
Depth: 5" (12.7 cm)

Width: 13" (33.0 cm)

Height: 13-5/8" (34.6 cm)

Overall Height 17-1/2" (44.5 cm)

Weight: 21 lbs (9.5 kg)



A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and system-level interoperability.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is A+ Certified when ordered with DTL® controls marked by a shaded background. DTL DLL equipped luminaires meet the A+ specification for luminaire to photocontrol interoperability1
- This luminaire is part of an A+ Certified solution for ROAM® or XPoint™ Wireless control networks, providing out-of-the-box control compatibility with simple commissioning, when ordered with drivers and control options marked by a shaded background[1]

To learn more about A+, visit www.acuitybrands.com/aplus.

1. See ordering tree for details.
2. A+ Certified Solutions for ROAM require the order of one ROAM node per luminaire. Sold Separately: Link to Roam; Link to DTL DLL

A+ Capable options indicated by this color background.

Ordering Information

EXAMPLE: DSXF3 LED 6 P2 40K FL MVOLT THK DDBXD

DSXF3 LED

Series	Light Engines	Performance Package	Color Temperature	Distribution	Voltage	Mounting
DSXF3 LED	6 Six COB engines	P1 Performance Package P2 Performance Package	30K 3000K 40K 4000K 50K 5000K	NSP Narrow spot MSP Medium spot MFL Medium flood FL Flood WFL Wide flood WFR Wide flood, rectangular HMF Horizontal medium flood	MVOLT[1] 120[2] 208[2] 240[2] 277[2] 347[2] 480[2]	**Shipped included** THK Knuckle with 3/4" NPT threaded pipe YKC62 Yoke with 16-3 SO cord IS Integral slipfitter (fits 2-3/8" O.D. tenon) **Shipped separately[3]** FTS CG6 Tenon slipfitter (fits 2-3/8" to 2-7/8" O.D. tenon. YKC62 required)

Options

Shipped installed

PER	NEMA twist-lock receptacle only (controls ordered separate)[4]
PER5	Five-wire receptacle only (controls ordered separate)[4,5]
DMG	0-10v dimming wires pulled outside fixture (for use with an external control, ordered separately)
SF	Single fuse (120, 277, 347V)[2]
DF	Double fuse (208, 240, 480V)[2]
WTB	Utility terminal block

Shipped installed

PNMTDD3	Part night, dim till dawn[6]
PNMT5D3	Part night, dim 5 hrs.[6]
PNMT6D3	Part night, dim 6 hrs.[6]
PNMT7D3	Part night, dim 7 hrs.[6]
BL30	Bi-level switched dimming, 30%[7]
BL50	Bi-level switched dimming, 50%[7]

Shipped separately[8]

UBV	Upper/bottom visor (universal)
FV	Full visor
VG	Vandal guard
WG	Wire guard

Finish *(required)*

DDBXD	Dark bronze
DBLXD	Black
DNAXD	Natural aluminum
DWHXD	White

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Ordering Information

Accessories

Ordered and shipped separately.

FTS CG6 DDBXD U	Slipfitter for 2-3/8" to 2-7/8" OD tenons; mates with yoke mount (specify finish)
FRWB DDBXD U	Radius wall bracket, 2-3/8" OD tenon (specify finish)
FSPB DDBXD U	Steel square pole bracket, 2-3/8" OD tenon (specify finish)
DSXF3UBV DDBXD U	Upper/bottom visor accessory (specify finish)
DSXF3FV DDBXD U	Full visor accessory (specify finish)
DSXF3VG U	Vandal guard accessory
DSXF3WG DBLXD U	Wire guard accessory
DLL127F 1.5 JU	Photocell - SSL twist-lock (120-277V)[9]
DLL347F 1.5 CUL JU	Photocell - SSL twist-lock (347V)[9]
DLL480F 1.5 CUL JU	Photocell - SSL twist-lock (480V)[9]
DSHORT SBK U	Shorting cap[9]

For more mounting options, visit our Floodlighting Accessories pages.

For more control options, visit DTL and ROAM online.

Stock configurations are offered for shorter lead times:

Standard Part Number	Stock Part Number	CI Code
DSXF3 LED 6 P1 40K WFL MVOLT IS DDBXD	**DSXF3 LED 6 P1 40K IS**	***236CXJ**
DSXF3 LED 6 P1 50K WFL MVOLT IS DDBXD	**DSXF3 LED 6 P1 50K IS**	***236CXG**
DSXF3 LED 6 P1 40K WFL MVOLT YKC62 DDBXD	**DSXF3 LED 6 P1 40K YKC62**	***236CXH**
DSXF3 LED 6 P1 50K WFL MVOLT YKC62 DDBXD	**DSXF3 LED 6 P1 50K YKC62**	***236CX8**
DSXF3 LED 6 P2 40K WFL MVOLT IS DDBXD	**DSXF3 LED 6 P2 40K IS**	***236CX6**
DSXF3 LED 6 P2 50K WFL MVOLT IS DDBXD	**DSXF3 LED 6 P2 50K IS**	***236CX3**
DSXF3 LED 6 P2 40K WFL MVOLT YKC62 DDBXD	**DSXF3 LED 6 P2 40K YKC62**	***236CX5**
DSXF3 LED 6 P2 50K WFL MVOLT YKC62 DDBXD	**DSXF3 LED 6 P2 50K YKC62**	***236CX2**

NOTES

1. MVOLT driver operates on any line voltage from 120-277V.
2. Single fuse (SF) requires 120, 277 or 347 voltage option. Double fuse (DF) requires 208, 240 or 480 voltage option.
3. Must be ordered as an accessory; see Accessories information at left.
4. For units with a photocontrol receptacle, the mounting must be restricted to ± 45° from horizontal aim per ANSI C136.10-2010.
5. Specifies a ROAM® enabled luminaire with 0-10V dimming capability; PER5 option required. Additional hardware and services required for ROAM® deployment; must be purchased separately. Call 1-800-442-6745 or email: sales@roamservices.net.
6. MVOLT only. Not available with 347V, 480V, PER5, BL30 or BL50.
7. Requires (2) separately switched circuits. MVOLT only. Not available with 347V, 480V, or PER5.
8. Also available as separate accessories; see Accessories information at left.
9. Requires luminaire to be specified with PER option. Reference PER table on Page 2 for functionality.

Performance Data

Lumen Output

Lumen values are from photometric tests performed in accordance with IESNA LM-79-08. Data is considered to be representative of the configurations shown, within the tolerances allowed by Lighting Facts. Contact factory for performance data on any configurations not shown here.

Light Engines	Performance Package	System Watts	Dist. Type	Field Angle		Beam Angle		30K (3000K, 70 CRI)			40K (4000K, 70 CRI)			50K (5000K, 70 CRI)		
				°H	°V	°H	°V	Max Cd	Lumens	LPW	Max Cd	Lumens	LPW	Max Cd	Lumens	LPW
6	P1	129	NSP	38	35	18	18	84476	13,510	105	88800	14,201	110	88800	14,201	110
			MSP	53	52	27	27	49237	12,774	99	51757	13,428	104	51757	13,428	104
			MFL	59	59	45	45	22746	12,986	101	23911	13,650	106	23911	13,650	106
			FL	84	90	61	71	11658	13,952	108	12255	14,666	114	12255	14,666	114
			WFL	104	105	73	76	9435	14,454	112	9918	15,194	118	9918	15,194	118
			WFR	104	91	80	72	9546	14,377	111	10035	15,113	117	10035	15,113	117
			HMF	121	67	94	55	10455	13,238	103	10991	13,916	108	10991	13,916	108
	P2	183	NSP	38	35	18	18	105595	16,887	92	111000	17,751	97	111000	17,751	97
			MSP	53	52	27	27	61546	15,968	87	64696	16,785	92	64696	16,785	92
			MFL	59	59	45	45	28433	16,232	89	29888	17,063	93	29888	17,063	93
			FL	84	90	61	71	14573	17,440	95	15319	18,333	100	15319	18,333	100
			WFL	104	105	73	76	11794	18,067	99	12397	18,992	104	12397	18,992	104
			WFR	104	91	80	72	11933	17,972	98	12543	18,891	103	12543	18,891	103
			HMF	121	67	94	55	13069	16,548	90	13738	17,395	95	13738	17,395	95

Lumen Ambient Temperature (LAT) Multipliers

Use these factors to determine relative lumen output for average ambient temperatures from 0-35°C (32-95°F).

Ambient		Lumen Multiplier
0°C	32°F	1.08
0°C	50°F	1.05
20°C	68°F	1.02
25°C	**77°F**	**1.00**
30°C	86°F	0.98
35°C	95°F	0.96

Projected LED Lumen Maintenance

Data references the extrapolated performance projections for the DSXF3 LED 6 P2 platform based on 13,000 hours of LED testing (tested per IESNA LM-80-08 and projected per IESNA TM-21-11).

To calculate LLF, use the lumen maintenance factor that corresponds to the desired number of operating hours below. For other lumen maintenance values, contact factory.

Operating Hours	0	25,000	50,000	100,000
Lumen Maintenance Factor	1.0	0.97	0.97	0.96

Electrical Load

Performance Package	System Watts	Current (A) 120V	208V	240V	277V	347V	480V
P1	129	1.08	0.62	0.54	0.47	0.38	0.29
P2	183	1.54	0.87	0.75	0.65	0.53	0.40

PER Table

Control	PER (3 wire)	PER5 (5 wire)		PER7 (7 wire)		
			Wire 4/Wire5		Wire 4/Wire5	Wire 6/Wire7
Photocontrol Only (On/Off)	✓	⚠	Wired to dimming leads on driver	⚠	Wired to dimming leads on driver	Wires Capped inside fixture
ROAM	⊘	✓	Wired to dimming leads on driver	⚠	Wired to dimming leads on driver	Wires Capped inside fixture
ROAM with Motion	⊘	⚠	Wired to dimming leads on driver	⚠	Wired to dimming leads on driver	Wires Capped inside fixture
Futureproof*	⊘	⚠	Wired to dimming leads on driver	✓	Wired to dimming leads on driver	Wires Capped inside fixture
Futureproof* with Motion	⊘	⚠	Wired to dimming leads on driver	✓	Wired to dimming leads on driver	Wires Capped inside fixture

✓ Recommended

⊘ Will not work

⚠ Alternate

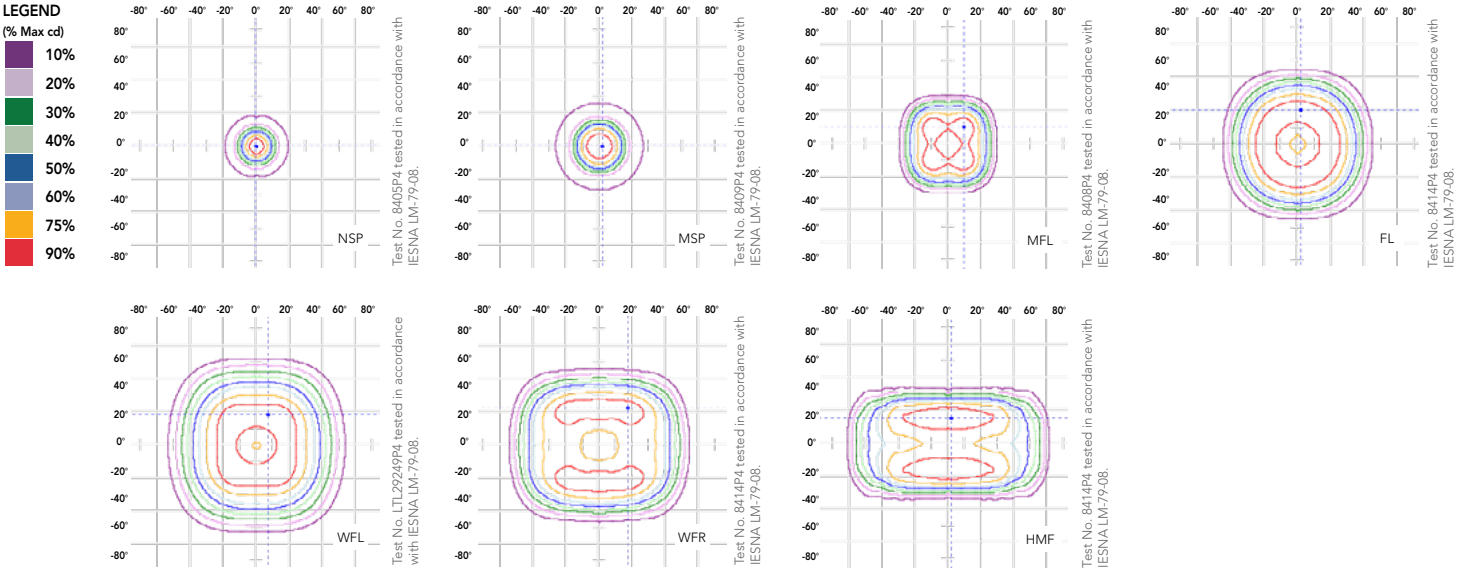
*Futureproof means: Ability to change controls in the future.

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Photometric Diagrams

To see complete photometric reports or download .ies files for this product, visit Lithonia Lighting's D-Series Flood Size 3 homepage.

Isocandela plots for the DSXF3 LED 6 P2 40K. Distances are in units of mount height (20ft).



Mounting, Options and Accessories



THK - Knuckle with 3/4" NPT threaded pipe

YKC62 - Yoke with SO cord
W= 5" (12.7 cm)
H= 3-1/2" (8.8 cm)
D= 2" (5.0 cm)

IS – Integral slipfitter
H= 4-1/2" (11.4 cm)
ID= 2-3/8" (6.0 cm)
OD= 3-1/2" (8.8cm)

UBV – Upper/bottom visor
W= 12" (30.4 cm)
H= 7-1/5" (19.0 cm)
D= 3" (7.6 cm)

FV – Full visor
W= 12" (30.4 cm)
H= 7-1/5" (19.0 cm)
D= 3" (7.6 cm)

VG – Vandal guard
W= 10-1/2" (26.6 cm)
H= 7-1/2" (19.0 cm)

WG – Wire guard
W= 10-1/2" (26.6 cm)
H= 7-1/2" (19.0 cm)
D= 1-1/5" (3.8 cm)

FEATURES & SPECIFICATIONS

INTENDED USE
The sleek design of the D-Series Size 3 Flood reflects the embedded high performance LED technology. It is ideal for wallwash, security and general area lighting in many commercial and institutional applications.

CONSTRUCTION
Die-cast aluminum housing has integral heat sink fins to optimize thermal management through conductive and convective cooling. The LED driver is mounted in direct contact with the casting to promote low operating temperature and long life. Housing is completely sealed against moisture and environmental contaminants (IP66). Low EPA (1.4 ft^2) for optimized wind loading.

FINISH
Exterior parts are protected by a zinc-infused Super Durable TGIC thermoset powder coat finish that provides superior resistance to corrosion and weathering. A tightly controlled multi-stage process ensures a minimum 3 mils thickness for a finish that can withstand extreme climate changes without cracking or peeling.

OPTICS
A variety of precision-molded vacuum-metallized specular reflectors are engineered for superior field-to-beam ratios, uniformity and spacing. Light engines are available in 3000K (70 CRI min.), 4000K (70 CRI min.) or 5000K (70 CRI min.) configurations. Optional visors offer additional versatility.

ELECTRICAL
Light engines consist of chip-on-board (COB) LEDs directly coupled to the housing to maximize heat dissipation and promote long life (100,000 hrs, L80). Class 1 electronic driver has a power factor >90%, THD <20%, and has an expected life of 100,000 hours with <1% failure rate. Surge protection meets a minimum Category C Low operation (per ANSI/IEEE C62.41.2).

INSTALLATION
Integral adjustable knuckle with 3/4-14 NPT threaded pipe, or yoke mounting, facilitates quick and easy installation to a variety of mounting accessories. This secure connection enables the D-Series Size 3 to withstand up to a 1.5 G vibration load rating per ANSI C136.31.

LISTINGS
CSA certified to U.S. and Canadian standards. Luminaire is IP66 rated. Rated for -40°C minimum ambient.
DesignLights Consortium® (DLC) qualified product. Not all versions of this product may be DLC qualified. Please check the DLC Qualified Products List at www.designlights.org to confirm which versions are qualified.

WARRANTY
5-year limited warranty. Complete warranty terms located at:
www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx.

Note: Actual performance may differ as a result of end-user environment and application. All values are design or typical values, measured under laboratory conditions at 25 °C. Specifications subject to change without notice.

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d-series

D-Series Size 2
LED Wall Luminaire

Catalog Number

Notes

Type

Hit the Tab key or mouse over the page to see all interactive elements.

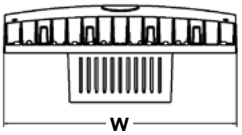
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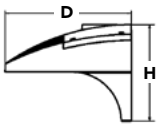
Luminaire

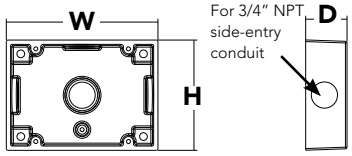
Width:	18-1/2" (47.0 cm)	**Weight:**	21 lbs (9.5 kg)
Depth:	10" (25.4 cm)		
Height:	7-5/8" (19.4 cm)		

Back Box (BBW)

Width:	5-1/2" (14.0 cm)	**BBW Weight:**	1 lbs (0.5 kg)
Depth:	1-1/2" (3.8 cm)		
Height:	4" (10.2 cm)		







Exterior Wall Mounted

A+ Capable options indicated by this color background.

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and system-level interoperability.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is A+ Certified when ordered with DTL® controls marked by a shaded background. DTL DLL equipped luminaires meet the A+ specification for luminaire to photocontrol interoperability1
- This luminaire is part of an A+ Certified solution for ROAM® or XPoint™ Wireless control networks, providing out-of-the-box control compatibility with simple commissioning, when ordered with drivers and control options marked by a shaded background[1]

To learn more about A+, visit www.acuitybrands.com/aplus.

1. See ordering tree for details.
2. A+ Certified Solutions for ROAM require the order of one ROAM node per luminaire. Sold Separately: Link to Roam; Link to DTL DLL

Ordering Information

EXAMPLE: DSXW2 LED 30C 700 40K T3M MVOLT DDBTXD

DSXW2 LED							
Series	**LEDs**	**Drive Current**	**Color temperature**	**Distribution**	**Voltage**	**Mounting**	**Control Options**
DSXW2 LED	20C 20 LEDs (two engines) 30C 30 LEDs (three engines)	350 350 mA 530 530 mA 700 700 mA 1000 1000 mA[1] (1 A)	30K 3000 K 40K 4000 K 50K 5000 K AMBPC Amber phosphor converted[2]	T2S Type II Short T2M Type II Medium T3S Type III Short T3M Type III Medium T4M Type IV Medium TFTM Forward Throw Medium	MVOLT[3] 120[4] 208[4] 240[4] 277[4] 347[4,5] 480[4,5]	**Shipped included** (blank) Surface mounting bracket **Shipped separately[6]** BBW Surface-mounted back box (for conduit entry)	**Shipped installed** PE Photoelectric cell, button type[7] PER NEMA twist-lock receptacle only (control ordered separate)[8] PER5 Five-wire receptacle only (control ordered separate)[8,9] PER7 Seven-wire receptacle only (control ordered separate)[8,9] DMG 0-10v dimming wires pulled outside fixture (for use with an external control, ordered separately) PIR 180° motion/ambient light sensor,<15' mtg ht[10,11] PIRH 180° motion/ambient light sensor, 15-30' mtg ht[10,11] PIR1FC3V Motion/ambient sensor, 8-15' mounting height, ambient sensor enabled at 1fc[11,12] PIRH1FC3V Motion/ambient sensor, 15-30' mounting height, ambient sensor enabled at 1fc[11,12]

Other Options				Finish *(required)*					
Shipped installed		**Shipped separately**[13]		DDBXD	Dark bronze	DSSXD	Sandstone	DWHGXD	Textured white
SF	Single fuse (120, 277, 347V)[3]	BSW	Bird-deterrent spikes	DBLXD	Black	DDBTXD	Textured dark bronze	DSSTXD	Textured sandstone
DF	Double fuse (208, 240, 480V)[3]	VG	Vandal guard	DNAXD	Natural aluminum	DBLBXD	Textured black		
HS	House-side shield[4]			DWHXD	White	DNATXD	Textured natural aluminum		
SPD	Separate surge protection[13]								

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Ordering Information

Accessories

Ordered and shipped separately.

DLL127F 1.5 JU	Photocell - SSL twist-lock (120-277V) [14]
DLL347F 1.5 CUL JU	Photocell - SSL twist-lock (347V) [14]
DLL480F 1.5 CUL JU	Photocell - SSL twist-lock (480V) [14]
DSHORT SBK U	Shorting cap (Included when ordering PER, PER5 or PER7) [14]
DSXWHS U	House-side shield (one per light engine)
DSXWBSW U	Bird-deterrent spikes
DSXW2VG U	Vandal guard accessory
DSXW2BBW DDBXD U	Back box accessory (specify finish)

For more control options, visit DTL and ROAM online.

NOTES

1 1000mA is not available with AMBPC.
2 AMBPC is not available with 1000mA.
3 MVOLT driver operates on any line voltage from 120-277V (50/60 Hz).
4 Single fuse (SF) requires 120, 277 or 347 voltage option. Double fuse (DF) requires 208, 240 or 480 voltage option.
5 Available with 30 LED/700mA options only (DSXW2 LED 30C 700). DMG option not available.
6 Also available as a separate accessory; see Accessories information.
7 Photocontrol (PE) requires 120, 208, 240, 277 or 347 voltage option. Not available with motion/ambient light sensors (PIR or PIRH).
8 Photocell ordered and shipped as a separate line item from Acuity Brands Controls. See accessories. Shorting Cap included.
9 If ROAM® node required, it must be ordered and shipped as a separate line item from Acuity Brands Controls. Shorting Cap included.
10 Reference Motion Sensor table on page 3.
11 Reference PER Table on page 3 for functionality.
12 PIR and PIR1FC3V specify the SensorSwitch SBGR-10-ODP control; PIRH and PIRH1FC3V specify the SensorSwitch SBGR-6-ODP control; see Motion Sensor Guide for details. Dimming driver standard. Not available with PER5 or PER7. Separate on/off required.
13 See the electrical section on page 2 for more details.
14 Requires luminaire to be specified with PER option. Ordered and shipped as a separate line item. See PER Table.

Performance Data

Lumen Output

Lumen values are from photometric tests performed in accordance with IESNA LM-79-08. Data is considered to be representative of the configurations shown, within the tolerances allowed by Lighting Facts. Contact factory for performance data on any configurations not shown here.

LEDs	Drive Current (mA)	System Watts	Dist. Type	30K					40K					50K				
				Lumens	B	U	G	LPW	Lumens	B	U	G	LPW	Lumens	B	U	G	LPW
20C (20 LEDs)	350 mA	25W	T2S	2,783	1	0	1	111	2,989	1	0	1	120	3,008	1	0	1	120
			T2M	2,709	1	0	1	108	2,908	1	0	1	116	2,926	1	0	1	117
			T3S	2,748	1	0	1	110	2,951	1	0	1	118	2,969	1	0	1	119
			T3M	2,793	1	0	1	112	2,999	1	0	1	120	3,018	1	0	1	121
			T4M	2,756	1	0	1	110	2,959	1	0	1	118	2,977	1	0	1	119
			TFTM	2,753	1	0	1	110	2,956	1	0	1	118	2,975	1	0	1	119
	530 mA	36W	T2S	4,030	1	0	1	112	4,327	1	0	1	120	4,354	1	0	1	121
			T2M	3,920	1	0	1	109	4,210	1	0	1	117	4,236	1	0	1	118
			T3S	3,978	1	0	1	111	4,272	1	0	1	119	4,299	1	0	1	119
			T3M	4,044	1	0	2	112	4,343	1	0	2	121	4,370	1	0	2	121
			T4M	3,990	1	0	1	111	4,284	1	0	1	119	4,310	1	0	1	120
			TFTM	3,987	1	0	1	111	4,281	1	0	1	119	4,308	1	0	1	120
	700 mA	47W	T2S	5,130	1	0	1	109	5,509	1	0	1	117	5,544	1	0	1	118
			T2M	4,991	1	0	2	106	5,360	1	0	2	114	5,393	1	0	2	115
			T3S	5,066	1	0	1	108	5,440	1	0	1	116	5,474	1	0	1	116
			T3M	5,148	1	0	2	110	5,529	1	0	2	118	5,563	1	0	2	118
			T4M	5,080	1	0	2	108	5,455	1	0	2	116	5,488	1	0	2	117
			TFTM	5,075	1	0	2	108	5,450	1	0	2	116	5,484	1	0	2	117
	1000 mA	73W	T2S	7,147	2	0	2	98	7,675	2	0	2	105	7,723	1	0	1	104
			T2M	6,954	2	0	2	95	7,467	2	0	2	102	7,514	2	0	2	103
			T3S	7,057	1	0	2	97	7,579	1	0	2	104	7,627	1	0	2	104
			T3M	7,172	2	0	3	98	7,702	2	0	3	106	7,751	2	0	3	106
			T4M	7,076	1	0	2	97	7,599	1	0	2	104	7,646	1	0	2	105
			TFTM	7,071	1	0	2	97	7,594	1	0	2	104	7,641	1	0	2	105
30C (30 LEDs)	350 mA	36W	T2S	4,160	1	0	1	116	4,467	1	0	1	124	4,494	1	0	1	125
			T2M	4,048	1	0	1	112	4,346	1	0	2	121	4,373	1	0	2	121
			T3S	4,108	1	0	1	114	4,411	1	0	1	123	4,438	1	0	1	123
			T3M	4,174	1	0	2	116	4,483	1	0	2	125	4,510	1	0	2	125
			T4M	4,119	1	0	1	114	4,423	1	0	2	123	4,450	1	0	2	124
			TFTM	4,115	1	0	1	114	4,419	1	0	1	123	4,446	1	0	1	124
	530 mA	54W	T2S	6,001	1	0	1	111	6,444	1	0	1	119	6,484	1	0	1	120
			T2M	5,838	1	0	2	108	6,270	2	0	2	116	6,308	2	0	2	117
			T3S	5,926	1	0	2	110	6,364	1	0	2	118	6,403	1	0	2	119
			T3M	6,023	1	0	2	112	6,467	1	0	2	120	6,507	1	0	2	121
			T4M	5,942	1	0	2	110	6,380	1	0	2	118	6,420	1	0	2	119
			TFTM	5,937	1	0	2	110	6,376	1	0	2	118	6,415	1	0	2	119
	700 mA	71W	T2S	7,403	2	0	2	104	8,170	2	0	2	115	8,221	2	0	2	116
			T2M	7,609	2	0	2	107	7,949	2	0	2	112	7,998	2	0	2	113
			T3S	7,513	1	0	2	106	8,068	1	0	2	114	8,118	1	0	2	114
			T3M	7,635	2	0	3	108	8,199	2	0	3	115	8,250	2	0	3	116
			T4M	7,534	1	0	2	106	8,089	1	0	2	114	8,140	1	0	2	115
			TFTM	7,527	1	0	2	106	8,082	2	0	2	114	8,134	2	0	2	115
	1000 mA	109W	T2S	10,468	2	0	2	96	11,241	2	0	2	103	11,311	2	0	2	104
			T2M	10,184	2	0	3	93	10,936	2	0	3	100	11,005	2	0	3	101
			T3S	10,335	2	0	2	95	11,099	2	0	2	102	11,169	2	0	2	102
			T3M	10,505	2	0	3	96	11,280	2	0	3	103	11,351	2	0	3	104
			T4M	10,365	2	0	2	95	11,129	2	0	2	102	11,198	2	0	2	103
			TFTM	10,356	2	0	2	95	11,121	2	0	3	102	11,190	2	0	3	103

Note:
Available with phosphor-converted amber LED's (nomenclature AMBPC). These LED's produce light with 97+% >530 nm.
Output can be calculated by applying a 0.7 factor to 4000 K lumen values and photometric files.

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Performance Data

Lumen Ambient Temperature (LAT) Multipliers

Use these factors to determine relative lumen output for average ambient temperatures from 0-40°C (32-104°F).

Ambient		Lumen Multiplier
0°C	32°F	1.02
10°C	50°F	1.01
20°C	68°F	1.00
25°C	**77°F**	**1.00**
30°C	86°F	1.00
40°C	104°F	0.98

Electrical Load

			Current (A)					
LEDs	Drive Current (mA)	System Watts	120V	208V	240V	277V	347V	480V
20C	350	25 W	0.23	0.13	0.12	0.10	-	-
	530	36 W	0.33	0.19	0.17	0.14	-	-
	700	47 W	0.44	0.25	0.22	0.19	-	-
	1000	74 W	0.68	0.39	0.34	0.29	-	-
30C	350	36 W	0.33	0.19	0.17	0.14	-	-
	530	54 W	0.50	0.29	0.25	0.22	-	-
	700	71 W	0.66	0.38	0.33	0.28	0.23	0.16
	1000	109 W	1.01	0.58	0.50	0.44	-	-

Projected LED Lumen Maintenance

Data references the extrapolated performance projections for the **DSXW2 LED 30C 1000** platform in a **25°C ambient**, based on 10,000 hours of LED testing (tested per IESNA LM-80-08 and projected per IESNA TM-21-11).

To calculate LLF, use the lumen maintenance factor that corresponds to the desired number of operating hours below. For other lumen maintenance values, contact factory.

Operating Hours	0	25,000	50,000	100,000
Lumen Maintenance Factor	1.0	0.95	0.92	0.87

Motion Sensor Default Settings						
Option	Dimmed State	High Level (when triggered)	Photocell Operation	Dwell Time	Ramp-up Time	Ramp-down Time
*PIR or PIRH	3V (37%) Output	10V (100%) Output	Enabled @ 5FC	5 min	3 sec	5 min
PIR1FC3V or PIRH1FC3V	3V (37%) Output	10V (100%) Output	Enabled @ 1FC	5 min	3 sec	5 min

*for use with Inline Dusk to Dawn or timer

PER Table

Control	PER (3 wire)	PER5 (5 wire)		PER7 (7 wire)		
			Wire 4/Wire5		Wire 4/Wire5	Wire 6/Wire7
Photocontrol Only (On/Off)	✓	⚠	Wired to dimming leads on driver	⚠	Wired to dimming leads on driver	Wires Capped inside fixture
ROAM	⊘	✓	Wired to dimming leads on driver	⚠	Wired to dimming leads on driver	Wires Capped inside fixture
ROAM with Motion	⊘	⚠	Wired to dimming leads on driver	⚠	Wired to dimming leads on driver	Wires Capped inside fixture
Futureproof*	⊘	⚠	Wired to dimming leads on driver	✓	Wired to dimming leads on driver	Wires Capped inside fixture
Futureproof* with Motion	⊘	⚠	Wired to dimming leads on driver	✓	Wired to dimming leads on driver	Wires Capped inside fixture

✓ Recommended

⊘ Will not work

⚠ Alternate

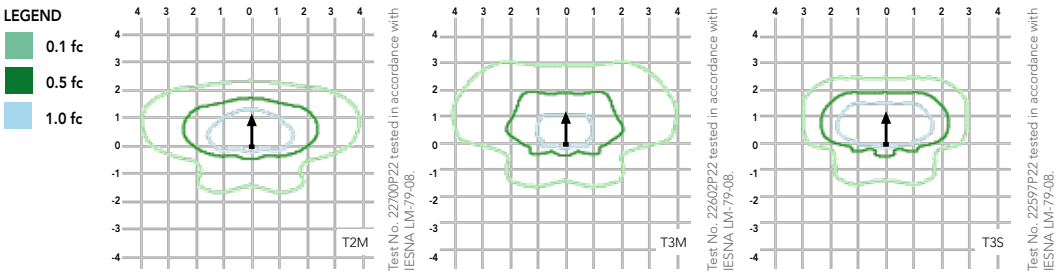
*Futureproof means: Ability to change controls in the future.

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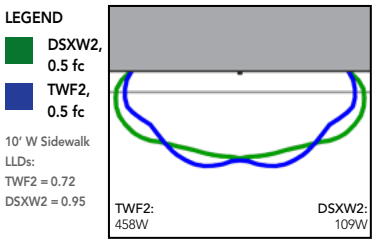
Photometric Diagrams

To see complete photometric reports or download .ies files for this product, visit Lithonia Lighting's D-Series Wall Size 2 homepage.

Isofootcandle plots for the DSXW2 LED 30C 1000 40K. Distances are in units of mounting height (25').



Distribution overlay comparison to 400W metal halide.



DSXW2 LED 30C 40K 1000 T2M, TWF2 400M Pulse, 25' Mounting Ht

FEATURES & SPECIFICATIONS

INTENDED USE

The energy savings, long life and easy-to-install design of the D-Series Wall Size 2 make it the smart choice for building-mounted doorway and pathway illumination for nearly any facility.

CONSTRUCTION

Two-piece die-cast aluminum housing has integral heat sink fins to optimize thermal management through conductive and convective cooling. Modular design allows for ease of maintenance. The LED driver is mounted to the door to thermally isolate it from the light engines for low operating temperature and long life. Housing is completely sealed against moisture and environmental contaminants (IP65).

FINISH

Exterior parts are protected by a zinc-infused Super Durable TGIC thermoset powder coat finish that provides superior resistance to corrosion and weathering. A tightly controlled multi-stage process ensures a minimum 3 mils thickness for a finish that can withstand extreme climate changes without cracking or peeling. Available in textured and non-textured finishes.

OPTICS

Precision-molded proprietary acrylic lenses provide multiple photometric distributions tailored specifically to building mounted applications. Light engines are available in 3000 K (70 min. CRI), 4000 K (70 min. CRI) or 5000 K (70 min. CRI) configurations.

ELECTRICAL

Light engine(s) consist of 10 high-efficacy LEDs mounted to a metal-core circuit board to maximize heat dissipation and promote long life (L87/100,000 hrs at 25°C). Class 1 electronic drivers have a power factor >90%, THD <20%, and a minimum 2.5KV surge rating. When ordering the SPD option, a separate surge protection device is installed within the luminaire which meets a minimum Category C Low (per ANSI/IEEE C62.41.2).

INSTALLATION

Included universal mounting bracket attaches securely to any 4" round or square outlet box for quick and easy installation. Luminaire has a slotted gasket wireway and attaches to the mounting bracket via corrosion-resistant screws.

LISTINGS

CSA certified to U.S. and Canadian standards. Rated for -40°C minimum ambient.

DesignLights Consortium® (DLC) qualified product. Not all versions of this product may be DLC qualified. Please check the DLC Qualified Products List at www.designlights.org to confirm which versions are qualified.

WARRANTY

Five-year limited warranty. Complete warranty terms located at www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx.

Note: Actual performance may differ as a result of end-user environment and application. All values are design or typical values, measured under laboratory conditions at 25 °C. Specifications subject to change without notice.

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Wall Mount High Abuse

LITHONIA LIGHTING®

Catalog Number	
Notes	
Type	

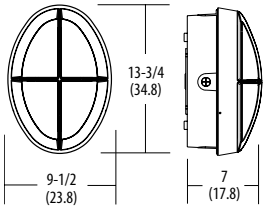
GRS GATEWAY®

Architectural Rough Service Fixture

VG04C

LED
Oval Open Face
Deep Housing
Ceiling/Wall Mounted





All dimensions are inches (centimeters).

FEATURES & SPECIFICATIONS

INTENDED USE — Architectural deep-cast luminaire provides general illumination for rough service (vandal resistant) applications. Ideal for interior or exterior applications where safety and security are a concern. Designed to complement building architecture and to endure extreme environmental conditions and physical abuse. Amber LEDs available for applications requiring turtle-safe lighting. Certain airborne contaminants can diminish integrity of acrylic. Click here for Acrylic Environmental Compatibility table for suitable uses.

CONSTRUCTION — *Bezel* - One-piece, die-cast aluminum, low copper alloy (<1% copper). Encloses lens and secures to housing with stainless steel Torx® T-10 set screws (two included) or optional stainless steel tamper-resistant screws (see options).

Housing - One-piece, die-cast aluminum, low copper alloy (<1% copper), with post-painted polyester powder coat finish. Four hole mounting detail for use directly over outlet box, or conduit entry through three 1/2" threaded openings on side or 3/4" threaded opening on rear surface. .012 gauge aluminum sheet metal internal bracket and board plate for thermal conduction and support.

