PROJECT MANUAL

INCLUDING CONSTRUCTION SPECIFICATIONS

for

BP-S00195
TERMINAL C, PHASE 1X – AIRSIDE CONCOURSE

CONTRACT DOCUMENTS

Volume 6 OF 7
(Division 26)

ORLANDO INTERNATIONAL AIRPORT

Orlando,Florida 32827

GREATER ORLANDO AVIATION AUTHORITY

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SECTION 26 01 00 - OPERATION AND MAINTENANCE MANUALS

PART 1- GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification sections apply to this section.

B. General: Refer to Section 01 78 00, Closeout Submittals for requirements related to the preparation and contents of Operation and Maintenance manuals/CDs.

1.2 OPERATION AND MAINTENANCE MANUALS

A. The various specification sections of Division 26 contain specific information to be included in the Operation and Maintenance (O&M) manuals/ Closeout Documents (CD's) in addition to the general requirements outlined in Section 01 78 00.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 26 01 00

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SECTION 26 01 03 - MINOR ELECTRICAL DEMOLITION FOR REMODELING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This section includes the requirements for Electrical Demolition.

B. Provide all equipment, labor, material, accessories, and mounting hardware for minor electrical demolition.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment for patching and extending work as specified in individual sections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that field measurements and circuiting arrangements are as shown on Drawings.

B. Verify that abandoned wiring and equipment serve only abandoned facilities.

C. Demolition drawings are based on field observation and existing record documents. Report discrepancies to OAR before disturbing existing installation.

D. Beginning of demolition means acceptance of existing conditions.

3.2 PREPARATION

A. Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.

B. Coordinate utility service outages with Utility Company and OAR, per section 01 31 14.13.

C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.

D. Existing Electrical Service for Escalators, Elevators, Moving Walks, Sump Pumps, Public Area Lighting and Building Controls: Maintain existing circuitry in service until new circuitry is complete and ready for energizing. Disable circuits and equipment only to make switchovers and connections. Submit Utility Outage Notification (UON) and obtain permission from OAR appropriately before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.

E. Existing Fire Alarm System: Maintain existing system devices in service until new system devices are installed. Disable system only to make switchovers and connections. Submit Utility Outage Notification (UON) and notify OAR and local fire management service appropriately before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area. A safety fireman's watch is required to be provided by approved personnel to enact a fire watch for areas that experience a loss of fire protection and notification coverage due to the modifications, for the full period of time the system is deactivated.

F. Existing Security System: Maintain existing system devices in service until new system devices are installed. Disable system only to make switchovers and connections. Submit

Utility Outage Notification (UON) and notify OAR and Operations Department appropriately before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area. A security watch is required to be provided by approved personnel to enact a watch for areas that experience a loss of security protection due to the modifications, for the full period of time the system is deactivated.

G. Existing Telephone System: Maintain existing system devices in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Submit Utility Outage Notification (UON) and notify OAR and GOAA's Telecommunications Department appropriately before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.

H. Existing Sound and Paging System: Maintain existing system devices and equipment in service until new sound and paging system is installed and ready for service. Disable system only to make switchovers and connections. Submit Utility Outage Notification (UON) and notify the OAR appropriately before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.

3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. Remove, relocate, and extend existing installations to accommodate new construction.

B. Remove all abandoned wiring to source of supply.

C. Remove exposed abandoned conduit, including abandoned conduit above accessible ceilings. Cut conduit flush with floors and provide firestopping at all abandoned penetrations in rated assemblies.

D. Disconnect abandoned outlets and remove devices, boxes and raceways.

E. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.

F. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.

G. Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate and as required to comply with the requirements of the NEC.

H. Extend existing installations using materials and methods compatible with existing electrical installations, however extension must meet or exceed the materials/methods specified in the Contract Documents.

3.4 CLEANING AND REPAIR

A. Clean and repair existing materials and equipment that remain or are to be reused.

B. Panelboards: Clean exposed surfaces and check tightness of connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement. Directory shall be typed original manufacturer’s card stock.

C. Luminaries: Clean existing luminaries. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps and broken electrical parts on all luminaries and ballast removed. Reuse and replace components as indicated in the Construction Documents.

END OF SECTION 26 01 03

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SECTION 26 01 05 - INVESTIGATION OF EXISTING ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This section includes the requirements for investigation and reporting on conditions of existing electrical systems.

1.3 DESCRIPTION

A. Test the essential features of the following existing electrical systems:

1. Alarm and bells.
2. Clock system.
3. Emergency and non-emergency lighting fixtures.
4. Controls and alarms.
5. Outlets: convenience.
6. Switches: regular, time.

B. Each system shall be tested once only, and after completion of testing, results given to the OAR. Point out any non-operational function noticed during testing.

C. Document the existing conditions and operation of the existing electrical systems prior to any work.

D. Contractor shall be responsible for all non-working systems and their components unless non-working status is verified prior to work on system.

1.4 TIME

A. The testing shall be held at a date to be agreed upon in writing by the OAR.

1.5 ATTENDING PARTIES

A. The testing shall be held in the presence of the OAR, and Contractor.

PART 2 - PRODUCTS (not applicable)

PART 3 - EXECUTION

3.1 PERFORMANCE VERIFICATION

A. Test the operation of each of the following existing devices and associated systems:

1. Lighting and Exit Lighting Fixtures in Areas of Renovation:
   a) Test all lighting fixtures and exit lights for proper operation, list bad ballasts, lamps or broken lenses. Record location of fixtures tested.
   b) Test light switches, relay controls, and photo cell controls for proper operation and record location of tested device and note operational or non-operational.
2. Clock System:
   a) Test each clock for proper operation and automatic connection feature.

3.2 MEMO OF INVESTIGATION (TESTING)

A. Submit Existing Facilities Investigation Memo and advise OAR of all deficiencies in system(s) prior to work. All systems will be assumed to be fully operational if Memo is not received by OAR prior to work on system.

B. Submit five copies of Existing Facilities Investigation Memo of tested devices and equipment, memo signed by the Contractor, Subcontractor and OAR. Submit each test result to the OAR.

END OF SECTION 26 01 05

SECTION 26 05 00 – COMMON WORK RESULTS FOR ELECTRICAL

PART 1- GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Contractual Conditions and other Division 01 Specification sections apply to this section.

1.2 SUMMARY

A. This section includes Basic Electrical Requirements specifically applicable to Division 26 Sections.

1.3 DESCRIPTION

A. Provide and install all equipment, labor, material and accessories, and mounting hardware for a complete and operating system as described within these Division 26 Specification Sections.

B. Furnish, perform, or provide all labor including planning, purchasing, transporting, storing, installing, testing, cutting and patching, trenching, excavating, backfilling, coordination, field verification, equipment (installation and safety), supplies, and materials necessary for the installation of complete electrical systems (as described or implied by these specifications and the applicable drawings) in strict accordance with applicable codes, which may not be repeated in these specifications, but are expected to be common knowledge of qualified Bidders.

C. All work shall comply with all applicable codes as a minimum and with the additional requirements called for in these Contract Documents.

D. Only trained and licensed personnel shall perform work. No Work shall be performed which violates applicable Codes, even if called for in the Contract Documents.

E. Coordinate requirements with Utility Company and all applicable GOAA Testing, Certification and repair contractor prior to bid. Bid to include all work required.

F. Make connections of all items in the Work using electric power including wire, conduit, circuit protection, disconnects and accessories. Securing of roughing-in drawings and connection information for equipment involved shall also be included under this division. See other divisions for specifications for electrically operated equipment.

G. The Contractor shall provide and install panic hardware on all electrical room doors where the electrical room houses switchboards or MCC's rated 800 amps or more per NEC 110.26. All electrical room doors shall open in the direction of egress.

1.4 QUALITY ASSURANCE

A. Install Work in locations shown or described in the Contract Documents, unless prevented by Project conditions.

B. Install all equipment so that all Code and Manufacturer recommended working and servicing clearances are maintained. Properly arrange and install all equipment within designated spaces. If a departure from the Contract Documents is necessary, submit to the OAR for approval, detailed drawings of the proposed changes with written reasons for the changes. No change shall be implemented without the issuance of a change order or other directive permitted by the General Conditions.

C. The Contractor shall verify finish dimensions at the project site in preference to using dimensions noted on Contract Documents.

1.5 INVESTIGATION OF SITE

A. Investigate the site and existing conditions thoroughly before bidding. Advise OAR of discrepancies or questions noted.

B. During the course of the site visit, electrical bidder shall become familiar with all aspects of the proposed work and existing field conditions of the work. No compensation or reimbursement for additional expenses for failure to investigate the existing facilities will be authorized. This shall include rerouting around existing obstructions.

C. Submission of a proposal will be construed as evidence that such examination has been made and later claims for labor, equipment or materials required because of difficulties encountered will not be recognized.