Gasket - Polycarbonate: Perimeter lens gasket is one-piece silicone "O" ring, mechanically held in lens channel. Glass: Perimeter lens gasket is closed-cell silicone. Pad mounting gasket is closed-cell neoprene and seals housing to mounting surface. Gaskets help cushion impact shock.

Finish - Standard finish is textured polyester powder coat in white, black or bronze. Optional architectural colors available (see paint finishes).

OPTICS — *Polycarbonate lens* – Injection-molded lens is .125 inch thick. Designed to enrich the LED color and lumen output. Smooth exterior allows for easy cleaning, and interior pattern diffuses light for even surface illumination.

ELECTRICAL — Utilizes high-efficiency LEDs mounted to 2 metal core circuit boards. 3500 Kelvin temperature. Driver: 2 electronic drivers wired in parallel allows total power to be reduced by half while maintaining even illumination across the 2 boards. 70% lumen maintenance at 50,000 hours. 100V through 277V, 50-60HZ operation. 6KV pulse rated. Integral surge protection standard.

INSTALLATION — Unit may be wall or ceiling mounted.

LISTINGS — CSA Certified to UL and C-UL standards. NOM Certified (see Options). CSA listed for 30°C ambient and wet locations. IP65 rated.

WARRANTY — 5-year limited warranty. Complete warranty terms located at: www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx

For installed Rough Service Product(s), Acuity warrants that, for the lifetime of the product(s), the polycarbonate lens and/or polycarbonate housing will withstand breakage resulting from occasional physical abuse and rough handling (the "Rough Service Warranty"), notwithstanding the vandalism exclusion set forth at www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx

NOTE: Actual performance may differ as a result of end-user environment and application.
All values are design or typical values, measured under laboratory conditions at 25°C.
Specifications subject to change without notice.

ORDERING INFORMATION For shortest lead times, configure products using **bolded options**.

Example: VG04C 40LED 120 DBLB SF LPI

VG04C							
Series	**Lumen output[1]/Color temperature[2]**		**Lens**	**Voltage**	**Paint finishes[3]**	**Options**	**Lamp**
VG04C	**Lumen output[1]** **40LED** 40W 25LED 25W	**Color temperature[2]** (**blank**) 3500K	(**blank**) Polycarbonate	**120** **277** **MVOLT**	Standard textured finishes **DWHG** White **DBLB** Black **DDBT** Dark bronze **DNAT** Natural aluminum **DSST** Sandstone	Shipped installed in fixture DF Double fuse[4,5] **SF** Single fuse[5] **DS** Dual switching[6] MSI8 Wet location motion sensor[5,7] **PE** Photoelectric cell[5,8] TRS Tamper-resistant screws[9] **NOM** Meets Mexican standards	**LPI** Lamp included

Accessories: *Order as separate catalog number.*

RK1 T10DRV Torx TX10 screwdriver, for use with Gateway set screws.
RK1 T20BIT Hex-base driver bit, Torx TX20, for tamper-resistant screws with center reject pin.
RK1 T20DRV Torx TX20 screwdriver for use with tamper-resistant screws with center reject pin.

Notes
1. Refer to table on back page.
2. The CCT value provided is of lamp source and actual CCT will vary upon power levels.
3. For additional colors, refer to Architectural Paint brochure.
4. Must specify DS option.
5. Must specify voltage. Not available with MVOLT.
6. Not available with SF or PE options.
7. Provided with lens for mounting up to 8'.
8. Not available with DS option.
9. T-20 screws with center reject pin.

System watts	Initial delivered lumens through polycarbonate lens*	Initial delivered lumens through glass lens*	mA	Ambient temperature °C
	3500K	3500K		
40	1165	780	500	30
25	900	605	350	30

* 3500K is LED CCT

SPECIAL APPLICATIONS: One Lithonia Way Conyers, GA 30012 Phone: 800.315.4963 Fax: 770-981-8191 www.lithonia.com

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LITHONIA LIGHTING®

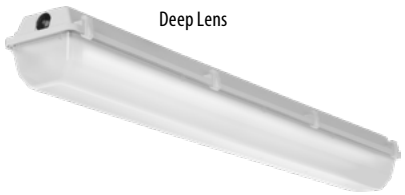
Catalog Number
Notes
Type

Low-Profile Enclosed and Gasketed Industrial

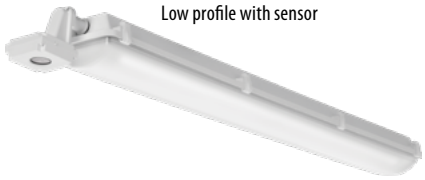
FEM LED

CEILING/ SUSPENDED MOUNT

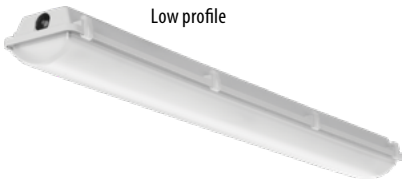
Deep Lens



Low profile with sensor



Low profile



FEATURES & SPECIFICATIONS

INTENDED USE — A general purpose and energy-efficient surface-mounted or suspended LED fixture, suitable for wet, damp and/or cold locations. For vapor-tight demanding environments where moisture or dust is a concern and where relatively low fixture mounting heights and wide fixture spacing are common. Typical applications include industrial facilities, parking garages, retail malls, multi-purpose rooms, garden centers, and food processing. **Certain airborne contaminants can diminish the integrity of acrylic and/or polycarbonate.** **Click here for Acrylic-Polycarbonate Compatibility table for suitable use.**

Certain airborne contaminants may adversely affect the functioning of LEDs and other electronic components, depending on various factors such as concentrations of the contaminants, ventilation, and temperature at the end-user location. **Click here for a list of substances that may not be suitable for interaction with LEDs and other electronic components.**

CONSTRUCTION — One-piece 5VA fiberglass housing with integral perimeter channel utilizing continuous poured-in-place NEMA 4X gasket. Approved as a wireway and for through wiring. Captive polymeric latches are standard. Stainless steel latches (#316) available as an option for food processing or more demanding applications.

Power connection is easily accomplished through pre-drilled holes. Fixture easily mounts to ceilings and other solid structures, or can be suspended with chain, cable or rod using stainless steel mounting brackets (included).

OPTICS — Injection molded, acrylic lens (.080" thick) provides high impact-resistance comparable to 100% DR. For L48 Medium Distribution, a UV stabilized polycarbonate diffuser is available (.080" thick) in clear or frosted for additional impact strength where vandal protection is desired.

Expected service life of 60,000 hours at 80% lumen maintenance (L80); predicted life of more than 100,000 hours.

ELECTRICAL — Utilizes high-efficiency LEDs mounted to core circuit boards. High-efficiency drivers operate 120 thru 277V, 347V and 480V offered with 0-10 volt dimming, allowing granular control when coupled with wireless networking controls. Luminaire Surge Protection Level: Designed to withstand up to 6kV/3kA per ANSI C82.77-5-2015.

INSTALLATION — Fixture can be ceiling or suspended mounted. Pre-punched stainless steel mounting brackets are included (two per luminaire) for easy field-attachment of bolts, screws and other mounting hardware. A covered ceiling is not required to maintain wet location listing or IP rating.

LISTINGS — CSA certified to UL and C-UL standards. Listed for wet locations in ambient temps ranging from -35°C (-31°F) to 25°C (77°F) when fixture is surface mounted or up to 45°C (113°F) when fixture is suspended at least 6" from ceiling. IP65, IP66 and IP67 rated. NSF splash-zone 2 certified and meets FDA/USDA guidelines. Nema 4X rated lens and housing. 1500 PSI hose-down. DesignLights Consortium® (DLC) Premium qualified product and DLC qualified product. Not all versions of this product may be DLC Premium qualified or DLC qualified. Please check the DLC Qualified Products List at www.designlights.org/QPL to confirm which versions are qualified.

WARRANTY — 5-year limited warranty. Complete warranty terms located at: www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx

NOTE: Actual performance may differ as a result of end-user environment and application. All values are design or typical values, measured under laboratory conditions at 25 °C. Specifications subject to change without notice.

Stock configurations are offered for shorter lead times:

Standard Part Number	Stock Part Number
FEM L48 4000LM LPAFL MD MVOLT GZ10 40K 80CRI	**FEM L48 4L MVOLT**
FEM L48 4000LM LPAFL MD MVOLT GZ10 50K 80CRI	**FEM L48 4L MVOLT 5K**

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is part of an A+ Certified solution for nLight® or XPoint™ Wireless control networks marked by a shaded background*

To learn more about A+, visit www.acuitybrands.com/aplus.

*See ordering tree for details

FEM LED Low-Profile Enclosed and Gasketed

A+ Capable options indicated by this color background.

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: FEM L48 4000LM IMAFL WD MVOLT GZ10 40K 80CRI

Series	Length	Nominal Lumens	Diffuser	Distribution	Voltage	Driver	Color temperature	CRI
FEM	L48 48" [1]	3000LM 3,000 lumens 4000LM 4,000 lumens 6000LM 6,000 lumens 8000LM 8,000 lumens 10000LM 10,000 lumens	IMAFL Acrylic, lineal ribbed frosted lens IMACD Acrylic, clear deep lens IMAFD Acrylic, deep frosted lens LPAFL Acrylic, low profile frosted lens[3] LPACL Acrylic, low profile clear lens[3] LPPCL Polycarbonate, low profile clear lens[3] LPPFL Polycarbonate, low profile frosted lens[3]	MD Medium WD Wide [4]	MVOLT MVOLT 120 120V 277 277V 347 347V[5] 480 480V[5]	GZ10 0 - 10V dimming	30K 3000K 35K 3500K 40K 4000K 50K 5000K	80CRI 80 CRI 90CRI 90 CRI
	L96 96" [2]	9000LM 9,000 lumens 12000LM 12,000 lumens 15000LM 15,000 lumens 18000LM 18,000 lumens 20000LM 20,000 lumens						

Options

SF	Single fuse (available with 120, 277, 347)[6]	CS88	6' Brad Harrison 16/3 cord and straight blade plug set[6]	Individual Controls: [12]	
DF	Double Fusing (available with 347, 480V)[6]	CS88L12	12' Brad Harrison 16/3 cord and straight blade plug set[6]	MSI10NWL	Low mount 360° integral motion sensor, wet location, On/Off operation[6]
BSL520	Bodine® emergency LED battery pack for -20°C and up. CA Title 20 Noncompliant [7,8]	CS88R	Brad Harrison receptacle	MSI102L3VWL	Low mount 360° integral motion sensor, wet location, High/Low operation (bi-level)[6]
E15WCP	Emergency battery pack, 15W constant power, Certified in CA Title 20 MAEDBS [6,7,9]	CS89	6' white cord, 16/3, no plug, wet location	MSI10NWL DSCNWL	Low mount 360° integral motion sensor, wet location, On/Off operation for motion sensing, override Off due to daylight[6]
BGTD	Generator transfer device[6,10]	CS89L12	12' white cord, 16/3, no plug, wet location	Xpoint Wireless: [12]	
SPD	Surge protection device, additional 10kV/5kA[6]	TRS	Tamper Resistant Torx® T10 screws	MSI10XAWL DSCXAWL	Xpoint wireless integral motion sensor, On/Off operation for motion sensing, override Off due to daylight[6]
WLF	Wet location fitting (two outboard, top)	DPMB	Dual pendant mounting bracket	XAD	XPoint™ wireless controller, 0-10V dimming[6]
WLFEND	Wet location fitting (one end)	STSL	Stainless steel latches	nLight Air:	
WLFEND2	Wet location fitting (both ends)[11]			NLTAIR2 RSBOR10	nLight AIR generation 2 enabled 306 low mount motion sensor [12]

Accessories: *Order as separate catalog number.*

MHCH 36	Jack chain 36" (pair)
MHHK120	10' single leg air craft cable (ships as pair)
MHHK120SS	10' single leg air craft cable, stainless steel (ships as pair)
RK1 T10BIT W/PIN U	Hex-base driver bit, Torx TX10, for tamper resistant screws with center reject pin
FEMDPMB	Dual pendant mounting bracket (ships as a pair)

Notes

1 Available with 3000LM, 4000LM, 6000LM, 8000LM, and 10000LM lumen packages. Not available with WD when using low profile diffuser.

2 Available with 9000LM, 12000LM, 15000LM, 18000LM, and 20000LM. Not available with low profile diffuser options.

3 Not available with L96. Not available with L48 when ordering WD option.

4 Not availabe with L48 when ordering low-profile lens options.

5 Utilizes step-down transformer. Not available with BGTD.

6 Must specify voltage.

7 Not available with 347 or 480V.

8 For use with ambient temperatures no lower than -20°C.

9 For use in ambient temperatures no lower than -17°C.

10 Available with 120V or 277V only. For use in ambient environments up to 25C. Not available with L48 when ordering 10000LM lumen package. Not available with L96 when ordering 18000LM or 20000LM lumen packages.

11 Not available with Sensor options or cord sets, or MSI controls.

12 Not available with multiple control options - other MSE or Xpoint.

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OPERATIONAL DATA

		Lumen packages	Wattage				Diffusers		
			120v	277v	347v	480v	Acrylic Lineal Frosted (IMAFL)	Frosted (IMAFD, LPAFL, LPPFL)	Clear (IMACD, LPACL, LPPCL)
L48 Medium Distribution *test results reflect less than 1% difference between acrylic (clear/deep/low profile) and polycarbonate (low profile) lens	**Delivered Lumens at 30K 80CRI**	3000LM	23	23	24	25	2972	3032	3071
		4000LM	31	30	31	32	4019	4100	4153
		6000LM	45	44	46	47	5925	6044	6122
		8000LM	69	67	70	71	7593	7746	7845
		10000LM	80	78	81	82	9781	9979	10107
	Delivered Lumens at 35K 80CRI	3000LM	23	23	24	25	3039	3100	3140
		4000LM	31	30	31	32	4109	4192	4246
		6000LM	45	44	46	47	6057	6179	6258
		8000LM	69	67	70	71	7762	7918	8020
		10000LM	80	78	81	82	9999	10201	10332
	Delivered Lumens at 40K 80CRI	3000LM	23	23	24	25	3086	3148	3189
		4000LM	31	30	31	32	4173	4257	4312
		6000LM	45	44	46	47	6151	6275	6356
		8000LM	69	67	70	71	7883	8042	8145
		10000LM	80	78	81	82	10155	10360	10493
	Delivered Lumens at 50K 80CRI	3000LM	23	23	24	25	3200	3264	3306
		4000LM	31	30	31	32	4326	4414	4470
		6000LM	45	44	46	47	6378	6506	6590
		8000LM	69	67	70	71	8173	8338	8445
		10000LM	80	78	81	82	10529	10741	10879

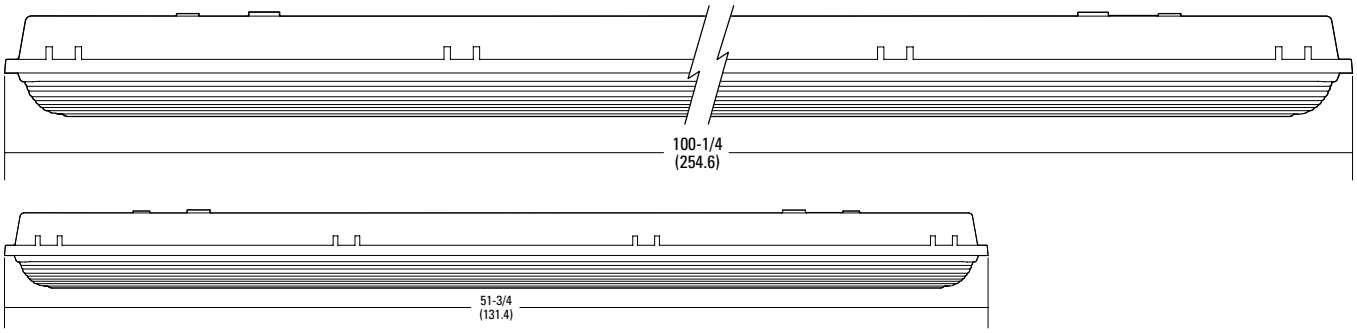
		Lumen packages	Wattage				Diffusers		
			120v	277v	347v	480v	Acrylic Lineal Frosted (IMAFL)	Acrylic Frosted (IMAFD)	Acrylic Clear (IMACD)
L96 Medium Distribution	**Delivered Lumens at 30K 80CRI**	9000LM	65	64	66	67	8718	8959	9072
		12000LM	88	86	89	90	11370	11685	11831
		15000LM	120	118	122	124	14263	14657	14841
		18000LM	145	141	146	148	16863	17330	17547
		20000LM	160	156	162	164	19313	19847	20096
	Delivered Lumens at 35K 80CRI	9000LM	65	64	66	67	8913	9159	9274
		12000LM	88	86	89	90	11624	11945	12095
		15000LM	120	118	122	124	14581	14984	15172
		18000LM	145	141	146	148	17239	17716	17938
		20000LM	160	156	162	164	19743	20289	20544
	Delivered Lumens at 40K 80CRI	9000LM	65	64	66	67	9051	9302	9419
		12000LM	88	86	89	90	11805	12131	12284
		15000LM	120	118	122	124	14808	15218	15409
		18000LM	145	141	146	148	17507	17992	18218
		20000LM	160	156	162	164	20051	20605	20864
	Delivered Lumens at 50K 80CRI	9000LM	65	64	66	67	9385	9644	9765
		12000LM	88	86	89	90	12239	12578	12736
		15000LM	120	118	122	124	15353	15778	15976
		18000LM	145	141	146	148	18152	18654	18888
		20000LM	160	156	162	164	20789	21364	21632

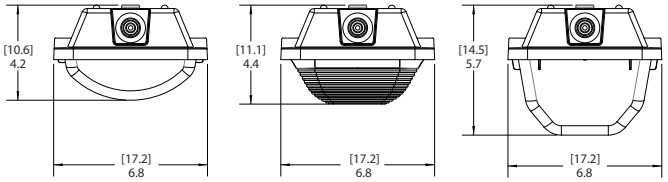
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DIMENSIONS

Specifications subject to change without notice.
All dimensions are inches (centimeters) unless otherwise indicated.

Weight (may vary with options or accessories)
FEM L48: 11.9 lbs (5.397kg)
FEM L96: 24.3 lbs (11.022kg)





Diffuser Type:
LPAFL
LPACL
LPPFL
LPPCL

Diffuser Type:
IMAFL

Diffuser Type:
IMAFD
IMACD

PHOTOMETRICS

See www.lithonia.com for photometry reports.

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D-Series Size 1
LED Area Luminaire

Catalog Number

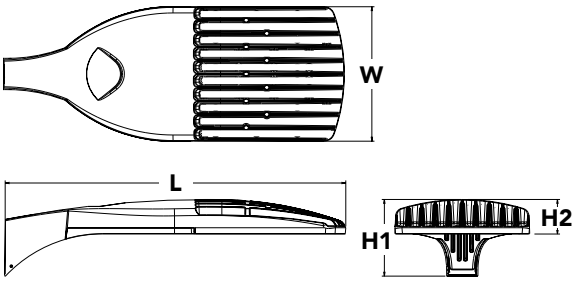
Notes

Type

Hit the Tab key or mouse over the page to see all interactive elements.

Specifications

EPA:	1.01 ft² (0.09 m²)
Length:	33″ (83.8 cm)
Width:	13″ (33.0 cm)
Height H1:	7-1/2″ (19.0 cm)
Height H2:	3-1/2″
Weight (max):	27 lbs (12.2 kg)



Introduction

The modern styling of the D-Series is striking yet unobtrusive - making a bold, progressive statement even as it blends seamlessly with its environment. The D-Series distills the benefits of the latest in LED technology into a high performance, high efficacy, long-life luminaire.

The outstanding photometric performance results in sites with excellent uniformity, greater pole spacing and lower power density. It is ideal for replacing up to 750W metal halide in pedestrian and area lighting applications with typical energy savings of 65% and expected service life of over 100,000 hours.

A+ Capable options indicated by this color background.

Ordering Information

EXAMPLE: DSX1 LED P7 40K T3M MVOLT SPA NLTAIR2 PIRHN DDBXD

DSX1 LED

Series

DSX1 LED

LEDs

Forward optics

P1	P4	P7
P2	P5	P8
P3	P6	P9

Rotated optics

P10[1]	P12[1]
P11[1]	P13[1]

Color temperature

30K	3000 K
40K	4000 K
50K	5000 K

Distribution

T1S	Type I short	T5VS	Type V very short
T2S	Type II short	T5S	Type V short
T2M	Type II medium	T5M	Type V medium
T3S	Type III short	T5W	Type V wide
T3M	Type III medium	BLC	Backlight control[2]
T4M	Type IV medium	LCCO	Left corner cutoff[2]
TFTM	Forward throw medium	RCCO	Right corner cutoff[2]

Voltage

MVOLT[3]
120[4]
208[4]
240[4]
277[4]
347[4,5]
480[4,5]

Mounting

Shipped included

SPA	Square pole mounting
RPA	Round pole mounting
WBA	Wall bracket
SPUMBA	Square pole universal mounting adaptor[6]
RPUMBA	Round pole universal mounting adaptor[6]

Shipped separately

KMA8 DDBXD U	Mast arm mounting bracket adaptor (specify finish)[7]

Control options

Shipped installed

NLTAIR2	nLight AIR generation 2 enabled[8]
PIRHN	Network, high/low motion/ambient sensor[9]
PER	NEMA twist-lock receptacle only (controls ordered separate)[10]
PER5	Five-pin receptacle only (controls ordered separate)[10,11]
PER7	Seven-pin receptacle only (controls ordered separate)[10,11]
DMG	0-10v dimming wires pulled outside fixture (for use with an external control, ordered separately)[12]
DS	Dual switching[12,13,14]
PIR	High/low, motion/ambient sensor, 8-15′ mounting height, ambient sensor enabled at 5fc[15,16]
PIRH	High/low, motion/ambient sensor, 15-30′ mounting height, ambient sensor enabled at 5fc[15,16]
PIR1FC3V	High/low, motion/ambient sensor, 8-15′ mounting height, ambient sensor enabled at 1fc[15,16]
PIRH1FC3V	Bi-level, motion/ambient sensor, 15-30′ mounting height, ambient sensor enabled at 1fc[15,16]
FAO	Field adjustable output[14]

Other options

Shipped installed

HS	House-side shield[17]
SF	Single fuse (120, 277, 347V)[4]
DF	Double fuse (208, 240, 480V)[4]
L90	Left rotated optics[1]
R90	Right rotated optics[1]

Shipped separately

BS	Bird spikes[18]
EGS	External glare shield[18]

Finish *(required)*

DDBXD	Dark bronze
DBLXD	Black
DNAXD	Natural aluminum
DWHXD	White
DDBTXD	Textured dark bronze
DBLBXD	Textured black
DNATXD	Textured natural aluminum
DWHGXD	Textured white

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Ordering Information

Accessories

Ordered and shipped separately.

DLL127F 1.5 JU	Photocell - SSL twist-lock (120-277V) [19]
DLL347F 1.5 CUL JU	Photocell - SSL twist-lock (347V) [19]
DLL480F 1.5 CUL JU	Photocell - SSL twist-lock (480V) [19]
DSHORT SBK U	Shorting cap [19]
DSX1HS 30C U	House-side shield for P1, P2, P3, P4 and P5[17]
DSX1HS 40C U	House-side shield for P6 and P7[17]
DSX1HS 60C U	House-side shield for P8, P9, P10, P11 and P12[17]
PUMBA DDBXD U*	Square and round pole universal mounting bracket (specify finish)[20]
KMA8 DDBXD U	Mast arm mounting bracket adaptor (specify finish) [6]

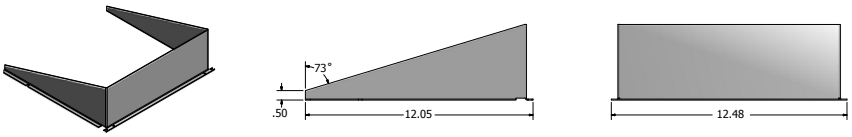
For more control options, visit DTL and ROAM online.

NOTES

1 P10, P11, P12 or P13 and rotated optics (L90, R90) only available together.
2 Not available with HS.
3 MVOLT driver operates on any line voltage from 120-277V (50/60 Hz).
4 Single fuse (SF) requires 120V, 277V or 347V. Double fuse (DF) requires 208V, 240V or 480V.
5 Not available in P1 or P10.
6 Universal mounting brackets intended for retrofit on existing, pre-drilled poles only. 1.5 G vibration load rating per ANCI C136.31.
7 Must order fixture with SPA option. Must be ordered as a separate accessory; see Accessories information. For use with 2-3/8" mast arm (not included).
8 Must be ordered with PIRHN. Sensor cover available only in dark bronze, black, white and natural aluminum colors.
9 Must be ordered with NLTAIR2. For more information on nLight Air 2 visit this link.
10 Photocell ordered and shipped as a separate line item from Acuity Brands Controls. See accessories. Not available with DS option. Shorting cap included.
11 If ROAM® node required, it must be ordered and shipped as a separate line item from Acuity Brands Controls. Node with integral dimming.
12 Provides 50/50fixture operation via (2) independent drivers. Not available with PER, PER5, PER7, PIR or PIRH. Not available P1, P2, P3, P4 or P5.
13 Requires (2) separately switched circuits with isolated neutrol. See Outdoor Control Technical Guide for details.
14 Reference Motion Sensor table on page 4.
15 Reference controls options table on page 4 to see functionality.
16 Not available with other dimming controls options
17 Not available with BLC, LCCO and RCCO distribution. Also available as a separate accessory; see Accessories information.
18 Must be ordered with fixture for factory pre-drilling.
19 Requires luminaire to be specified with PER, PER5 or PER7 option. See PER Table on page 3.
20 For retrofit use only.

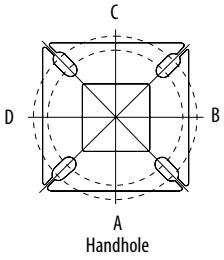
Options

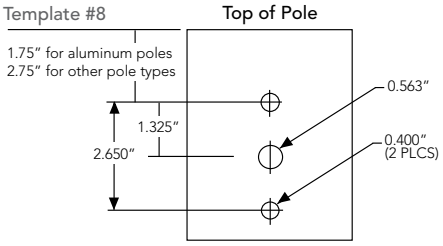
EGS - External Glare Shield



Drilling

HANDHOLE ORIENTATION





Tenon Mounting Slipfitter **

Tenon O.D.	Mounting	Single Unit	2 @ 180	2 @ 90	3 @120	3 @ 90	4 @ 90
2-3/8"	SPA/RPA	AS3-5 190	AS3-5 280	AS3-5 290	AS3-5 320	AS3-5 390	AS3-5 490
	SPUMBA	AS3-5 190	AS3-5 280	AS4-5 290	AS3-5 320	AS4-5 390	AS4-5 490
	RUPUMBA	AS3-5 190	AS3-5 280		AS3-5 320		
2-7/8"	SPA/RPA	AST25-190	AST25-280	AST25-290	AST25-320	AST25-390	AST25-490
	SPUMBA	AST25-190	AST25-280		AST25-320		
	RUPUMBA	AST25-190	AST25-280		AST25-320		
4"	SPA/RPA	AST35-190	AST35-280	AST35-290	AST35-320	AST35-390	AST35-490
	SPUMBA	AST35-190	AST35-280	AST35-290	AST35-320	AST35-390	AST35-490
	RUPUMBA	AST35-190	AST35-280		AST35-320		

Mounting Option	Drilling Template	Single	2 @ 180	2 @ 90	3 @ 90	3 @ 120	4 @ 90
Head Location		Side B	Side B & D	Side B & C	Side B, C & D	Round Pole Only	Side A, B, C & D
Drill Nomenclature	#8	DM19AS	DM28AS	DM29AS	DM39AS	DM32AS	DM49AS

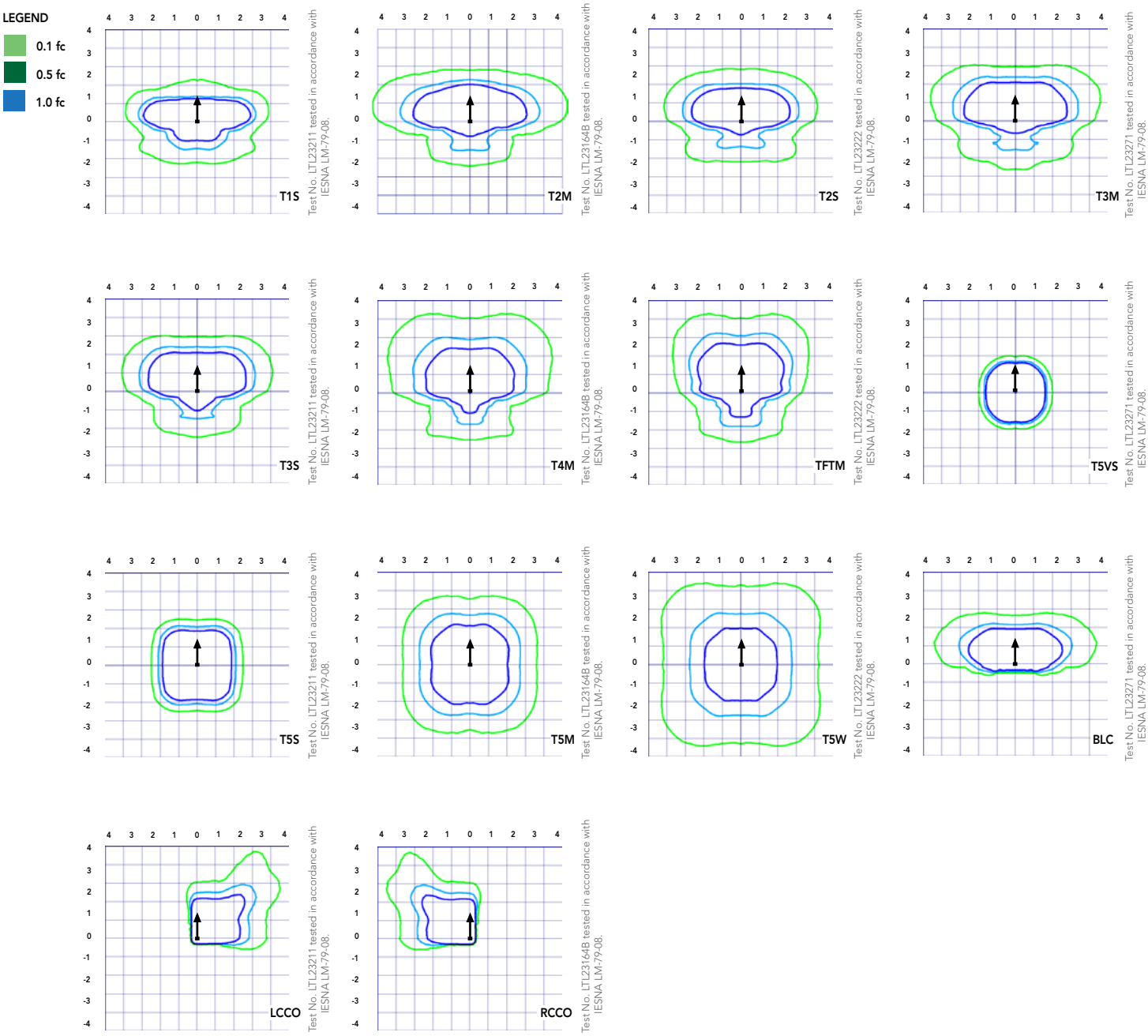
	Drilling Template	Minimum Acceptable Outside Pole Dimension					
SPA	#8	2-7/8"	2-7/8"	3.5"	3.5"	3"	3.5"
RPA	#8	2-7/8"	2-7/8"	3.5"	3.5"	3"	3.5"
SPUMBA	#5	2-7/8"	3"	4"	4"	3.5"	4"
RPUMBA	#5	2-7/8"	3.5"	5"	5"	3.5"	5"

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Photometric Diagrams

To see complete photometric reports or download .ies files for this product, visit Lithonia Lighting's D-Series Area Size 1 homepage.

Isofootcandle plots for the DSX1 LED 60C 1000 40K. Distances are in units of mounting height (25').



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Performance Data

Lumen Ambient Temperature (LAT) Multipliers

Use these factors to determine relative lumen output for average ambient temperatures from 0-40°C (32-104°F).

Ambient		Lumen Multiplier
0°C	32°F	1.04
5°C	41°F	1.04
10°C	50°F	1.03
15°C	50°F	1.02
20°C	68°F	1.01
25°C	**77°F**	**1.00**
30°C	86°F	0.99
35°C	95°F	0.98
40°C	104°F	0.97

Projected LED Lumen Maintenance

Data references the extrapolated performance projections for the platforms noted in a **25°C ambient**, based on 10,000 hours of LED testing (tested per IESNA LM-80-08 and projected per IESNA TM-21-11).

To calculate LLF, use the lumen maintenance factor that corresponds to the desired number of operating hours below. For other lumen maintenance values, contact factory.

Operating Hours	Lumen Maintenance Factor
0	1.00
25,000	0.96
50,000	0.92
100,000	0.85

Motion Sensor Default Settings						
Option	Dimmed State	High Level (when triggered)	Phototcell Operation	Dwell Time	Ramp-up Time	Ramp-down Time
PIR or PIRH	3V (37%) Output	10V (100%) Output	Enabled @ 5FC	5 min	3 sec	5 min
*PIR1FC3V or PIRH1FC3V	3V (37%) Output	10V (100%) Output	Enabled @ 1FC	5 min	3 sec	5 min
*for use when motion sensor is used as dusk to dawn control.						

Electrical Load

					Current (A)					
	Performance Package	LED Count	Drive Current	Wattage	120	208	240	277	347	480
Forward Optics (Non-Rotated)	P1	30	530	54	0.45	0.26	0.23	0.19	0.10	0.12
	P2	30	700	70	0.59	0.34	0.30	0.25	0.20	0.16
	P3	30	1050	102	0.86	0.50	0.44	0.38	0.30	0.22
	P4	30	1250	125	1.06	0.60	0.52	0.46	0.37	0.27
	P5	30	1400	138	1.16	0.67	0.58	0.51	0.40	0.29
	P6	40	1250	163	1.36	0.78	0.68	0.59	0.47	0.34
	P7	40	1400	183	1.53	0.88	0.76	0.66	0.53	0.38
	P8	60	1050	207	1.74	0.98	0.87	0.76	0.64	0.49
	P9	60	1250	241	2.01	1.16	1.01	0.89	0.70	0.51
Rotated Optics (Requires L90 or R90)	P10	60	530	106	0.90	0.52	0.47	0.43	0.33	0.27
	P11	60	700	137	1.15	0.67	0.60	0.53	0.42	0.32
	P12	60	1050	207	1.74	0.99	0.87	0.76	0.60	0.46
	P13	60	1250	231	1.93	1.12	0.97	0.86	0.67	0.49

Controls Options				
Nomenclature	Descripton	Functionality	Primary control device	Notes
FAO	Field adjustable output device installed inside the lumiaire; wired to the driver dimming leads.	Allows the lumiaire to be manually dimmed, effectively trimming the light output.	FAO device	Cannot be used with other controls options that need the 0-10V leads
DS	Drivers wired independantly for 50/50 luminaire operation	The luminaire is wired to two separate circuits, allowing for 50/50 operation.	Independently wired drivers	Requires two seperately switched circuits. Consider nLight AIR as a more cost effective alternative.
PER5 or PER7	Twist-lock photocell recepticle	Compatible with standard twist-lock photocells for dusk to dawn operation, or advanced control nodes that provide 0-10V dimming signals.	Twist-lock photocells such as DLL Elite or advanced control nodes such as ROAM.	Pins 4 & 5 to dimming leads on driver, Pins 6 & 7 are capped inside luminaire
PIR or PIRH	Motion sensors with integral photocell. PIR for 8-15' mounting; PIRH for 15-30' mounting	Luminaires dim when no occupancy is detected.	Acuity Controls SBOR	Also available with PIRH1FC3V when the sensor photocell is used for dusk-to-dawn operation.
NLTAIR2 PIRHN	nLight AIR enabled luminaire for motion sensing, photocell and wireless communication.	Motion and ambient light sensing with group response. Scheduled dimming with motion sensor over-ride when wirelessly connected to the nLight Eclypse.	nLight Air rSDGR	nLight AIR sensors can be programmed and commissioned from the ground using the CIAIRity Pro app.