D. Existing conditions and utilities indicated are taken from existing construction documents, surveys, and field investigations. Unforeseen conditions probably exist and existing conditions shown on drawings may differ from the actual existing installation with the result being that new work may not be field located exactly as shown on the drawings. Notify OAR if deviations are found.

E. All existing electrical is not shown. The Contractor shall become familiar with all existing conditions prior to bidding, and include in his bid the removal of all electrical equipment, wire, conduit, devices, fixtures, etc. that is abandoned due to renovation.

F. Protect all existing electrical raceways within concrete slabs, below concrete slabs, overhead raceways, equipment, etc. from damage due to renovation. Repair or replacement of utilities or other property damaged by operations in conjunction with the work will be at no cost to the Owner.

G. Remove existing power, lighting, systems, material and equipment which are made obsolete or which interfere with the construction of the project. Reinstall power, lighting, systems, materials and equipment which are required to remain active for the facility to be fully functional.

H. Reroute conduit and wiring in area of construction remaining active. Include temporary connections necessary to maintain continuity of existing circuitry required to remain active during renovation. Existing conduits indicated in Contract Documents are approximate locations only. Determine routing of existing conduits and pipes prior to any excavation, cutting or demolition.

I. Occupied existing buildings must remain in operation while work is being performed. Schedule work for a minimum outage to Owner. Notify the OAR appropriately for any shut-down of existing systems.

J. Bid shall include all removal and relocation of all piping, fixtures or other items required for completion of alterations and new construction.

K. Refer to Section 26 01 03 Minor Electrical Demolition for Remodeling for additional requirements associated with existing conditions.

1.6 CONTRACT DOCUMENTS

A. The drawings are diagrammatic and are not intended to include every detail of construction, materials, methods, and equipment. They indicate the result to be achieved by an assemblage of various systems. Coordinate equipment locations with Architectural and Structural drawings. Layout equipment before installation so that all trades may install equipment in spaces available. Coordinate installation in a neat and workmanlike manner. Provide 1/4" scale coordination drawings per specifications prior to start of work.

B. Contractor shall provide 1/4" scale coordination drawings for all electrical, mechanical and communications rooms during the shop drawing submittal phase, utilizing detailed dimensions from equipment actually submitted (all disciplines) and field-measured/verified existing conditions. These drawings are also required for any room where conduits equal to or over 1-1/4" in size, equipment (panels, HVAC, disconnects, comm. racks) or other large objects are being installed. Drawings shall show all electrical, mechanical, plumbing, fire protection, structural, etc. coordinated so that problems are discovered/prevented prior to installation. Claims during construction for additional funding in rooms where properly coordinated drawings were not submitted will not be considered.

C. Wiring arrangements for equipment shown on the drawings are intended to be diagrammatic and do not show all required conductors and functional connections. All such items incidental to a complete and operating system shall be provided.

D. Submit specific shop drawings which indicate the fabrication, assembly, installation, and erection of particular systems' components. Drawings that are part of the Contract Documents shall not be considered a substitute for required shop drawings, field installation drawings, code requirements, or applicable standards.

E. Locations indicated for outlets, switches, and equipment are approximate and shall be coordinated with the Contract Documents. Where instructions or notes are insufficient to locate the item, notify the OAR.

1.7 MATERIALS AND EQUIPMENT

A. Unless otherwise noted, all material shall be new and UL listed or labeled. In lieu of UL listing or labeling, a statement or data demonstrating compliance with contract documents from a nationally recognized testing agency shall be submitted to the OAR.

B. All materials shall comply with the requirements for Low Emitting Materials. This shall include:

1. Low Emitting Materials for Paints and Coatings
2. Low Emitting Materials for Adhesives and Sealants
3. Low Emitting Composite Wood

C. Reference section 01 8113.14 "Sustainable Design Requirements – LEED V4 BD+C for additional information.

D. Where Contract Documents list design selection, manufacturer or type, this model shall set the standard of quality and performance required. Where no brand name is specified, the source and quality shall be subject to Designers/OAR review and approval. Where Contract Documents list approved substitutions, these items shall comply with Division 01 requirements for substitutions.

E. When a product is specified to be in accordance with a trade association or government standard and at the request of Designers/OAR the Contractor shall furnish a certificate that the product complies with the referenced standard and supporting test data to substantiate compliance.

F. Where multiple items of the same equipment or materials are required, they shall be the product of the same Manufacturer.

G. Prior to placing equipment orders, verify the physical size of specified equipment to fit spaces allotted on the drawings and with NEC working clearances. Internal access for proposed equipment substitutions shall be provided. Provide 1/4” scale drawings showing that this coordination has taken place.

H. Electrical equipment shall be protected from the weather, during shipment, storage, and construction per manufacturer's recommendations. Should any apparatus be subjected to possible damage by water, it shall be thoroughly dried and put through a dielectric test, at the expense of the Contractor, to ascertain the suitability of the apparatus, or it shall be replaced without additional cost to the Owner.

I. Inspect all electrical equipment and materials prior to installation. Damaged equipment and materials shall not be installed or placed in service. Replace or repair and test damaged equipment in compliance with industry standards at no additional cost to the Owner. Equipment required for the test shall be provided by the Contractor.

J. Material and equipment shall be provided complete and shall function up to the specified capacity/function. Should any material or equipment as a part or as a whole fail to meet performance requirements, replacements shall be made to bring performance up to specified requirements. Damages to finish by such replacements, alterations, or repairs shall be restored to prior conditions, at no additional cost to the Owner.

K. Where tamperproof screws are specified or required, Phillips head or Allen head devices shall not be accepted. For each type used, provide OAR with three tools. OAR will designate the specific hardware design to correspond with existing devices elsewhere in the building, to limit special tool requirements.

L. Communications backboards shall be 3/4" A/B grade, Class A, flame spread, painted with light gray fire retardant paint. Neatly mask off a minimum of one (1) plywood manufactures pre-printed certified fire rating stamp per section of board prior to application of paint. Remove masking after paint has cured. Plywood shall comply with the requirements of Low Emitting Materials for composite wood.

1.8 SUPERVISION OF THE WORK

A. Reference the General Conditions for additional requirements.

B. A qualified and experienced electrical superintendent shall be in charge of the work in progress at all times. If, in the judgement of the OAR, the electrical superintendent is not performing his duties satisfactorily, the Contractor shall immediately replace him upon receipt of a letter of request from the OAR. Once a satisfactory electrical superintendent has been assigned to the work, he shall not be withdrawn by the Contractor without the written consent of the OAR.

C. Provide field superintendent who has had a minimum of four (4) years previous successful experience on projects of comparable sizes and complexity. Superintendent shall be present at all times that work under this Division is being installed or affected. All work performed by a non-

licensed Journeyman shall be under the direct supervision (in the presence of) of a Licensed Journeyman as specified herein. Increase the quantity of licensed Journeymen as required for supervision of all areas where direct contact is not possible. Project Superintendent and supervising Journeyman shall have passed a proctored H.H. Block Journeyman Exam with 75% grade or better and shall be a licensed Journeyman within the State of Florida. A resume of the Project superintendent's experience shall be submitted to OAR before starting work. At least one member of the electrical contracting firm shall hold a State Master Certificate of Competency. Each Journeyman shall have possession of licensing documentation at all times during work. Display to designer/OAR when requested.

D. Superintendent shall be employed by a State certified (Type "E.C." License) electrical contractor.

1.9 COORDINATION

A. Provide all required coordination and supervision where work connects to or is affected by work of others, and comply with all requirements affecting this Division. Work required under other divisions, specifications or drawings to be performed by this Division shall be coordinated with the Contractor and such work performed at no additional cost to Owner including but not limited to electrical work required for:

1. Door hardware
2. Roll-up doors
3. Roll-up grilles
4. Signage
5. Fire shutters
6. Elevators
7. Escalators
8. Sliding doors
9. Mechanical Division of the Specifications
10. Landscape Architect drawings
11. Lifts
12. Lift Station
13. Kitchen equipment
14. Conveyors
15. Flight information display systems
16. Interior design drawings
17. Fountains
18. Millwork design drawings and shop drawings
19. Parking control equipment

B. Provide electrical subcontractor a set of Contract Documents for all areas of Electrical Work.

C. Installation studies shall be made to coordinate the electrical work with other trades. Work shall be preplanned. Unresolved conflicts shall be referred to the OAR prior to installation of the equipment.

D. Coordination drawings shall be prepared prior to the start of work. Drawings shall show the actual physical dimension required for the installation to assure proper integration of equipment with building systems and NEC required clearances. Location of conduit racking, etc., shall be provided. Coordination drawings shall be provided for all areas. Comply with the requirements of Division 01.

E. Secure approved shop drawings from all required disciplines and verify final electrical characteristics before roughing power feeds to any equipment. When electrical data on approved shop drawings differs from that shown or called for in Construction Documents, make adjustments to the wiring, disconnects, and branch circuit protection to match that required for the equipment installed. Adjustments to contract value will not be considered due to lack of coordination.