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Performance Data

Lumen Output

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Forward Optics

LED Count	Drive Current	Power Package	System Watts	Dist. Type	30K (3000 K, 70 CRI)					40K (4000 K, 70 CRI)					50K (5000 K, 70 CRI)				
					Lumens	B	U	G	LPW	Lumens	B	U	G	LPW	Lumens	B	U	G	LPW
30	530	**P1**	54W	T1S	6,457	2	0	2	120	6,956	2	0	2	129	7,044	2	0	2	130
				T2S	6,450	2	0	2	119	6,949	2	0	2	129	7,037	2	0	2	130
				T2M	6,483	1	0	1	120	6,984	2	0	2	129	7,073	2	0	2	131
				T3S	6,279	2	0	2	116	6,764	2	0	2	125	6,850	2	0	2	127
				T3M	6,468	1	0	2	120	6,967	1	0	2	129	7,056	1	0	2	131
				T4M	6,327	1	0	2	117	6,816	1	0	2	126	6,902	1	0	2	128
				TFTM	6,464	1	0	2	120	6,963	1	0	2	129	7,051	1	0	2	131
				T5VS	6,722	2	0	0	124	7,242	3	0	0	134	7,334	3	0	0	136
				T5S	6,728	2	0	1	125	7,248	2	0	1	134	7,340	2	0	1	136
				T5M	6,711	3	0	1	124	7,229	3	0	1	134	7,321	3	0	2	136
				T5W	6,667	3	0	2	123	7,182	3	0	2	133	7,273	3	0	2	135
				BLC	5,299	1	0	1	98	5,709	1	0	2	106	5,781	1	0	2	107
				LCCO	3,943	1	0	2	73	4,248	1	0	2	79	4,302	1	0	2	80
				RCCO	3,943	1	0	2	73	4,248	1	0	2	79	4,302	1	0	2	80
30	700	**P2**	70W	T1S	8,249	2	0	2	118	8,886	2	0	2	127	8,999	2	0	2	129
				T2S	8,240	2	0	2	118	8,877	2	0	2	127	8,989	2	0	2	128
				T2M	8,283	2	0	2	118	8,923	2	0	2	127	9,036	2	0	2	129
				T3S	8,021	2	0	2	115	8,641	2	0	2	123	8,751	2	0	2	125
				T3M	8,263	2	0	2	118	8,901	2	0	2	127	9,014	2	0	2	129
				T4M	8,083	2	0	2	115	8,708	2	0	2	124	8,818	2	0	2	126
				TFTM	8,257	2	0	2	118	8,896	2	0	2	127	9,008	2	0	2	129
				T5VS	8,588	3	0	0	123	9,252	3	0	0	132	9,369	3	0	0	134
				T5S	8,595	3	0	1	123	9,259	3	0	1	132	9,376	3	0	1	134
				T5M	8,573	3	0	2	122	9,236	3	0	2	132	9,353	3	0	2	134
				T5W	8,517	3	0	2	122	9,175	4	0	2	131	9,291	4	0	2	133
				BLC	6,770	1	0	2	97	7,293	1	0	2	104	7,386	1	0	2	106
				LCCO	5,038	1	0	2	72	5,427	1	0	2	78	5,496	1	0	2	79
				RCCO	5,038	1	0	2	72	5,427	1	0	2	78	5,496	1	0	2	79
30	1050	**P3**	102W	T1S	11,661	2	0	2	114	12,562	3	0	3	123	12,721	3	0	3	125
				T2S	11,648	2	0	2	114	12,548	3	0	3	123	12,707	3	0	3	125
				T2M	11,708	2	0	2	115	12,613	2	0	2	124	12,773	2	0	2	125
				T3S	11,339	2	0	2	111	12,215	3	0	3	120	12,370	3	0	3	121
				T3M	11,680	2	0	2	115	12,582	2	0	2	123	12,742	2	0	2	125
				T4M	11,426	2	0	3	112	12,309	2	0	3	121	12,465	2	0	3	122
				TFTM	11,673	2	0	2	114	12,575	2	0	3	123	12,734	2	0	3	125
				T5VS	12,140	3	0	1	119	13,078	3	0	1	128	13,244	3	0	1	130
				T5S	12,150	3	0	1	119	13,089	3	0	1	128	13,254	3	0	1	130
				T5M	12,119	4	0	2	119	13,056	4	0	2	128	13,221	4	0	2	130
				T5W	12,040	4	0	3	118	12,970	4	0	3	127	13,134	4	0	3	129
				BLC	9,570	1	0	2	94	10,310	1	0	2	101	10,440	1	0	2	102
				LCCO	7,121	1	0	3	70	7,671	1	0	3	75	7,768	1	0	3	76
				RCCO	7,121	1	0	3	70	7,671	1	0	3	75	7,768	1	0	3	76
30	1250	**P4**	125W	T1S	13,435	3	0	3	107	14,473	3	0	3	116	14,657	3	0	3	117
				T2S	13,421	3	0	3	107	14,458	3	0	3	116	14,641	3	0	3	117
				T2M	13,490	2	0	2	108	14,532	3	0	3	116	14,716	3	0	3	118
				T3S	13,064	3	0	3	105	14,074	3	0	3	113	14,252	3	0	3	114
				T3M	13,457	2	0	2	108	14,497	2	0	2	116	14,681	2	0	2	117
				T4M	13,165	2	0	3	105	14,182	2	0	3	113	14,362	2	0	3	115
				TFTM	13,449	2	0	3	108	14,488	2	0	3	116	14,672	2	0	3	117
				T5VS	13,987	4	0	1	112	15,068	4	0	1	121	15,259	4	0	1	122
				T5S	13,999	3	0	1	112	15,080	3	0	1	121	15,271	3	0	1	122
				T5M	13,963	4	0	2	112	15,042	4	0	2	120	15,233	4	0	2	122
				T5W	13,872	4	0	3	111	14,944	4	0	3	120	15,133	4	0	3	121
				BLC	11,027	1	0	2	88	11,879	1	0	2	95	12,029	1	0	2	96
				LCCO	8,205	1	0	3	66	8,839	1	0	3	71	8,951	1	0	3	72
				RCCO	8,205	1	0	3	66	8,839	1	0	3	71	8,951	1	0	3	72
30	1400	**P5**	138W	T1S	14,679	3	0	3	106	15,814	3	0	3	115	16,014	3	0	3	116
				T2S	14,664	3	0	3	106	15,797	3	0	3	114	15,997	3	0	3	116
				T2M	14,739	3	0	3	107	15,878	3	0	3	115	16,079	3	0	3	117
				T3S	14,274	3	0	3	103	15,377	3	0	3	111	15,572	3	0	3	113
				T3M	14,704	2	0	3	107	15,840	3	0	3	115	16,040	3	0	3	116
				T4M	14,384	2	0	3	104	15,496	3	0	3	112	15,692	3	0	3	114
				TFTM	14,695	2	0	3	106	15,830	3	0	3	115	16,030	3	0	3	116
				T5VS	15,283	4	0	1	111	16,464	4	0	1	119	16,672	4	0	1	121
				T5S	15,295	3	0	1	111	16,477	4	0	1	119	16,686	4	0	1	121
				T5M	15,257	4	0	2	111	16,435	4	0	2	119	16,644	4	0	2	121
				T5W	15,157	4	0	3	110	16,328	4	0	3	118	16,534	4	0	3	120
				BLC	12,048	1	0	2	87	12,979	1	0	2	94	13,143	1	0	2	95
				LCCO	8,965	1	0	3	65	9,657	1	0	3	70	9,780	1	0	3	71
				RCCO	8,965	1	0	3	65	9,657	1	0	3	70	9,780	1	0	3	71

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Performance Data

Lumen Output

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Forward Optics

LED Count	Drive Current	Power Package	System Watts	Dist. Type	30K (3000 K, 70 CRI)					40K (4000 K, 70 CRI)					50K (5000 K, 70 CRI)				
					Lumens	B	U	G	LPW	Lumens	B	U	G	LPW	Lumens	B	U	G	LPW
40	1250	**P6**	163W	T1S	17,654	3	0	3	108	19,018	3	0	3	117	19,259	3	0	3	118
				T2S	17,635	3	0	3	108	18,998	3	0	3	117	19,238	3	0	3	118
				T2M	17,726	3	0	3	109	19,096	3	0	3	117	19,337	3	0	3	119
				T3S	17,167	3	0	3	105	18,493	3	0	3	113	18,727	3	0	3	115
				T3M	17,683	3	0	3	108	19,049	3	0	3	117	19,290	3	0	3	118
				T4M	17,299	3	0	3	106	18,635	3	0	4	114	18,871	3	0	4	116
				TFTM	17,672	3	0	3	108	19,038	3	0	4	117	19,279	3	0	4	118
				T5VS	18,379	4	0	1	113	19,800	4	0	1	121	20,050	4	0	1	123
				T5S	18,394	4	0	2	113	19,816	4	0	2	122	20,066	4	0	2	123
				T5M	18,348	4	0	2	113	19,766	4	0	2	121	20,016	4	0	2	123
				T5W	18,228	5	0	3	112	19,636	5	0	3	120	19,885	5	0	3	122
				BLC	14,489	2	0	2	89	15,609	2	0	3	96	15,806	2	0	3	97
				LCCO	10,781	1	0	3	66	11,614	1	0	3	71	11,761	2	0	3	72
				RCCO	10,781	1	0	3	66	11,614	1	0	3	71	11,761	2	0	3	72
40	1400	**P7**	183W	T1S	19,227	3	0	3	105	20,712	3	0	3	113	20,975	3	0	3	115
				T2S	19,206	3	0	3	105	20,690	3	0	3	113	20,952	3	0	3	114
				T2M	19,305	3	0	3	105	20,797	3	0	3	114	21,060	3	0	3	115
				T3S	18,696	3	0	3	102	20,141	3	0	3	110	20,396	3	0	4	111
				T3M	19,258	3	0	3	105	20,746	3	0	3	113	21,009	3	0	3	115
				T4M	18,840	3	0	4	103	20,296	3	0	4	111	20,553	3	0	4	112
				TFTM	19,246	3	0	4	105	20,734	3	0	4	113	20,996	3	0	4	115
				T5VS	20,017	4	0	1	109	21,564	4	0	1	118	21,837	4	0	1	119
				T5S	20,033	4	0	2	109	21,581	4	0	2	118	21,854	4	0	2	119
				T5M	19,983	4	0	2	109	21,527	5	0	3	118	21,799	5	0	3	119
				T5W	19,852	5	0	3	108	21,386	5	0	3	117	21,656	5	0	3	118
				BLC	15,780	2	0	3	86	16,999	2	0	3	93	17,214	2	0	3	94
				LCCO	11,742	2	0	3	64	12,649	2	0	3	69	12,809	2	0	3	70
				RCCO	11,742	2	0	3	64	12,649	2	0	3	69	12,809	2	0	3	70
60	1050	**P8**	207W	T1S	22,490	3	0	3	109	24,228	3	0	3	117	24,535	3	0	3	119
				T2S	22,466	3	0	4	109	24,202	3	0	4	117	24,509	3	0	4	118
				T2M	22,582	3	0	3	109	24,327	3	0	3	118	24,635	3	0	3	119
				T3S	21,870	3	0	4	106	23,560	3	0	4	114	23,858	3	0	4	115
				T3M	22,527	3	0	4	109	24,268	3	0	4	117	24,575	3	0	4	119
				T4M	22,038	3	0	4	106	23,741	3	0	4	115	24,041	3	0	4	116
				TFTM	22,513	3	0	4	109	24,253	3	0	4	117	24,560	3	0	4	119
				T5VS	23,415	5	0	1	113	25,224	5	0	1	122	25,543	5	0	1	123
				T5S	23,434	4	0	2	113	25,244	4	0	2	122	25,564	4	0	2	123
				T5M	23,374	5	0	3	113	25,181	5	0	3	122	25,499	5	0	3	123
				T5W	23,221	5	0	4	112	25,016	5	0	4	121	25,332	5	0	4	122
				BLC	18,458	2	0	3	89	19,885	2	0	3	96	20,136	2	0	3	97
				LCCO	13,735	2	0	3	66	14,796	2	0	4	71	14,983	2	0	4	72
				RCCO	13,735	2	0	3	66	14,796	2	0	4	71	14,983	2	0	4	72
60	1250	**P9**	241W	T1S	25,575	3	0	3	106	27,551	3	0	3	114	27,900	3	0	3	116
				T2S	25,548	3	0	4	106	27,522	3	0	4	114	27,871	3	0	4	116
				T2M	25,680	3	0	3	107	27,664	3	0	3	115	28,014	3	0	3	116
				T3S	24,870	3	0	4	103	26,791	3	0	4	111	27,130	3	0	4	113
				T3M	25,617	3	0	4	106	27,597	3	0	4	115	27,946	3	0	4	116
				T4M	25,061	3	0	4	104	26,997	3	0	4	112	27,339	3	0	4	113
				TFTM	25,602	3	0	4	106	27,580	3	0	4	114	27,929	3	0	4	116
				T5VS	26,626	5	0	1	110	28,684	5	0	1	119	29,047	5	0	1	121
				T5S	26,648	4	0	2	111	28,707	5	0	2	119	29,070	5	0	2	121
				T5M	26,581	5	0	3	110	28,635	5	0	3	119	28,997	5	0	3	120
				T5W	26,406	5	0	4	110	28,447	5	0	4	118	28,807	5	0	4	120
				BLC	20,990	2	0	3	87	22,612	2	0	3	94	22,898	2	0	3	95
				LCCO	15,619	2	0	4	65	16,825	2	0	4	70	17,038	2	0	4	71
				RCCO	15,619	2	0	4	65	16,825	2	0	4	70	17,038	2	0	4	71

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Performance Data

Lumen Output

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Rotated Optics

LED Count	Drive Current	Power Package	System Watts	Dist. Type	30K (3000 K, 70 CRI)					40K (4000 K, 70 CRI)					50K (5000 K, 70 CRI)				
					Lumens	B	U	G	LPW	Lumens	B	U	G	LPW	Lumens	B	U	G	LPW
60	530	**P10**	106W	T1S	13,042	3	0	3	123	14,050	3	0	3	133	14,228	3	0	3	134
				T2S	12,967	4	0	4	122	13,969	4	0	4	132	14,146	4	0	4	133
				T2M	13,201	3	0	3	125	14,221	3	0	3	134	14,401	3	0	3	136
				T3S	12,766	4	0	4	120	13,752	4	0	4	130	13,926	4	0	4	131
				T3M	13,193	4	0	4	124	14,213	4	0	4	134	14,393	4	0	4	136
				T4M	12,944	4	0	4	122	13,945	4	0	4	132	14,121	4	0	4	133
				TFTM	13,279	4	0	4	125	14,305	4	0	4	135	14,486	4	0	4	137
				T5VS	13,372	3	0	1	126	14,405	4	0	1	136	14,588	4	0	1	138
				T5S	13,260	3	0	1	125	14,284	3	0	1	135	14,465	3	0	1	136
				T5M	13,256	4	0	2	125	14,281	4	0	2	135	14,462	4	0	2	136
				T5W	13,137	4	0	3	124	14,153	4	0	3	134	14,332	4	0	3	135
				BLC	10,906	3	0	3	103	11,749	3	0	3	111	11,898	3	0	3	112
				LCCO	7,789	1	0	3	73	8,391	1	0	3	79	8,497	1	0	3	80
				RCCO	7,779	4	0	4	73	8,380	4	0	4	79	8,486	4	0	4	80
60	700	**P11**	137W	T1S	16,556	3	0	3	121	17,835	3	0	3	130	18,061	4	0	4	132
				T2S	16,461	4	0	4	120	17,733	4	0	4	129	17,957	4	0	4	131
				T2M	16,758	4	0	4	122	18,053	4	0	4	132	18,281	4	0	4	133
				T3S	16,205	4	0	4	118	17,457	4	0	4	127	17,678	4	0	4	129
				T3M	16,748	4	0	4	122	18,042	4	0	4	132	18,271	4	0	4	133
				T4M	16,432	4	0	4	120	17,702	4	0	4	129	17,926	4	0	4	131
				TFTM	16,857	4	0	4	123	18,159	4	0	4	133	18,389	4	0	4	134
				T5VS	16,975	4	0	1	124	18,287	4	0	1	133	18,518	4	0	1	135
				T5S	16,832	4	0	1	123	18,133	4	0	2	132	18,362	4	0	2	134
				T5M	16,828	4	0	2	123	18,128	4	0	2	132	18,358	4	0	2	134
				T5W	16,677	4	0	3	122	17,966	5	0	3	131	18,193	5	0	3	133
				BLC	13,845	3	0	3	101	14,915	3	0	3	109	15,103	3	0	3	110
				LCCO	9,888	1	0	3	72	10,652	2	0	3	78	10,787	2	0	3	79
				RCCO	9,875	4	0	4	72	10,638	4	0	4	78	10,773	4	0	4	79
60	1050	**P12**	207W	T1S	22,996	4	0	4	111	24,773	4	0	4	120	25,087	4	0	4	121
				T2S	22,864	4	0	4	110	24,631	5	0	5	119	24,943	5	0	5	120
				T2M	23,277	4	0	4	112	25,075	4	0	4	121	25,393	4	0	4	123
				T3S	22,509	4	0	4	109	24,248	5	0	5	117	24,555	5	0	5	119
				T3M	23,263	4	0	4	112	25,061	4	0	4	121	25,378	4	0	4	123
				T4M	22,824	5	0	5	110	24,588	5	0	5	119	24,899	5	0	5	120
				TFTM	23,414	5	0	5	113	25,223	5	0	5	122	25,543	5	0	5	123
				T5VS	23,579	5	0	1	114	25,401	5	0	1	123	25,722	5	0	1	124
				T5S	23,380	4	0	2	113	25,187	4	0	2	122	25,506	4	0	2	123
				T5M	23,374	5	0	3	113	25,181	5	0	3	122	25,499	5	0	3	123
				T5W	23,165	5	0	4	112	24,955	5	0	4	121	25,271	5	0	4	122
				BLC	19,231	4	0	4	93	20,717	4	0	4	100	20,979	4	0	4	101
				LCCO	13,734	2	0	3	66	14,796	2	0	4	71	14,983	2	0	4	72
				RCCO	13,716	4	0	4	66	14,776	4	0	4	71	14,963	4	0	4	72
60	1250	**P13**	231W	T1S	25,400	4	0	4	110	27,363	4	0	4	118	27,709	4	0	4	120
				T2S	25,254	5	0	5	109	27,205	5	0	5	118	27,550	5	0	5	119
				T2M	25,710	4	0	4	111	27,696	4	0	4	120	28,047	4	0	4	121
				T3S	24,862	5	0	5	108	26,783	5	0	5	116	27,122	5	0	5	117
				T3M	25,695	5	0	5	111	27,680	5	0	5	120	28,031	5	0	5	121
				T4M	25,210	5	0	5	109	27,158	5	0	5	118	27,502	5	0	5	119
				TFTM	25,861	5	0	5	112	27,860	5	0	5	121	28,212	5	0	5	122
				T5VS	26,043	5	0	1	113	28,056	5	0	1	121	28,411	5	0	1	123
				T5S	25,824	4	0	2	112	27,819	5	0	2	120	28,172	5	0	2	122
				T5M	25,818	5	0	3	112	27,813	5	0	3	120	28,165	5	0	3	122
				T5W	25,586	5	0	4	111	27,563	5	0	4	119	27,912	5	0	4	121
				BLC	21,241	4	0	4	92	22,882	4	0	4	99	23,172	4	0	4	100
				LCCO	15,170	2	0	4	66	16,342	2	0	4	71	16,549	2	0	4	72
				RCCO	15,150	5	0	5	66	16,321	5	0	5	71	16,527	5	0	5	72

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A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and system-level interoperability.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is A+ Certified when ordered with DTL® controls marked by a shaded background. DTL DLL equipped luminaires meet the A+ specification for luminaire to photocontrol interoperability1
- This luminaire is part of an A+ Certified solution for ROAM® or XPoint™ Wireless control networks, providing out-of-the-box control compatibility with simple commissioning, when ordered with drivers and control options marked by a shaded background[1]

To learn more about A+, visit www.acuitybrands.com/aplus.

1. See ordering tree for details.
2. A+ Certified Solutions for ROAM require the order of one ROAM node per luminaire. Sold Separately: Link to Roam; Link to DTL DLL

FEATURES & SPECIFICATIONS

INTENDED USE

The sleek design of the D-Series Size 1 reflects the embedded high performance LED technology. It is ideal for many commercial and municipal applications, such as parking lots, plazas, campuses, and streetscapes.

CONSTRUCTION

Single-piece die-cast aluminum housing has integral heat sink fins to optimize thermal management through conductive and convective cooling. Modular design allows for ease of maintenance and future light engine upgrades. The LED drivers are mounted in direct contact with the casting to promote low operating temperature and long life. Housing is completely sealed against moisture and environmental contaminants (IP65). Low EPA (1.01 ft^2) for optimized pole wind loading.

FINISH

Exterior parts are protected by a zinc-infused Super Durable TGIC thermoset powder coat finish that provides superior resistance to corrosion and weathering. A tightly controlled multi-stage process ensures a minimum 3 mils thickness for a finish that can withstand extreme climate changes without cracking or peeling. Available in both textured and non-textured finishes.

OPTICS

Precision-molded proprietary acrylic lenses are engineered for superior area lighting distribution, uniformity, and pole spacing. Light engines are available in standard 3000 K, 4000 K and 5000 K (70 CRI) configurations. The D-Series Size 1 has zero uplight and qualifies as a Nighttime Friendly™ product, meaning it is consistent with the LEED® and Green Globes™ criteria for eliminating wasteful uplight.

ELECTRICAL

Light engine configurations consist of high-efficacy LEDs mounted to metal-core circuit boards to maximize heat dissipation and promote long life (up to L85/100,000 hours at 25°C). Class 1 electronic drivers are designed to have a power factor >90%, THD <20%, and an expected life of 100,000 hours with <1% failure rate. Easily serviceable 10kV surge protection device meets a minimum Category C Low operation (per ANSI/IEEE C62.41.2).

STANDARD CONTROLS

The DSX1 LED area luminaire has a number of control options. Dusk to dawn controls can be utilized via optional NEMA twist-lock photocell receptacles. Integrated motion sensors with on-board photocells feature field-adjustable programing and are suitable for mounting heights up to 30 feet.

nLIGHT AIR CONTROLS

The DSX1 LED area luminaire is also available with nLight® AIR for the ultimate in wireless control. This powerful controls platform provides out-of-the-box basic motion sensing and photocontrol functionality and is suitable for mounting heights up to 40 feet. Once commissioned using a smartphone and the easy-to-use CLAIRITY app, nLight AIR equipped luminaries can be grouped, resulting in motion sensor and photocell group response without the need for additional equipment. Scheduled dimming with motion sensor over-ride can be achieved when used with the nLight Eclypse. Additional information about nLight Air can be found here.

INSTALLATION

Included mounting block and integral arm facilitate quick and easy installation. Stainless steel bolts fasten the mounting block securely to poles and walls, enabling the D-Series Size 1 to withstand up to a 3.0 G vibration load rating per ANSI C136.31. The D-Series Size 1 utilizes the AERIS™ series pole drilling pattern (template #8). NEMA photocontrol receptacle are also available.

LISTINGS

UL Listed for wet locations. Light engines are IP66 rated; luminaire is IP65 rated. Rated for -40ºC minimum ambient. U.S. Patent No. D672,492 S. International patent pending.

DesignLights Consortium® (DLC) Premium qualified product and DLC qualified product.
Not all versions of this product may be DLC Premium qualified or DLC qualified. Please check the DLC Qualified Products List at www.designlights.org/QPL to confirm which versions are qualified.

International Dark-Sky Association (IDA) Fixture Seal of Approval (FSA) is available for all products on this page utilizing 3000K color temperature only.

WARRANTY

5-year limited warranty. Complete warranty terms located at:
www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx

Note: Actual performance may differ as a result of end-user environment and application.
All values are design or typical values, measured under laboratory conditions at 25 °C.
Specifications subject to change without notice.

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D-Series Size 2
LED Area Luminaire

Catalog Number

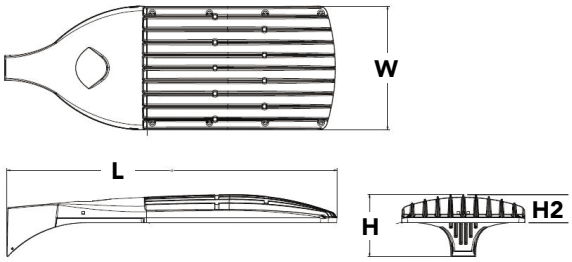
Notes

Type

Hit the Tab key or mouse over the page to see all interactive elements.

Specifications

EPA:	1.1 ft² *(0.10 m²)*
Length:	40″ *(101.6 cm)*
Width:	15″ *(38.1 cm)*
Height 1:	7-1/4″ *(18.4 cm)*
Height 2: (max):	3.5″
Weight:	36lbs



Introduction

The modern styling of the D-Series is striking yet unobtrusive - making a bold, progressive statement even as it blends seamlessly with its environment.

The D-Series distills the benefits of the latest in LED technology into a high performance, high efficacy, long-life luminaire. The outstanding photometric performance results in sites with excellent uniformity, greater pole spacing and lower power density. The Size 2 is ideal for replacing 400-1000W metal halide in area lighting applications with energy savings of up to 80% and expected service life of over 100,000 hours.

A+ Capable options indicated by this color background.

Ordering Information

EXAMPLE: DSX2 LED P7 40K T3M MVOLT SPA NLTAIR2 PIRHN DDBXD

DSX2 LED

Series	LEDs	Color temperature	Distribution	Voltage	Mounting
DSX2 LED	**Forward optics** P1 P5 P2 P6 P3 P7 P4 P8 **Rotated optics**[1] P10 P13 P11 P14 P12	30K 3000 K 40K 4000 K 50K 5000 K	T1S Type I Short T2S Type II Short T2M Type II Medium T3S Type III Short T3M Type III Medium T4M Type IV Medium TFTM Forward Throw Medium T5VS Type V Very Short T5S Type V Short T5M Type V Medium T5W Type V Wide BLC Backlight control[2] LCCO Left corner cutoff[2] RCCO Right corner cutoff[2]	MVOLT[3] 120[4] 208[4] 240[4] 277[4] 347[4] 480[4]	**Shipped included** SPA Square pole mounting RPA Round pole mounting WBA Wall bracket SPUMBA Square pole universal mounting adaptor[5] RPUMBA Round pole universal mounting adaptor[5] **Shipped separately** KMA8 DDBXD U Mast arm mounting bracket adaptor (specify finish)[6]

Control options

Shipped installed

NLTAIR2	nLight AIR generation 2 enabled[7]
PIRHN	Network, Bi-Level motion/ambient sensor[8]
PER	NEMA twist-lock receptacle only (no controls)[9]
PER5	Five-wire receptacle only (no controls)[9,10]
PER7	Seven-wire receptacle only (no controls)[9,10]
DMG	0-10V dimming extend out back of housing for external control (no controls)
DS	Dual switching[11,12]
PIRH	Bi-level, motion/ambient sensor, 15-30′ mounting height, ambient sensor enable at 5fc
FAO	Field Adjustable Output[13]

Other options

Shipped installed

HS	House-side shield[14]
SF	Single fuse (120, 277, 347V)[4]
DF	Double fuse (208, 240, 480V)[4]
L90	Left rotated optics[1]
R90	Right rotated optics[1]

Shipped separately

BS	Bird spikes[15]
EGS	External glare shield[15]

Finish *(required)*

DDBXD	Dark bronze
DBLXD	Black
DNAXD	Natural aluminum
DWHXD	White
DDBTXD	Textured dark bronze
DBLBXD	Textured black
DNATXD	Textured natural aluminum
DWHGXD	Textured white

One Lithonia Way • Conyers, Georgia 30012 • Phone: 800-705-SERV (7378) • www.lithonia.com

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Ordering Information

Accessories

Ordered and shipped separately.

DLL127F 1.5 JU	Photocell - SSL twist-lock (120-277V) [16]
DLL347F 1.5 CUL JU	Photocell - SSL twist-lock (347V) [16]
DLL480F 1.5 CUL JU	Photocell - SSL twist-lock (480V) [16]
DSHORT SBK U	Shorting cap [16]
DSX2HS 80C U	House-side shield for 80 LED unit [17]
DSX2HS 90C U	House-side shield for 90 LED unit [17]
DSX2HS 100C U	House-side shield for 100 LED unit [17]
PUMBA DDBXD U*	Square and round pole universal mounting bracket (specify finish) [18]
KMA8 DDBXD U	Mast arm mounting bracket adaptor (specify finish) [5]

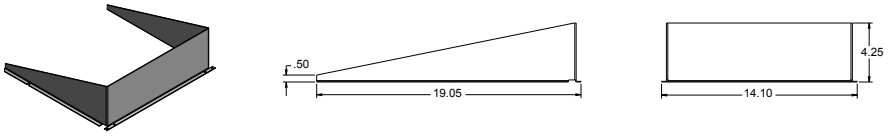
For more control options, visit DTL and ROAM online.

NOTES

1 P10, P11, P12, P13 or P14 and rotated optics (L90, R90) only available together.
2 Not available with HS.
3 MVOLT driver operates on any line voltage from 120-277V (50/60 Hz).
4 Single fuse (SF) requires 120V, 277V or 347V. Double fuse (DF) requires 208V, 240V or 480V.
5 Universal mounting bracket intended for retrofit on existing pre-drilled poles only. 1.5 G vibration load rating per ANCI C136.31.
6 Must order fixture with SPA otion.Must be ordered as a separate accessory; see Accessories information. For use with 2-3/8" mast arm (not included).
7 Must be ordered with PIRHN. Sensor cover only available in dark bronze, black, white or natural aluminum color.
8 Must be ordered with NLTAIR2. For more information on nLight Air 2 visit this link.
9 Photocell ordered and shipped as a separate line item from Acuity Brands Controls. See accessories. Not available with DS option. Shorting Cap included.
10 If ROAM® node required, it must be ordered and shipped as a separate line item from Acuity Brands Controls. Node with integral dimming. .
11 Requires (2) separately switched circuits with isolated neutrals. See Outdoor Control Technical Guide for details.
12 Provides 50/50 fixture operation via (2) independent drivers. Not available with PER, PER5, PER7, PIR or PIRH. Not available with P1, P2, P10.
13 Reference controls options table on page 4.
14 Not available with BLC, LCCO and RCCO distribution. Also available as a separate accessories; see Accessories information.
15 Must be ordered with fixture for factory pre-drilling.
16 Requires luminaire to be specified with PER, PER5 and PER7 option. Ordered and shipped as a separate line item from Acuity Brands Controls.
17 Not available with other dimming controls options.
18 For retrofit use only.

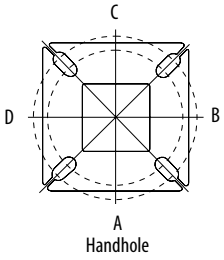
Options

EGS - External Glare Shield

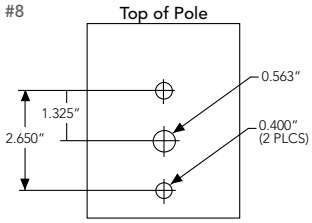


Drilling

HANDHOLE ORIENTATION



Template #8



Tenon Mounting Slipfitter**

Tenon O.D.	Mounting	Single Unit	2 @ 180	2 @ 90	3 @120	3 @ 90	4 @ 90
2-3/8"	SPA/RPA	AS3-5 190	AS3-5 280	AS3-5 290	AS3-5 320	AS3-5 390	AS3-5 490
	SPUMBA	AS3-5 190	AS3-5 280	AS4-5 290	AS3-5 320	AS4-5 390	AS4-5 490
	RUPUMBA	AS3-5 190	AS3-5 280		AS3-5 320		
2-7/8"	SPA/RPA	AST25-190	AST25-280	AST25-290	AST25-320	AST25-390	AST25-490
	SPUMBA	AST25-190	AST25-280		AST25-320		
	RUPUMBA	AST25-190	AST25-280		AST25-320		
4"	SPA/RPA	AST35-190	AST35-280	AST35-290	AST35-320	AST35-390	AST35-490
	SPUMBA	AST35-190	AST35-280	AST35-290	AST35-320	AST35-390	AST35-490
	RUPUMBA	AST35-190	AST35-280		AST35-320		

Mounting Option	Drilling Template	Single	2 @ 180	2 @ 90	3 @ 90	3 @ 120	4 @ 90
Head Location		Side B	Side B & D	Side B & C	Side B, C & D	Round Pole Only	Side A, B, C & D
Drill Nomenclature	#8	DM19AS	DM28AS	DM29AS	DM39AS	DM32AS	DM49AS

	Drilling Template	Minimum Acceptable Outside Pole Dimension					
SPA	#8	2-7/8"	2-7/8"	3.5"	3.5"	3"	3.5"
RPA	#8	2-7/8"	2-7/8"	3.5"	3.5"	3"	3.5"
SPUMBA	#5	2-7/8"	3"	4"	4"	3.5"	4"
RPUMBA	#5	2-7/8"	3.5"	5"	5"	3.5"	5"

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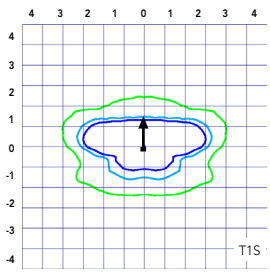
Photometric Diagrams

To see complete photometric reports or download .ies files for this product, visit Lithonia Lighting's D-Series Area Size 2 homepage.

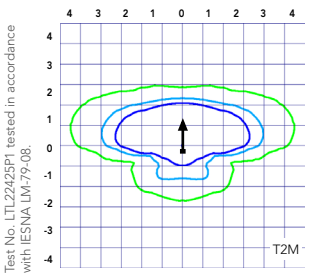
Isofootcandle plots for the DSX2 LED 80C 1000 40K. Distances are in units of mounting height (30').

LEGEND

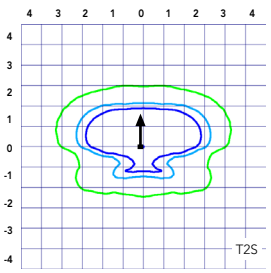
- 0.1 fc
- 0.5 fc
- 1.0 fc



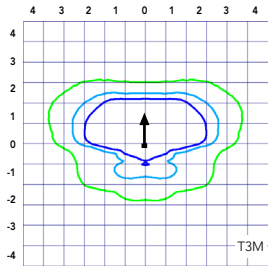
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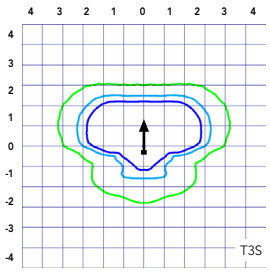
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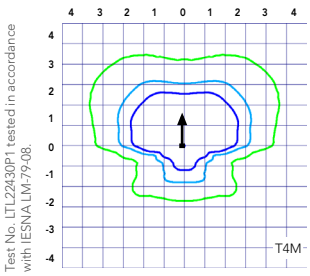
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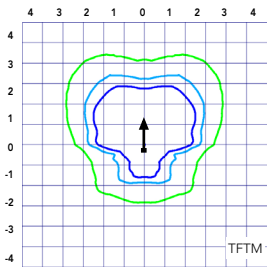
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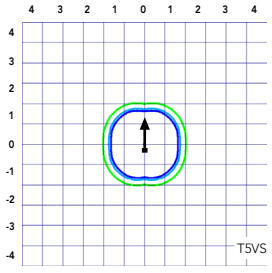
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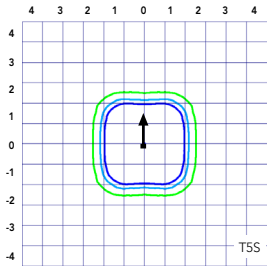
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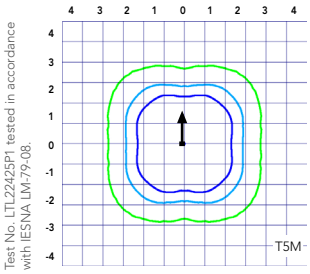
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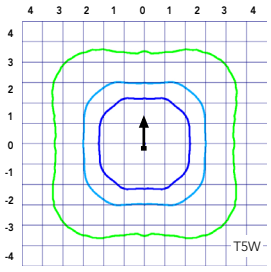
Test No. LTL22430P1 tested in accordance with IESNA LM-79-08.