F. Damage from interference caused by inadequate coordination shall be corrected at no additional cost to the Owner.

G. Coordinate the exact location of floor outlets, floor ducts, floor stub-ups, etc. with OAR and Designer (and receive their approval) prior to rough-in. Locations indicated in Contract Documents are only approximate locations.

H. The Contract Documents describe specific sizes of switches, breakers, fuses, conduits, conductors, motor starters and other items of wiring equipment. These sizes are based on specific items of power consuming equipment (heaters, lights, motors for fans, compressors, pumps, etc.). Coordinate the requirements of each load with each load's respective circuitry shown and with each load's requirements as noted on its nameplate data and manufacturer's published electrical criteria. Adjust circuit breaker, fuse, conduit, and conductor sizes to meet the actual requirements of the equipment being provided and installed and change from single point to multiple points of connection (or vice versa) to meet equipment requirements. Changes shall be made at no additional cost to the Owner.

1.10 PROVISION FOR OPENINGS

A. Locate openings required for work. Provide sleeves, guards or other approved methods to allow passage of items installed.

B. Coordinate with roofing Contractor on installation of electrical items which penetrate the roof. Roof penetrations shall be installed so as to not void roof warranty.

C. Where work pierces waterproofing, it shall maintain the integrity of the waterproofing. Coordinate roofing materials which pierce roof for compatibility with membrane or other roof types with Contractor.

1.11 CONCRETE PADS

A. Furnish and install reinforced concrete pads for transformers, switchgear, generators, motor control centers, and other free-standing equipment. Unless otherwise noted, pads shall be four (4) inches high and shall exceed dimensions of equipment being set on them, including future sections, by three () (3) inches each side, except when equipment is flush against a wall where the side against the wall shall be flush with the equipment. Pads shall be reinforced with W1.4 x 1.4 6 x 6 welded wire mesh. Chamfer top edges 1/2". Trowel all surfaces smooth. Provide 3000 psi concrete.

1.12 SURFACE MOUNTED EQUIPMENT

A. Surface mounted fixtures, outlets, cabinets, conduit, panels, etc. shall have finish or shall be painted as directed by designer. Paint shall be in accordance with applicable sections and/or divisions of these specifications.

1.13 CUTTING AND PATCHING

A. Reference Division 01 - General Requirements.

B. New Construction:

1. Cutting of work in place shall be cut, drilled, patched and refinished by trade responsible for initial installation.
2. Backfill new grades to match adjacent undisturbed surface.

C. Remodeling:

1. See Section 26 01 03 Minor Electrical Demolition.

1.14 INSTALLATION

A. Erect equipment to minimize interference and delays with the execution of the Work.

B. Take care in erection and installation of equipment and materials to avoid marring finishes or surfaces. Any damage shall be repaired or replaced as determined by the designer/OAR at no additional cost to the Owner.

C. Equipment requiring electrical service shall not be energized or placed in service until OAR is notified and is present or have waived their right to be present. Where equipment to be placed in service involves service or connection from another Contractor or the OAR, notify the OAR in writing as appropriate when the equipment will be ready.

D. Equipment supports shall be secured and supported from structural members unless written approval is granted by OAR.

E. Plywood material shall not be used as a backboard for mounting panel boards, disconnects, motor starters, and dry type transformers. Provide "cast in place" type inserts or install expansion type anchor bolts. Electrical equipment shall not be mounted directly to dry wall for support without additional channels as anchors. Channels shall be anchored to the floor and structure above. Panelboards and terminal cabinets shall be provided with structural framing located within drywall partitions.

F. Inserts, pipe sleeves, supports, and anchorage of electrical equipment shall be provided. Where items are to be set or embedded in concrete or masonry, the items shall be furnished and layout made for setting or embedment thereof so as to cause no delay.

G. Conduit or piping systems that contain water or liquid of any kind shall not be installed over the top of any electrical equipment, transformers, racks, cabinets, or enclosures without prior written approval from the OAR.

1.15 AS-BUILT DOCUMENTS

A. As-Built Documents: As-built Documents include Drawings, Shop Drawings, Specifications, Addenda, Change Orders, and other modifications permitted by the General Conditions.

B. Comply with all requirements of Division 01

C. Verify aspects of redlined as-builts for accuracy. As-Built Documents shall show all components including but not limited to:

1. All raceways 1-1/4" and above, cable tray systems, and grouped raceway racking as installed, including dimensions from fixed building lines such as column lines.
2. All site underground raceways and duct banks indicating burial depths and distances from fixed building lines or global tracking coordinates.
3. Underground pull boxes and manholes including elevations. Detail manhole and pull boxes, conduit terminations (butterfly layout) including conduit sizes, designated systems and cabling description.
4. General conduit routing from receptacle to receptacle, fixture to fixture, device to device. (Exact routing is not required for raceways 1” and smaller.)
5. Lighting: Diagrammatically show junction boxes that are located above accessible ceiling with flexible conduit connections to luminaries.
6. All junction boxes for Sections 28 31 11, 27 13 00 / 27 15 00, 27 13 00 / 27 15 00 and 27 51 16 shall be shown exactly where installed.
7. Junction box splices shall be shown in exact location and clearly noted referring to the written authorization by the OAR.
8. The first junction box within each homerun, regardless of size shall be shown in the installed location.
9. All junction boxes and pull boxes located above non-accessible ceilings shall be shown in exact location. All junction boxes 6”X6” and larger shall be shown in exact location.
10. Any combining of circuits (which is only allowed by specific permission) or change in homerun outlet box shall be indicated.
11. Any circuit number changes.
12. All conductors and cables, conductors and cable sizes, raceway sizes, etc. not shown on contract documents and any changes from the documents.
13. Any switchboard, panelboard, motor control center, relay panel, or dimming control panel schedule changes, including load changes.
14. All access panels.
15. All existing conditions.
16. Location of lighting control devices such as photocell controls, space occupancy sensors, etc.
17. Exact quantity of conductors and cables shall be shown for all raceway systems.
18. All devices, wall outlet boxes, and control components.
19. All wireway and cable tray systems.
20. Exact location of all driven grounding electrodes including burial depths and dimensions from fixed building lines. Location of all grounding system busbars.
21. All building automation system (BAS) control panels and associated electrical devices, connections, power supplies, and dampers.
22. Riser diagrams exactly as installed.
23. Motor control devices, terminal cabinets, equipment racks, disconnects and switches and surge protection devices.
24. Change the equipment schedules (i.e. symbol legends, light fixture schedule, etc.) to agree with items actually furnished.
25. Change plan notes to agree with items actually furnished, actual installation methods, etc. respectfully.
26. Cross-out all items, circuitry, devices, etc. not applicable.

D. As-Built red line information shall not compromise the clarity of the Contract Documents and Shop Drawings. Major components such as grouped raceway assemblies, cable tray systems, larger conduits, duct banks, racking, elevations, dimensions, etc. shall be shown on a clean architectural base plan(s) separate from the Contract Electrical Documents, as required to clearly delineate work. Obtain electronic base plan file from OAR.

1.16 "OBSERVATION OF WORK" REPORT

A. Reference the General Conditions.

B. Items noted by designer/OAR during construction and before final acceptance which do not comply with the Contract Documents will be listed in an "Observation of Work" report which will be sent to the Contractor for action. Correct all deficiencies in a prompt concise manner. After completion of the outstanding items, provide a written confirmation report for each item. The report shall indicate each item noted, and method of correction. Enter the date on which the item was corrected, and return the signed reports so items can be rechecked. Failure to correct the deficiencies in a prompt concise manner or failure to return the signed reports shall be cause for disallowing request for payments.

C. The electrical project superintendent shall be present at all required observation of work reviews as project progresses. Provide the OAR with equipment for access and review of all Work in place, as well as personnel fully familiar with all aspects of the work. Provide access to all electrical components such as junction boxes, panelboards, switchboards, devices and fixtures for their review by the designer/OAR.

D. Prior to start of Substantial Completion inspection, provide access to and prepare all electrical equipment and related components complete and ready for review by designer/OAR including but not limited to the following :

1. All panelboard covers removed
2. Switchboard and distributions panelboards readily for immediate removal of covers
3. Terminal cabinet covers open or removed.
4. Wireway covers open or removed
5. Underground pull boxes ready for immediate removal of cover(s)
6. Access to all grounding/bonding terminations
7. Access to rated wall and through floor fire stopping
8. Access to all control systems for the CCTV, Voice, Data, Fire Alarm, and Sound/Paging.
9. Access to mechanical equipment, electrical connection points, and control devices
10. Access to elevator and escalator machine rooms, hoistway, pits, etc.
11. Access to all raceways crossing structural expansion/deflection joints.
12. Access to all components of the fire alarm control system including control devices and fire dampers.
13. Access to power company equipment
14. Removal of access panels
15. Removal of a minimum of one (1) acoustical lay-in ceiling tile throughout each area of work. Larger areas shall have one (1)-ceiling tile removed for every 30 square foot of ceiling area.
16. Each and every item deemed necessary by A/E to perform a comprehensive review of the work as installed relative to the contract documents.

E. Items noted after acceptance during one-year guarantee period shall be checked by the Contractor in the same manner as above. The signed reports are to be returned by him when the items have been corrected.

1.17 SYSTEMS WARRANTY

A. Reference the General Conditions.

B. Warranty shall be by the Contractor to the Owner and shall cover for a period of one year from the date of the Substantial Completion. Warranty shall not include light bulbs lamps in service after one month from date of substantial completion of the System.

1. Explain the provisions of warranty to the Owner at the "Demonstration of Completed System" meeting to be scheduled with the OAR upon project completion.

C. Where items of equipment or materials carry a manufacturer's warranty for any period in excess of twelve (12) months, then the manufacturer's warranty shall apply for that particular piece of equipment or material.

D. Where extended Guarantees are called for herein, furnish three copies to be inserted in Operation and Maintenance Manuals.

E. All preventative maintenance and normal service will be performed by the Owner's maintenance personnel after final acceptance of the work which shall not alter the Contractor's warranty.

1.18 WASTE MATERIALS DISPOSAL

A. Include in base bid the transport and disposal or recycling of all waste materials generated by this project in accordance with all rules, regulations and guidelines applicable. Comply fully with Florida Statute 403.7186 regarding mercury containing devices and lamps. Lamps, ballasts and other materials shall be transported and disposed of in accordance with all DEP and EPA guidelines applicable at time of disposal. Provide OAR with written certification of approved disposal.

1.19 PROHIBITION OF ASBESTOS AND PCB

A. Prior to the Final Review field visit the Contractor shall certify in writing that the equipment and materials installed in this Project under this Division 26 contain no asbestos or PCB. Additionally, all manufacturers shall provide a statement with their submittal that indicates that their product contains no asbestos or PCB. This statement shall be signed by a duly authorized agent of the manufacturer.

PART 2- PRODUCTS (Not Applicable)

PART 3- EXECUTION (Not Applicable)

END OF SECTION 26 05 00

SECTION 26 05 10 - ELECTRICAL SYMBOLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification Sections, apply to this section.

1.2 SYMBOLS

A. In general the symbols used on the drawings conform to the Standard Symbols of the Institute of Electrical and Electronic Engineers with the exception of special systems or agencies as hereinafter noted.

1. Corps of Engineers.

2. Special Symbols as shown in schedules or legends.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 26 05 10

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SECTION 26 05 19 – BUILDING WIRE AND CABLE

PART 1- GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification sections apply to this section.

1.2 SUMMARY

A. This section includes the requirements for provision and installation of Building Wire and Cable.

1.3 DESCRIPTION

A. Provide all equipment, labor, material, accessories, and mounting hardware to properly install all conductors and cables rated 600 volts and less for a complete and operating system for the following:

1. Building wire and cable.
2. Wiring connectors and connections.

B. No aluminum conductors shall be permitted.

C. All sizes shall be given in American Wire Gauge (AWG) or in thousand circular mils (MCM/KCMIL).

1.4 SUBMITTALS

A. Product Data: Submit catalog cut sheet showing, type and UL listing of each type of conductor, connector and termination.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years experience.

1.6 REFERENCES AND REGULATORY REQUIREMENTS

A. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

B. Conform to the requirements of ANSI/NFPA 70.

1.7 PROJECT CONDITIONS

A. Verify that field measurements are as shown on Drawings.

B. Conductor sizes are based on copper.

C. Wire and cable routing shown on Drawings is approximate unless dimensioned. Route wire and cable as required to meet Project Conditions.

D. Where wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required. Record actual routing on red lined as-builts.

E. Conductors with different voltages (i.e. 120 volt and 277 volt) shall not be combined in the same conduit without prior written approval from OAR and Engineer.

F. Conductors for each branch of power (Normal, Life safety, Critical, Security, and Equipment) shall be installed in its own dedicated raceway system.

1.8 COORDINATION

A. Determine required separation between cable and other work.

B. Coordinate cable routing to avoid interference with other work disciplines.

PART 2 - PRODUCTS

2.1 BUILDING WIRE AND CABLE

A. Description: Single conductor insulated wire.

B. Conductor: Copper.

C. Insulation Voltage Rating: 600 volts.

D. Insulation: ANSI/NFPA 70, Type THHN/THWN-2 and XHHW.

E. Cable supports shall be O Z/Gedney Type “S” or approved substitution.

PART 3 - EXECUTION

3.1 GENERAL

A. Install products in accordance with manufacturer’s instructions.

B. Neatly train and lace wiring inside boxes, equipment, and panelboards.

C. Before installing raceways and pulling wire to any mechanical equipment, verify electrical characteristics with final submittal on equipment to assure proper number and AWG of conductors. (As for multiple speed motors, different motor starter arrangements, etc.).

D. Conductors #12 AWG and #10 AWG shall be 600 volt type THHN/THWN, solid unless specifically noted otherwise, rated 90 degrees C. dry.

E. Use conductor not smaller than 12 AWG for power and lighting circuits.

F. Provide dedicated neutral conductor for each branch phase conductor for 120V and 277V circuits (power and lighting). Multi-pole breakers to comply with NEC 210.4 are not permitted.

G. Use 10 AWG conductors minimum for 20 ampere, 120 volt branch circuits longer than 75 feet (23 m). See General Notes on drawings for additional requirements.

H. Use 10 AWG conductors minimum for 20 ampere, 277 volt branch circuits longer than 200 feet (61 m). See General Notes on drawings for additional requirements.

I. All conductors shall be installed in raceway.

J. Conductor sizes indicated on circuit homeruns or in schedules shall be installed over the entire length of the circuit unless noted otherwise on the drawings or in these specifications.

K. Coordinate all wire sizes with lug sizes on equipment, devices, etc. Provide/install lugs as required to match wire size.

L. Where oversized conductors are called for due to voltage drop, etc., provide/install lugs as required to match conductors, or provide/install splice box, and splice to reduce conductor size to match lug size.

M. For all service entrance feeders (Normal and Emergency Transformers feeding drawout switchgear), provide current limiter at both ends of each phase conductor.

3.2 EXAMINATION

A. Verify that interior of building has been protected from weather.

B. Verify that mechanical work likely to damage wire has been completed.

3.3 PREPARATION

A. Completely and thoroughly swab raceway before installing wire.

3.4 WIRING METHODS

A. Use only building wire, 90° C THHN (dry locations) and THWN-2 (wet or dry locations) for ampacity adjustments purposes, using NEC Section 310.15.

B. Wiring in vicinity of heat producing equipment: Use only XHHW insulation, in raceway.

C. Conductors installed within fluorescent fixture channels shall be Type THHN or XHHW, rated 90 degrees C dry. Conductors for all other light fixtures shall have temperature ratings as required to meet the UL listing of the fixture; however, in no case shall the temperature rating be less than 90 degrees Centigrade. Remove incorrect insulation types in new work.

3.5 INTERFACE WITH OTHER PRODUCTS

A. Identify wire and cable under provisions of Section 26 05 53 Identification for Electrical Systems.

B. Identify each conductor with its circuit number or other designation indicated on Drawings.

C. Identify neutrals with its associated circuit number(s) per NEC Article 210.4(D).

3.6 FIELD QUALITY CONTROL

A. Perform field inspection and testing under provisions of the General Requirements of the Contract Documents and Section 26 08 13 Tests and Performance Verification.

B. Inspect wire for physical damage and proper connection.

C. Measure tightness of bolted connections and compare torque measurements with manufacturer's recommended values.

D. Verify continuity of each branch circuit conductor.

E. Submit “Conductor Insulation Resistance Test” form as required in Section 26 08 13.

3.7 VERTICAL RISERS

A. Provide vertical cable riser supports per Article 300-19 in NFPA 70. These shall be located in accessible pullboxes of adequate size. Provide for adequate structural connection of cable supports to pullbox, which will transfer cable weight to building.

3.8 PULLING

A. No wire shall be pulled until the conduit system is complete from pull point to pull point and major equipment terminating conduits have been fixed in position.

B. Mechanical pulling devices shall not be used on conductors sized #8 and smaller. Pulling means which might damage the raceway shall not be used.

C. Use only powdered soapstone or other pulling lubricant acceptable to the Designer/OAR. Compound or lubricant shall not cause the conductor or insulation to deteriorate.

D. All conductors to be installed in a common raceway shall be pulled together. The manufacturer's recommended pulling tensions shall not be exceeded.

E. Bending radius of insulated wire or cable shall not be less than the minimum recommended by the manufacturer.

F. Where coaxial type conductors are installed, special requirements shall apply as outlined under that specific system detail specifications.

G. Where control or signal circuits with a lower insulation rating enter an enclosure with conductors having a 600 volt or higher insulation rating, a separate wire way will be installed or proper clearance distance will be maintained per NEC.

H. All conductors shall be pulled in conduits by industry approved cable pulling “tuggers” equipment. The use of construction equipment such as fork lifts, tractors and other vehicles will not be allowed. All conductors will be routed and protected by using the proper pulleys and sheaves.