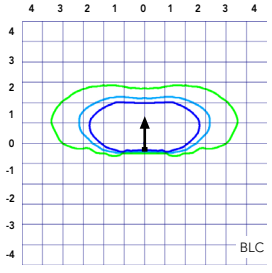
Test No. LTL22425P1 tested in accordance with IESNA LM-79-08.



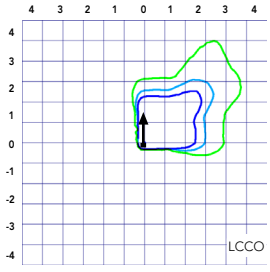
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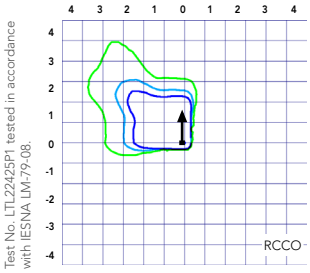
Test No. LTL22428P1 tested in accordance with IESNA LM-79-08.



Test No. LTL22430P1 tested in accordance with IESNA LM-79-08.



Test No. LTL22425P1 tested in accordance with IESNA LM-79-08.



Test No. LTL22434P1 tested in accordance with IESNA LM-79-08.

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Performance Data

Lumen Ambient Temperature (LAT) Multipliers

Use these factors to determine relative lumen output for average ambient temperatures from 0-40°C (32-104°F).

Ambient		Lumen Multiplier
0°C	32°F	1.04
5°C	41°F	1.04
10°C	50°F	1.03
15°C	50°F	1.02
20°C	68°F	1.01
25°C	**77°F**	**1.00**
30°C	86°F	0.99
35°C	95°F	0.98
40°C	104°F	0.97

Projected LED Lumen Maintenance

Data references the extrapolated performance projections for the platforms noted in a **25°C ambient**, based on 10,000 hours of LED testing (tested per IESNA LM-80-08 and projected per IESNA TM-21-11).

To calculate LLF, use the lumen maintenance factor that corresponds to the desired number of operating hours below. For other lumen maintenance values, contact factory.

Operating Hours	0	25000	50000	100000
Lumen Maintenance Factor	1.00	0.96	0.92	0.85

Electrical Load

					Current (A)					
	Performance Package	LED Count	Drive Current	Wattage	120	208	240	277	347	480
Forward Optics (Non-Rotated)	P1	80	530	140	1.18	0.68	0.59	0.51	0.40	0.32
	P2	80	700	185	1.56	0.90	0.78	0.66	0.52	0.39
	P3	80	850	217	1.82	1.05	0.90	0.80	0.63	0.48
	P4	80	1050	270	2.27	1.31	1.12	0.99	0.79	0.59
	P5	80	1250	321	2.68	1.54	1.34	1.17	0.93	0.68
	P6	100	1050	343	2.89	1.66	1.59	1.37	1.00	0.71
	P7	100	1250	398	3.31	1.91	1.66	1.45	1.16	0.81
	P8	100	1350	431	3.61	2.07	1.81	1.57	1.25	0.91
Rotated Optics (Requires L90 or R90)	P10	90	530	156	1.30	0.76	0.65	0.62	0.45	0.32
	P11	90	700	207	1.75	1.01	0.87	0.74	0.60	0.46
	P12	90	850	254	2.12	1.22	1.06	0.94	0.73	0.55
	P13	90	1200	344	2.88	1.65	1.44	1.25	1.00	0.73
	P14	90	1400	405	3.39	1.95	1.71	1.48	1.18	0.86

Motion Sensor Default Settings						
Option	Dimmed State	High Level (when triggered)	Photocell Operation	Dwell Time	Ramp-up Time	Ramp-down Time
PIR or PIRH	3V (37%) Output	10V (100%) Output	Enabled @ 5FC	5 min	3 sec	5 min
*PIR1FC3V or PIRH1FC3V	3V (37%) Output	10V (100%) Output	Enabled @ 1FC	5 min	3 sec	5 min
*for use when motion sensor is used as dusk to dawn control.						

Controls Options				
Nomenclature	Descripton	Functionality	Primary control device	Notes
FAO	Field adjustable output device installed inside the lumiaire; wired to the driver dimming leads.	Allows the lumiaire to be manually dimmed, effectively trimming the light output.	FAO device	Cannot be used with other controls options that need the 0-10V leads
DS	Drivers wired independantly for 50/50 luminaire operation	The luminaire is wired to two separate circuits, allowing for 50/50 operation.	Independently wired drivers	Requires two seperately switched circuits. Consider nLight AIR as a more cost effective alternative.
PER5 or PER7	Twist-lock photocell receptical	Compatible with standard twist-lock photocells for dusk to dawn operation, or advanced control nodes that provide 0-10V dimming signals.	Twist-lock photocells such as DLL Elite or advanced control nodes such as ROAM.	Pins 4 & 5 to dimming leads on driver, Pins 6 & 7 are capped inside luminaire
PIR or PIRH	Motion sensors with integral photocell. PIR for 8-15' mounting; PIRH for 15-30' mounting	Luminaires dim when no occupancy is detected.	Acuity Controls SBOR	Also available with PIRH1FC3V when the sensor photocell is used for dusk-to-dawn operation.
NLTAIR2 PIRHN	nLight AIR enabled luminaire for motion sensing, photocell and wireless communication.	Motion and ambient light sensing with group response. Scheduled dimming with motion sensor over-ride when wirelessly connected to the nLight Eclypse.	nLight Air rSBGR	nLight AIR sensors can be programmed and commissioned from the ground using the CIAIRity Pro app.

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Performance Data

Lumen Output

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Forward Optics

LED Count	Drive Current	Power Package	System Watts	Dist. Type	30K (3000 K, 70 CRI)					40K (4000 K, 70 CRI)					50K (5000 K, 70 CRI)				
					Lumens	B	U	G	LPW	Lumens	B	U	G	LPW	Lumens	B	U	G	LPW
80	530	**P1**	140W	T1S	17,575	3	0	3	126	18,933	3	0	3	135	19,173	3	0	3	137
				T2S	17,556	3	0	3	125	18,913	3	0	3	135	19,152	3	0	3	137
				T2M	17,647	3	0	3	126	19,010	3	0	3	136	19,251	3	0	3	138
				T3S	17,090	3	0	3	122	18,411	3	0	3	132	18,644	3	0	3	133
				T3M	17,604	3	0	3	126	18,964	3	0	3	135	19,204	3	0	3	137
				T4M	17,221	3	0	3	123	18,552	3	0	4	133	18,787	3	0	4	134
				TFTM	17,593	3	0	3	126	18,952	3	0	4	135	19,192	3	0	4	137
				T5VS	18,297	4	0	1	131	19,711	4	0	1	141	19,961	4	0	1	143
				T5S	18,312	4	0	2	131	19,727	4	0	2	141	19,977	4	0	2	143
				T5M	18,266	4	0	2	130	19,677	4	0	2	141	19,926	4	0	2	142
				T5W	18,146	5	0	3	130	19,548	5	0	3	140	19,796	5	0	3	141
				BLC	14,424	2	0	2	103	15,539	2	0	3	111	15,736	2	0	3	112
				LCCO	10,733	1	0	3	77	11,562	1	0	3	83	11,709	2	0	3	84
				RCCO	10,733	1	0	3	77	11,562	1	0	3	83	11,709	2	0	3	84
80	700	**P2**	185W	T1S	22,305	3	0	3	121	24,029	3	0	3	130	24,333	3	0	3	132
				T2S	22,281	3	0	4	120	24,003	3	0	4	130	24,307	3	0	4	131
				T2M	22,396	3	0	3	121	24,127	3	0	3	130	24,432	3	0	3	132
				T3S	21,690	3	0	4	117	23,366	3	0	4	126	23,662	3	0	4	128
				T3M	22,342	3	0	4	121	24,068	3	0	4	130	24,373	3	0	4	132
				T4M	21,857	3	0	4	118	23,545	3	0	4	127	23,844	3	0	4	129
				TFTM	22,328	3	0	4	121	24,054	3	0	4	130	24,358	3	0	4	132
				T5VS	23,222	5	0	1	126	25,016	5	0	1	135	25,333	5	0	1	137
				T5S	23,241	4	0	2	126	25,037	4	0	2	135	25,354	4	0	2	137
				T5M	23,182	5	0	3	125	24,974	5	0	3	135	25,290	5	0	3	137
				T5W	23,030	5	0	4	124	24,810	5	0	4	134	25,124	5	0	4	136
				BLC	18,307	2	0	3	99	19,721	2	0	3	107	19,971	2	0	3	108
				LCCO	13,622	2	0	3	74	14,674	2	0	4	79	14,860	2	0	4	80
				RCCO	13,622	2	0	3	74	14,674	2	0	4	79	14,860	2	0	4	80
80	850	**P3**	217W	T1S	26,202	3	0	3	121	28,226	3	0	3	130	28,584	3	0	3	132
				T2S	26,174	3	0	4	121	28,196	3	0	4	130	28,553	3	0	4	132
				T2M	26,309	3	0	3	121	28,342	3	0	3	131	28,700	3	0	3	132
				T3S	25,479	3	0	4	117	27,448	3	0	4	126	27,795	3	0	4	128
				T3M	26,245	3	0	4	121	28,273	3	0	4	130	28,631	3	0	4	132
				T4M	25,675	3	0	4	118	27,659	3	0	4	127	28,009	3	0	4	129
				TFTM	26,229	3	0	4	121	28,255	3	0	4	130	28,613	3	0	4	132
				T5VS	27,279	5	0	1	126	29,387	5	0	1	135	29,759	5	0	1	137
				T5S	27,301	4	0	2	126	29,410	5	0	2	136	29,783	5	0	2	137
				T5M	27,232	5	0	3	125	29,336	5	0	3	135	29,707	5	0	3	137
				T5W	27,053	5	0	4	125	29,144	5	0	4	134	29,513	5	0	4	136
				BLC	21,504	2	0	3	99	23,166	2	0	3	107	23,459	2	0	4	108
				LCCO	16,001	2	0	4	74	17,238	2	0	4	79	17,456	2	0	4	80
				RCCO	16,001	2	0	4	74	17,238	2	0	4	79	17,456	2	0	4	80
80	1050	**P4**	270W	T1S	30,963	4	0	4	115	33,355	4	0	4	124	33,777	4	0	4	125
				T2S	30,930	4	0	4	115	33,320	4	0	4	123	33,742	4	0	4	125
				T2M	31,089	3	0	4	115	33,491	3	0	4	124	33,915	3	0	4	126
				T3S	30,108	4	0	4	112	32,435	4	0	5	120	32,845	4	0	5	122
				T3M	31,014	3	0	4	115	33,410	3	0	4	124	33,833	3	0	4	125
				T4M	30,340	3	0	5	112	32,684	3	0	5	121	33,098	3	0	5	123
				TFTM	30,995	3	0	5	115	33,390	3	0	5	124	33,812	3	0	5	125
				T5VS	32,235	5	0	1	119	34,726	5	0	1	129	35,166	5	0	1	130
				T5S	32,261	5	0	2	119	34,754	5	0	2	129	35,194	5	0	2	130
				T5M	32,180	5	0	4	119	34,667	5	0	4	128	35,105	5	0	4	130
				T5W	31,969	5	0	4	118	34,439	5	0	5	128	34,875	5	0	5	129
				BLC	25,412	2	0	4	94	27,376	2	0	4	101	27,722	2	0	4	103
				LCCO	18,909	2	0	4	70	20,370	2	0	4	75	20,628	2	0	4	76
				RCCO	18,909	2	0	4	70	20,370	2	0	4	75	20,628	2	0	4	76

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Performance Data

Lumen Output

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Forward Optics

LED Count	Drive Current	Power Package	System Watts	Dist. Type	30K (3000 K, 70 CRI)					40K (4000 K, 70 CRI)					50K (5000 K, 70 CRI)				
					Lumens	B	U	G	LPW	Lumens	B	U	G	LPW	Lumens	B	U	G	LPW
80	1250	**P5**	321W	T1S	35,193	4	0	4	110	37,912	4	0	4	118	38,392	4	0	4	120
				T2S	35,155	4	0	5	110	37,872	4	0	5	118	38,351	4	0	5	119
				T2M	35,336	4	0	4	110	38,067	4	0	4	119	38,549	4	0	4	120
				T3S	34,222	4	0	5	107	36,866	4	0	5	115	37,333	4	0	5	116
				T3M	35,251	3	0	4	110	37,974	3	0	5	118	38,455	4	0	5	120
				T4M	34,485	3	0	5	107	37,149	4	0	5	116	37,620	4	0	5	117
				TFTM	35,229	3	0	5	110	37,951	3	0	5	118	38,431	3	0	5	120
				T5VS	36,639	5	0	1	114	39,470	5	0	1	123	39,970	5	0	1	125
				T5S	36,669	5	0	2	114	39,502	5	0	2	123	40,002	5	0	2	125
				T5M	36,576	5	0	4	114	39,403	5	0	4	123	39,901	5	0	4	124
				T5W	36,336	5	0	5	113	39,144	5	0	5	122	39,640	5	0	5	123
				BLC	28,884	3	0	4	90	31,115	3	0	4	97	31,509	3	0	4	98
				LCCO	21,492	2	0	4	67	23,153	2	0	5	72	23,446	3	0	5	73
				RCCO	21,492	2	0	4	67	23,153	2	0	5	72	23,446	3	0	5	73
100	1050	**P6**	343W	T1S	37,824	4	0	4	110	40,747	4	0	4	119	41,263	4	0	4	120
				T2S	37,784	4	0	5	110	40,704	4	0	5	119	41,219	4	0	5	120
				T2M	37,979	4	0	4	111	40,913	4	0	4	119	41,431	4	0	4	121
				T3S	36,780	4	0	5	107	39,623	4	0	5	116	40,124	4	0	5	117
				T3M	37,886	3	0	5	110	40,814	4	0	5	119	41,331	4	0	5	120
				T4M	37,063	4	0	5	108	39,927	4	0	5	116	40,433	4	0	5	118
				TFTM	37,863	3	0	5	110	40,789	4	0	5	119	41,305	4	0	5	120
				T5VS	39,379	5	0	1	115	42,422	5	0	1	124	42,959	5	0	1	125
				T5S	39,411	5	0	2	115	42,456	5	0	2	124	42,993	5	0	2	125
				T5M	39,311	5	0	4	115	42,349	5	0	4	123	42,885	5	0	4	125
				T5W	39,053	5	0	5	114	42,071	5	0	5	123	42,604	5	0	5	124
				BLC	31,043	3	0	4	91	33,442	3	0	4	97	33,865	3	0	4	99
				LCCO	23,099	2	0	5	67	24,884	3	0	5	73	25,199	3	0	5	73
				RCCO	23,099	2	0	5	67	24,884	3	0	5	73	25,199	3	0	5	73
100	1250	**P7**	398W	T1S	42,599	4	0	4	107	45,890	4	0	4	115	46,471	4	0	4	117
				T2S	42,553	4	0	5	107	45,842	4	0	5	115	46,422	4	0	5	117
				T2M	42,773	4	0	4	107	46,078	4	0	4	116	46,661	4	0	5	117
				T3S	41,423	4	0	5	104	44,624	4	0	5	112	45,189	4	0	5	114
				T3M	42,669	4	0	5	107	45,966	4	0	5	115	46,548	4	0	5	117
				T4M	41,742	4	0	5	105	44,967	4	0	5	113	45,537	4	0	5	114
				TFTM	42,643	4	0	5	107	45,938	4	0	5	115	46,519	4	0	5	117
				T5VS	44,350	5	0	1	111	47,777	5	0	1	120	48,381	5	0	1	122
				T5S	44,385	5	0	2	112	47,815	5	0	3	120	48,420	5	0	3	122
				T5M	44,273	5	0	4	111	47,695	5	0	4	120	48,298	5	0	4	121
				T5W	43,983	5	0	5	111	47,382	5	0	5	119	47,982	5	0	5	121
				BLC	34,962	3	0	4	88	37,664	3	0	5	95	38,140	3	0	5	96
				LCCO	26,015	3	0	5	65	28,025	3	0	5	70	28,380	3	0	5	71
				RCCO	26,015	3	0	5	65	28,025	3	0	5	70	28,380	3	0	5	71
100	1350	**P8**	448W	T1S	45,610	4	0	4	106	49,135	4	0	4	114	49,757	4	0	4	115
				T2S	45,562	4	0	5	106	49,083	4	0	5	114	49,704	4	0	5	115
				T2M	45,797	4	0	4	106	49,336	4	0	5	114	49,960	4	0	5	116
				T3S	44,352	4	0	5	103	47,779	4	0	5	111	48,384	4	0	5	112
				T3M	45,686	4	0	5	106	49,216	4	0	5	114	49,839	4	0	5	116
				T4M	44,693	4	0	5	104	48,147	4	0	5	112	48,756	4	0	5	113
				TFTM	45,657	4	0	5	106	49,186	4	0	5	114	49,808	4	0	5	116
				T5VS	47,485	5	0	1	110	51,155	5	0	1	119	51,802	5	0	1	120
				T5S	47,524	5	0	3	110	51,196	5	0	3	119	51,844	5	0	3	120
				T5M	47,404	5	0	4	110	51,067	5	0	5	118	51,713	5	0	5	120
				T5W	47,093	5	0	5	109	50,732	5	0	5	118	51,374	5	0	5	119
				BLC	37,434	3	0	5	87	40,326	3	0	5	94	40,837	3	0	5	95
				LCCO	27,854	3	0	5	65	30,006	3	0	5	70	30,386	3	0	5	71
				RCCO	27,854	3	0	5	65	30,006	3	0	5	70	30,386	3	0	5	71

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Performance Data

Lumen Output

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Rotated Optics

LED Count	Drive Current	Power Package	System Watts	Dist. Type	30K (3000 K, 70 CRI)					40K (4000 K, 70 CRI)					50K (5000 K, 70 CRI)				
					Lumens	B	U	G	LPW	Lumens	B	U	G	LPW	Lumens	B	U	G	LPW
90	530	**P10**	156W	T1S	20,145	4	0	4	129	21,702	4	0	4	139	21,977	4	0	4	141
				T2S	20,029	4	0	4	128	21,577	4	0	4	138	21,850	4	0	4	140
				T2M	20,391	4	0	4	131	21,967	4	0	4	141	22,245	4	0	4	143
				T3S	19,719	4	0	4	126	21,242	4	0	4	136	21,511	4	0	4	138
				T3M	20,379	4	0	4	131	21,954	4	0	4	141	22,232	4	0	4	143
				T4M	19,995	4	0	4	128	21,540	4	0	4	138	21,812	5	0	5	140
				TFTM	20,511	4	0	4	131	22,096	5	0	5	142	22,376	5	0	5	143
				T5VS	20,655	4	0	1	132	22,251	4	0	1	143	22,533	4	0	1	144
				T5S	20,482	4	0	2	131	22,064	4	0	2	141	22,343	4	0	2	143
				T5M	20,477	5	0	3	131	22,059	5	0	3	141	22,338	5	0	3	143
				T5W	20,293	5	0	3	130	21,861	5	0	3	140	22,138	5	0	4	142
				BLC	16,846	4	0	4	108	18,148	4	0	4	116	18,378	4	0	4	118
				LCCO	12,032	2	0	3	77	12,961	2	0	3	83	13,125	2	0	3	84
				RCCO	12,016	4	0	4	77	12,944	4	0	4	83	13,108	4	0	4	84
90	700	**P11**	207W	T1S	25,518	4	0	4	123	27,490	4	0	4	133	27,837	4	0	4	134
				T2S	25,371	5	0	5	123	27,331	5	0	5	132	27,677	5	0	5	134
				T2M	25,829	4	0	4	125	27,825	4	0	4	134	28,177	4	0	4	136
				T3S	24,977	5	0	5	121	26,907	5	0	5	130	27,248	5	0	5	132
				T3M	25,814	5	0	5	125	27,809	5	0	5	134	28,161	5	0	5	136
				T4M	25,327	5	0	5	122	27,284	5	0	5	132	27,629	5	0	5	133
				TFTM	25,981	5	0	5	126	27,989	5	0	5	135	28,343	5	0	5	137
				T5VS	26,164	5	0	1	126	28,185	5	0	1	136	28,542	5	0	1	138
				T5S	25,943	4	0	2	125	27,948	5	0	2	135	28,302	5	0	2	137
				T5M	25,937	5	0	3	125	27,941	5	0	3	135	28,295	5	0	3	137
				T5W	25,704	5	0	4	124	27,691	5	0	4	134	28,041	5	0	4	135
				BLC	21,339	4	0	4	103	22,988	4	0	4	111	23,279	4	0	4	112
				LCCO	15,240	2	0	4	74	16,418	2	0	4	79	16,626	2	0	4	80
				RCCO	15,220	5	0	5	74	16,396	5	0	5	79	16,604	5	0	5	80
90	850	**P12**	254W	T1S	29,912	4	0	4	118	32,223	4	0	4	127	32,631	5	0	4	128
				T2S	29,740	5	0	5	117	32,038	5	0	5	126	32,443	5	0	5	128
				T2M	30,277	4	0	4	119	32,616	5	0	5	128	33,029	5	0	5	130
				T3S	29,278	5	0	5	115	31,540	5	0	5	124	31,940	5	0	5	126
				T3M	30,259	5	0	5	119	32,597	5	0	5	128	33,010	5	0	5	130
				T4M	29,688	5	0	5	117	31,982	5	0	5	126	32,387	5	0	5	128
				TFTM	30,455	5	0	5	120	32,808	5	0	5	129	33,224	5	0	5	131
				T5VS	30,669	5	0	1	121	33,039	5	0	1	130	33,457	5	0	1	132
				T5S	30,411	5	0	2	120	32,761	5	0	2	129	33,176	5	0	2	131
				T5M	30,404	5	0	3	120	32,753	5	0	4	129	33,168	5	0	4	131
				T5W	30,131	5	0	4	119	32,459	5	0	4	128	32,870	5	0	4	129
				BLC	25,013	4	0	4	98	26,946	4	0	4	106	27,287	4	0	4	107
				LCCO	17,865	2	0	4	70	19,245	2	0	4	76	19,489	2	0	4	77
				RCCO	17,841	5	0	5	70	19,220	5	0	5	76	19,463	5	0	5	77
90	1200	**P13**	344W	T1S	38,768	5	0	5	113	41,764	5	0	5	121	42,292	5	0	5	123
				T2S	38,545	5	0	5	112	41,523	5	0	5	121	42,049	5	0	5	122
				T2M	39,241	5	0	5	114	42,273	5	0	5	123	42,808	5	0	5	124
				T3S	37,947	5	0	5	110	40,879	5	0	5	119	41,396	5	0	5	120
				T3M	39,218	5	0	5	114	42,249	5	0	5	123	42,783	5	0	5	124
				T4M	38,478	5	0	5	112	41,451	5	0	5	120	41,976	5	0	5	122
				TFTM	39,472	5	0	5	115	42,522	5	0	5	124	43,060	5	0	5	125
				T5VS	39,749	5	0	1	116	42,821	5	0	1	124	43,363	5	0	1	126
				T5S	39,415	5	0	2	115	42,461	5	0	2	123	42,998	5	0	2	125
				T5M	39,405	5	0	4	115	42,450	5	0	4	123	42,988	5	0	4	125
				T5W	39,052	5	0	5	114	42,069	5	0	5	122	42,602	5	0	5	124
				BLC	32,419	5	0	5	94	34,925	5	0	5	102	35,367	5	0	5	103
				LCCO	23,154	3	0	5	67	24,943	3	0	5	73	25,259	3	0	5	73
				RCCO	23,124	5	0	5	67	24,910	5	0	5	72	25,226	5	0	5	73
90	1400	**P14**	405W	T1S	42,867	5	0	5	106	46,180	5	0	5	114	46,764	5	0	5	115
				T2S	42,621	5	0	5	105	45,914	5	0	5	113	46,495	5	0	5	115
				T2M	43,390	5	0	5	107	46,743	5	0	5	115	47,335	5	0	5	117
				T3S	41,959	5	0	5	104	45,201	5	0	5	112	45,773	5	0	5	113
				T3M	43,365	5	0	5	107	46,716	5	0	5	115	47,307	5	0	5	117
				T4M	42,547	5	0	5	105	45,834	5	0	5	113	46,414	5	0	5	115
				TFTM	43,646	5	0	5	108	47,018	5	0	5	116	47,614	5	0	5	118
				T5VS	43,952	5	0	1	109	47,349	5	0	1	117	47,948	5	0	1	118
				T5S	43,583	5	0	2	108	46,950	5	0	2	116	47,545	5	0	3	117
				T5M	43,572	5	0	4	108	46,939	5	0	4	116	47,533	5	0	4	117
				T5W	43,181	5	0	5	107	46,518	5	0	5	115	47,107	5	0	5	116
				BLC	35,847	5	0	5	89	38,617	5	0	5	95	39,106	5	0	5	97
				LCCO	25,602	3	0	5	63	27,580	3	0	5	68	27,930	3	0	5	69
				RCCO	25,569	5	0	5	63	27,544	5	0	5	68	27,893	5	0	5	69

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A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and system-level interoperability.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is A+ Certified when ordered with DTL® controls marked by a shaded background. DTL DLL equipped luminaires meet the A+ specification for luminaire to photocontrol interoperability1
- This luminaire is part of an A+ Certified solution for ROAM® or XPoint™ Wireless control networks, providing out-of-the-box control compatibility with simple commissioning, when ordered with drivers and control options marked by a shaded background[1]

To learn more about A+, visit www.acuitybrands.com/aplus.

1. See ordering tree for details.
2. A+ Certified Solutions for ROAM require the order of one ROAM node per luminaire.
   Sold Separately: Link to Roam; Link to DTL DLL

FEATURES & SPECIFICATIONS

INTENDED USE
The sleek design of the D-Series Area Size 2 reflects the embedded high performance LED technology. It is ideal for applications like car dealerships and large parking lots adjacent to malls, transit stations, grocery stores, home centers, and other big-box retailers.

CONSTRUCTION
Single-piece die-cast aluminum housing has integral heat sink fins to optimize thermal management through conductive and convective cooling. Modular design allows for ease of maintenance and future light engine upgrades. The LED drivers are mounted in direct contact with the casting to promote low operating temperature and long life. Housing is completely sealed against moisture and environmental contaminants (IP65). Low EPA (1.1 ft^2) for optimized pole wind loading.

FINISH
Exterior parts are protected by a zinc-infused Super Durable TGIC thermoset powder coat finish that provides superior resistance to corrosion and weathering. A tightly controlled multi-stage process ensures a minimum 3 mils thickness for a finish that can withstand extreme climate changes without cracking or peeling. Available in both textured and non-textured finishes.

OPTICS
Precision-molded proprietary acrylic lenses are engineered for superior area lighting distribution, uniformity, and pole spacing. Light engines are available in 3000 K, 4000 K, or 5000 K (70 CRI) configurations. The D-Series Size 2 has zero uplight and qualifies as a Nighttime Friendly™ product, meaning it is consistent with the LEED® and Green Globes™ criteria for eliminating wasteful uplight.

ELECTRICAL
Light engine configurations consist of high-efficacy LEDs mounted to metal-core circuit boards to maximize heat dissipation and promote long life (up to L85/100,000 hrs at 25ºC). Class 1 electronic drivers are designed to have a power factor >90%, THD <20%, and an expected life of 100,000 hours with <1% failure rate. Easily-serviceable 10kV surge protection device meets a minimum Category C Low operation (per ANSI/IEEE C62.41.2).

INSTALLATION
Included mounting block and integral arm facilitate quick and easy installation. Stainless steel bolts fasten the mounting block securely to poles and walls, enabling the D-Series Size 2 to withstand up to a 2.0 G vibration load rating per ANSI C136.31. The D-Series Size 2 utilizes the AERIS™ series pole drilling pattern (Template #8). NEMA photocontrol receptacle is available.

STANDARD CONTROLS
The DSX2 LED area luminaire has a number of control options. Dusk to dawn controls can be utilized via optional NEMA twist-lock photocell receptacles. Integrated motion sensors with on-board photocells feature field-adjustable programing and are suitable for mounting heights up to 30 feet.

nLIGHT AIR CONTROLS
The DSX2 LED area luminaire is also available with nLight® AIR for the ultimate in wireless control. This powerful controls platform provides out-of-the-box basic motion sensing and photocontrol functionality and is suitable for mounting heights up to 40 feet. Once commissioned using a smartphone and the easy-to-use CLAIRITY app, nLight AIR equipped luminaries can be grouped, resulting in motion sensor and photocell group response without the need for additional equipment. Scheduled dimming with motion sensor over-ride can be achieved when used with the nLight Eclypse. Additional information about nLight Air can be found here.

LISTINGS
UL Listed for wet locations. Light engines are IP66 rated; luminaire is IP65 rated. Rated for -40ºC minimum ambient. U.S. Patent No. D670,857 S. International patent pending.

DesignLights Consortium® (DLC) Premium qualified product and DLC qualified product. Not all versions of this product may be DLC Premium qualified or DLC qualified. Please check the DLC Qualified Products List at www.designlights.org/QPL to confirm which versions are qualified.

International Dark-Sky Association (IDA) Fixture Seal of Approval (FSA) is available for all products on this page utilizing 3000K color temperature only.

WARRANTY
5-year limited warranty. Complete warranty terms located at:
www.acuitybrands.com/support/customer-support/terms-and-conditions

Note: Actual performance may differ as a result of end-user environment and application.
All values are design or typical values, measured under laboratory conditions at 25 °C.
Specifications subject to change without notice.

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PARKING LOTS



D-Series Size 0
LED Area Luminaire

Catalog Number

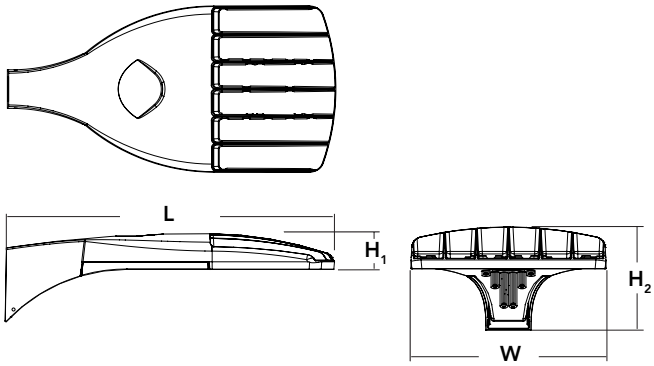
Notes

Type

Hit the Tab key or mouse over the page to see all interactive elements.

Specifications

EPA:	0.95 ft² (.09 m²)
Length:	26" (66.0 cm)
Width:	13" (33.0 cm)
Height$_1$:	3" (7.62 cm)
Height$_2$:	7" (17.8 cm)
Weight (max):	16 lbs (7.25 kg)



Introduction

The modern styling of the D-Series is striking yet unobtrusive - making a bold, progressive statement even as it blends seamlessly with its environment. The D-Series distills the benefits of the latest in LED technology into a high performance, high efficacy, long-life luminaire. The outstanding photometric performance results in sites with excellent uniformity, greater pole spacing and lower power density. It is ideal for replacing up to 400W metal halide with typical energy savings of 70% and expected service life of over 100,000 hours.

A+ Capable options indicated by this color background.

Ordering Information

EXAMPLE: DSX0 LED P6 40K T3M MVOLT SPA NLTAIR2 PIRHN DDBXD

DSX0 LED

Series	LEDs	Color temperature	Distribution	Voltage	Mounting
DSX0 LED	**Forward optics** P1 P4 P7 P2 P5 P3 P6 **Rotated optics** P10[1] P12[1] P11[1] P13[1]	30K 3000 K 40K 4000 K 50K 5000 K	T1S Type I short T2S Type II short T2M Type II medium T3S Type III short T3M Type III medium T4M Type IV medium TFTM Forward throw medium T5VS Type V very short T5S Type V short T5M Type V medium T5W Type V wide BLC Backlight control[2] LCCO Left corner cutoff[2] RCCO Right corner cutoff[2]	MVOLT [3,4] 120 [4] 208 [4] 240 [4] 277 [4] 347 [4,5] 480 [4,5]	**Shipped included** SPA Square pole mounting RPA Round pole mounting WBA Wall bracket SPUMBA Square pole universal mounting adaptor [6] RPUMBA Round pole universal mounting adaptor [6] **Shipped separately** KMA8 DDBXD U Mast arm mounting bracket adaptor (specify finish)[7]

Control options

Shipped installed

NLTAIR2	nLight AIR generation 2 enabled[8,9]
PIRHN	Network, high/low motion/ambient sensor[10]
PER	NEMA twist-lock receptacle only (control ordered separate) [11]
PER5	Five-pin receptacle only (control ordered separate) [11,12]
PER7	Seven-pin receptacle only (leads exit fixture) (control ordered separate) [11,12]
DMG	0-10V dimming extend out back of housing for external control (control ordered separate)
PIR	High/low, motion/ambient sensor, 8-15' mounting height, ambient sensor enabled at 5fc [13,14]
PIRH	High/low, motion/ambient sensor, 15-30' mounting height, ambient sensor enabled at 5fc [13,14]
PIR1FC3V	High/low, motion/ambient sensor, 8-15' mounting height, ambient sensor enabled at 1fc [13,14]
PIRH1FC3V	High/low, motion/ambient sensor, 15-30' mounting height, ambient sensor enabled at 1fc [13,14]
FAO	Field adjustable output [15]

Other options

Shipped installed

HS	House-side shield [16]
SF	Single fuse (120, 277, 347V) [4]
DF	Double fuse (208, 240, 480V) [4]
L90	Left rotated optics [1]
R90	Right rotated optics [1]
DDL	Diffused drop lens [16]

Shipped separately

BS	Bird spikes [17]
EGS	External glare shield [17]

Finish *(required)*

DDBXD	Dark bronze
DBLXD	Black
DNAXD	Natural aluminum
DWHXD	White
DDBTXD	Textured dark bronze
DBLBXD	Textured black
DNATXD	Textured natural aluminum
DWHGXD	Textured white

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Ordering Information

Accessories

Ordered and shipped separately.

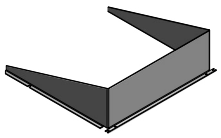
DLL127F 1.5 JU	Photocell - SSL twist-lock (120-277V) [18]
DLL347F 1.5 CUL JU	Photocell - SSL twist-lock (347V) [18]
DLL480F 1.5 CUL JU	Photocell - SSL twist-lock (480V) [18]
DSHORT SBK U	Shorting cap [18]
DSX0HS 20C U	House-side shield for P1,P2,P3 and P4 [16]
DSX0HS 30C U	House-side shield for P10,P11,P12 and P13 [16]
DSX0HS 40C U	House-side shield for P5,P6 AND P7 [16]
DSX0DDL U	Diffused drop lens (polycarbonate) [16]
PUMBA DDBXD U*	Square and round pole universal mounting bracket adaptor (specify finish) [19]
KMA8 DDBXD U	Mast arm mounting bracket adaptor (specify finish) [6]

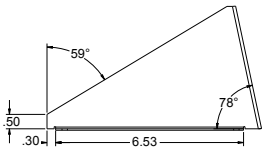
For more control options, visit DTL and ROAM online. Link to nLight Air 2

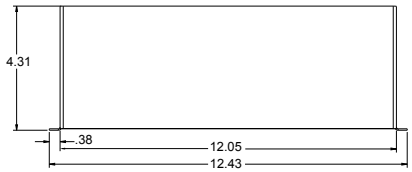
NOTES

1 P10, P11, P12 and P13 and rotated options (L90 or R90) only available together.
2 Not available with HS or DDL.
3 MVOLT driver operates on any line voltage from 120-277V (50/60 Hz).
4 Single fuse (SF) requires 120V, 277V or 347V. Double fuse (DF) requires 208V, 240V or 480V.
5 Not available in P4, P7 or P13. Not available with BL30, BL50 or PNMT options.
6 Universal mounting brackets intended for retrofit on existing pre-drilled poles only. 1.5 G vibration load rating per ANCI C136.31.
7 Must order fixture with SPA mounting. Must be ordered as a separate accessory; see Accessories information. For use with 2-3/8" mast arm (not included).
8 Must be ordered with PIRHN.
9 Sensor cover available only in dark bronze, black, white and natural aluminum colors.
10 Must be ordered with NLTAIR2. For more information on nLight Air 2 visit this link
11 Photocell ordered and shipped as a separate line item from Acuity Brands Controls. See accessories. Shorting Cap included.
12 If ROAM® node required, it must be ordered and shipped as a separate line item from Acuity Brands Controls. Shorting Cap included.
13 Reference Motion Sensor table on page 3.
14 Reference PER Table on page 3 to see functionality.
15 Not available with other dimming controls options.
16 Not available with BLC, LCCO and RCCO distribution.
17 Must be ordered with fixture for factory pre-drilling.
18 Requires luminaire to be specified with PER, PER5 or PER7 option. See PER Table on page 3.
19 For retrofit use only.

EGS – External Glare Shield

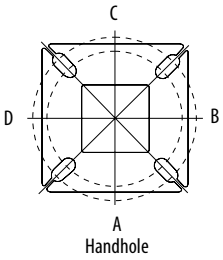




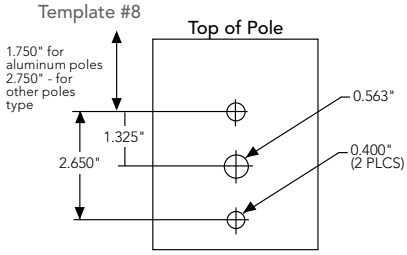


Drilling

HANDHOLE ORIENTATION
(from top of pole)



Template #8



Tenon Mounting Slipfitter

Tenon O.D.	Single Unit	2 at 180°	2 at 90°	3 at 120°	3 at 90°	4 at 90°
2-3/8"	AST20-190	AST20-280	AST20-290	AST20-320	AST20-390	AST20-490
2-7/8"	AST25-190	AST25-280	AST25-290	AST25-320	AST25-390	AST25-490
4"	AST35-190	AST35-280	AST35-290	AST35-320	AST35-390	AST35-490

							
Mounting Option	**Drilling Template**	**Single**	**2 @ 180**	**2 @ 90**	**3 @ 90**	**3 @ 120**	**4 @ 90**
Head Location		Side B	Side B & D	Side B & C	Side B, C & D	Round Pole Only	Side A, B, C & D
Drill Nomenclature	#8	DM19AS	DM28AS	DM29AS	DM39AS	DM32AS	DM49AS
		Minimum Acceptable Outside Pole Dimension					
SPA	#8	2-7/8"	2-7/8"	3.5"	3.5"		3.5"
RPA	#8	2-7/8"	2-7/8"	3.5"	3.5"	3"	3.5"
SPUMBA	#5	2-7/8"	3"	4"	4"		4"
RPUMBA	#5	2-7/8"	3.5"	5"	5"	3.5"	5"

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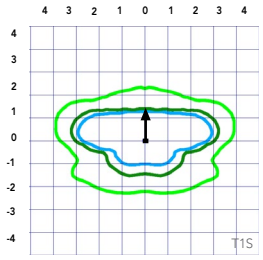
Photometric Diagrams

To see complete photometric reports or download .ies files for this product, visit Lithonia Lighting's D-Series Area Size 0 homepage.

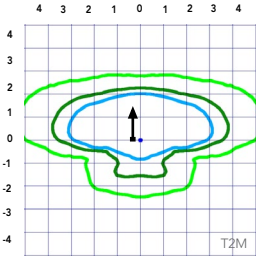
Isofootcandle plots for the DSX0 LED 40C 1000 40K. Distances are in units of mounting height (20').

LEGEND

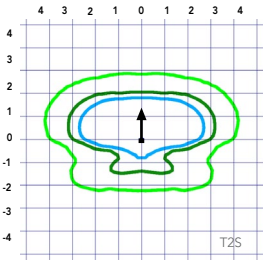
- 0.1 fc
- 0.5 fc
- 1.0 fc



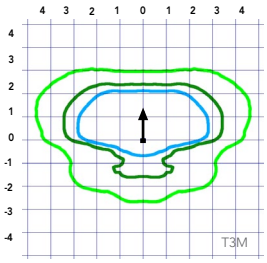
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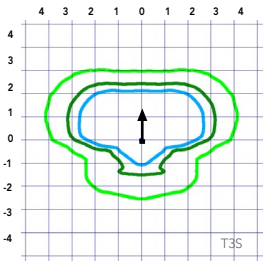
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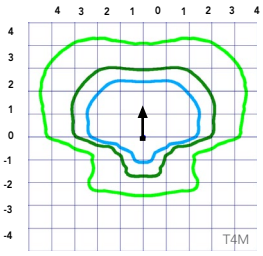
Test No. LTL23457P25 tested in accordance with IESNA LM-79-08.



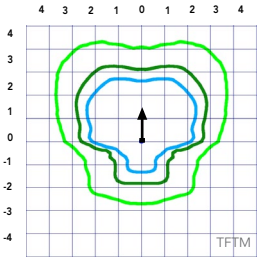
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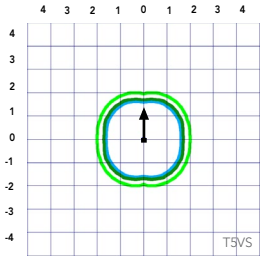
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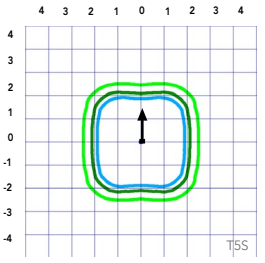
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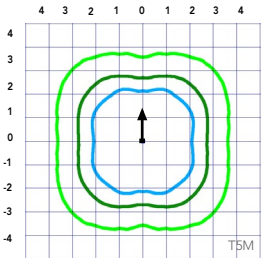
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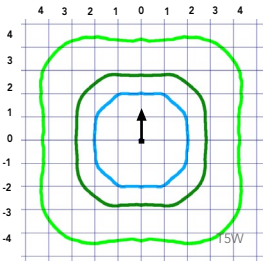
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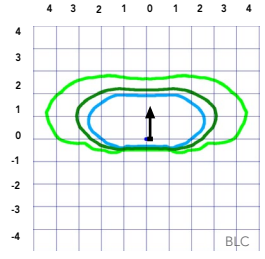
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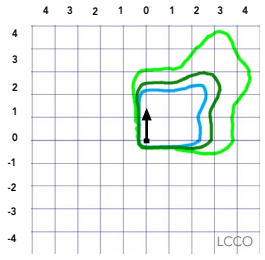
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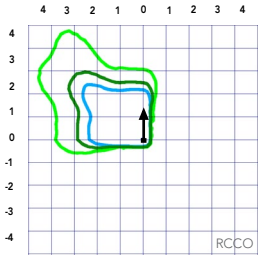
Test No. LTL23451P25 tested in accordance with IESNA LM-79-08.



Test No.



Test No.



Test No.

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Lumen Ambient Temperature (LAT) Multipliers

Use these factors to determine relative lumen output for average ambient temperatures from 0-40°C (32-104°F).

Ambient		Lumen Multiplier
0°C	32°F	1.04
5°C	41°F	1.04
10°C	50°F	1.03
15°C	50°F	1.02
20°C	68°F	1.01
25°C	**77°C**	**1.00**
30°C	86°F	0.99
35°C	95°F	0.98
40°C	104°F	0.97

Projected LED Lumen Maintenance

Data references the extrapolated performance projections for the platforms noted in a **25°C ambient**, based on 10,000 hours of LED testing (tested per IESNA LM-80-08 and projected per IESNA TM-21-11).

To calculate LLF, use the lumen maintenance factor that corresponds to the desired number of operating hours below. For other lumen maintenance values, contact factory.

Operating Hours	Lumen Maintenance Factor
25,000	0.96
50,000	0.92
100,000	0.85

Motion Sensor Default Settings						
Option	Dimmed State	High Level (when triggered)	Photocell Operation	Dwell Time	Ramp-up Time	Ramp-down Time
PIR or PIRH	3V (37%) Output	10V (100%) Output	Enabled @ 5FC	5 min	3 sec	5 min
*PIR1FC3V or PIRH1FC3V	3V (37%) Output	10V (100%) Output	Enabled @ 1FC	5 min	3 sec	5 min
*for use with separate Dusk to Dawn or timer.						

Electrical Load

					Current (A)					
	Performance Package	LED Count	Drive Current	Wattage	120	208	240	277	347	480
Forward Optics (Non-Rotated)	P1	20	530	38	0.32	0.18	0.15	0.15	0.10	0.08
	P2	20	700	49	0.41	0.23	0.20	0.19	0.14	0.11
	P3	20	1050	71	0.60	0.37	0.32	0.27	0.21	0.15
	P4	20	1400	92	0.77	0.45	0.39	0.35	0.28	0.20
	P5	40	700	89	0.74	0.43	0.38	0.34	0.26	0.20
	P6	40	1050	134	1.13	0.65	0.55	0.48	0.39	0.29
	P7	40	1300	166	1.38	0.80	0.69	0.60	0.50	0.37
Rotated Optics (Requires L90 or R90)	P10	30	530	53	0.45	0.26	0.23	0.21	0.16	0.12
	P11	30	700	72	0.60	0.35	0.30	0.27	0.20	0.16
	P12	30	1050	104	0.88	0.50	0.44	0.39	0.31	0.23
	P13	30	1300	128	1.08	0.62	0.54	0.48	0.37	0.27

Controls Options

Nomenclature	Descripton	Functionality	Primary control device	Notes
FAO	Field adjustable output device installed inside the lumiaire; wired to the driver dimming leads.	Allows the lumiaire to be manually dimmed, effectively trimming the light output.	FAO device	Cannot be used with other controls options that need the 0-10V leads
DS	Drivers wired independantly for 50/50 luminaire operation	The luminaire is wired to two separate circuits, allowing for 50/50 operation.	Independently wired drivers	Requires two seperately switched circuits. Consider nLight AIR as a more cost effective alternative.
PER5 or PER7	Twist-lock photocell receptacle	Compatible with standard twist-lock photocells for dusk to dawn operation, or advanced control nodes that provide 0-10V dimming signals.	Twist-lock photocells such as DLL Elite or advanced control nodes such as ROAM.	Pins 4 & 5 to dimming leads on driver, Pins 6 & 7 are capped inside luminaire
PIR or PIRH	Motion sensors with integral photocell. PIR for 8-15' mounting; PIRH for 15-30' mounting	Luminaires dim when no occupancy is detected.	Acuity Controls SBOR	Also available with PIRH1FC3V when the sensor photocell is used for dusk-to-dawn operation.
NLTAIR2 PIRHN	nLight AIR enabled luminaire for motion sensing, photocell and wireless communication.	Motion and ambient light sensing with group response. Scheduled dimming with motion sensor over-ride when wirelessly connected to the nLight Eclypse.	nLight Air rSDGR	nLight AIR sensors can be programmed and commissioned from the ground using the CIAIRity Pro app.

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Performance Data

Lumen Output

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Forward Optics

Power Package	LED Count	Drive Current	System Watts	Dist. Type	30K (3000 K, 70 CRI)					40K (4000 K, 70 CRI)					50K (5000 K, 70 CRI)				
					Lumens	B	U	G	LPW	Lumens	B	U	G	LPW	Lumens	B	U	G	LPW
P1	20	530	38W	T1S	4,369	1	0	1	115	4,706	1	0	1	124	4,766	1	0	1	125
				T2S	4,364	1	0	1	115	4,701	1	0	1	124	4,761	1	0	1	125
				T2M	4,387	1	0	1	115	4,726	1	0	1	124	4,785	1	0	1	126
				T3S	4,248	1	0	1	112	4,577	1	0	1	120	4,634	1	0	1	122
				T3M	4,376	1	0	1	115	4,714	1	0	1	124	4,774	1	0	1	126
				T4M	4,281	1	0	1	113	4,612	1	0	2	121	4,670	1	0	2	123
				TFTM	4,373	1	0	1	115	4,711	1	0	2	124	4,771	1	0	2	126
				T5VS	4,548	2	0	0	120	4,900	2	0	0	129	4,962	2	0	0	131
				T5S	4,552	2	0	0	120	4,904	2	0	0	129	4,966	2	0	0	131
				T5M	4,541	3	0	1	120	4,891	3	0	1	129	4,953	3	0	1	130
				T5W	4,576	3	0	2	120	4,929	3	0	2	130	4,992	3	0	2	131
				BLC	3,586	1	0	1	94	3,863	1	0	1	102	3,912	1	0	1	103
				LCCO	2,668	1	0	1	70	2,874	1	0	2	76	2,911	1	0	2	77
				RCCO	2,668	1	0	1	70	2,874	1	0	2	76	2,911	1	0	2	77
P2	20	700	49W	T1S	5,570	1	0	1	114	6,001	1	0	1	122	6,077	2	0	2	124
				T2S	5,564	1	0	2	114	5,994	1	0	2	122	6,070	2	0	2	124
				T2M	5,593	1	0	1	114	6,025	1	0	1	123	6,102	1	0	1	125
				T3S	5,417	1	0	2	111	5,835	1	0	2	119	5,909	2	0	2	121
				T3M	5,580	1	0	2	114	6,011	1	0	2	123	6,087	1	0	2	124
				T4M	5,458	1	0	2	111	5,880	1	0	2	120	5,955	1	0	2	122
				TFTM	5,576	1	0	2	114	6,007	1	0	2	123	6,083	1	0	2	124
				T5VS	5,799	2	0	0	118	6,247	2	0	0	127	6,327	2	0	0	129
				T5S	5,804	2	0	0	118	6,252	2	0	0	128	6,332	2	0	1	129
				T5M	5,789	3	0	1	118	6,237	3	0	1	127	6,316	3	0	1	129
				T5W	5,834	3	0	2	119	6,285	3	0	2	128	6,364	3	0	2	130
				BLC	4,572	1	0	1	93	4,925	1	0	1	101	4,987	1	0	1	102
				LCCO	3,402	1	0	2	69	3,665	1	0	2	75	3,711	1	0	2	76
				RCCO	3,402	1	0	2	69	3,665	1	0	2	75	3,711	1	0	2	76
P3	20	1050	71W	T1S	7,833	2	0	2	110	8,438	2	0	2	119	8,545	2	0	2	120
				T2S	7,825	2	0	2	110	8,429	2	0	2	119	8,536	2	0	2	120
				T2M	7,865	2	0	2	111	8,473	2	0	2	119	8,580	2	0	2	121
				T3S	7,617	2	0	2	107	8,205	2	0	2	116	8,309	2	0	2	117
				T3M	7,846	2	0	2	111	8,452	2	0	2	119	8,559	2	0	2	121
				T4M	7,675	2	0	2	108	8,269	2	0	2	116	8,373	2	0	2	118
				TFTM	7,841	2	0	2	110	8,447	2	0	2	119	8,554	2	0	2	120
				T5VS	8,155	3	0	0	115	8,785	3	0	0	124	8,896	3	0	0	125
				T5S	8,162	3	0	1	115	8,792	3	0	1	124	8,904	3	0	1	125
				T5M	8,141	3	0	2	115	8,770	3	0	2	124	8,881	3	0	2	125
				T5W	8,204	3	0	2	116	8,838	4	0	2	124	8,950	4	0	2	126
				BLC	6,429	1	0	2	91	6,926	1	0	2	98	7,013	1	0	2	99
				LCCO	4,784	1	0	2	67	5,153	1	0	2	73	5,218	1	0	2	73
				RCCO	4,784	1	0	2	67	5,153	1	0	2	73	5,218	1	0	2	73
P4	20	1400	92W	T1S	9,791	2	0	2	106	10,547	2	0	2	115	10,681	2	0	2	116
				T2S	9,780	2	0	2	106	10,536	2	0	2	115	10,669	2	0	2	116
				T2M	9,831	2	0	2	107	10,590	2	0	2	115	10,724	2	0	2	117
				T3S	9,521	2	0	2	103	10,256	2	0	2	111	10,386	2	0	2	113
				T3M	9,807	2	0	2	107	10,565	2	0	2	115	10,698	2	0	2	116
				T4M	9,594	2	0	2	104	10,335	2	0	3	112	10,466	2	0	3	114
				TFTM	9,801	2	0	2	107	10,558	2	0	2	115	10,692	2	0	2	116
				T5VS	10,193	3	0	1	111	10,981	3	0	1	119	11,120	3	0	1	121
				T5S	10,201	3	0	1	111	10,990	3	0	1	119	11,129	3	0	1	121
				T5M	10,176	4	0	2	111	10,962	4	0	2	119	11,101	4	0	2	121
				T5W	10,254	4	0	3	111	11,047	4	0	3	120	11,186	4	0	3	122
				BLC	8,036	1	0	2	87	8,656	1	0	2	94	8,766	1	0	2	95
				LCCO	5,979	1	0	2	65	6,441	1	0	2	70	6,523	1	0	3	71
					5,979	1	0	2	65	6,441	1	0	2	70	6,523	1	0	3	71

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Performance Data

Lumen Output

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Forward Optics

Power Package	LED Count	Drive Current	System Watts	Dist. Type	30K (3000 K, 70 CRI)					40K (4000 K, 70 CRI)					50K (5000 K, 70 CRI)				
					Lumens	B	U	G	LPW	Lumens	B	U	G	LPW	Lumens	B	U	G	LPW
P5	40	700	89W	T1S	10,831	2	0	2	122	11,668	2	0	2	131	11,816	2	0	2	133
				T2S	10,820	2	0	2	122	11,656	2	0	2	131	11,803	2	0	2	133
				T2M	10,876	2	0	2	122	11,716	2	0	2	132	11,864	2	0	2	133
				T3S	10,532	2	0	2	118	11,346	2	0	2	127	11,490	2	0	2	129
				T3M	10,849	2	0	2	122	11,687	2	0	2	131	11,835	2	0	2	133
				T4M	10,613	2	0	3	119	11,434	2	0	3	128	11,578	2	0	3	130
				TFTM	10,842	2	0	2	122	11,680	2	0	2	131	11,828	2	0	2	133
				T5VS	11,276	3	0	1	127	12,148	3	0	1	136	12,302	3	0	1	138
				T5S	11,286	3	0	1	127	12,158	3	0	1	137	12,312	3	0	1	138
				T5M	11,257	4	0	2	126	12,127	4	0	2	136	12,280	4	0	2	138
				T5W	11,344	4	0	3	127	12,221	4	0	3	137	12,375	4	0	3	139
				BLC	8,890	1	0	2	100	9,576	1	0	2	108	9,698	1	0	2	109
				LCCO	6,615	1	0	3	74	7,126	1	0	3	80	7,216	1	0	3	81
				RCCO	6,615	1	0	3	74	7,126	1	0	3	80	7,216	1	0	3	81
P6	40	1050	134W	T1S	14,805	3	0	3	110	15,949	3	0	3	119	16,151	3	0	3	121
				T2S	14,789	3	0	3	110	15,932	3	0	3	119	16,134	3	0	3	120
				T2M	14,865	3	0	3	111	16,014	3	0	3	120	16,217	3	0	3	121
				T3S	14,396	3	0	3	107	15,509	3	0	3	116	15,705	3	0	3	117
				T3M	14,829	2	0	3	111	15,975	3	0	3	119	16,177	3	0	3	121
				T4M	14,507	2	0	3	108	15,628	3	0	3	117	15,826	3	0	3	118
				TFTM	14,820	2	0	3	111	15,965	3	0	3	119	16,167	3	0	3	121
				T5VS	15,413	4	0	1	115	16,604	4	0	1	124	16,815	4	0	1	125
				T5S	15,426	3	0	1	115	16,618	4	0	1	124	16,828	4	0	1	126
				T5M	15,387	4	0	2	115	16,576	4	0	2	124	16,786	4	0	2	125
				T5W	15,506	4	0	3	116	16,704	4	0	3	125	16,915	4	0	3	126
				BLC	12,151	1	0	2	91	13,090	1	0	2	98	13,255	1	0	2	99
				LCCO	9,041	1	0	3	67	9,740	1	0	3	73	9,863	1	0	3	74
				RCCO	9,041	1	0	3	67	9,740	1	0	3	73	9,863	1	0	3	74
P7	40	1300	166W	T1S	17,023	3	0	3	103	18,338	3	0	3	110	18,570	3	0	3	112
				T2S	17,005	3	0	3	102	18,319	3	0	3	110	18,551	3	0	3	112
				T2M	17,092	3	0	3	103	18,413	3	0	3	111	18,646	3	0	3	112
				T3S	16,553	3	0	3	100	17,832	3	0	3	107	18,058	3	0	3	109
				T3M	17,051	3	0	3	103	18,369	3	0	3	111	18,601	3	0	3	112
				T4M	16,681	3	0	3	100	17,969	3	0	3	108	18,197	3	0	3	110
				TFTM	17,040	3	0	3	103	18,357	3	0	4	111	18,590	3	0	4	112
				T5VS	17,723	4	0	1	107	19,092	4	0	1	115	19,334	4	0	1	116
				T5S	17,737	4	0	2	107	19,108	4	0	2	115	19,349	4	0	2	117
				T5M	17,692	4	0	2	107	19,059	4	0	2	115	19,301	4	0	2	116
				T5W	17,829	5	0	3	107	19,207	5	0	3	116	19,450	5	0	3	117
				BLC	13,971	2	0	2	84	15,051	2	0	2	91	15,241	2	0	2	92
				LCCO	10,396	1	0	3	63	11,199	1	0	3	67	11,341	1	0	3	68
					10,396	1	0	3	63	11,199	1	0	3	67	11,341	1	0	3	68

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Performance Data

Lumen Output

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Rotated Optics

Power Package	LED Count	Drive Current	System Watts	Dist. Type	30K (3000 K, 70 CRI)					40K (4000 K, 70 CRI)					50K (5000 K, 70 CRI)				
					Lumens	B	U	G	LPW	Lumens	B	U	G	LPW	Lumens	B	U	G	LPW
P10	30	530	53W	T1S	6,727	2	0	2	127	7,247	3	0	3	137	7,339	3	0	3	138
				T2S	6,689	3	0	3	126	7,205	3	0	3	136	7,297	3	0	3	138
				T2M	6,809	3	0	3	128	7,336	3	0	3	138	7,428	3	0	3	140
				T3S	6,585	3	0	3	124	7,094	3	0	3	134	7,183	3	0	3	136
				T3M	6,805	3	0	3	128	7,331	3	0	3	138	7,424	3	0	3	140
				T4M	6,677	3	0	3	126	7,193	3	0	3	136	7,284	3	0	3	137
				TFTM	6,850	3	0	3	129	7,379	3	0	3	139	7,472	3	0	3	141
				T5VS	6,898	3	0	0	130	7,431	3	0	0	140	7,525	3	0	0	142
				T5S	6,840	2	0	1	129	7,368	2	0	1	139	7,461	2	0	1	141
				T5M	6,838	3	0	1	129	7,366	3	0	2	139	7,460	3	0	2	141
				T5W	6,777	3	0	2	128	7,300	3	0	2	138	7,393	3	0	2	139
				BLC	5,626	2	0	2	106	6,060	2	0	2	114	6,137	2	0	2	116
				LCCO	4,018	1	0	2	76	4,328	1	0	2	82	4,383	1	0	2	83
				RCCO	4,013	3	0	3	76	4,323	3	0	3	82	4,377	3	0	3	83
P11	30	700	72W	T1S	8,594	3	0	3	119	9,258	3	0	3	129	9,376	3	0	3	130
				T2S	8,545	3	0	3	119	9,205	3	0	3	128	9,322	3	0	3	129
				T2M	8,699	3	0	3	121	9,371	3	0	3	130	9,490	3	0	3	132
				T3S	8,412	3	0	3	117	9,062	3	0	3	126	9,177	3	0	3	127
				T3M	8,694	3	0	3	121	9,366	3	0	3	130	9,484	3	0	3	132
				T4M	8,530	3	0	3	118	9,189	3	0	3	128	9,305	3	0	3	129
				TFTM	8,750	3	0	3	122	9,427	3	0	3	131	9,546	3	0	3	133
				T5VS	8,812	3	0	0	122	9,493	3	0	0	132	9,613	3	0	0	134
				T5S	8,738	3	0	1	121	9,413	3	0	1	131	9,532	3	0	1	132
				T5M	8,736	3	0	2	121	9,411	3	0	2	131	9,530	3	0	2	132
				T5W	8,657	4	0	2	120	9,326	4	0	2	130	9,444	4	0	2	131
				BLC	7,187	3	0	3	100	7,742	3	0	3	108	7,840	3	0	3	109
				LCCO	5,133	1	0	2	71	5,529	1	0	2	77	5,599	1	0	2	78
				RCCO	5,126	3	0	3	71	5,522	3	0	3	77	5,592	3	0	3	78
P12	30	1050	104W	T1S	12,149	3	0	3	117	13,088	3	0	3	126	13,253	3	0	3	127
				T2S	12,079	4	0	4	116	13,012	4	0	4	125	13,177	4	0	4	127
				T2M	12,297	3	0	3	118	13,247	3	0	3	127	13,415	3	0	3	129
				T3S	11,891	4	0	4	114	12,810	4	0	4	123	12,972	4	0	4	125
				T3M	12,290	3	0	3	118	13,239	4	0	4	127	13,407	4	0	4	129
				T4M	12,058	4	0	4	116	12,990	4	0	4	125	13,154	4	0	4	126
				TFTM	12,369	4	0	4	119	13,325	4	0	4	128	13,494	4	0	4	130
				T5VS	12,456	3	0	1	120	13,419	3	0	1	129	13,589	4	0	1	131
				T5S	12,351	3	0	1	119	13,306	3	0	1	128	13,474	3	0	1	130
				T5M	12,349	4	0	2	119	13,303	4	0	2	128	13,471	4	0	2	130
				T5W	12,238	4	0	3	118	13,183	4	0	3	127	13,350	4	0	3	128
				BLC	10,159	3	0	3	98	10,944	3	0	3	105	11,083	3	0	3	107
				LCCO	7,256	1	0	3	70	7,816	1	0	3	75	7,915	1	0	3	76
				RCCO	7,246	3	0	3	70	7,806	4	0	4	75	7,905	4	0	4	76
P13	30	1300	128W	T1S	14,438	3	0	3	113	15,554	3	0	3	122	15,751	3	0	3	123
				T2S	14,355	4	0	4	112	15,465	4	0	4	121	15,660	4	0	4	122
				T2M	14,614	3	0	3	114	15,744	4	0	4	123	15,943	4	0	4	125
				T3S	14,132	4	0	4	110	15,224	4	0	4	119	15,417	4	0	4	120
				T3M	14,606	4	0	4	114	15,735	4	0	4	123	15,934	4	0	4	124
				T4M	14,330	4	0	4	112	15,438	4	0	4	121	15,633	4	0	4	122
				TFTM	14,701	4	0	4	115	15,836	4	0	4	124	16,037	4	0	4	125
				T5VS	14,804	4	0	1	116	15,948	4	0	1	125	16,150	4	0	1	126
				T5S	14,679	3	0	1	115	15,814	3	0	1	124	16,014	3	0	1	125
				T5M	14,676	4	0	2	115	15,810	4	0	2	124	16,010	4	0	2	125
				T5W	14,544	4	0	3	114	15,668	4	0	3	122	15,866	4	0	3	124
				BLC	7919	3	0	3	62	8531	3	0	3	67	8639	3	0	3	67
				LCCO	5145	1	0	2	40	5543	1	0	2	43	5613	1	0	2	44
					5139	3	0	3	40	5536	3	0	3	43	5606	3	0	3	44

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A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and system-level interoperability.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is A+ Certified when ordered with DTL® controls marked by a shaded background. DTL DLL equipped luminaires meet the A+ specification for luminaire to photocontrol interoperability1
- This luminaire is part of an A+ Certified solution for ROAM® or XPoint™ Wireless control networks, providing out-of-the-box control compatibility with simple commissioning, when ordered with drivers and control options marked by a shaded background[1]

To learn more about A+, visit www.acuitybrands.com/aplus.

1. See ordering tree for details.
2. A+ Certified Solutions for ROAM require the order of one ROAM node per luminaire. Sold Separately: Link to Roam; Link to DTL DLL

FEATURES & SPECIFICATIONS

INTENDED USE

The sleek design of the D-Series Size 0 reflects the embedded high performance LED technology. It is ideal for many commercial and municipal applications, such as parking lots, plazas, campuses, and pedestrian areas.

CONSTRUCTION

Single-piece die-cast aluminum housing has integral heat sink fins to optimize thermal management through conductive and convective cooling. Modular design allows for ease of maintenance and future light engine upgrades. The LED driver is mounted in direct contact with the casting to promote low operating temperature and long life. Housing is completely sealed against moisture and environmental contaminants (IP65). Low EPA (0.95 ft^2) for optimized pole wind loading.

FINISH

Exterior parts are protected by a zinc-infused Super Durable TGIC thermoset powder coat finish that provides superior resistance to corrosion and weathering. A tightly controlled multi-stage process ensures a minimum 3 mils thickness for a finish that can withstand extreme climate changes without cracking or peeling. Available in both textured and non-textured finishes.

OPTICS

Precision-molded proprietary acrylic lenses are engineered for superior area lighting distribution, uniformity, and pole spacing. Light engines are available in 3000 K, 4000 K or 5000 K (70 CRI) configurations. The D-Series Size 0 has zero uplight and qualifies as a Nighttime Friendly™ product, meaning it is consistent with the LEED® and Green Globes™ criteria for eliminating wasteful uplight.

ELECTRICAL

Light engine(s) configurations consist of high-efficacy LEDs mounted to metal-core circuit boards to maximize heat dissipation and promote long life (up to L85/100,000 hours at 25°C). Class 1 electronic drivers are designed to have a power factor >90%, THD <20%, and an expected life of 100,000 hours with <1% failure rate. Easily serviceable 10kV surge protection device meets a minimum Category C Low operation (per ANSI/IEEE C62.41.2).

STANDARD CONTROLS

The DSX0 LED area luminaire has a number of control options. Dusk to dawn controls can be utilized via optional NEMA twist-lock photocell receptacles. Integrated motion sensors with on-board photocells feature field-adjustable programing and are suitable for mounting heights up to 30 feet.

nLIGHT AIR CONTROLS

The DSX0 LED area luminaire is also available with nLight® AIR for the ultimate in wireless control. This powerful controls platform provides out-of-the-box basic motion sensing and photocontrol functionality and is suitable for mounting heights up to 40 feet. Once commissioned using a smartphone and the easy-to-use CLAIRITY app, nLight AIR equipped luminaries can be grouped, resulting in motion sensor and photocell group response without the need for additional equipment. Scheduled dimming with motion sensor over-ride can be achieved when used with the nLight Eclypse. Additional information about nLight Air can be found here.

INSTALLATION

Included mounting block and integral arm facilitate quick and easy installation. Stainless steel bolts fasten the mounting block securely to poles and walls, enabling the D-Series Size 0 to withstand up to a 3.0 G vibration load rating per ANSI C136.31. The D-Series Size 0 utilizes the AERIS™ series pole drilling pattern (template #8). Optional terminal block and NEMA photocontrol receptacle are also available.

LISTINGS

UL Listed for wet locations. Light engines are IP66 rated; luminaire is IP65 rated. Rated for -40°C minimum ambient. U.S. Patent No. D672,492 S. International patent pending.

DesignLights Consortium® (DLC) Premium qualified product and DLC qualified product. Not all versions of this product may be DLC Premium qualified or DLC qualified. Please check the DLC Qualified Products List at www.designlights.org/QPL to confirm which versions are qualified.

International Dark-Sky Association (IDA) Fixture Seal of Approval (FSA) is available for all products on this page utilizing 3000K color temperature only.

WARRANTY

5-year limited warranty. Complete warranty terms located at: www.acuitybrands.com/resources/terms-and-conditions

Note: Actual performance may differ as a result of end-user environment and application.
All values are design or typical values, measured under laboratory conditions at 25 °C.
Specifications subject to change without notice.

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d-series

D-Series Size 2
LED Wall Luminaire

Catalog Number

Notes

Type

Hit the Tab key or mouse over the page to see all interactive elements.

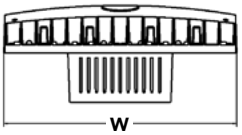
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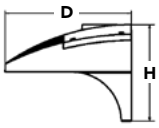
Luminaire

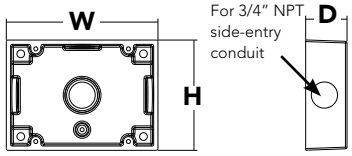
Width:	18-1/2" (47.0 cm)	**Weight:**	21 lbs (9.5 kg)
Depth:	10" (25.4 cm)		
Height:	7-5/8" (19.4 cm)		

Back Box (BBW)

Width:	5-1/2" (14.0 cm)	**BBW Weight:**	1 lbs (0.5 kg)
Depth:	1-1/2" (3.8 cm)		
Height:	4" (10.2 cm)		







A+ Capable options indicated by this color background.

A+ Capable Luminaire

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To learn more about A+, visit www.acuitybrands.com/aplus.

1. See ordering tree for details.
2. A+ Certified Solutions for ROAM require the order of one ROAM node per luminaire. Sold Separately: Link to Roam; Link to DTL DLL

Ordering Information

EXAMPLE: DSXW2 LED 30C 700 40K T3M MVOLT DDBTXD

DSXW2 LED

Series	LEDs	Drive Current	Color temperature	Distribution	Voltage	Mounting	Control Options
DSXW2 LED	20C 20 LEDs (two engines) 30C 30 LEDs (three engines)	350 350 mA 530 530 mA 700 700 mA 1000 1000 mA[1] (1 A)	30K 3000 K 40K 4000 K 50K 5000 K AMBPC Amber phosphor converted[2]	T2S Type II Short T2M Type II Medium T3S Type III Short T3M Type III Medium T4M Type IV Medium TFTM Forward Throw Medium	MVOLT[3] 120[4] 208[4] 240[4] 277[4] 347[4,5] 480[4,5]	**Shipped included** (blank) Surface mounting bracket **Shipped separately[6]** BBW Surface-mounted back box (for conduit entry)	**Shipped installed** PE Photoelectric cell, button type[7] PER NEMA twist-lock receptacle only (control ordered separate)[8] PER5 Five-wire receptacle only (control ordered separate)[8,9] PER7 Seven-wire receptacle only (control ordered separate)[8,9] DMG 0-10v dimming wires pulled outside fixture (for use with an external control, ordered separately) PIR 180° motion/ambient light sensor,<15' mtg ht[10,11] PIRH 180° motion/ambient light sensor, 15-30' mtg ht[10,11] PIR1FC3V Motion/ambient sensor, 8-15' mounting height, ambient sensor enabled at 1fc[11,12] PIRH1FC3V Motion/ambient sensor, 15-30' mounting height, ambient sensor enabled at 1fc[11,12]

Other Options

Shipped installed

SF	Single fuse (120, 277, 347V)[3]
DF	Double fuse (208, 240, 480V)[3]
HS	House-side shield[4]
SPD	Separate surge protection[13]

Shipped separately[13]

BSW	Bird-deterrent spikes
VG	Vandal guard

Finish *(required)*

DDBXD	Dark bronze	DSSXD	Sandstone	DWHGXD	Textured white
DBLXD	Black	DDBTXD	Textured dark bronze	DSSTXD	Textured sandstone
DNAXD	Natural aluminum	DBLBXD	Textured black		
DWHXD	White	DNATXD	Textured natural aluminum		

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Ordering Information

Accessories

Ordered and shipped separately.

DLL127F 1.5 JU	Photocell - SSL twist-lock (120-277V) [14]
DLL347F 1.5 CUL JU	Photocell - SSL twist-lock (347V) [14]
DLL480F 1.5 CUL JU	Photocell - SSL twist-lock (480V) [14]
DSHORT SBK U	Shorting cap (Included when ordering PER, PER5 or PER7) [14]
DSXWHS U	House-side shield (one per light engine)
DSXWBSW U	Bird-deterrent spikes
DSXW2VG U	Vandal guard accessory
DSXW2BBW DDBXD U	Back box accessory (specify finish)

For more control options, visit DTL and ROAM online.

NOTES

1 1000mA is not available with AMBPC.
2 AMBPC is not available with 1000mA.
3 MVOLT driver operates on any line voltage from 120-277V (50/60 Hz).
4 Single fuse (SF) requires 120, 277 or 347 voltage option. Double fuse (DF) requires 208, 240 or 480 voltage option.
5 Available with 30 LED/700mA options only (DSXW2 LED 30C 700). DMG option not available.
6 Also available as a separate accessory; see Accessories information.
7 Photocontrol (PE) requires 120, 208, 240, 277 or 347 voltage option. Not available with motion/ambient light sensors (PIR or PIRH).
8 Photocell ordered and shipped as a separate line item from Acuity Brands Controls. See accessories. Shorting Cap included.
9 If ROAM® node required, it must be ordered and shipped as a separate line item from Acuity Brands Controls. Shorting Cap included.
10 Reference Motion Sensor table on page 3.
11 Reference PER Table on page 3 for functionality.
12 PIR and PIR1FC3V specify the SensorSwitch SBGR-10-ODP control; PIRH and PIRH1FC3V specify the SensorSwitch SBGR-6-ODP control; see Motion Sensor Guide for details. Dimming driver standard. Not available with PER5 or PER7. Separate on/off required.
13 See the electrical section on page 2 for more details.
14 Requires luminaire to be specified with PER option. Ordered and shipped as a separate line item. See PER Table.