3.9 CONTROL AND SIGNAL CIRCUITS

A. For control and signal circuits above 50 VAC, conductors shall be #14 AWG minimum size, Type XHHW or THHN/THWN as permitted by NFPA 70, within voltage drop limits, increased to #12 AWG as necessary for proper operation.

B. For control and signal circuits 50 VAC and below, conductors, at the Contractor's option, may be #16 AWG, 300 volt rated, PVC insulated, except where specifically noted otherwise in the contract documents.

C. Conductor insulation for fire alarm systems shall be as approved by Code Inspection Authority only. Wire approvals by the Designer/OAR shall not supersede this final approval for conditions of this specific project.

D. Install circuit conductors in conduit.

E. Circuit conductors #8 AWG and larger to be stranded.

3.10 COLOR CODING

A. All power feeders and branch circuits No. 6 and smaller shall be wired with color-coded wire with the same color used for a system throughout the building. Power feeders above No. 6 shall either be fully color-coded or shall have black insulation and be similarly color-coded with tape in all junction boxes and panels. Tape shall completely cover the full length of conductor insulation within the box or panel.

B. Unless otherwise approved or required by DESIGNER to match existing, color-code shall be as follows: Neutrals to be white for 120/208V system, natural grey for 277/480V system; ground wire green, bare or green, insulated ground conductor green with yellow tracer. 120/208V, Phase A - black; Phase B - red; Phase C - blue. 480/277V, Phase A brown; Phase B - orange; Phase C - yellow. All switch legs, other voltage system wiring, control and interlock wiring shall be color-coded other than those above.

3.11 TAPS/SPLICES/CONNECTORS/TERMINATIONS

A. Taps and splices are not acceptable unless specifically noted otherwise on drawings or special written approval is granted by Designer/OAR. (See 3.1K) Submit locations, sizes, etc., where taps will be necessary to coordinate with lug sizes/quantities for review and approval prior to installation.

B. Clean conductor surfaces before installing lugs and connectors.

C. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.

D. Power and lighting conductors shall be continuous and unspliced where located within conduit. Splices shall occur within troughs, wireways, outlet boxes, or equipment enclosures where

sufficient additional room is provided for all splices. No splices shall be made in in-ground pull boxes (without special written approval of OAR).

E. Splices in lighting and power outlet boxes, wireway, and troughs shall be kept to a minimum, pull conductors through to equipment, terminal cabinets, and devices.

F. No splices shall be made in junction box, and outlet boxes (wire No. 8 and larger) without written approval of OAR.

G. No splices shall be made in communications outlet boxes, pull boxes or wireways (i.e., fire alarm, computer, telephone, intercom, sound system, etc.) without written approval of OAR. Pull cables through to equipment cabinets, terminal cabinets and devices.

H. No splices shall be made in circuits of #8 AWG conductors or larger of 1000 feet or less without written approval of the OAR.

I. Allow adequate conductor lengths in all junction boxes, pull boxes and terminal cabinets. All termination of conductors in which conductor is in tension will be rejected and shall be replaced with conductors of adequate length. This requirement shall include the providing by the Contractor of sleeve type vertical cable supports in vertical raceway installations provided in pullboxes at proper vertical spacings.

J. A calibrated torque wrench shall be used for all bolt tightening. A torque mark should be used after torqueing is performed. Torque mark should consist of a permanent mark over the mechanical lug, bolt, nut, etc.

K. Interior Locations:

1. All (non-electronic systems) copper taps and splices in No. 8 or smaller shall be fastened together by means of "Screw-on spring type (wire nut)" connectors. All “Push-in” or “Stab-in” type connectors are prohibited. All taps and splices in wire larger than No. 8 shall be made with compression type connectors approved by OAR and taped to provide insulation equal to wire.

END OF SECTION 26 05 19

SECTION 26 05 26 - GROUNDING AND BONDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification sections apply to this section.

1.2 SUMMARY

A. This section includes the requirements for provision and installation of grounding and bonding.

1.3 DESCRIPTION

A. Provide all labor, materials, and equipment necessary to properly install a grounding system conductor in all new branch wiring and feeder installations that shall be in full compliance with all applicable Codes as approved by the authorities having jurisdiction. The secondary distribution system shall include a grounding conductor in all raceways in addition to the return path of the metallic conduit.

B. In general, all electrical equipment (metallic conduit, motor frames, panelboards, etc.) shall be bonded together with a green insulated or bare copper system grounding conductor in accordance with specific rules of Article 250 of the N.E.C. and State codes. Bonding conductor through the raceway system shall be continuous from main switch ground bus to panel ground bar of each panelboard, and from panel grounding bar of each panelboard to branch circuit equipment and devices.

C. All raceways shall have an insulated copper system ground conductor throughout the entire length of circuit installed with-in conduit in strict accordance with NEC. Grounding conductor shall be included in total conduit fill determining conduit sizes, even though not included or shown on drawings. Grounding conductors run with feeders in PVC conduit outside of building(s) shall be bare only.

D. Section Includes

1. Grounding electrodes and conductors.
2. Equipment grounding conductors.
3. Bonding.
4. Counterpoise System
5. Ground Ring.

1.4 SUBMITTALS

A. Submit catalog cut sheet showing brand and selection for all conductors, test wells, components, etc., as specified herein showing that all materials are UL listed and labeled as applicable and manufactured in the United States.

B. Product data shall prove compliance with Contract Documents, National Electric Code, Underwriters Laboratories, manufacturer's specifications, manufacturer's written installation data and compliance with all performance criteria.

C. Include instructions for storage, handling, protection, examination, preparation, operation and installation of product.

D. Indicate application conditions and limitations of use stipulated by product testing agency specified under regulatory requirements.

E. Show all dimensions, colors, configurations, covers and applicable labeling/stamping.

F. Record actual locations of grounding electrodes on red lined as-built documents.

G. Submit test results of each ground rod. See Section 26 08 13.

1.5 REFERENCES AND REGULATORY REQUIREMENTS

A. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

B. Conform to requirements of ANSI/NFPA 70 - National Electrical Code.

PART 2 - PRODUCTS

2.1 ROD ELECTRODE

A. Material: Copper-clad steel.

B. Diameter: 5/8 inch.

C. Length: 30 feet minimum. Increase lengths as required to achieve specified resistance.

2.2 MECHANICAL CONNECTORS

A. All grounding connectors shall be in accordance with UL 467 and UL listed for use with rods, conductors, reinforcing bars, etc., as appropriate.

B. Connectors and devices used in the grounding systems shall be fabricated of copper or bronze materials, and properly applied for their intended use. Specified items of designated manufacturers indicate required criteria and equal products may be provided if approved. All connectors and devices shall be compatible with the surfaces being bonded and shall not cause galvanic corrosion by dissimilar metals. Materials in items not listed herein shall be of equal quality to the following specified items:

1. Lugs: substantial construction, of cast copper or cast bronze, with "ground" (micro-flat) surfaces equal to Burndy QQA-B Series, two hole, T&B, or approved substitution. Light weight and "competitive" devices shall be rejected.
2. Grounding and Bonding Bushings: Malleable iron, Thomas and Betts (T&B), or approved substitution.

3. Piping Clamps: Burndy "GAR-TC series" with two hole compression lug under U-Bolt nut, or T&B, or approved substitution.
4. Grounding Screw and Pigtail: Raco No. 983 or approved substitution.
5. Fastening hardware: Grade 5 silicone bronze with beveled washers. Copperplate is not acceptable

C. Mechanical lugs or wire terminals shall be used to bond ground wires together or to junction boxes and panel cabinets and shall be manufactured by Anderson, Buchanan, Thomas and Betts Co., or Burndy.

2.3 WIRE

A. Material: Stranded copper.

B. Size: Size to meet NFPA 70 requirements as a minimum, increase size if called for on drawings, in these specifications, or as required for voltage drop.

C. Insulated THWN (or bare as noted elsewhere).

2.4 GROUNDING WELL COMPONENTS

A. Grass Non-Traffic Areas:

1. Well: Minimum 12 inch long by 12 inch wide by 18 inches deep with open.
2. Well Cover: High density plastic, composolite, or cast iron with legend "GROUND" embossed on cover. Added cover shall be secured by Dallas lock or 3/8” or larger stainless steel bolts.
3. Material: Structural Plastic, composolite, or concrete.
4. Manufacturer: Brooks Products 70 Series or equal by Quazite or approved substitution.
5. Increase depth, diameter or size as required to provide proper access at installed location.

B. Paving and Low Traffic Areas:

1. Well: Minimum 12 inch long by 12 inch wide by 18 inches deep with open bottom.
2. Well Cover: Traffic rated for use with "GROUND" embossed on cover.
3. Material: Composolite.
4. Manufacturer: Quazite or approved substitution.
5. Increase depth, diameter or size as required to provide proper access at installed location.