Performance Data

Lumen Output

Lumen values are from photometric tests performed in accordance with IESNA LM-79-08. Data is considered to be representative of the configurations shown, within the tolerances allowed by Lighting Facts. Contact factory for performance data on any configurations not shown here.

LEDs	Drive Current (mA)	System Watts	Dist. Type	30K					40K					50K				
				Lumens	B	U	G	LPW	Lumens	B	U	G	LPW	Lumens	B	U	G	LPW
20C (20 LEDs)	350 mA	25W	T2S	2,783	1	0	1	111	2,989	1	0	1	120	3,008	1	0	1	120
			T2M	2,709	1	0	1	108	2,908	1	0	1	116	2,926	1	0	1	117
			T3S	2,748	1	0	1	110	2,951	1	0	1	118	2,969	1	0	1	119
			T3M	2,793	1	0	1	112	2,999	1	0	1	120	3,018	1	0	1	121
			T4M	2,756	1	0	1	110	2,959	1	0	1	118	2,977	1	0	1	119
			TFTM	2,753	1	0	1	110	2,956	1	0	1	118	2,975	1	0	1	119
	530 mA	36W	T2S	4,030	1	0	1	112	4,327	1	0	1	120	4,354	1	0	1	121
			T2M	3,920	1	0	1	109	4,210	1	0	1	117	4,236	1	0	1	118
			T3S	3,978	1	0	1	111	4,272	1	0	1	119	4,299	1	0	1	119
			T3M	4,044	1	0	2	112	4,343	1	0	2	121	4,370	1	0	2	121
			T4M	3,990	1	0	1	111	4,284	1	0	1	119	4,310	1	0	1	120
			TFTM	3,987	1	0	1	111	4,281	1	0	1	119	4,308	1	0	1	120
	700 mA	47W	T2S	5,130	1	0	1	109	5,509	1	0	1	117	5,544	1	0	1	118
			T2M	4,991	1	0	2	106	5,360	1	0	2	114	5,393	1	0	2	115
			T3S	5,066	1	0	1	108	5,440	1	0	1	116	5,474	1	0	1	116
			T3M	5,148	1	0	2	110	5,529	1	0	2	118	5,563	1	0	2	118
			T4M	5,080	1	0	2	108	5,455	1	0	2	116	5,488	1	0	2	117
			TFTM	5,075	1	0	2	108	5,450	1	0	2	116	5,484	1	0	2	117
	1000 mA	73W	T2S	7,147	2	0	2	98	7,675	2	0	2	105	7,723	1	0	1	104
			T2M	6,954	2	0	2	95	7,467	2	0	2	102	7,514	2	0	2	103
			T3S	7,057	1	0	2	97	7,579	1	0	2	104	7,627	1	0	2	104
			T3M	7,172	2	0	3	98	7,702	2	0	3	106	7,751	2	0	3	106
			T4M	7,076	1	0	2	97	7,599	1	0	2	104	7,646	1	0	2	105
			TFTM	7,071	1	0	2	97	7,594	1	0	2	104	7,641	1	0	2	105
30C (30 LEDs)	350 mA	36W	T2S	4,160	1	0	1	116	4,467	1	0	1	124	4,494	1	0	1	125
			T2M	4,048	1	0	1	112	4,346	1	0	2	121	4,373	1	0	2	121
			T3S	4,108	1	0	1	114	4,411	1	0	1	123	4,438	1	0	1	123
			T3M	4,174	1	0	2	116	4,483	1	0	2	125	4,510	1	0	2	125
			T4M	4,119	1	0	1	114	4,423	1	0	2	123	4,450	1	0	2	124
			TFTM	4,115	1	0	1	114	4,419	1	0	1	123	4,446	1	0	1	124
	530 mA	54W	T2S	6,001	1	0	1	111	6,444	1	0	1	119	6,484	1	0	1	120
			T2M	5,838	1	0	2	108	6,270	2	0	2	116	6,308	2	0	2	117
			T3S	5,926	1	0	2	110	6,364	1	0	2	118	6,403	1	0	2	119
			T3M	6,023	1	0	2	112	6,467	1	0	2	120	6,507	1	0	2	121
			T4M	5,942	1	0	2	110	6,380	1	0	2	118	6,420	1	0	2	119
			TFTM	5,937	1	0	2	110	6,376	1	0	2	118	6,415	1	0	2	119
	700 mA	71W	T2S	7,403	2	0	2	104	8,170	2	0	2	115	8,221	2	0	2	116
			T2M	7,609	2	0	2	107	7,949	2	0	2	112	7,998	2	0	2	113
			T3S	7,513	1	0	2	106	8,068	1	0	2	114	8,118	1	0	2	114
			T3M	7,635	2	0	3	108	8,199	2	0	3	115	8,250	2	0	3	116
			T4M	7,534	1	0	2	106	8,089	1	0	2	114	8,140	1	0	2	115
			TFTM	7,527	1	0	2	106	8,082	2	0	2	114	8,134	2	0	2	115
	1000 mA	109W	T2S	10,468	2	0	2	96	11,241	2	0	2	103	11,311	2	0	2	104
			T2M	10,184	2	0	3	93	10,936	2	0	3	100	11,005	2	0	3	101
			T3S	10,335	2	0	2	95	11,099	2	0	2	102	11,169	2	0	2	102
			T3M	10,505	2	0	3	96	11,280	2	0	3	103	11,351	2	0	3	104
			T4M	10,365	2	0	2	95	11,129	2	0	2	102	11,198	2	0	2	103
			TFTM	10,356	2	0	2	95	11,121	2	0	3	102	11,190	2	0	3	103

Note:
Available with phosphor-converted amber LED's (nomenclature AMBPC). These LED's produce light with 97+% >530 nm.
Output can be calculated by applying a 0.7 factor to 4000 K lumen values and photometric files.

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Performance Data

Lumen Ambient Temperature (LAT) Multipliers

Use these factors to determine relative lumen output for average ambient temperatures from 0-40°C (32-104°F).

Ambient		Lumen Multiplier
0°C	32°F	1.02
10°C	50°F	1.01
20°C	68°F	1.00
25°C	**77°F**	**1.00**
30°C	86°F	1.00
40°C	104°F	0.98

Electrical Load

			Current (A)					
LEDs	Drive Current (mA)	System Watts	120V	208V	240V	277V	347V	480V
20C	350	25 W	0.23	0.13	0.12	0.10	-	-
	530	36 W	0.33	0.19	0.17	0.14	-	-
	700	47 W	0.44	0.25	0.22	0.19	-	-
	1000	74 W	0.68	0.39	0.34	0.29	-	-
30C	350	36 W	0.33	0.19	0.17	0.14	-	-
	530	54 W	0.50	0.29	0.25	0.22	-	-
	700	71 W	0.66	0.38	0.33	0.28	0.23	0.16
	1000	109 W	1.01	0.58	0.50	0.44	-	-

Projected LED Lumen Maintenance

Data references the extrapolated performance projections for the **DSXW2 LED 30C 1000** platform in a **25°C ambient**, based on 10,000 hours of LED testing (tested per IESNA LM-80-08 and projected per IESNA TM-21-11).

To calculate LLF, use the lumen maintenance factor that corresponds to the desired number of operating hours below. For other lumen maintenance values, contact factory.

Operating Hours	0	25,000	50,000	100,000
Lumen Maintenance Factor	1.0	0.95	0.92	0.87

Motion Sensor Default Settings						
Option	Dimmed State	High Level (when triggered)	Photocell Operation	Dwell Time	Ramp-up Time	Ramp-down Time
*PIR or PIRH	3V (37%) Output	10V (100%) Output	Enabled @ 5FC	5 min	3 sec	5 min
PIR1FC3V or PIRH1FC3V	3V (37%) Output	10V (100%) Output	Enabled @ 1FC	5 min	3 sec	5 min

*for use with Inline Dusk to Dawn or timer

PER Table

Control	PER (3 wire)	PER5 (5 wire)		PER7 (7 wire)		
			Wire 4/Wire5		Wire 4/Wire5	Wire 6/Wire7
Photocontrol Only (On/Off)	✓	⚠	Wired to dimming leads on driver	⚠	Wired to dimming leads on driver	Wires Capped inside fixture
ROAM	⊘	✓	Wired to dimming leads on driver	⚠	Wired to dimming leads on driver	Wires Capped inside fixture
ROAM with Motion	⊘	⚠	Wired to dimming leads on driver	⚠	Wired to dimming leads on driver	Wires Capped inside fixture
Futureproof*	⊘	⚠	Wired to dimming leads on driver	✓	Wired to dimming leads on driver	Wires Capped inside fixture
Futureproof* with Motion	⊘	⚠	Wired to dimming leads on driver	✓	Wired to dimming leads on driver	Wires Capped inside fixture

✓ Recommended

⊘ Will not work

⚠ Alternate

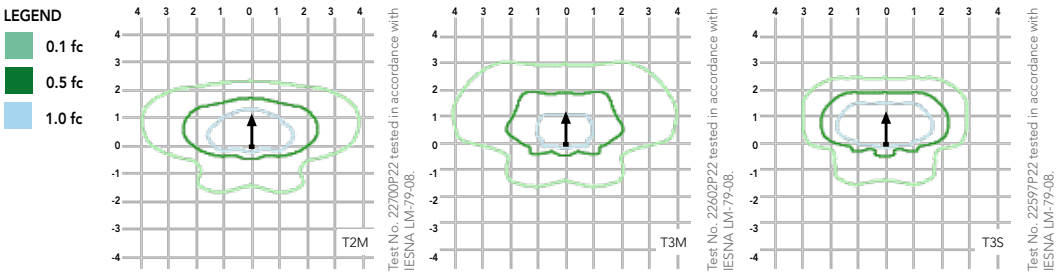
*Futureproof means: Ability to change controls in the future.

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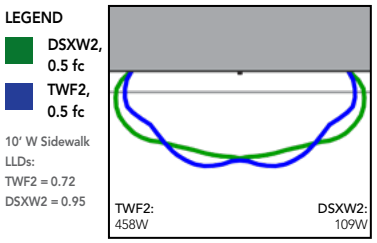
Photometric Diagrams

To see complete photometric reports or download .ies files for this product, visit Lithonia Lighting's D-Series Wall Size 2 homepage.

Isofootcandle plots for the DSXW2 LED 30C 1000 40K. Distances are in units of mounting height (25').



Distribution overlay comparison to 400W metal halide.



DSXW2 LED 30C 40K 1000 T2M, TWF2 400M Pulse, 25' Mounting Ht

FEATURES & SPECIFICATIONS

INTENDED USE

The energy savings, long life and easy-to-install design of the D-Series Wall Size 2 make it the smart choice for building-mounted doorway and pathway illumination for nearly any facility.

CONSTRUCTION

Two-piece die-cast aluminum housing has integral heat sink fins to optimize thermal management through conductive and convective cooling. Modular design allows for ease of maintenance. The LED driver is mounted to the door to thermally isolate it from the light engines for low operating temperature and long life. Housing is completely sealed against moisture and environmental contaminants (IP65).

FINISH

Exterior parts are protected by a zinc-infused Super Durable TGIC thermoset powder coat finish that provides superior resistance to corrosion and weathering. A tightly controlled multi-stage process ensures a minimum 3 mils thickness for a finish that can withstand extreme climate changes without cracking or peeling. Available in textured and non-textured finishes.

OPTICS

Precision-molded proprietary acrylic lenses provide multiple photometric distributions tailored specifically to building mounted applications. Light engines are available in 3000 K (70 min. CRI), 4000 K (70 min. CRI) or 5000 K (70 min. CRI) configurations.

ELECTRICAL

Light engine(s) consist of 10 high-efficacy LEDs mounted to a metal-core circuit board to maximize heat dissipation and promote long life (L87/100,000 hrs at 25°C). Class 1 electronic drivers have a power factor >90%, THD <20%, and a minimum 2.5KV surge rating. When ordering the SPD option, a separate surge protection device is installed within the luminaire which meets a minimum Category C Low (per ANSI/IEEE C62.41.2).

INSTALLATION

Included universal mounting bracket attaches securely to any 4" round or square outlet box for quick and easy installation. Luminaire has a slotted gasket wireway and attaches to the mounting bracket via corrosion-resistant screws.

LISTINGS

CSA certified to U.S. and Canadian standards. Rated for -40°C minimum ambient.

DesignLights Consortium® (DLC) qualified product. Not all versions of this product may be DLC qualified. Please check the DLC Qualified Products List at www.designlights.org to confirm which versions are qualified.

WARRANTY

Five-year limited warranty. Complete warranty terms located at www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx.

Note: Actual performance may differ as a result of end-user environment and application. All values are design or typical values, measured under laboratory conditions at 25 °C. Specifications subject to change without notice.

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LITHONIA LIGHTING®

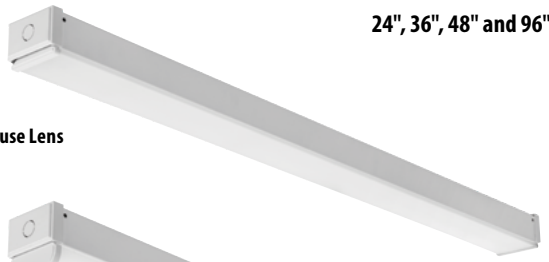
Catalog Number	
Notes	
Type	

LED Linear

CLX

Work light - Chain hung or surface mounted

24", 36", 48" and 96" Lengths



Flat Diffuse Lens



Round Diffuse Lens



Wide Diffuse Lens

FEATURES & SPECIFICATIONS

INTENDED USE — The CLX is a linear lighting solution that is available in multiple lengths, lumen packages and distributions. Designed for versatility, the CLX can address virtually any indoor lighting need. The CLX is also offered in standard and high efficacy configurations and capable of being continuous row mounted or installed as a stand-alone fixture. Ideal for uplight and downlight in commercial, retail, manufacturing, warehouse, and display applications. **Certain airborne contaminants can diminish the integrity of acrylic and/or polycarbonate.** Click here for Acrylic-Polycarbonate Compatibility table for suitable uses.

CONSTRUCTION — Channel and cover are formed from code-gauge cold-rolled steel. Housing and lens endcaps are injection molded plastic to provide a more architectural look and feel. The endcaps come standard with a 7/8" knock out for continuous mounting but can be ordered without.

Finish: Paint options include high-gloss, baked white polyester (WH), galvanized (GALV), matte black (MB) and smoke gray (SKGY). Five-stage iron phosphate pre-treatment ensures superior paint adhesion and rust resistance.

OPTICS — Offered with acrylic lens and less lens configurations. Provides a choice of optical distributions including, wide, narrow, and aisle.

ELECTRICAL — Utilizes high-output LEDs integrated on a two-layer circuit board, ensuring cool-running operation. Optional internal pluggable wiring harness for reduced labor cost in row mounting applications. (See PLR_ ordering information on page 15.) Electronic LED driver is multi-volt input and 0-10V dimming standard (see Operational Data on page 12 for actual wattage consumption). This fixture is designed to withstand a maximum line surge of 2.5kV at 0.75kA combination wave for indoor locations, for applications requiring higher level of protection additional surge protection must be provided.

L70>100,000 hours at 25˚C.

LEDs provide nominal 80 CRI or 90CRI at 3000 K, 3500 K,4000 K, or 5000 K.

Lumen output up to 2,500 lumens per foot.

INSTALLATION — Fixture may be ceiling or wall mounted (with or without THCLX hanger or angle mounted with CLXANGBRT), pendant or stem mounted with appropriate mounting options.

WARNING — Removing the lens and opening the fixture during installation exposes the LEDs, putting them at risk for damage.

If you plan to surface mount the fixture, we recommend using the THCLX. This eliminates the need to open the fixture.

If you plan to continuous row mount, we recommend using the PLR wiring harness option. This eliminates the need to open the fixture.

Damage to the LEDs caused during installation will not be covered under the warranty.

LISTINGS — CSA certified to US and Canadian safety standards. For use in damp locations between -4°F (-20°C) and 104°F (40°C). Optional High Ambient (HA) ranging to 122°F(50°C) available on certain lumen packages (See ambient temperature chart for additional information).
DesignLights Consortium® (DLC) Premium qualified product and DLC qualified product. Not all versions of this product may be DLC Premium qualified or DLC qualified. Please check the DLC Qualified Products List at www.designlights.org/QPL to confirm which versions are qualified.

WARRANTY — 5-year limited warranty. Complete warranty terms located at:
www.acuitybrands.com/resources/terms-and-conditions

Note: Actual performance may differ as a result of end-user environment and application.
All values are design or typical values, measured under laboratory conditions at 25 °C.
Specifications subject to change without notice.

Stock configurations are offered for shorter lead times:

Stock Part Number	UPC	DLC QPL Product ID	DLC Premium
CLX L48 3000LM SEF FDL MVOLT GZ10 40K 80CRI WH	00191723525816	PJANKZR4	Yes
CLX L48 3000LM SEF FDL MVOLT GZ10 50K 80CRI WH	00191723525885	PKW32VKL	Yes
CLX L48 5000LM SEF FDL MVOLT GZ10 40K 80CRI WH	00191723525939	P77I8Z20	Yes
CLX L48 5000LM SEF FDL MVOLT GZ10 50K 80CRI WH	00191723525908	P8A42C1H	Yes
CLX L96 6000LM SEF FDL MVOLT GZ10 40K 80CRI WH	00191723525861	PPFTGRBV	Yes
CLX L96 6000LM SEF FDL MVOLT GZ10 50K 80CRI WH	00191723525915	PW6250TE	Yes
CLX L96 10000LM SEF FDL MVOLT GZ10 40K 80CRI WH	00191723525922	PYK0C7EW	Yes
CLX L96 10000LM SEF FDL MVOLT GZ10 50K 80CRI WH	00191723525830	PKYPL35K	Yes
CLX L48 3000LM SEF RDL MVOLT GZ10 40K 80CRI WH	00191723525960	PJANKZR4	Yes
CLX L48 3000LM SEF RDL MVOLT GZ10 50K 80CRI WH	00191723525892	PKW32VKL	Yes
CLX L48 5000LM SEF RDL MVOLT GZ10 40K 80CRI WH	00191723525854	P77I8Z20	Yes
CLX L48 5000LM SEF RDL MVOLT GZ10 50K 80CRI WH	00191723525946	P8A42C1H	Yes
CLX L96 6000LM SEF RDL MVOLT GZ10 40K 80CRI WH	00191723525878	PPFTGRBV	Yes
CLX L96 6000LM SEF RDL MVOLT GZ10 50K 80CRI WH	00191723525823	PD0SSIAD	Yes
CLX L96 10000LM SEF RDL MVOLT GZ10 40K 80CR WH	00191723525953	PYK0C7EW	Yes
CLX L96 10000LM SEF RDL MVOLT GZ10 50K 80CRI WH	00191723525847	PKYPL35K	Yes

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is part of an A+ Certified solution for nLight® or XPoint™ Wireless control networks marked by a shaded background*

To learn more about A+, visit www.acuitybrands.com/aplus.

*See ordering tree for details

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: CLX L48 5000LM SEF WDL MVOLT GZ10 40K 80CRI WH

Series	Length	Nominal lumens	Performance package	Louver	Lens
CLX LED linear	L24 24"[1,2]	1500LM 1,500 lumens 2000LM 2,000 lumens 2500LM 2,500 lumens 3500LM 3,500 lumens 4500LM 4,500 lumens 5000LM 5,000 lumens[3,4]	SEF Standard efficiency[5] HEF Premium efficiency	(Blank) Less louver SBLW Straight blade louver, white[6] SBLMB Straight blade louver, matte black[6] SBLGV Straight blade louver, galvanized[6] SBLSKGY Straight blade louver, smoke gray[6]	L/Lens Less lens FDL Flat diffuse[7,8] RDL Round diffuse[7,8] WDL Wide diffuse[7,8]
	L36 36"[2]	2250LM 2,250 lumens 3000LM 3,000 lumens 3750LM 3,750 lumens 5250LM 5,250 lumens 6750LM 6,750 lumens 7500LM 7,500 lumens[3,4]			
	L48 48"	3000LM 3,000 lumens 4000LM 4,000 lumens 5000LM 5,000 lumens 7000LM 7,000 lumens[2] 9000LM 9,000 lumens[2] 10000LM 10,000 lumens[2,4]			
	L96 96"	6000LM 6,000 lumens 8000LM 8,000 lumens 10000LM 10,000 lumens 14000LM 14,000 lumens[2,4] 18000LM 18,000 lumens[2,4] 20000LM 20,000 lumens[2,4]			

Distribution	Voltage		Driver[14]	Color temperature	Coloring rendering index
(Blank) General	MVOLT 120-277V[10]	277 277V	GZ10 0 -10V dimming[15]	30K 3000 K	80CRI 80 CRI
ND Narrow[8,9]	120 120V	347 347V[12,13]	EZ1 Dimming to 1%[2]	35K 3500 K	90CRI 90 CRI
WD Wide[8,9]	208 208V[11]	480 480V[12,13]		40K 4000 K	
AD2 Aisle, 24° off center[8,9]	240 240V[11]			50K 5000 K	

Options

PS1050	Emergency battery pack, 10W, CA Title 20 Noncompliant[2,11,13,16,17]
E10WLCP	Emergency battery pack, 10W Linear Constant Power, Certified in CA Title 20 MAEDBS[2,11,13,16,17]
BGTD	Generator transfer device, not avaialble with PS1050[13,16,18]
OCS	5', 18/3 Reloc selectable One Pass cable[16]
HA	High ambient, for use in ambient temperatures up to 50°C[11]
EPNKO	Decorative endplate, no knock out[19]
OUTCTR	Wiring leads pulled through back center of fixture[20]
OUTEND	Wiring leads pulled through end of fixture[21]
Cord Sets:	
CS1W	Staight blade plug, 120V[10,16]
CS3W	NEMA twist-lock plug, 120V[10,16]
CS7W	Staight blade plug, 277V[10,16]
CS11W	NEMA twist-lock plug, 277V[10,16]
CS25W	NEMA twist-lock plug, 347V[10,16]
CS97W	NEMA twist-lock plug, 480V[10,16]
CS93W	600V SEOOW white cord, no plug (no voltage required)
CS6G16ST0WD5D	6' white cord, 16/5, no plug, includes low voltage dimming wires (no voltage required)[15]
PLR___	Plug-in wiring, see page 16 for ordering information
PLR1LVG	Plug-in wiring,low voltage dimming[22]
RRL___	RELOC®-ready luminaire. See page 15 for ordering information
SPD	Surge protection device, provides up to 6kV protection[16,20]
USPOM	Assembled in the United States
nLight® Wireless:[23,24]	
NLTAIR2 RES7	nLight® Generation 2 enabled PIR integral occupancy sensor with automatic dimming photocell
NLTAIR2 RES7PDT	nLight AIR Generation 2 enabled dual technology integral occupancy sensor with automatic dimming photocell
NLTAIR2 RIO	No sensor control
nLight® Wired:[23,25,26]	
N100	nLight® without lumen management
NES7	nLight® nES 7 PIR integral occupancy sensor[27]
NESPDT7	nLight® nES PDT 7 dual technology integral occupancy control[27]
NES7ADCX	nLight® nES 7 ADCX PIR integral occupancy sensor with automatic dimming photocell[27]
NESPDT7ADCX	nLight® nES PDT 7 dual technology integral occupancy sensor with automatic dimming photocell[27]
Individual controls:[23,25]	
MSD7	PIR integral occupancy sensor
MSDPDT7	PDT 7 dual technology integral occupancy control
MSD7ADC	PIR integral occupancy sensor with automatic dimming control photocell
MSDPDT7ADC	PDT integral occupancy sensor with automatic dimming control photocell

Finish

WH	White
GALVW	Galvanized with white lens end caps
GALVB	Galvanized with black lens end caps
MB	Matte black
SKGYW	Smoke gray with white lens end caps
SKGYB	Smoke gray with black lens end caps

See Accessories and footnotes on next page

INDUSTRIAL: One Lithonia Way, Conyers, GA 30012 Phone: 800-315-4963 www.lithonia.com

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Accessories: *Order as separate catalog number.*

Mounting:

ZACVH	Aircraft cable 120" (one pair)
ZAC120	One adjustable aircraft cable with canopy 120" [28]
ZACFP120	One adjustable aircraft cable with feed (3 conductor) and canopy, 120" [28]
ZACFPD120	One adjustable aircraft cable with feed (5 conductor) and canopy 120" [28]
ZAC240	One adjustable aircraft cable with canopy 240" [28]
ZACFP240	One adjustable aircraft cable with feed (3 conductor) and canopy, 240" [28]
ZACFPD240	One adjustable aircraft cable with feed (5 conductor) and canopy 240" [28]
SQ_	Stem kit, 2" increments up to 48" [28]

THCLX __	Tong hanger (Must specify color) (one pair) [29]
CLXANGBKT ____	Angle bracket, (Must specify color) (one pair) [29]
HC36	Hanger chain, 36" (one pair)

Sensors & Controls:

LSXR	Sensor Switch ® LSXR occupancy sensor [30]
NPP16D	nLight® switching/dimming module
NPP16DER	nLight® switching/dimming module with emergency relay
rPP20D	nLight® air dimming/switching module
XPA CMRB0	XPoint™ Wireless 0-10V relay, external, 55°C max ambient

Reflectors:

CLXRW24___	Wide decorative 24" reflector, (Must specify color) [31]
CLXRW36___	Wide decorative 36" reflector, (Must specify color) [31]
CLXRW48___	Wide decorative 48" reflector, (Must specify color) [31]
CLXRW96___	Two wide decorative 48" reflectors, (Must specify color) [31]
CLXRWU24___	Wide decorative 24" reflector with uplight, (Must specify color) [31]
CLXRWU36___	Wide decorative 36" reflector with uplight, (Must specify color) [31]
CLXRWU48___	Wide decorative 48" reflector with uplight, (Must specify color) [31]
CLXRWU96___	Two wide decorative 48" reflectors with uplight, (Must specify color) [31]
CLXRN24	Narrow 24" reflector, (Must specify color) [32]
CLXRN36	Narrow 36" reflector, (Must specify color) [32]
CLXRN48	Narrow 48" reflector, (Must specify color) [32]
CLXRN96___	Two narrow 48" reflectors, (Must specify color) [32]

Wireguards:

WGCLX24___	24" wireguard, (Must specify color) [33]
WGCLX36___	36" wireguard, (Must specify color) [33]
WGCLX48___	48" wireguard, XX, (Must specify color) 96" fixture requires two [33]

Notes

1 Not available with OUTCTR option.
2 Not available with HA option.
3 Not available with SEF when ordered in combination with EZ1.
4 Not available with NLTAIR2 RES7, NLTAIR2 RES7PDT, or NLTAIR2 RIO.
5 Not available with EZ1 when ordered with L24 with 5000LM or L36 with 7500LM.
6 When ordered with L24 only available with 1500LM or 2000LM in combination with GZ10 driver. Not for use with THCLX, CLXANGBKT, CLX reflectors or WGCLX accessories. Not available with RDL lens options.
7 Only available with general distribution.
8 Not available with CLXRN accessories.
9 Available L/LENS only.
10 Not available with PS1050, E10WLCP, or BGTD.
11 Not available with BGTD option.
12 Voltage selected utilizes a step-down transformer. Not available with L24 when ordered with N100.Not available with PS1050, E10WLCP or BGTD option.
13 Requires SPD option.
14 When continuous row mounting, fixtures must all have the same driver selection.
15 Not available with Individual controls, nLight wired networking, nLight wireless networking, nLight wireless zone control options.
16 Must specify voltage.
17 Not available with L24 or L36. Not available with L48 in combination with N100.
18 Available with L48 or L96 only. 20 Not available with PS1050 or E10WLCP options. Not available with 208 or 240V. Not available Individual controls, NLight Wired, or NLight Wireless options.
19 Not available OUTEND.
20 Required with PS1050, E10WLCP, BGTD, XAD, or XAD924.
21 Not available with PLR options.
22 Not available with XPoint, Individual controls, NLight Wired, or NLight Wireless options.
23 Sensor housing will be the same color as lens end caps.
24 Not available with L24 in combination with 5000LM, not available with L36 in combination with 7500LM, not available with L48 in combination with 10000LM, and not available with L96 in combination with 14000LM, 18000LM, or 20000LM. Not available with PLRs containing low voltage dimming wires.
25 Not available with any other control option. Requires EZ1.
26 Only available in WDL.
27 Requires N100 option.
28 Ships standard as white.
29 Not available with louver, wireguards, wide reflectors.
30 More configurations on LSXR Specification Sheet.
31 L24 reflector is 22.65", L36 reflector is 34.01", L48 reflector is 46.80", L96 comes with two L48 reflectors.
32 For use with L/LENS fixtures only. L24 reflector is 22.75", L36 reflector is 34.20", L48 reflector is 46.85", L96 comes with two L48 reflectors.
33 Not for use with CLX wide reflector accessories.

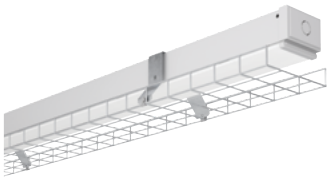
OPTIONS AND ACCESSORIES



Narrow reflector
Ships separtely from fixture.
Order as:
CLXRN24___
CLXRN36___
CLXRN48___
CLXRN96___



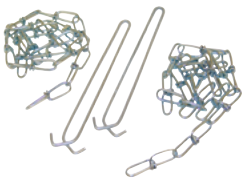
Wide decorative reflector
Ships separtely from fixture.
Order as:
CLXRW24___
CLXRW36___
CLXRW48___
CLXRW96___



Wireguard
Ships separately from fixture:
96" fixture requires two WGCLX48.
Order as:
WGCLX24___
WGCLX36___
WGCLX48___



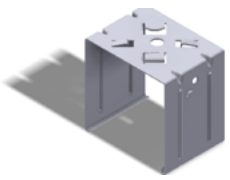
Aircraft Cable with Canopy
Available in 120" or 240"
Order as:
ZAC120
ZAC240



HANGER CHAIN
36" chain with Y hanger. ships as a pair
Order as:
HC36



ZACVH HANGER
10' Aircraft cable with Y hanger.
Order as:
ZACVH



Tong hanger
Ships as a pair
Order As:
THCLX___

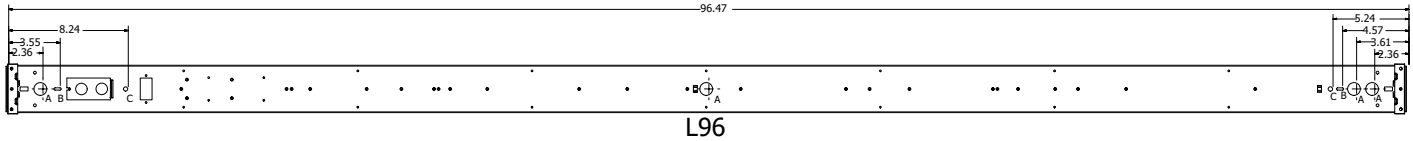
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DIMENSIONS

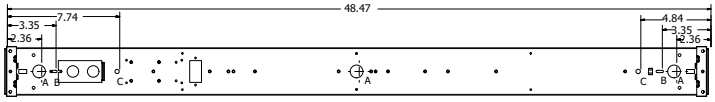
All dimensions are in inches (centimeters) unless otherwise indicated.
Dimensions may vary with options or accessories.

INTEGRATED SENSOR ADDS 2.0 INCHES TO STANDALONE FIXTURE LENGTH
HOUSING END CAP ADDS 0.236 INCHES TO FIXTURE LENGTH PER SIDE. DIMENSIONS BELOW INCLUDE ENDCAPS.

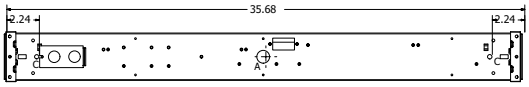
A - 7/8" KNOCK OUT
B - 0.5" by 0.16" SLOT
C - 0.3" DIA HOLE



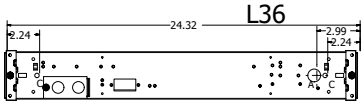
L96



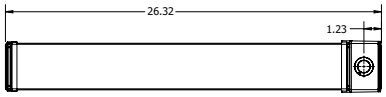
L48



L36



L24

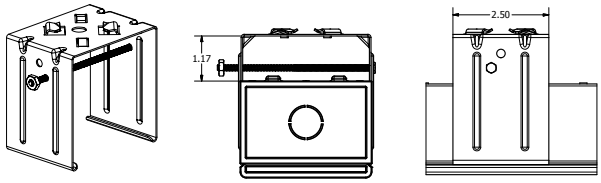


L24 WITH SENSOR

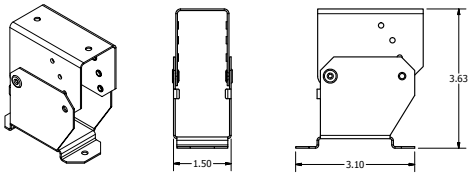
PALLET DIMENSIONS

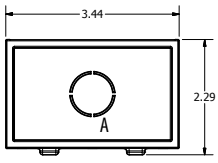
Length	Approx Weight	Fixtures per pallet	Pallet Dims (L X W X H)
L24	4 lb	100	54x46x37
L36	5 lb	80	54x46x37
L48	7.5 lb	64	54x46x37
L96	14 lb	64	98x46x37

THCLX - SHIPS TWO PER ORDER,
UTILIZES A #8 HEX HEAD SCREW AND NUT
FIXTURE SITS 1.3 INCHES FROM STRUCTURE WHEN MOUNTED

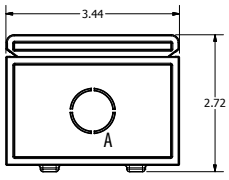


CLXANGBKT - SHIPS TWO PER ORDER
HOLES TO MOUNTING STRUCTURE ARE 0.175" DIA, 2.5" APART
FIXTURE SITS APPROXIMATELY 3.5" FROM STRUCTURE
WHEN MOUNTED HORIZONTAL TO STRUCTURE

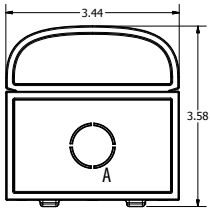




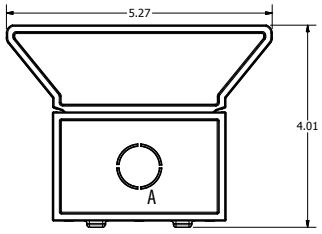
L/LENS



FDL



RDL



WDL

PHOTOMETRICS

See www.lithonia.com.

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POWER SENTRY EMERGENCY BATTERY PACKS

		SEF Emergency Lumens	HEF Emergency Lumens
PS1050	Factory installable	1400	1500
E10WLCP	Factory installable	1400	1500
PS1555LCP	Field installable, remote mount only	2000	2100

Note: For emergency lumen output of specific model, please consult factory. One board will be illuminated during emergency operation.

CLX CHARACTERISTICS

Nominal Lumen Package	Length	Wattage								Length	Width	Depth	Comparable Light Source
		Standard efficiency				High efficiency							
		120V	277V	347V	480V	120V	277V	347V	480V	Dimensions are shown in inches			
2500LM	24"	19.9	19.9	25.9	25.9	18.5	18.5	24.5	24.5	24	3.5	3.75	1-lamp 32WT8, 1-lamp 54W T5HO, 50W HID
5000LM	24"	41.9	41.9	47.9	47.9	37.9	37.9	43.9	43.9	24	3.5	3.75	2-lamp 32WT8, 1-lamp 54W T5HO, 70W HID
3750LM	36"	28.1	28.1	34.1	34.1	27.0	27.0	33.0	33.0	36	3.5	3.75	1-lamp 32WT8, 1-lamp 54W T5HO, 50W HID
7500LM	36"	62.9	62.9	68.9	68.9	56.8	56.8	62.8	62.8	36	3.5	3.75	2-lamp 32WT8, 1-lamp 54W T5HO, 70W HID
5000LM	48"	35.4	35.4	41.4	41.4	32.9	32.9	38.9	38.9	48	3.5	3.75	2-lamp 32WT8, 1-lamp 54W T5HO, 70W HID
10000LM	48"	77.1	77.1	83.1	83.1	70.4	70.4	76.4	76.4	48	3.5	3.75	3 -lamp 32WT8, 2-lamp 54W T5HO, 100W HID
10000LM	96"	70.8	70.8	76.8	76.8	65.8	65.8	71.8	71.8	96	3.5	3.75	3 -lamp 32WT8, 2-lamp 54W T5HO, 100W HID
20000LM	96"	154.2	154.2	160.2	160.2	140.8	140.8	146.8	146.8	96	3.5	3.75	6 - lamp 32WT8, 4 -lamp 54T5HO, 200W HID

AMBIENT TEMPERATURE RATINGS

Driver Package		GZ10			EZ1 or EOHN			Any Driver	
Length	Lumen package	Direct Surface	THCLX/ Suspended	HA Option (Direct or Suspended)	Direct Surface	THCLX	Suspended 18"	Xpoint/ BGTD Direct Surface	PS1050 Suspended
L24	1500LM	40C	40C	N/A	35C	35C	35C	N/A	N/A
	2000LM	40C	40C		35C	35C	35C		
	2500LM	40C	40C		35C	35C	35C		
	3000LM	40C	40C		40C	40C	40C		
	4500LM	40C	40C		35C	35C	40C		
	5000LM	40C	40C		25C	30C	35C		
L36	2250LM	40C	40C		40C	40C	40C		
	3000LM	40C	40C		40C	40C	40C		
	3750LM	40C	40C		40C	40C	40C		
	5250LM	40C	40C		35C	35C	40C		
	6750LM	30C	40C		35C	35C	40C		
	7500LM	30C	40C		25C	30C	35C		
L48	3000LM	40C	40C	50C	40C	40C	40C	35C	25C
	4000LM	40C	40C	50C	40C	40C	40C		
	5000LM	40C	40C	50C	35C	35C	40C		
	7000LM	30C	40C	N/A	35C	35C	40C		
	9000LM	30C	40C		25C	30C	35C		
	10000LM	30C	40C		25C	30C	35C		
L96	6000LM	40C	40C	50C	35C	35C	40C		
	8000LM	30C	40C	50C	35C	35C	40C		
	10000LM	30C	40C	50C	25C	30C	35C		
	14000LM	40C	40C	N/A	35C	35C	40C		
	18000LM	30C	40C		25C	30C	35C		
	20000LM	30C	40C		25C	30C	35C		

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CLX OPERATIONAL DATA

	Length	Nominal lumen package	Performance package	CRI	Delivered Lumens				Wattage
					Color Temperature				
					3000K	3500K	4000K	5000K	
L/Lens	L24	1500LM	SEF	80	1497	1540	1582	1619	10.85
				90	1305	1333	1371	1441	10.85
			HEF	80	1493	1514	1582	1586	10.39
				90	1220	1237	1301	1301	10.39
		2000LM	SEF	80	2066	2125	2183	2235	14.48
				90	1801	1840	1892	1989	14.48
			HEF	80	2060	2089	2183	2189	13.46
				90	1684	1708	1796	1796	13.46
		2500LM	SEF	80	2616	2689	2763	2829	18.41
				90	2279	2329	2394	2517	18.41
			HEF	80	2607	2644	2763	2771	17.42
				90	2132	2161	2273	2273	17.42
		3500LM	SEF	80	3518	3617	3716	3804	25.83
				90	3065	3132	3220	3385	25.83
			HEF	80	3506	3556	3716	3726	25.04
				90	2867	2907	3057	3057	25.04
		4500LM	SEF	80	5040	5182	5325	5451	38.7
				90	4392	4487	4614	4851	38.7
			HEF	80	5024	5096	5325	5339	34.8
				90	4108	4165	4380	4380	34.8
		5000LM	SEF	80	5355	5506	5657	5791	41.48
				90	4667	4767	4902	5153	41.48
			HEF	80	5338	5414	5657	5672	38.11
				90	4364	4425	4653	4653	38.11
	L36	2250LM	SEF	80	2411	2547	2101	2207	16.36
				90	2479	2607	2146	2320	16.36
			HEF	80	2437	2554	1965	2095	15.47
				90	2547	2403	1992	2095	15.47
		3000LM	SEF	80	3221	3388	2730	2868	20.8
				90	3310	3133	2789	3015	20.8
			HEF	80	3167	3319	2553	2722	19.98
				90	3310	3123	2589	2722	19.98
		3750LM	SEF	80	4123	4337	3495	3671	26.47
				90	4236	4010	3570	3859	26.47
			HEF	80	4054	4248	3268	3485	25.09
				90	4236	3997	3314	3485	25.09
		5250LM	SEF	80	5545	5833	4700	4937	39.9
				90	5698	5393	4801	5190	39.9
			HEF	80	5452	5713	4396	4687	34.3
				90	5698	5376	4457	4687	34.3
		6750LM	SEF	80	7081	7448	6001	6303	54.85
				90	7275	6886	6131	6627	54.85
			HEF	80	6962	7294	5613	5984	47.97
				90	7275	6864	5691	5984	47.97
		7500LM	SEF	80	7756	8158	6574	6905	62.6
				90	7969	7543	6716	7260	62.6
			HEF	80	7626	7991	6148	6555	54.02
				90	7969	7519	6234	6555	54.02

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CLX OPERATIONAL DATA (continued)

	Length	Nominal lumen package	Performance package	CRI	Delivered Lumens				Wattage
					Color Temperature				
					3000K	3500K	4000K	5000K	
L/Lens	L48	3000LM	SEF	80	3019	3104	3190	3265	20.32
				90	2631	2688	2764.	2906.	20.32
			HEF	80	3010	3052	3190	3198	19.01
				90	2461	2495	2624	2624	19.01
		4000LM	SEF	80	4034	4148	4262	4363	27.58
				90	3515	3591	3693	3882	27.58
			HEF	80	4021	4078	4262	4273	24.75
				90	3288	3334	3505	3505	24.75
		5000LM	SEF	80	5047	5189	5332	5458	34.8
				90	4398	4493	4620	4857	34.8
			HEF	80	5031	5102	5332	5346	31.77
				90	4113	4171	4386	4386	31.77
		7000LM	SEF	80	7311	7517	7724	7907	49.05
				90	6371	6509	6692	7036	49.05
			HEF	80	7288	7391	7724	7744	44.67
				90	5959	6042	6353	6353	44.67
		9000LM	SEF	80	9215	9475	9735	9967	63.99
				90	8031	8204	8435	8869	63.99
			HEF	80	9186	9317	9735	9762	58.58
				90	7511	7615	8008	8008	58.58
		10000LM	SEF	80	10299	10590	10880	11139	73.37
				90	8975	9169	9427	9912	73.37
			HEF	80	10266	10412	10880	10910	66.27
				90	8394	8511	8950	8950	66.27
	L96	6000LM	SEF	80	5942	6110	6278	6427	38.15
				90	5178	5290	5439	5719	38.15
			HEF	80	5923	6008	6278	6294	35.54
				90	4843	4911	5164	5164	35.54
		8000LM	SEF	80	7929	8153	8376	8575	52.32
				90	6910	7059	7258	7631	52.32
			HEF	80	7903	8016	8376	8399	48.5
				90	6462	6552	6890	6890	48.5
		10000LM	SEF	80	9808	10085	10362	10608	66.47
				90	8548	8732	8978	9439	66.47
			HEF	80	9777	9916	10362	10390	60.89
				90	7994	8106	8523	8523	60.89
		14000LM	SEF	80	14323	14727	15131	15491	94.78
				90	12482	12752	13111	13784	94.78
			HEF	80	14277	14480	15131	15172	85.96
				90	11674	11836	12447	12447	85.96
		18000LM	SEF	80	18458	18979	19500	19963	128.98
				90	16086	16433	16896	17764	128.98
			HEF	80	18399	18661	19500	19552	116.92
				90	15044	15254	16040	16040	116.92
		20000LM	SEF	80	20386	20962	21537	22048	146.83
				90	17766	18150	18661	19619	146.83
			HEF	80	20321	20610	21537	21595	131.6
				90	16616	16847	17716	17716	131.6

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CLX OPERATIONAL DATA (continued)

	Length	Nominal lumen package	Performance package	CRI	Delivered Lumens				Wattage
					Color Temperature				
					3000K	3500K	4000K	5000K	
RDL	L24	1500LM	SEF	80	1359	1397	1436	1470	10.85
				90	1184	1210	1244	1308	10.85
			HEF	80	1355	1374	1436	1439	10.39
				90	1107	1123	1181	1181	10.39
		2000LM	SEF	80	1875	1928	1981	2028	14.48
				90	1634	1670	1717	1805	14.48
			HEF	80	1869	1896	1981	1987	13.46
				90	1528	1550	1630	1630	13.46
		2500LM	SEF	80	2374	2441	2508	2567	18.41
				90	2069	2113	2173	2284	18.41
			HEF	80	2366	2400	2508	2514	17.42
				90	1935	1962	2063	2063	17.42
		3500LM	SEF	80	3192	3282	3372	3452	25.83
				90	2782	2842	2922	3072	25.83
			HEF	80	3182	3227	3372	3381	25.04
				90	2602	2638	2774	2774	25.04
		4500LM	SEF	80	4574	4703	4832	4947	38.7
				90	3986	4072	4187	4402	38.7
			HEF	80	4560	4624	4832	4845	34.8
				90	3728	3780	3975	3975	34.8
		5000LM	SEF	80	4860	4997	5134	5256	41.48
				90	4235	4327	4448	4677	41.48
			HEF	80	4844	4913	5134	5148	38.11
				90	3961	4016	4223	4223	38.11
	L36	2250LM	SEF	80	2188	2250	2311	2366	16.36
				90	1907	1948	2003	2106	16.36
			HEF	80	2181	2212	2311	2318	15.47
				90	1783	1808	1901	1901	15.47
		3000LM	SEF	80	2843	2924	3004	3075	20.8
				90	2478	2531	2603	2736	20.8
			HEF	80	2834	2875	3004	3012	19.98
				90	2317	2350	2471	2471	19.98
		3750LM	SEF	80	3639	3742	3845	3936	26.47
				90	3171	3240	3331	3502	26.47
			HEF	80	3628	3679	3845	3855	25.09
				90	2966	3007	3162	3162	25.09
		5250LM	SEF	80	4895	5033	5171	5294	39.9
				90	4265	4357	4480	4710	39.9
			HEF	80	4879	4948	5171	5185	34.3
				90	3989	4045	4253	4253	34.3
		6750LM	SEF	80	6250	6426	6602	6759	54.85
				90	5446	5564	5721	6014	54.85
			HEF	80	6230	6318	6602	6620	47.97
				90	5094	5165	5431	5431	47.97
		7500LM	SEF	80	6846	7039	7232	7404	62.6
				90	5966	6095	6266	6588	62.6
			HEF	80	6824	6921	7232	7252	54.02
				90	5580	5657	5949	5949	54.02

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CLX OPERATIONAL DATA (continued)

	Length	Nominal lumen package	Performance package	CRI	Delivered Lumens				Wattage
					Color Temperature				
					3000K	3500K	4000K	5000K	
RDL	L48	3000LM	SEF	80	2740	2817	2895	2963	20.32
				90	2388	2439	2508	2637	20.32
			HEF	80	2731	2770	2895	2902	19.01
				90	2233	2264	2381	2381	19.01
		4000LM	SEF	80	3661	3764	3868	3959	27.58
				90	3190	3259	3351	3523	27.58
			HEF	80	3649	3701	3868	3878	24.75
				90	2984	3025	3181	3181	24.75
		5000LM	SEF	80	4580	4710	4839	4954	34.8
				90	3992	4078	4193	4408	34.8
			HEF	80	4566	4631	4839	4852	31.77
				90	3733	3785	3980	3980	31.77
		7000LM	SEF	80	6635	6822	7009	7176	49.05
				90	5782	5907	6073	6385	49.05
			HEF	80	6614	6708	7009	7028	44.67
				90	5408	5483	5766	5766	44.67
		9000LM	SEF	80	8363	8599	8835	9045	63.99
				90	7288	7446	7655	8049	63.99
			HEF	80	8336	8455	8835	8859	58.58
				90	6816	6911	7268	7268	58.58
		10000LM	SEF	80	9347	9611	9874	10109	73.37
				90	8145	8321	8556	8995	73.37
			HEF	80	9317	9450	9874	9901	66.27
				90	7618	7724	8122	8122	66.27
	L96	6000LM	SEF	80	5393	5545	5697	5832	38.15
				90	4700	4801	4936	5190	38.15
			HEF	80	5375	5452	5697	5712	35.54
				90	4395	4457	4686	4686	35.54
		8000LM	SEF	80	7196	7399	7602	7782	52.32
				90	6271	6406	6587	6925	52.32
			HEF	80	7173	7275	7602	7622	48.5
				90	5865	5946	6253	6253	48.5
		10000LM	SEF	80	8902	9153	9404	9627	66.47
				90	7757	7925	8148	8567	66.47
			HEF	80	8873	8999	9404	9429	60.89
				90	7255	7356	7735	7735	60.89
		14000LM	SEF	80	12999	13366	13732	14058	94.78
				90	11328	11573	11899	12510	94.78
			HEF	80	12957	13142	13732	13769	85.96
				90	10594	10742	11296	11296	85.96
		18000LM	SEF	80	16751	17224	17697	18117	128.98
				90	14598	14913	15334	16121	128.98
			HEF	80	16698	16936	17697	17744	116.92
				90	13653	13843	14557	14557	116.92
		20000LM	SEF	80	18501	19023	19545	20009	146.83
				90	16123	16471	16935	17805	146.83
			HEF	80	18442	18705	19545	19598	131.6
				90	15079	15290	16078	16078	131.6

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CLX OPERATIONAL DATA (continued)

	Length	Nominal lumen package	Performance package	CRI	Delivered Lumens				Wattage
					Color Temperature				
					3000K	3500K	4000K	5000K	
FDL	L24	1500LM	SEF	80	1320	1358	1395	1428	10.85
				90	1151	1175	1208	1271	10.85
			HEF	80	1316	1335	1395	1399	10.39
				90	1076	1091	1147	1147	10.39
		2000LM	SEF	80	1822	1874	1925	1971	14.48
				90	1588	1622	1668	1754	14.48
			HEF	80	1816	1842	1925	1930	13.46
				90	1485	1506	1583	1583	13.46
		2500LM	SEF	80	2306	2371	2436	2494	18.41
				90	2010	2053	2111	2219	18.41
			HEF	80	2299	2332	2436	2443	17.42
				90	1880	1906	2004	2004	17.42
		3500LM	SEF	80	3102	3189	3277	3354	25.83
				90	2703	2761	2839	2985	25.83
			HEF	80	3092	3136	3277	3285	25.04
				90	2528	2563	2695	2695	25.04
		4500LM	SEF	80	4444	4570	4695	4807	38.7
				90	3873	3957	4068	4277	38.7
			HEF	80	4430	4493	4695	4708	34.8
				90	3622	3673	3862	3862	34.8
		5000LM	SEF	80	4722	4855	4988	5107	41.48
				90	4115	4204	4322	4544	41.48
			HEF	80	4707	4774	4988	5002	38.11
				90	3848	3902	4103	4103	38.11
	L36	2250LM	SEF	80	2126	2186	2246	2299	16.36
				90	1852	1892	1946	2046	16.36
			HEF	80	2119	2149	2246	2252	15.47
				90	1732	1757	1847	1847	15.47
		3000LM	SEF	80	2762	2840	2918	2988	20.8
				90	2407	2459	2529	2659	20.8
			HEF	80	2754	2793	2918	2926	19.98
				90	2251	2283	2401	2401	19.98
		3750LM	SEF	80	3536	3636	3735	3824	26.47
				90	3081	3148	3237	3403	26.47
			HEF	80	3525	3575	3735	3745	25.09
				90	2882	2922	3073	3073	25.09
		5250LM	SEF	80	4755	4890	5024	5143	39.9
				90	4144	4234	4353	4577	39.9
			HEF	80	4740	4808	5024	5037	34.3
				90	3876	3930	4132	4132	34.3
		6750LM	SEF	80	6072	6243	6415	6567	54.85
				90	5292	5406	5558	5844	54.85
			HEF	80	6053	6139	6415	6432	47.97
				90	4949	5018	5276	5276	47.97
		7500LM	SEF	80	6651	6839	7027	7194	62.6
				90	5796	5922	6088	6401	62.6
			HEF	80	6630	6725	7027	7046	54.02
				90	5421	5497	5780	5780	54.02

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CLX OPERATIONAL DATA (continued)

	Length	Nominal lumen package	Performance package	CRI	Delivered Lumens				Wattage
					Color Temperature				
					3000K	3500K	4000K	5000K	
FDL	L48	3000LM	SEF	80	2662	2737	2812	2879	20.32
				90	2320	2370	2437	2562	20.32
			HEF	80	2654	2691	2812	2820	19.01
				90	2170	2200	2313	2313	19.01
		4000LM	SEF	80	3557	3657	3758	3847	27.58
				90	3100	3167	3256.	3423	27.58
			HEF	80	3546	3596	3758	3768	24.75
				90	2899	2939	3091	3091	24.75
		5000LM	SEF	80	4450	4576	4701	4813	34.8
				90	3878	3962	4073	4283	34.8
			HEF	80	4436	4499	4701	4714	31.77
				90	3627	3678	3867	3867	31.77
		7000LM	SEF	80	6446	6628	6810	6972	49.05
				90	5618	5739	5901	6204	49.05
			HEF	80	6426	6517	6810	6829	44.67
				90	5254	5327	5602	5602	44.67
		9000LM	SEF	80	8126	8355	8584	8788	63.99
				90	7081	7234	7438	7820	63.99
			HEF	80	8100	8215	8584	8607	58.58
				90	6623	6715	7061	7061	58.58
		10000LM	SEF	80	9081	9338	9594	9822	73.37
				90	7914	8085	8313	8740	73.37
			HEF	80	9052	9181	9594	9620	66.27
				90	7402	7505	7892	7892	66.27
	L96	6000LM	SEF	80	5240	5387	5535	5667	38.15
				90	4566	4665	4796	5042	38.15
			HEF	80	5223	5297	5535	5550	35.54
				90	4270	4330	4553	4553	35.54
		8000LM	SEF	80	6991	7189	7386	7561	52.32
				90	6093	6224	6400	6728	52.32
			HEF	80	6969	7068	7386	7406	48.5
				90	5698	5778	6075	6075	48.5
		10000LM	SEF	80	8649	8893	9137	9354	66.47
				90	7537	7700	7917	8323	66.47
			HEF	80	8621	8744	9137	9161	60.89
				90	7049	7147	7516	7516	60.89
		14000LM	SEF	80	12630	12986	13342	13659	94.78
				90	11006	11244	11561	12154	94.78
			HEF	80	12589	12768	13342	13378	85.96
				90	10293	10437	10975	10975	85.96
		18000LM	SEF	80	16276	16735	17194	17602	128.98
				90	14184	14490	14898	15663	128.98
			HEF	80	16223	16454	17194	17240	116.92
				90	13265	13450	14143	14143	116.92
		20000LM	SEF	80	17976	18483	18990	19441	146.83
				90	15665	16004	16454	17300	146.83
			HEF	80	17918	18173	18990	19041	131.6
				90	14651	14855	15621	15621	131.6

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CLX OPERATIONAL DATA (continued)

	Length	Nominal lumen package	Performance package	CRI	Delivered Lumens				Wattage
					Color Temperature				
					3000K	3500K	4000K	5000K	
WDL	L24	1500LM	SEF	80	1377	1415	1454	1489	10.85
				90	1200	1226	1260	1325	10.85
			HEF	80	1372	1392	1454	1458	10.39
				90	1122	1138	1196	1196	10.39
		2000LM	SEF	80	1900	1953	2007	2055	14.48
				90	1656	1691	1739	1828	14.48
			HEF	80	1894	1921	2007	2012	13.46
				90	1548	1570	1651	1651	13.46
		2500LM	SEF	80	2405	2472	2540	2601	18.41
				90	2095	2141	2201	2314	18.41
			HEF	80	2397	2431	2540	2547	17.42
				90	1960	1987	2090	2090	17.42
		3500LM	SEF	80	3234	3325	3416	3497	25.83
				90	2818	2879	2960	3112	25.83
			HEF	80	3223	3269	3416	3426	25.04
				90	2636	2672	2810	2810	25.04
		4500LM	SEF	80	4634	4765	4895	5012	38.7
				90	4038	4125	4242	4459	38.7
			HEF	80	4619	4685	4895	4908	34.8
				90	3777	3829	4027	4027	34.8
		5000LM	SEF	80	4923	5062	5201	5324	41.48
				90	4290	4383	4506	4738	41.48
			HEF	80	4907	4977	5201	5215	38.11
				90	4012	4068	4278	4278	38.11
	L36	2250LM	SEF	80	2216	2279	2341	2397	16.36
				90	1931	1973	2029	2133	16.36
			HEF	80	2209	2241	2341	2348	15.47
				90	1806	1832	1926	1926	15.47
		3000LM	SEF	80	2880	2962	3043	3115	20.8
				90	2510	2564	2636	2772	20.8
			HEF	80	2871	2912	3043	3051	19.98
				90	2347	2380	2503	2503	19.98
		3750LM	SEF	80	3687	3791	3895	3987	26.47
				90	3213	3282	3375	3548	26.47
			HEF	80	3675	3727	3895	3905	25.09
				90	3005	3047	3204	3204	25.09
		5250LM	SEF	80	4958	5098	5238	5362	39.9
				90	4321	4414	4539	4772	39.9
			HEF	80	4942	5013	5238	5252	34.3
				90	4041	4097	4309	4309	34.3
		6750LM	SEF	80	6331	6510	6688	6847	54.85
				90	5517	5636	5795	6093	54.85
			HEF	80	6311	6401	6688	6706	47.97
				90	5160	5232	5502	5502	47.97
		7500LM	SEF	80	6935	7131	7326	7500	62.6
				90	6044	6174	6348	6674	62.6
			HEF	80	6913	7011	7326	7346	54.02
				90	5652	5731	6027	6027	54.02

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CLX OPERATIONAL DATA (continued)

	Length	Nominal lumen package	Performance package	CRI	Delivered Lumens				Wattage
					Color Temperature				
					3000K	3500K	4000K	5000K	
WDL	L48	3000LM	SEF	80	2776	2854	2932	3002	20.32
				90	2419	2471	2541	2671	20.32
			HEF	80	2767	2806	2932	2940	19.01
				90	2262	2294	2412	2412	19.01
		4000LM	SEF	80	3709	3813	3918	4011	27.58
				90	3232	3302	3395	3569	27.58
			HEF	80	3697	3749	3918	3929	24.75
				90	3023	3065	3223	3223	24.75
		5000LM	SEF	80	4640	4771	4902	5018	34.8
				90	4044	4131	4247	4465	34.8
			HEF	80	4625	4691	4902	4915	31.77
				90	3782	3834	4032	4032	31.77
		7000LM	SEF	80	6721	6911	7101	7269	49.05
				90	5857	5984	6152	6469	49.05
			HEF	80	6700	6795	7101	7120	44.67
				90	5478	5554	5841	5841	44.67
		9000LM	SEF	80	8472	8711	8950	9163	63.99
				90	7383	7543	7755	8154	63.99
			HEF	80	8445	8565	8950	8974	58.58
				90	6905	7001	7362	7362	58.58
		10000LM	SEF	80	9469	9736	10003	10240	73.37
				90	8252	8430	8667	9112	73.37
			HEF	80	9438	9573	10003	10030	66.27
				90	7717	7825	8228	8228	66.27
	L96	6000LM	SEF	80	5463	5617	5771	5908	38.15
				90	4761	4864	5001	5258	38.15
			HEF	80	5445	5523	5771	5787	35.54
				90	4452	4515	4747	4747	35.54
		8000LM	SEF	80	7289	7495	7701	7884	52.32
				90	6353	6490	6672	7015	52.32
			HEF	80	7266	7370	7701	7722	48.5
				90	5941	6024	6334	6334	48.5
		10000LM	SEF	80	9017	9272	9526	9752	66.47
				90	7858	8028	8254	8678	66.47
			HEF	80	8988	9117	9526	9552	60.89
				90	7349	7452	7836	7836	60.89
		14000LM	SEF	80	13168	13540	13911	14241	94.78
				90	11476	11723	12054	12673	94.78
			HEF	80	13126	13313	13911	13949	85.96
				90	10732	10882	11443	11443	85.96
		18000LM	SEF	80	16970	17448	17927	18353	128.98
				90	14788	15108	15533	16331	128.98
			HEF	80	16915	17156	17927	17975	116.92
				90	13831	14024	14746	14746	116.92
		20000LM	SEF	80	18742	19271	19800	20270	146.83
				90	16333	16686	17156	18037	146.83
			HEF	80	18682	18948	19800	19853	131.6
				90	15276	15489	16287	16287	131.6

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RRL - RELOC®-Ready Luminaire

- RRL connectors can be used with Quick-Flex®, System 820 and OnePass® systems.
- Load side of connector factory installed to luminaire.
- 4-pole mating connector with push-in terminations allows for simple installation.
- Touch-safe design on both halves meets UL/CSA requirement.
- Wiping contact design allows safe disconnect under load.



ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: RRLA

Series		Wiring instructions	
RRL	RELOC®-ready luminaire	A	Hot conductor wired to position #1 (phase A)
		B	Hot conductor wired to position #2 (phase B)
		C	Hot conductor wired to position #3 (phase C) [1]

Compatible RELOC® Cables for Industrial Luminaires (ordered and shipped separately)



OCS



OCU



OD



DC



PT

Notes

1 C, ABE, and C12S options are not used with Quick-Flex QFC, QSFC, QPT, and QD.

PRODUCT INFORMATION

Advanced plug-in system with two-circuit capability. Available on industrial and strip products and a variety of architectural products mounted in continuous rows. 1, 2, 3 and 4-lamp fixtures. PLR22 (2-circuit) and crossover harness switches hot circuit serving next fixture in row. Reduces fixture types on job for alternating circuit applications (see example below.)

Easy one-step installation, saves up to 35% on labor costs. Expanded switching flexibility helps save energy.

Rows can be 50% longer with two-circuit systems. Polarized, lock-together nylon connectors prevent miswiring in the field. #12 THHN conductor, rated 600V, 90°C. White neutral wire included. Grounding accomplished by fixture in-row connectors.

CSA certified systems available with up to 2 circuits. G ground required.

Note: Specifications subject to change without notice.



Wiring

PLR

Advanced 1 or 2-Circuit Plug-In

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Series	Number of hot wires		Branch circuits				Dimming		Ground	
			Circuits to which ballast is connected		Emergency circuit connected					
PLR	(blank)	Not required for 22	(blank)	Not required for 22	(blank)	No emergency circuit	LV	Low-voltage dimming	G	Ground
PLR22	1	Black	A	Black wire	ELA	Emergency circuit wired to black wire				
	2	Black and red	B	Red wire	ELB	Emergency circuit wired to red wire				

Typical Applications

- Multiple-circuit and single-circuit for longer continuous rows
- Multiple-circuit with alternating fixtures on separate circuits and 2-circuit (PLR 22)
- Multiple circuit with night-lights located along row as desired

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ClearTouch

Buyers Guide



Learning Solutions for Tomorrow's Classroom



Innovation. Collaboration. Support.

Clear Touch™ is a forward-thinking educational technology provider recently named to the Inc. 500 list of the fastest-growing companies in the United States. Our commitment to our customers, the reliability of our products, and our industry-leading innovation have paved the way for our growth.

Customer-Focused Programs
We offer convenient financing options through our Clear Touch Capital™ program as well as ongoing, self-paced professional development and technical support through Clear Touch Academy™.

U.S. Owned & Operated
We're 100% American owned and operated, and we take immense pride in the quality and reliability of our products and service.

Flexible Warranty Options
Our long-term (1, 3, and 5-year) warranties give teachers and schools more confidence in our panels.

Comprehensive Service & Support
We don't ship our support services overseas or install products and walk away. As a full-service partner with regional, in-house support, we stay alongside customers through installation, training and ongoing support.

6000K



65", 75" & 86" AVAILABLE

The best educational technology allows educators and students to customize their experience, collaborate intuitively, and create flexible environments.

Maximize ROI and cost-effectiveness by investing in multi-purpose products that are able to grow and adapt as your needs change.

We develop innovative product features that have set us apart from the market's product providers, and empower users.

THE CLEAR TOUCH™ DIFFERENCE

What Sets the 6000K Apart

Walk-Up Ready, Intuitive User Experience
Clear Touch™ panels are so easy to use. Just turn the panel on and start exploring the familiar Android interface.

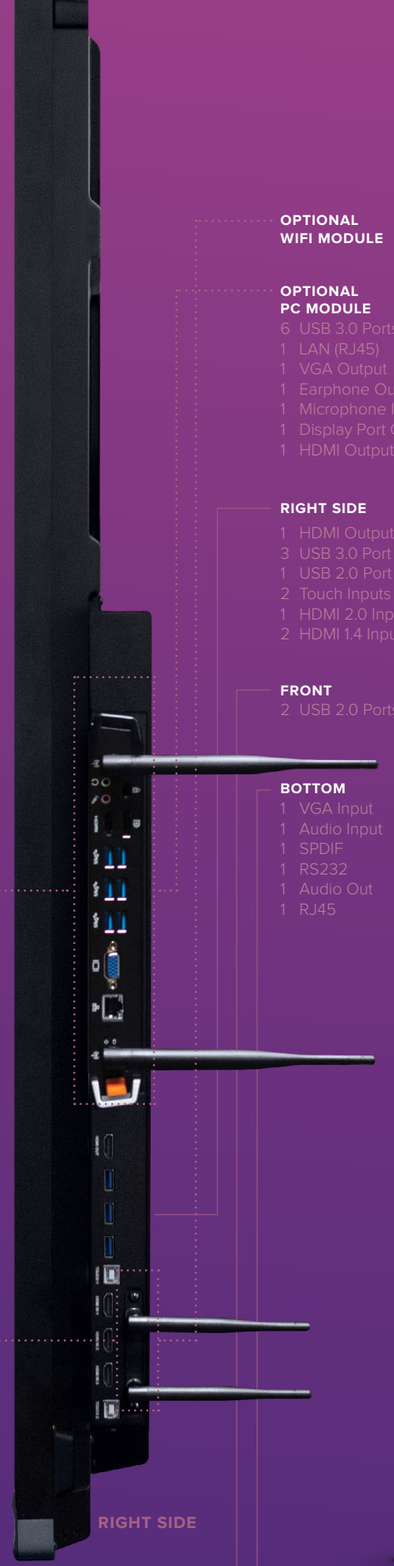
Easy to Customize to Your Learning Environment
Clear Touch™ accessories create complete flexibility. Choose accessories that fit your teaching needs—easily adjust height on a stand, or add an optional PC or Wifi module.

Smart, Multi-Touch Technology
20 points of simultaneous touch on a cool, responsive, smooth-glide surface that is highly accurate without calibration.

Simple, Streamlined Connection to Multiple Devices
Multiple USB ports, HDMI inputs and output, and wireless connectivity make set-up extremely simple.

Our Software or Yours
No annual software licenses or cloud-based storage subscriptions with our bundled software. Our panels are also software agnostic, which means you can use any program you like, including competitor software.

Tested, Dependable Technology
Our displays go through rigorous safety and reliability testing. The 6000K is certified by United Laboratories.



6000K Series

WITH INFRARED RECOGNITION

Panel Operating System

System Version . . . . . Android 8.0
CPU . . . . . Dual Core A73
Dual Core A53
GPU . . . . . Quad Core Mali G51
RAM 3GB
ROM 16GB

Panel Interactivity

Sensing Type . . . . . Infrared recognition
Compatibility . . . . . Windows, Android,
MacOSX, Linux, Chrome
Touch Point . . . . . 10 points writing
20 points touch
Minimum Object Size . . . 3mm
Touch Tool . . . . . Finger
Opaque objects
Passive infrared pen
Response Time . . . . . <10 ms
Accuracy . . . . . 1.5 mm *(over 90% Area)*
Communication Mode . . . Full-speed USB *(driver free)*
Interface . . . . . USB
Surface Hardness . . . . . 7 mohs toughened glass
Output Coordinate . . . . . 32767 x 32767

Panel Ambient

Operation Temperature . 32°F – 104°F
Operation Humidity . . . . . 10% – 90%
Storage Temperature . . . -4°F – 140°F
Storage Humidity . . . . . 10% – 90%
Altitude . . . . . Below 16404.2'

Included Accessories

3 pens, remote control, 2 AAA batteries, power cord, HDMI cable, USB touch cable



		6065K ULTRA HD	6075K ULTRA HD	6086K ULTRA HD
Panel Display				
Size		65"	75"	86"
Screen Type	LED	●	●	●
Aspect Ratio	16:9	●	●	●
Resolution	3840H x 2160V Ultra HD	●	●	●
Display Area		56.24" x 31.63"	64.95" x 36.53"	74.61" x 41.97"
Pixel Pitch		.372mm x .372mm	.430mm x .430mm	.494mm x .494mm
Back Light Unit	Direct type LED	●	●	●
Response Time		8 ms	6 ms	8 ms
Refreshing Frequency	60Hz	●	●	●
Display Color	1.07B (10bit)	●	●	●
Brightness	350 cd/m²	●	●	●
Contrast Ratio		1200:1	1100:1	1200:1
Viewing Angle	178°	●	●	●
Life Time	30,000 hours	●	●	●
Panel Audio				
Speaker Type	Built-in speaker	●	●	●
Output Power	12W x 2	●	●	●
Panel Connectors				
HDMI Output		●	●	●
USB 2.0		3	3	3
USB 3.0		3	3	3
Touch Input		2	2	2
HDMI Input		3	3	3
VGA Input		●	●	●
Audio Input		●	●	●
Audio Output		●	●	●
RS232 Port		●	●	●
RJ45 Port		●	●	●
SPDIF		●	●	●
Power				
Power Requirements	100-240V~ 50/60Hz	●	●	●
Standby Power	≤0.5W	●	●	●
Overall Power *(nominal)*		350W	350W	550W
Physical Specification				
Key Location		Front	Front	Front
Dimension	LxWxD	58.62" x 35.32" x 3.39"	67.32" x 40.16" x 3.39"	77.09" x 45.67" x 3.39"
Package Dimension	LxWxH	65.20" x 8.03" x 41.34"	73.23" x 11.02" x 46.06"	87.05" x 11.02" x 53.94"
Net Weight		82.34 lbs	107.37 lbs	142.53 lbs
Gross Weight		102.29 lbs	141.43 lbs	190.48 lbs
Machine + Wall Mount Thickness *(CTI-MOUNT-FIXW)*		5.20"	5.20"	5.20"
Wall-hanging Screw Spec	M8 x 25 mm	●	●	●
VESA		600 x 400 mm	800 x 400 mm	600 x 800 mm

7000X

55" & 65"
AVAILABLE



Clear Touch™ displays are powerful educational tools that support whole class instruction, student-led discussions, small group collaboration, and individual learning—easily transitioning between multiple roles in the classroom.

When combined with a 180 degree rotating screen on our convertible mobile stand, teachers can easily create an interactive tabletop environment that accommodates all students, regardless of height or disability.

THE CLEAR TOUCH™ DIFFERENCE

What Sets the 7000X Apart

Smart, Multi-Touch Technology
20 points of simultaneous touch on a low friction glass surface that utilizes capacitive touch, allows for sleek, flat edges and fast response times.

Pressure Sensitivity
The multi-touch surface has the ability to detect differences in pressure and react with thicker or thinner lines.