2.5 GROUNDING BARS/GROUND BUS (INCLUDING 'SYSTEMS' GROUND BUS/BARS AND GROUND BUS BARS)

A. Ground bars shall be copper of the size and description as shown on the drawings. If not sized on drawings, bus bar shall be minimum 1/4" x 2" bus grade copper, spaced from wall on insulating 2" polyester molded insulator standoff/supports, and be 12" or greater minimum overall length, allowing 2" length per lug connected thereto. Increase overall length as required to facilitate all lugs required while maintaining 2" spacing. Size of bus bar used in main electrical room shall be similar except minimum of 4" high and 24" long.

B. Provide bolt tapping lug with two hex head mounting bolts for each terminating ground conductor, sized to match conductors. Mount on bus bar at 2 inches on center spacing. Lugs to be manufactured by Burndy, T&B or approved substitution.

C. Bus bar shall have rows of holes in accordance with NEMA Standards for specified lugs.

D. Standoff supports to be 2" polyester as manufactured by Glastic #2015-4C or approved substitution.

PART 3 - EXECUTION

3.1 GENERAL

A. Install products in accordance with manufacturer's instructions.

B. Install grounding electrodes conductor, bonding conductors, ground rods, etc. with all required accessories.

C. Grounding shall meet (or exceed as required to meet these specifications) all the requirements of the N.E.C., the NFPA, and applicable standards of IEEE.

D. Where there is a conflict between these specifications and the above applicable codes or standards, or between this section and other specifications sections then the most stringent or excessive requirement shall govern. Where there is an omission of a code/standard requirement in these specifications then the code/standard requirements shall be complied with.

E. Requirement in these specifications to comply with a specific code/standard article, etc. is not to be construed as deleting of requirements of other applicable codes/standards and their articles, etc.

F. Verify that final backfill and compaction has been completed before driving rod electrodes.

3.2 GROUNDING ELECTRODES

A. All connections shall be exothermic welded unless otherwise noted herein. All connections above grade and in accessible locations may be by exothermic welding or by brasing or clamping with devices UL listed as suitable for use except in locations where exothermic welding is specifically specified in these specifications or called for on drawings.

B. Each rod shall be die stamped with identification of manufacturer and rod length.

C. Install rod electrodes at locations indicated and/or as called for in these specifications.

D. Ground Resistance:

1. Main Electrical Service (to each building and Site) and Generator Locations:

a) Grounding resistance measured at each main service electrode system and at each generator electrode system shall not exceed 5 ohms.

2. Lightning Protection Ground Locations:

a) Lightning Protection system ground locations shall not exceed 5 ohms measured at ground electrode.

3. Site Distribution Counterpoise Ground Locations:

a) Counterpoise system ground locations shall not exceed 25 ohms measured at ground electrode.

4. Other Locations:

a) Resistance to ground of all non-current carrying metal parts shall not exceed 25 ohms measured at motors, panels, busses, cabinets, equipment racks, light poles, transformers, and other equipment.

5. Resistance called for above shall be maximum resistance of each ground electrode prior to connection to grounding electrode conductor. Where ground electrode system being measured consists of two (2) or more ground rod electrodes at each location, then the resistance specified above shall be the maximum resistance with two (2) or more rods connected together but not connected to the grounding electrode conductor.

E. Install additional rod electrodes as required to achieve specified resistance to ground (specified ground resistance is for each ground rod location prior to connection to ground electrode conductor).

F. Provide grounding well with cover at each rod location, with the only exception being a site distribution counterpoise ground rod. Install grounding well top flush with finished grade.

G. Install ground rods not less than 1 foot below grade level and not less than 2 feet from structure foundation.

3.3 GROUND RESISTANCE AT LOCATION OTHER THAN LOCATION OF GROUNDING ELECTRODES.

A. Resistance to ground of all non-current carrying metal parts shall not exceed 25 ohms measured at motors, panels, busses, cabinets, equipment racks, light poles, transformers, and other equipment.

3.4 GROUNDING ELECTRODE CONDUCTOR

A. Conductor shall be sized to meet (or exceed requirements of Contract Documents) the requirements of NEC 250.66.

3.5 EQUIPMENT GROUNDING CONDUCTOR

A. Grounding conductors shall be provided with every circuit to meet (or exceed requirements of Contract Documents) the requirements of NEC 250.122.

B. At every voltage level, new portions of the electrical power distribution system shall be grounded with a dedicated copper conductor which extends from termination back to power source in supply panelboard.

C. Provide separate, insulated (bare if with feeder in PVC conduit) conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.

D. Except as otherwise indicated, each feeder raceway on the load side of the service entrance shall contain a ground conductor sized as indicated and where not shown shall be sized to meet (or exceed requirements of Contract Documents) the requirements of NEC 250.122. Conductor shall be connected to the equipment grounding bus in switchboards and panelboards, to the Grounding Bus in all motor control centers, and as specified, to lighting fixtures, motors and other types of equipment and outlets. The ground shall be in addition to the metallic raceway and shall be connected, using a lug device located within each item enclosure at the point of electric power connections to permit convenient inspection.

E. Provide green insulated ground wire for all grounding type receptacles and for equipment of all voltages. In addition to grounding strap connection to metallic outlet boxes, a supplemental grounding wire and screw equal to Raco No. 983 shall be provided to connect receptacle ground terminal to the box.

F. All plugstrips and metallic surface raceway shall contain a green insulation ground conductor from supply panel ground bus connected to grounding screw on each receptacle in strip and to strip channel. Conductor shall be continuous.

G. Where integral grounding conductor is specified elsewhere in bus duct construction, provide equivalent capacity conductor from supply switchboard or panelboard grounding bus to the bus duct grounding conductor. Bond integral conductor to bus duct enclosure at each tap and each termination.

H. All motors, all heating coil assemblies, and all building equipment requiring flexible connections shall have a green grounding conductor properly connected to the frames and extending continuously inside conduit with circuit conductors to the supply source bus with approved connectors regardless of conduit size or type. This shall include "Equipment by Owner" to which an electric conduit is provided under this Division.

3.6 MAIN ELECTRICAL SERVICE

A. Complete installation shall meet or exceed the requirements of the NEC 250.

B. Artificial electrodes shall be provided for the main service in sufficient number and configuration to secure resistance specified.

C. Provide and bond to all of the following:

1. Ground rods.
2. Metal water pipe.
3. Building metal frame, structural steel or reinforced structural concrete.
4. Encased Electrodes.
5. Ground ring.
6. Site distribution counterpoise ground system.
7. Lightning protection system.

D. A main ground, bare copper conductor, sized per NEC Table 250.66, but in no case less than #2/0, shall be run in conduit from the main switchgear of each building to the building steel in respective building. This ground conductor shall also be run individually from the main switchgear and be bonded to the main water service ahead of any union in pipe and must be

metal pipe of length and location as acceptable by authorities having jurisdiction. Provide properly sized bonding shunt around water meter and/or dielectric unions in the water pipe. Also required is the same size ground wire to ground rod electrode as called for below:

1. Three 30 ft. ground rods in a delta configuration at no less than 30 ft. spacing driven to a minimum depth of 30 feet, one foot below grade.
2. Bond ground rod electrodes together with a bare copper ground conductor that matches size required by NEC Table 250.66, but in no case less than #2/0.
3. Provide additional rod electrodes as required to achieve specified ground resistance.

E. Ground/bond neutral per NEC 250.

F. A main ground, bare copper conductor, sized per applicable Table in NEC 250, but in no case less than #2/0, shall be run in conduit from the main switchgear of each building to a concrete encased electrode per NEC 250.52(3).
   1. For New Buildings: Provide and install and bond to concrete encased electrode in compliance with the NEC.
   2. For Existing Buildings: Bond to existing concrete encased electrode when available.

G. Bond grounding electrodes to site counterpoise grounding system and lightning protection system where provided.

H. Provide and install ground bus bar on wall near main service disconnect/switchboard. Connect to ground bar in disconnect/switchboard bonded to switchboard/disconnect enclosure/neutral with copper grounding conductor sized per NEC Table 250.66.

3.7 TRANSFORMER GROUNDING

A. Ground all transformers and enclosures of 120/208V and 277/480V "separately derived systems" as specified herein.

1. Ground per NEC 250 and these specifications.
2. Bond neutral to transformer frame/enclosure and the equipment grounding conductors of the derived system with copper ground conductor sized per NEC Table 250.66.
3. Connect transformer neutral/ground to grounding electrode per NEC 250.30 with grounding electrode conductor sized per NEC Table 250.66.
4. In addition to connection to grounding electrode conductor called for above, provide supplemental grounding electrode as follows:

   a) Where grounding required per NEC 250.30 is to building steel/structure, supplement this grounding with connection to nearest available effectively grounded metal water pipe.
   b) Where grounding connection required per NEC 250.30 is to grounded metal water pipe, supplement with connection to building steel/structure in addition to any other available electrodes specified in NEC 250.50 and 250.52.
   c) Where supplemental grounding electrodes required above is a ground rod electrode, provide two or more 30 ft. ground rod electrodes at no less than 30 ft. spacing, driven full length into the earth one foot below grade.

5. Where neither building steel nor water pipe grounding electrodes are available (i.e. exterior locations with no available water pipe electrode) provide two (2) ground connections: each

30 ft. ground rod electrodes at not less than 30 ft. spacing, driven full length into the earth one foot below grade.

6. Where transformer is mounted to exterior of building, one (1) of the two (2) ground electrodes required shall be ground rod electrode as called for in 5. above. This ground rod electrode shall also be connected to counterpoise system.

B. Provide additional ground electrodes as required to achieve specified ground resistance.

C. Where two or more ground electrodes are used at any required ground location, they shall be bonded together with a copper ground conductor, sized to meet NEC Table 250.66, but in no case less than #2/0.

D. Complete installation shall meet or exceed the minimum requirements of NEC 250.

E. Equipment ground conductors shall be provided in addition to above grounding. See 'EQUIPMENT GROUNDING CONDUCTOR', NEC 250.122.

F. Provide ground bus bar on wall near transformer (or in associated electrical room for exterior mounted transformers). Connect to ground lug in transformer bonded to transformer enclosure/neutral with copper ground conductor sized per NEC Table 250.66.

G. Multiple separately derived systems may be grounded as allowed in NEC 250.30(A)(4).

3.8 GENERATOR GROUNDING

A. Separately derived systems (i.e. systems where generator neutral is not solidly interconnected to service supplied system neutral such as 4 pole switched neutral transfer switch systems).

1. Ground per NEC 250.20, 250.30, 250.66 and these specifications.
2. Bond neutral to transformer frame/enclosure and the equipment grounding conductors of the derived system with copper ground conductor sized per NEC Table 250.66.
3. Connect generator neutral/ground to grounding electrodes per NEC 250.30 with grounding electrode conductor sized per NEC Table 250.66.
4. In addition, provide supplemental grounding electrode as follows:

    a) Where grounding required per NEC 250.30 is to building steel/structure, supplement with connection to nearest available effectively grounded metal water pipe.
    b) Where grounding connection required per NEC 250.30 is to grounded metal water pipe, grounding with connection to other electrodes specified in NEC 250.50 and 250.52.
    c) Where supplemental grounding electrode required above is a ground rod electrode, provide two or more 30 ft. ground rod electrodes at no less than 30 ft. spacing, driven vertical to a minimum depth of 30 ft. plus 1 foot below grade.

5. Where neither building steel nor water pipe grounding electrodes are available provide two (2) ground connections: each to two (2) or more 30 ft. ground rod electrodes at no less than 30 ft. spacing, driven vertical to a minimum depth of 30 ft. plus 1 foot below grade.
6. Where generator is mounted to exterior of building, one (1) of the two (2) ground electrodes required shall be ground rod electrode as called for in Paragraph 3.8 A.5. This ground rod electrode shall also be connected to counterpoise system.

B. Provide additional ground electrodes as required to achieve specified ground resistance.

C. Where two or more ground electrodes are used at any one required ground location, they shall be bonded together with a copper ground conductor, sized to meet NEC Table 250.66, but in no case less than #2/0.

D. Complete installation shall meet or exceed the minimum requirements of NEC 250.

E. Equipment ground conductors shall be provided in addition to above grounding. See 'EQUIPMENT GROUNDING CONDUCTOR'.

3.9 LIGHTNING PROTECTION SYSTEMS

A. Ground per Section 26 41 13 – Lightning Protection for Structures, NFPA 780, and as specified herein. The most stringent requirements shall govern.

B. Bond lightning protection system grounds to electrical service system ground, and counterpoise system ground where provided.

3.10 EXTERIOR GRADE (OR FREE STANDING ABOVE GROUND) MOUNTED EQUIPMENT

A. General:

1. All equipment mounted exterior to building shall have their enclosures grounded directly to a grounding electrode at the equipment location in addition to the building equipment ground connection.
2. Bond each equipment enclosure, metal rack support, mounting channels, etc. to ground electrode system at each rack with an insulated copper ground conductor sized to match the grounding electrode conductor required by NEC Table 250.66 based on equipment feeder size, but in no case shall conductor be smaller than #6 copper or larger than #2 copper. This connection is in addition to grounding electrode connections required for services.

B. Main electrical service rack mounted equipment.

1. Ground per "MAIN ELECTRICAL SERVICE".
2. Bond all metal parts as noted in this section.

C. Electrical sub service rack mounted equipment.

1. Ground per "MAIN ELECTRICAL SERVICE", except do not bond neutral to ground.
2. Bond all metal parts as noted in this section.

D. Electrical equipment connection rack mounted equipment.

1. Bond all metal parts as noted in this section.

E. Grounding electrodes (ground electrodes system) shall be:

1. Located at each rack location.
2. For service equipment: Ground electrode required per "MAIN ELECTRICAL SERVICE".
3. For equipment connection: Two or more 30 ft. ground rods at no less than 30 ft. spacing, driven vertical to a minimum depth of 30 ft. plus 1 ft. below grade. Bond ground rods together with a size to meet NEC Table 250.66, but no less than a #2 copper ground

conductor. Provide additional rod electrodes as required to achieve specified ground resistance.

F. Complete installation shall meet or exceed the minimum requirements of NEC 250 and, when applicable, NFPA 78.

3.11 ROOF MOUNTED EQUIPMENT

A. Bond all roof mounted electrical equipment to lightning protection system (when provided) per NFPA 780.

3.12 LIGHTING FIXTURES

A. All new and reinstalled fixtures shall be provided with green grounding conductor, solidly connected to unit. Individual fixtures grounds shall be with lug to fixture body, locate at point of electrical connection to the fixture unit.

B. All suspended fixtures and those supplied through flexible metallic conduit shall have green ground conductor from outlet box to fixture. Cord connected fixtures shall contain a separate green ground conductor.

C. Pole Light Fixtures:

1. Metal Pole Light Fixtures:

a) Freestanding pole mounted lighting fixtures shall each have a - Class I or Class II Materials - lightning protection main copper down conductor connected to grounding electrodes at base of pole.
b) Conductor shall be bonded to metal pole via UL Listed ground clamp suitable for use. Locate ground lug opposite to handhole (or adjacent if visible through handhole).

2. Concrete or Non-Metallic Pole:

a) Freestanding pole mounted lighting fixtures shall each have a Class I or Class II lightning protection main copper down conductor connected to grounding electrodes at base of pole.
b) Conductor shall be extended from grounding electrode to top of pole and terminate at the top of pole in a Class I or Class II copper lightning protection air terminal.
c) Each metal part of light fixture assembly, bracket, ballast cabinet, disconnect, transformer, etc. that is mounted to pole shall be bonded to down conductor.

3. Fixtures located on elevated roadway ramps: provide with a connection to lightning counterpoise grounding system.
4. Grounding electrode(s) at each pole shall be bonded to site distribution counterpoise system.
5. Grounding Electrodes:

a) Two or more 30 ft. ground rods at no less than 30 ft. spacing shall be driven full length into the earth one foot below grade.
b) Bond ground rod electrodes together with a Class I or Class II lightning protection main copper conductor.

c) Provide additional rod electrodes as required to achieve specified ground resistance.
d) Two (2) or more grounding rod electrodes shall be installed at each light pole.

6. Installation shall exceed minimum requirements of NFPA 780.

3.13 PULLBOX, MANHOLE, HANDHOLE GROUNDING.

A. One 30 ft. ground rod electrode shall be driven vertically to a minimum depth of 30 ft. plus 1 ft. below grade in each manhole, handhole or pullbox (in ground).

B. The complete installation shall exceed the minimum requirements of the NEC.

C. Provide additional ground rod electrodes as required to provide resistance called for herein.

D. Where more than one ground rod electrode is required bond the two or more ground rod electrodes together with a copper ground conductor as called for under 'Counterpoise System.'

E. Bond to counterpoise system.

F. Bond grounding electrode to all exposed metal parts of manhole, handhole, pullbox (including metal cover) with #6 copper ground conductor. Connect to ground rod electrode with exothermic weld. Connect to metal cover with exothermic weld. Connect to other metal parts with exothermic weld or UL approved grounding clamp. Provide minimum 3 ft. slack ground cable on cover connection to facilitate removal of cover.

3.14 HAZARDOUS LOCATIONS

A. Grounding in hazardous locations shall be done in accordance with applicable portions of Articles 500, 501, 502, 503, 511 and 514 of the National Electrical Code.

3.15 GROUND RING

A. Provide complete underground building perimeter ground ring system, completely encircling building.

B. Install minimum24” depth into earth.

C. Install ground rods (minimum 30 ft. long) every 150 feet section of ground ring conductor.

D. Bond ground ring to building steel every 150 feet of building perimeter, bond to any and all electrical and piping systems that cross the ground ring system, bond to lightning protection down conductors and to any lightning or other earth grounding electrodes that may be present on the premises.