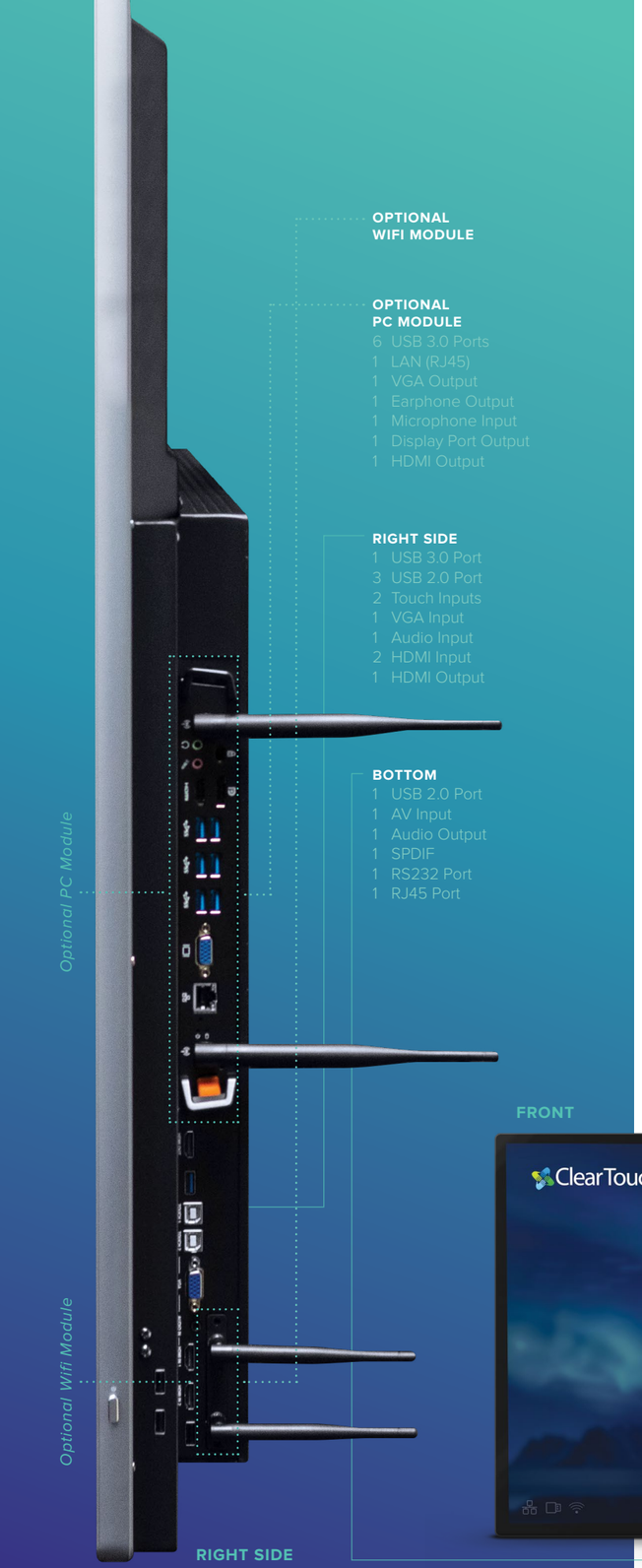
Walk-Up Ready, Intuitive User Experience
Clear Touch™ panels are easy to use. Just turn the panel on to start exploring the familiar Android interface.

Simple, Streamlined Connection to Multiple Devices.
Multiple USB ports, HDMI inputs, and wireless connectivity make set-up extremely simple.

Easy to Customize to Your Learning Environment
Clear Touch™ accessories create complete flexibility. Choose accessories that fit your teaching needs—easily adjust height on a stand, or add an optional PC or Wifi module for.

Use Our Software or Yours
No annual software licenses or cloud-based storage subscriptions with our bundled software. Our panels are also software agnostic, which means you can use any program you like, including competitor software.

Tested, Dependable Technology
Our displays go through rigorous safety and reliability testing. The 7000X is certified by the TÜV SÜD.





7000X Series

WITH CAPACITIVE RECOGNITION

Panel Operating System

System Version . . . . . Android 7.0
CPU A73x2
GPU . . . . . Mali 450x5
RAM 2GB
ROM 16GB

Panel Interactivity

Sensing Type . . . . . Capacitive recognition
Compatibility . . . . . Windows, MacOSX, Android, Linux, Chrome
Touch Point . . . . . 10 points writing, 20 points touch
Touch Tool . . . . . Finger, Capacitive stylus
Response Time . . . . . <30 ms
Accuracy . . . . . 1 mm
Touch Recognition . . . . . Palm Rejection, Simultaneous multiple colors, Simultaneous multiple pens, Pressure sensitivity
Surface Hardness . . . . . 7 mohs toughened glass
Output Coordinate . . . . . 32767 x 32767

Panel Ambient

Operation Temperature . 32°F – 104°F
Operation Humidity . . . . . 10% – 90%
Storage Temperature . . . -4°F – 140°F
Storage Humidity . . . . . 10% – 90%
Altitude . . . . . Below 16404.2'

Included Accessories

3 pens, remote control, 2 AAA batteries, power cord, HDMI cable, USB touch cable

		7055X ULTRA HD	7065X ULTRA HD
Display			
Size		55"	65"
Panel Type	IPS	●	●
Aspect Ratio	16:9	●	●
Resolution	3840 x 2160 Ultra HD	●	●
Display Area		47.62" x 26.79"	56.24" x 31.63"
Pixel Pitch		.315mm x .315mm	.372mm x .372mm
Back Light Unit	Direct type LED	●	●
Response Time		6 ms	9 ms
Refreshing Frequency	60Hz	●	●
Display Color	1.07B (10bit)	●	●
Brightness	350 cd/m²	●	●
Contrast Ratio	1200:1	●	●
Viewing Angle	178°	●	●
Life Time	30,000 hours	●	●
Audio			
Speaker Type	Built-in speaker	●	●
Output Power	10W + 15W x 2	●	●
Connectors			
USB 2.0		4	4
USB 3.0		●	●
Touch Input		2	2
HDMI Input		2	2
VGA Input		●	●
Audio Input		●	●
AV Input		●	●
HDMI Output		●	●
Audio Output		●	●
RS232 Port		●	●
RJ45 Port		●	●
SPDIF		●	●
Power			
Power Requirements	100-240V~ 50/60Hz	●	●
Standby Power	≤0.5W	●	●
Overall Power *(nominal)*		250W	300W
Physical Specifications			
Key Location	Right side	●	●
Dimension	LxWxD	49.96" x 29.41" x 3.43"	58.78" x 34.33" x 3.46"
Package Dimension	LxWxH	56.22" x 8.66" x 33.27"	66.8" x 8.66" x 40.9"
Net Weight		63.93 lbs	98.44 lbs
Gross Weight		89.51 lbs	131.09 lbs
Machine + Wall Mount Thickness *(CTI-MOUNT-FIXW)*		5.24"	5.28"
Wall-hanging Screw Spec	M8 x 25 mm	●	●
VESA		400 x 200 mm	600 x 400 mm

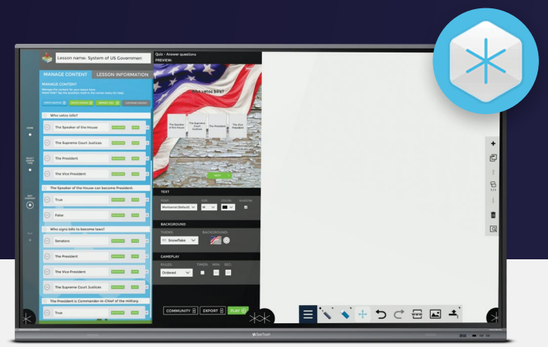
Software

PASSIONATE EDUCATORS +

A POWERFUL SOFTWARE SUITE =

INFINITE POSSIBILITIES

Educators have thousands of innovative ideas for bringing their subject to life for students—and they need technology that can keep pace with their creativity. Our integrated software suite gives teachers and students all the tools they'll ever need, right at their fingertips.

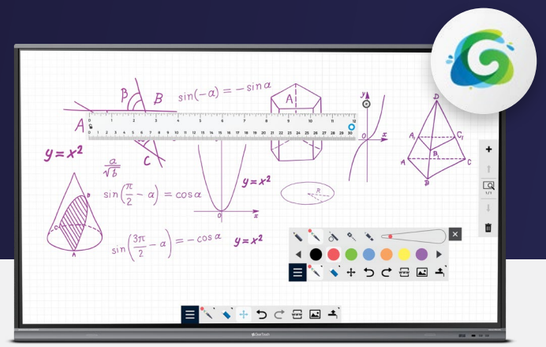


Snowflake

Exclusive Features Found Only With Clear Touch™

This version of Snowflake MultiTeach® is a powerful suite of more than 30 applications designed specifically for use on Clear Touch™ panels. These applications give teachers a toolkit for creating compelling classroom experiences. Pre-built tools allow users to craft custom games and activities, such as drag-and-drop challenges, word scrambles, matching quizzes, spinner games, and more.

- Open all media types—videos, pictures, flash games, notes, and more
- Able to split the screen into "zones" for multiple apps running at the same time
- Create your own content tailored to your curriculum or choose from pre-built lessons online
- Auto stop feature on our convertible mobile stands ensures no fingers get caught while stand is moving
- Pre-load convertible mobile stand orientation when specific zones are chosen, so you can keep your focus on the class while the panel is being repositioned

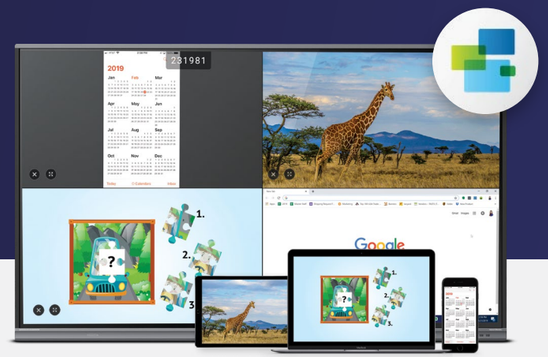


Canvas

Teach Without Limits

Clear Touch Canvas™ gives you an infinite whiteboard that allows you to open all media types directly from the white-board, or open unlimited bowser's inside your lessons to explore deeper. No more need to hyperlink, save book-marks, or jump out of your lesson into multiple third-party applications, losing students along the way. You can even incorporate YouTube videos but avoid unwanted video ads, comments, and links to related videos.

- Unlimited whiteboard space to annotate and write
- Ability to save files to the cloud or email
- Open unlimited live browsers or videos without leaving Canvas
- Able to access Canvas directly through exclusive Snowflake Multiteach® version
- Built in math and graph tools

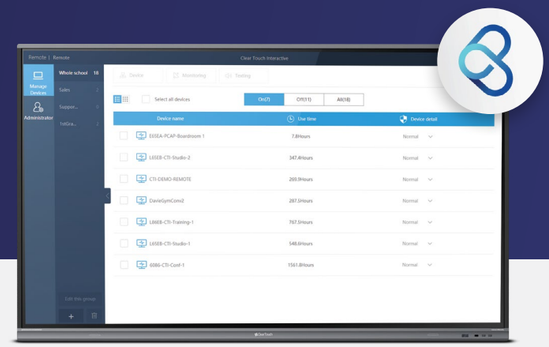


Collage

Encourage Classroom Interaction

Clear Touch Collage™ makes it simpler than ever for teachers to get the whole class involved by allowing users to project content wirelessly and connect up to four devices simulta-neously. Simply enable Collage on your touchscreen panel, enter the displayed access code, and you're ready to go.

- Enable up to four devices to connect and share simultaneously
- Permission control for teacher to allow or restrict devices from sharing
- Compatible with iPads, Chromebooks, Macs, PCs, and Android devices
- Code or QR verification protected so only members in the room can join



Command

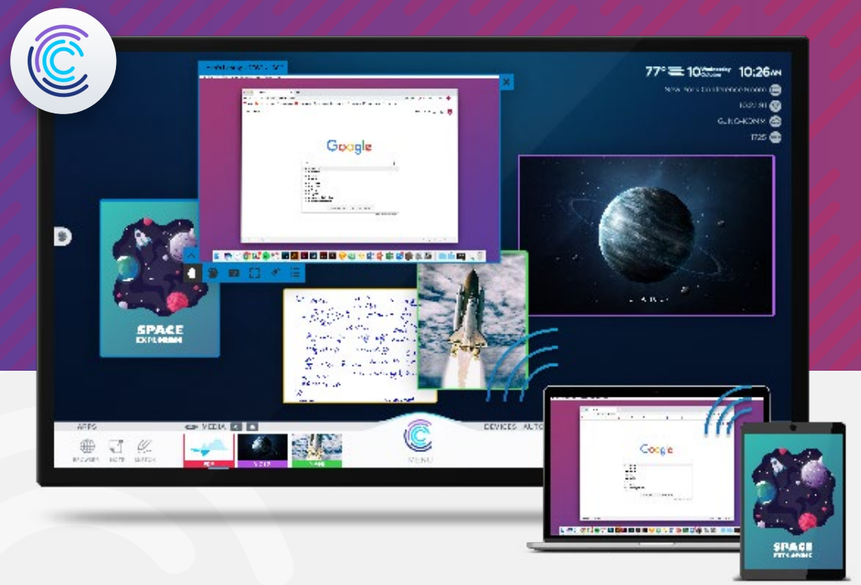
Manage Technology in the Connected Classroom

Clear Touch Command™ gives IT departments and school administrators the ability to remotely troubleshoot their touchscreen panels, automatically deploy updates, monitor device usage statistics, and communicate announcements and messages across an entire school or district. With Command, your IT team can see and update all panels remotely from a centralized computer instead of disrupting classes by going to individual classrooms.

- Automatic event scheduling including power controls
- Built in text messaging capabilities to individual or district wide panels
- Comprehensive panel usage statistics and monitoring
- Login individual panels remotely to troubleshoot or conduct updates

Snowflake, Canvas, Collage and Command are bundled with Clear Touch™ panels.
To learn more about our software programs visit **getcleartouch.com**.

Upgrades



Chorus

Collaboration in Harmony

Clear Touch Chorus™ is a simple, all-in-one classroom solution that transforms your interactive panel into a powerful hub enabling teachers and students to easily share ideas and content.

Connect to your favorite video conferencing tool, access a webcam, open and navigate in multiple browsers, and stream content to the interactive panel from multiple devices at once. All without ever leaving the shared workspace.

Prepare your students for today's work environment with Chorus, an enterprise-level software solution that corporations use for remote collaboration and video conferencing.

Chorus is available for a separate, affordable licensing fee and does not come bundled with the panels.

PC Modules

Enhance the Power of Your Panel

We offer five PC models that can boost your speed and storage—and make it simpler to share panels among teachers. Find the right model for your needs:



Standard	Premium	Enterprise	Premium	Enterprise
INTEL® CORE™ i5	INTEL® CORE™ i5	INTEL® CORE™ i5 vPro	INTEL® CORE™ i7	INTEL® CORE™ i7 vPro
CTI-PCMOD-PC25-ST	CTI-PCMOD-PC25-IG	CTI-PCMOD-PC25-VP	CTI-PCMOD-PC27-IG	CTI-PCMOD-PC27-VP
Intel H110 Express Chipset	Intel H110 Express Chipset	Intel H110 Express Chipset	Intel H110 Express Chipset	Intel Q170 Express Chipset
Intel® Quad Core™ i5 6500 (3.2 GHz) Processor	Intel® Quad Core™ i5 7400 (3.0 GHz) Processor	Intel® Quad Core™ i5 6500 (3.2 GHz) Processor	Intel® Quad Core™ i7 6700 (3.4 GHz) Processor	Intel® Quad Core™ i7 6700 (3.4 GHz) Processor
8GB DDR4 Memory	8GB DDR4 Memory	8GB DDR4 Memory	16GB DDR4 Memory	16GB DDR4 Memory
128GB SDD Storage	128GB SDD Storage	128GB SDD Storage	256GB SDD Storage	256GB SDD Storage
Integrated Intel® HD Graphics	NVIDIA GT730 Independent Graphics	Integrated Intel® HD Graphics	NVIDIA GT730 Independent Graphics	Integrated Intel® HD Graphics

PC modules do not ship with an operating system. Clear Touch™ provides operating system installation services & recommends Microsoft Windows 10 (CTI-OTHER-PC01).

Accessories



CTI-MOUNT-ADJW

Adjustable Wall Mount

Features

- Supports 6000K & 7000X Clear Touch™ panels
- Electrical powered stand makes adjustments simple
- Quiet electrical motor
- 28" height adjustment
- Optional shelf available

Warranty

3 year warranty on all components

Dimensions & weight

Product weight . . . . . 76 lbs
Shipping weight . . . . . 84 lbs
Shipping sizes *(2 boxes)*
CTI-STAND-MCCM . . . . . 32" x 11" x 9"
CTI-MOUNT-FXDM . . . . . 6" x 34" x 18"



CTI-STAND-FIXM

Fixed Mobile Stand

Features

- Supports 6000K & 7000X Clear Touch™ panels
- Strong and sturdy, supporting up to 300 lbs
- Convenient shelving for your other devices
- Three different height settings for different applications
- Tapered base provides greater accessibility for all users
- Optional shelf available

Warranty

3 year warranty on all components

Dimensions & weight

Product weight . . . . . 81 lbs
Shipping weight . . . . . 99 lbs
Shipping sizes. . . . . 60" x 26" x 5"
Shipping sizes *(1 boxes)*
CTI-STAND-FIXM. . . . . 32" x 11" x 9"



CTI-STAND-ADJM

Adjustable Mobile Stand

Features

- Supports 6000K & 7000X Clear Touch™ panels
- Fully adjustable height
- Electrical powered stand makes adjustments simple
- Quiet electrical motor
- Tapered base provides greater accessibility for all users
- Optional shelf available

Warranty

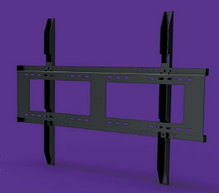
3 year warranty on all components

Dimensions & weight

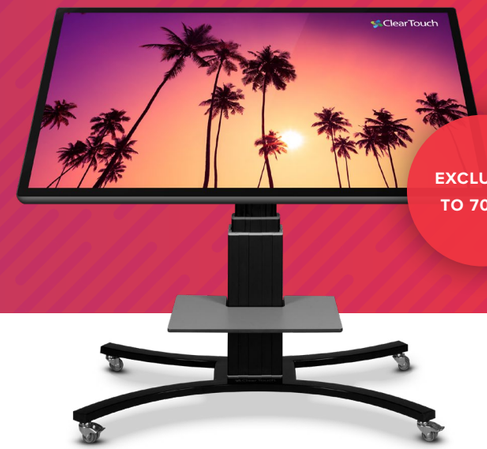
Product weight . . . . . 143 lbs
Shipping weight . . . . . 154 lbs
Shipping sizes *(3 boxes)*
CTI-STAND-MCCM . . . . . 32"x11"x9"
CTI-MOUNT-FXDM . . . . . 6"x34"x18"
CTI-STAND-MBBL . . . . . 53"x31"x5"

CTI-MOUNT-FIXW

Fixed Wall Mount



The fixed wall mount, included with all panels, is constructed of solid metal to prevent bowing and warping, and it supports up to 300 lbs.
(90 day replacement warranty included)



EXCLUSIVE TO 7000X

CTI-STAND-CONM-V2

Convertible Mobile Stand

Features

- Supports 7000X Clear Touch™ panels
- Electrical powered stand makes adjustments simple
- Quiet electrical motor
- Tapered base provides greater accessibility for all users
- Fully adjustable height & angle
- Optional shelf available

Warranty

3 year warranty on all components

Dimensions & weight

Product weight . . . . . 161 lbs
Shipping weight . . . . . 170 lbs
Shipping sizes *(3 boxes)*
CTI-STAND-MCCM . . . . . 32" x 11" x 9"
CTI-MOUNT-TAD. . . . . 35" x 30" x 19"
CTI-STAND-MBBL . . . . . 53" x 31" x 5"

Accessories



Wifi Module

Stay Connected

Enjoy a more stable bandwidth and less channel interference with the Clear Touch™ Wifi Module. This wifi module connects seamlessly with your 6000K or 7000X panels and delivers the access of the internet to your classroom.

The wifi module can also be set as a public hotspot, to let your phone, pad, or notebook get online, when the Clear Touch™ interactive display is connected to the internet.

- Bluetooth 4.0:
  One to one pair to transfer files & data
- Dual Wifi bandwidth:
  2.4GHz / 5GHz
- Simple to install into the panel



Mini Wireless Keyboard & Touchpad

Step Away from the Screen

With our Mini Wireless Keyboard & Touchpad, you gain the freedom to move about and interact with your classroom while still controlling every detail of your presentation.

Change slides, type notes, zoom in, zoom out, and highlight important information—all from up to 30 feet away. The full QWERTY keyboard allows you to enter text without returning to your PC or laptop. Then, with the simple touch of a button, the device converts to a classic touchpad for easier screen navigation and control.

- Includes a full QWERTY keyboard & classic touchpad in one device
- Small and lightweight for easy portability
- Compatible with all Clear Touch™ panels as well as a wide range of interactive panels, laptops, tablets, and smart TVs.



Webcam

Bring the Entire Group to the Table

The Clear Touch™ web camera extends the educational capabilities of Clear Touch™ panels, allowing for easy video and audio capabilities to your interactive panel.

The web camera features wide-angle viewing and built-in microphone so your entire class can be seen and heard. In addition, installation is easy as the web camera comes equipped with rotary brackets that fit to the Clear Touch™ panels.

- Featuring a clear and sharp image even in low light environments.
- Built-in microphone array to pick up sound equally from all directions
- Wide angle field of view. Maximum horizontal field of view can be 120°



Document Camera

Teach from a Whole New Angle

The ability to see an object or text clearly from anywhere in the classroom is important for student comprehension and understanding. However, this is not always possible without having students gather around or look at individual handouts or textbooks.

With the Clear Touch™ document camera, teachers can now project any object or text clearly to the entire classroom:

- Built in microphone and light
- Compatible with all Clear Touch™ panels and other devices
- Simple to connect, easy to use
- Wireless configurations enable mobile use

Clear Touch Academy™

Self-Paced Classes Turn Teachers Into Clear Touch™ Experts

Clear Touch Academy™ is one more way we continue to support educators long after your initial purchase—helping our users get the most value out of their panels. Clear Touch™ Academy members get free, 24/7, access to our:

- Training portal with all training modules
- Technical support community
- Lesson-sharing community
- Exclusive video content, web clinics, and written content
- Additional lesson-building & software tips
- Professional development team made up of educators for both custom online and onsite services

Clear Touch Capital™

Flexible Financing & Leasing

Clear Touch Capital™ is designed specifically with school budgets in mind, helping you make your technology purchases match your fiscal year. We offer competitive, fixed-payment and fixed-rate loan, and lease structures.

Loan terms start at 24 months, and we can allow for skip payments and seasonal payments so that you can match your repayment plan to your fiscal year. We offer:

- Tax exempt municipal loans
- Taxable loans
- Operational leases

If you're considering purchasing or upgrading your Clear Touch™ panels, ask us for a proposal that includes financing.

To learn more about our support options, visit **getcleartouch.com.**

ClearTouch

Clear Touch™ Support Programs

2/19/2019

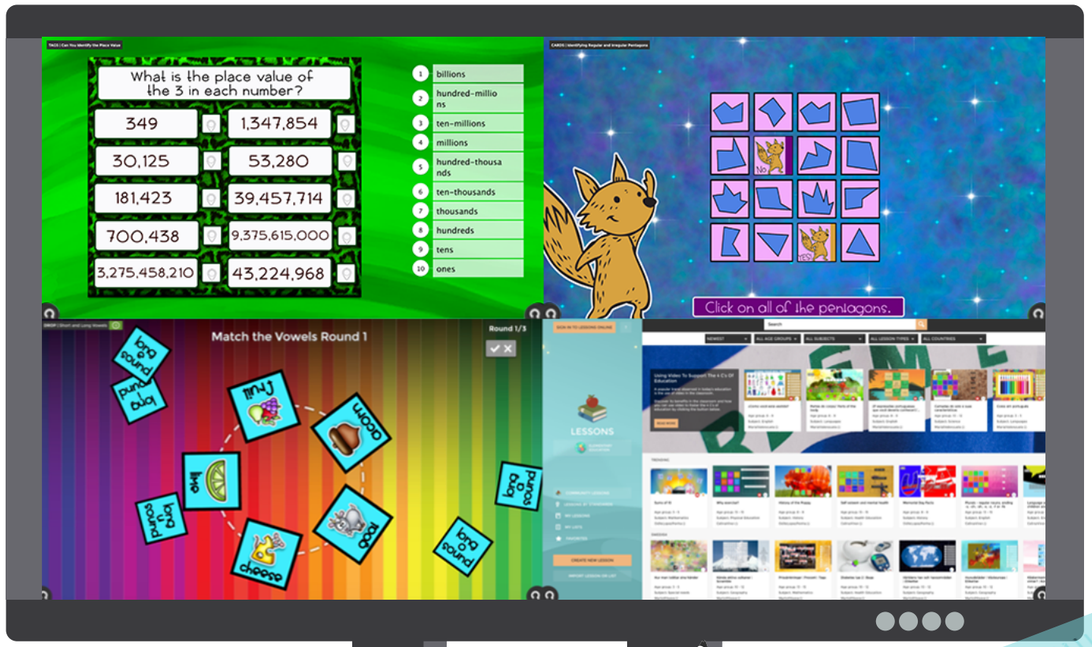
ClearTouch

Buyers Guide



getcleartouch.com • 1100 Thousand Oaks Blvd • Greenville, SC 29607 • (864) 973-7973 • info@getcleartouch.com

Learning Solutions for Tomorrow's Classroom



MAKING EDUCATION FUN

NUITEQ®
SNOWFLAKE

WHAT IS NUITEQ SNOWFLAKE

NUITEQ Snowflake is a desktop and online educational software that brings interactivity to your school and boosts classroom engagement by using **Smarter Human Interaction.**

Snowflake enables teachers and students to tell engaging, interactive **stories** that align closely with the curriculum, it provides a **safe** community for online and small group collaboration, and it allows **simultaneous** personalized instruction making curriculum relevant to students' lives.

For teachers, Snowflake also means spending less time preparing and more time working with students.

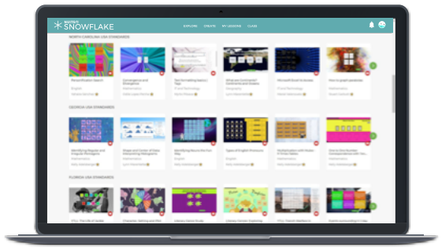
Smarter Human Interaction means doing more with every touch, and it means minimizing the effort of every student to be active learners.

SIMPLER

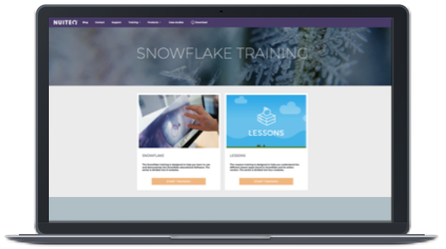
- **PROJECT-BASED LEARNING:** Create an adventure with a list of lessons.
- **STEAM LABS, MAKER SPACES:** Learn and create with video tutorials and hands-on activities.
- **PROFESSIONAL DEVELOPMENT:** With online courses and videos.
- **LEARNING STATIONS:** For small groups in upright and tabletop settings.
- **MULTIPLE MEANS OF PRESENTATION:** Keep slides, websites, videos, and activities always visible.
- **STANDARDS ALIGNMENT:** Lessons made by teachers for teachers.
- **STUDENT VOICE:** Less typing more formative feedback.
- **ACCESSIBILITY:** Guided access, voice recording, dyslexia friendly font, and color overlays.

FOR TEACHERS

Smarter Human Interaction means spending less time preparing and more time working with students.



SAVE LESSON PLANNING TIME: Teachers can find standards-aligned Snowflake Lessons created by teachers for teachers that they can edit to suit their needs. Our video-linked lessons show an instructional video prior to starting the activity and all of the activity information can be found in the lesson description.



FREE TRAINING: Search for tutorial lessons or getting started right inside Snowflake. Take a training course at **training.nuiteq.com**.

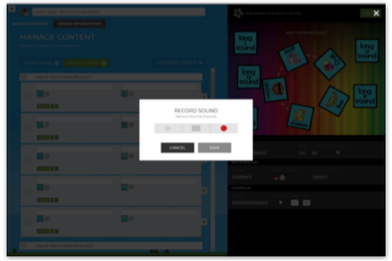


DO MORE WITH EVERY TOUCH: Smarter Human Interaction means doing more with every touch. Save your preferred custom Zones layouts so you can have an entire collaboration station with one single tap. Load a lesson playlist or webpage directly from your home screen.

HIGHLIGHT STUDENT WORK: Students share work they are proud of to their classmates and teachers can easily highlight student achievement on the large display. NUITEQ Remote allows students to mirror their iOS, Android, Windows, and Mac devices inside a zone, capture the screen and annotate a collage of screenshots.

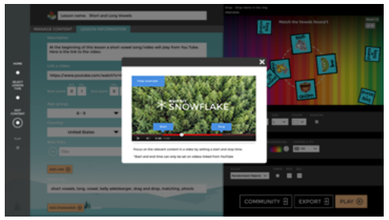
VIDEO LINKED LESSONS

More and more teachers are using videos to boost student engagement in the classroom. With Snowflake, you have access to video-linked lessons that provide hands-on activities aligned with educational standards. These lessons are made by teachers for teachers: by the members of NUITEQ's Global Content Department, but also by teachers all over the world who use Snowflake in their classroom. Play the lessons online, on your PC, Chromebook, laptop, or other mobile device or in tabletop mode on a large interactive display.



ACCESSIBLE:

Use closed captions or record your voice.



VIDEO CLIPS:

Watch the essential parts of any video.



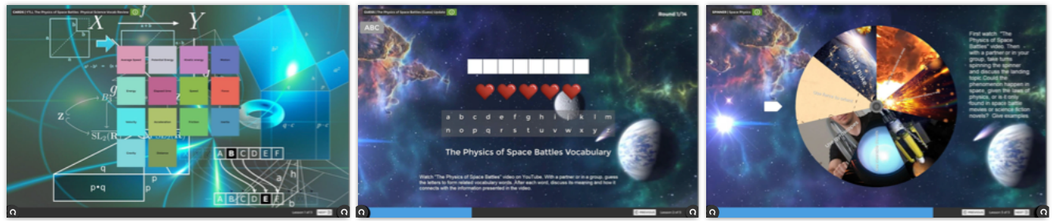
STANDARDS SEARCH:

Engaging lessons by topic or skill.



CONTENT GALLERY:

Fun templates to make your lesson pop.



PLAYLISTS:

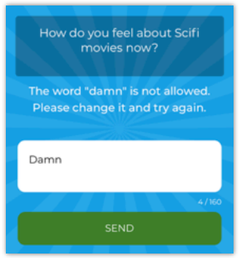
Tell a story with lessons playlists.

ENGAGING STUDENTS

At NUITEQ we believe that Making Education Fun means listening to students and how they want to learn. The student's voice enables authentic dialog and deep reflection but we need Smarter Human Interaction to ensure that more class time is spent on reflecting and active learning.



FUN CONTENT: Transform quality videos from trusted sources into learning activities and provide multiple ways to learn the material (e.g. Wikipedia, Podcasts) so that every student can succeed.



A SAFE PLACE TO SHARE: When you answer multiple choice, true/false, and even open-ended questions in a Snowflake Poll, students can be anonymous and grades are hidden. Students can share their feelings with emojis and bad words in English and Spanish are filtered out.

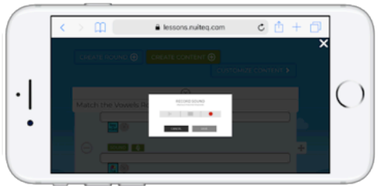


DRAFTING AND DESIGN: Snowflake allows multiple students to work simultaneously on the same display with different apps. Capture your personal zone and use it as a collage for markup and presentation.

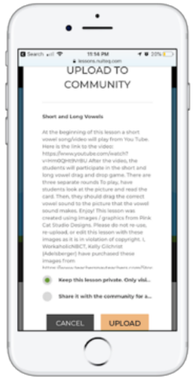
CREATION ON MOBILE

At NUITEQ we believe that mobile creation is the key to creative self-expression in the classroom. That's why we've made it possible to play every activity and with the online version of Snowflake (accessible at **snow.live**). Use images from your camera roll, and record your voice for use inside your lesson.

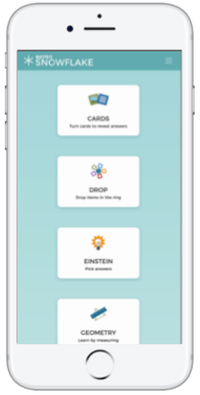
Snowflake lessons fall under the POCKET acronym: Pair, Order, Choice, Keyword, Engagement, and Tools. For a detailed explanation see the "Lessons in you POCKET" video, by searching "NUITEQ POCKET" on YouTube.



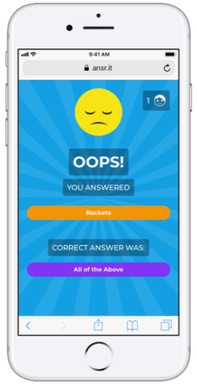
ACCESSIBLE: Use Open Dyslexic font and closed captions, and voice recording for early readers.



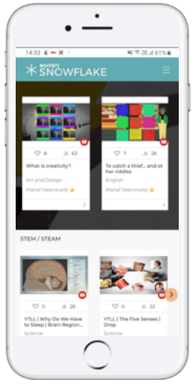
COMMUNITY: Share lessons with only your classmates and teacher.



BYOD: Laptops, tablets, smartphones it just works!



FORMATIVE: Visualize progress in real time and export the results.



AGE APPROPRIATE: Show only grade relevant content.

FOR IT ADMINS

Deployment made Simple

SIMPLE LICENSING: Bulk licensing and adopting teacher trial accounts makes it easy to manage licensing. Snowflake detects partner interactive displays and automatically adds licenses. IT Admins can even save NUITEQ settings as part of an image and deploy that to every interactive panel.

UPDATES: No subscription required. Follow NUITEQ's blog to find out when a new version is available.

OFFLINE: Snowflake desktop works offline and can load videos shared on a local network.

GOOGLE CLASSROOM: Teachers can easily share their lessons by importing from their Google Classroom and they will receive a notification when a new lesson is added to their classroom group.

GRADED LESSONS: the online version of Snowflake (**snow.live**) provides formative assessment through graded lessons . After a lesson is completed the teacher can specify additional lessons to improve performance. Grades can be monitored online to provide feedback at the speed of teaching.

BACKWARDS COMPATIBLE: Use you old SMART Notebook and Promethean ClassFlow lessons inside a zone. See how at **https://youtu.be/GkbbSwEC51I**

FOR POLICY MAKERS

GLOBAL CONTENT DEPARTMENT: With regular curriculum changes, the adoption of education technology in schools has been limited since teachers need to build lessons from scratch. Having ready-made lessons in a variety of languages, subjects, grades, and standards means that teachers can spend less time lesson planning and more time working on student outcomes.

OVER 400 000 STANDARDS: NUITEQ is the only EdTech software to support over 400 000 curriculum standards from around the world. If you are interested in standards then Snowflake is the best solution in the industry. If you have a particular curriculum standard that you would like added please email **content@NUITEQ.com.**

MULTIPLE WAYS TO LEARN: With the growing amount of educational content available on the Internet, slide presentations alone do not reflect the choices available to today's learners. The Snowflake lessons provide links to many (online and print) learning materials that can be shown at the same time in class using saved zones.

PEDAGOGY ENABLED

- **BLENDED/FLIPPED:**
  Videos at home or before instruction, activities in class.
- **STEM & STEAM POWER TOOLS:**
  Ignite your classroom.
- **PROBLEM-BASED:**
  Inquiry-driven learning.
- **PERSONALIZED:**
  Every learning journey is unique.
- **SCAFFOLDING:**
  Appropriate tools for the job.
- **SIMULTANEOUSLY:**
  Collaborate with personalized Zones.

TRY SNOWFLAKE TODAY

Snowflake makes classroom engagement as easy as using your phone using **Smarter Human Interaction**. Try our Snowflake educational technology today with its free of charge 60-day trial.



SNOWFLAKE FOR MAC AND WINDOWS

(NUITEQ.com/Snowflake)

Snowflake enables you to split the front-of-class display into zones. Multiple apps can be used at the same time, by multiple students. Whether your touchscreen is in upright or tabletop orientation, the software allows you to create an interactive learning environment. Snowflake also enables lessons to be played offline without the use of an Internet connection.

Snowflake is the only active learning platform that supports over 400 000 educational standards from curriculum around the world. If you are looking for engaging content that is aligned to what you need to teach then Snowflake is the best solution for you.



SNOWFLAKE ONLINE

(snow.live)

The online version of Snowflake enables interactive learning anywhere, any time and it can be used on any device. It is the only EdTech activity maker that allows the creation of lessons on mobile using your camera roll and recording your voice.

If you have any questions please don't hesitate to contact us at **support@NUITEQ.com**

NUITEQ®

NUITEQ.com/Snowflake

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