E. Bond to building service and counterpoise ground systems.

3.16 MISCELLANEOUS GROUNDING CONNECTIONS

A. Provide bonding to meet regulatory requirements.

B. Required connections to building steel shall be with UL approved non-reversible crimp type ground lugs exothermically welded to bus bar that is either exothermically welded to steel or bolted to steel in locations where weld will affect the structural properties of the steel.

C. Install grounding conductors to permit shortest and most direct path from equipment to ground; install in conduit; bond to conduit at both ends when conduit is metal; have connections accessible for inspection; and made with approved solderless connectors brazed (or bolted) to the equipment ground; in NO case be a current carrying conductor; have a green jacket unless it is bare copper; be run in conduit with power and branch circuit conductors. The main grounding electrodes conductor shall be exothermically welded to ground rods, water pipe, and building steel.

D. All surfaces to which grounding connections are made shall be thoroughly cleaned to maximum conductive condition immediately before connections are made thereto. Metal rustproofing shall be removed at grounding contact surfaces, for 0 ohms by digital Vm. Exposed bare metal at the termination point shall be painted.

E. All ground connections that are buried or in otherwise inaccessible locations, shall be welded exothermically. The weld shall provide a connection which shall not corrode or loosen and which shall be equal or larger in size than the conductors joined together. The connection shall have the same current carrying capacity as the largest conductor.

F. Install ground bushings on all metal conduits entering enclosures where the continuity of grounding is broken between the conduit and enclosure (i.e. metal conduit stub-up into a motor control center enclosure or at ground bus bar). Provide an appropriately sized bond jumper from the ground bushing to the respective equipment ground bus or ground bus bar.

G. Each feeder metallic conduit shall be bonded at all discontinuities, including at switchboards and all subdistribution and branch circuit panels with conductors in accordance with Table 250.122 of NEC for parallel return with respective interior grounding conductor.

H. Grounding provisions shall include double locknuts on all heavywall conduits.

I. Install grounding bus in all existing panelboards of remodeled areas, for connection of new grounding conductors, connected to an approved ground point.

J. Bond together reinforcing steel and metal accessories in pool and fountain structures and bond to electrical system per NEC.

K. Where reinforced concrete is utilized for building grounding system, proper reinforced bonding shall be provided to secure low resistance to earth with "thermite" type devices, and #10AWG wire ties shall be provided to not less than ten (10) full length rebars which contact the connected rebar. Provide size and length of rod to meet NEC requirements.

3.17 GROUNDING BAR/GROUND BUS (INCLUDING 'SYSTEMS' GROUND BUS/BAR ON GROUND BUS/BAR) INSTALLATION

A. Where indicated on the drawings, provide grounding bar/ground bus (bus bar). Metal sheaths of underground cables are also to be grounded thereto at points of building entrance.

B. Mount bolt tapping lugs with hex head bolts to bus bar at 2" o.c. spacing, one for each ground conductor.

C. Mount bus bar to wall using 2" polyester molded insulator stand-off.

D. Extend a #2/0 (minimum size) or larger THWN insulated copper ground conductor (if larger size is called for on drawings or required by N.E.C. for service ground, etc.) in PVC conduit to approved service ground installation or ground bus/bar in main service equipment enclosure.

E. Extend #6 insulated copper ground wire from respective bus/bar to each 'local' ground bus/bar in each cabinet for system.

F. 'SYSTEMS' grounding bus/bar must be connected with #2/0 insulated copper conductor to grounding electrodes system as defined in NEC "Article 800.40.

3.18 COUNTERPOISE SYSTEM

A. Install counterpoise and ground over all sections of underground ductbanks, conduits, or cables outside (exterior) to building.

B. No. 2 bare stranded copper counterpoise shall be run 6 inches above all underground duct banks, conduits and cables outside (exterior) to building.

C. Provide one counterpoise conductor for ductbanks (or conduit groupings) 12 inches wide or less. Provide two counterpoise conductors above outside edge of ductbank (or conduit groupings) over 12 inches wide.

D. Counterpoise shall run to building and be grounded at each building to the main building electrical service ground rod electrode (exterior to building). Counterpoise shall be bonded to ground rod at all light poles, pullboxes, manholes, handholes and at each building. Provide and install appropriate ground rod every 150 foot length of counterpoise conductor (see "Grounding Electrodes"). Counterpoise conductor shall not be run into interior of building. Route counterpoise underground around exterior perimeter of building to main service ground rod installation.

3.19 TESTING AND REPORTS

A. Raceway Continuity: Metallic raceway system as a component of the facilities ground system shall be tested for electrical continuity. Resistance to ground throughout the system shall not exceed specified limits.

B. Ground resistance measurements shall be made on each system utilized including:

1. Building structural steel.
2. Driven grounding system.
3. Water pipe grounding system.
4. Other approved systems.

C. Ground resistance measurements shall be made in normally dry weather, not less than 24 hours after rainfall, and with the ground under test isolated from other grounds and equipment. Resistances measured shall not exceed specified limits.

D. Upon completion of testing, the testing conditions and results shall be certified by the Contractor and submitted to the Designer as called for in Section 26 08 13 - Test and Performance Verification.

3.20 INTERFACE WITH OTHER PRODUCTS

A. Interface with site grounding system.

B. Interface with lightning protection system installed under Section 26 41 13.

3.21 FIELD QUALITY CONTROL

A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

B. Use suitable test instruments to measure resistance to ground of system. Perform testing in accordance with test instrument manufacturer's recommendations using the fall- of-potential method.

END OF SECTION 26 05 26

SECTION 26 05 29 – HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification sections apply to this section.

1.2 SUMMARY

A. This section includes the requirements for provision and installation of supporting devices.

1.3 DESCRIPTION

A. Furnish and install all supports, anchors, fasteners, hangers and inserts required to mount fixtures, conduit, cables, pullboxes and other equipment furnished under this Division.

1.4 REFERENCES AND REGULATORY REQUIREMENTS

A. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

B. Conform to the requirements of the following:

1. NECA - National Electrical Contractors Association.
2. ANSI/NFPA 70 - National Electrical Code.

1.5 SUBMITTALS

A. Submit catalog cut sheet showing brand of conduit supporting hardware to be used and (where applicable) showing that conduit supporting hardware is UL listed and labeled.

B. Submit catalog cut sheet on all types of conduit support fittings, hardware, straps, and hangers.

C. Product data shall be submitted for approval on:

1. Mounting hardware and inserts.
2. Conduit straps, hangers and fittings.
3. Supporting channel.

D. Product data shall prove compliance with Contract Documents, National Electric Code, National Board of Fire Underwriters, manufacturer's specifications and written installation data.

E. Submit shop drawing showing routing and location of all conduit racking systems. Provide coordination drawings.

PART 2 - PRODUCTS

2.1 PRODUCT REQUIREMENTS

A. Materials and Finishes: Provide corrosion resistance.

B. Provide materials, sizes, and types of anchors, fasteners and supports to carry the loads of equipment and conduit. Consider weight of wire in conduit when selecting products.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Provide anchors, fasteners, and supports in accordance with NECA "Standard of Installation."

C. Do not fasten supports to pipes, ducts, mechanical equipment, and conduit.

D. Do not use spring steel clips and clamps and metal banding straps.

E. Do not fasten supports to sides or bottom of pre-cast structural beams.

F. Obtain permission from Owner before using powder-actuated anchors.

G. Obtain permission from OAR before drilling, or cutting structural members.

H. Fabricate supports from structural steel or steel channel. Rigidly weld members or use hexagon head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.

I. Install surface-mounted cabinets and panelboards with minimum of four anchors.

J. In wet and damp locations use stainless steel channel supports to stand cabinets and panelboards one inch (25) mm) off wall.

K. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.

L. All items shall be supported from the structural portion of the building, except standard ceiling-mounted lighting fixtures. Small devices may be supported from ceiling system where permitted by ceiling system manufacturer, however, no sagging of the ceiling will be permitted. Wire shall not be used as a support. Boxes and conduit shall not be supported or fastened to ceiling suspension wires or to ceiling channels.

M. Lay out and install work in advance of the laying of floors or walls, and provide all sleeves that may be required for openings through floors, walls, or other assemblies. Where plans call for conduit to be run exposed, provide all inserts and clamps for the supporting of conduit.

N. All conduits shall be securely fastened in place on maximum of 8 foot intervals. Hangers, supports or fastenings shall be provided at each elbow and at the end of each straight run

terminating at a box or cabinet. The use of perforated iron for supporting conduits will not be permitted. The required strength of the supporting equipment and size and type of anchors shall be based on the combined weight of conduit, hanger and cables. Horizontal and vertical conduit runs may be supported by one-hole malleable straps, clamp-backs, or other approved devices with suitable bolts, expansion shields (where needed) or beam-clamps for mounting to building structure or special brackets.

O. Where two or more conduits are ran parallel or in a similar direction, they shall be grouped together and supported by means of 1½" x 1½", 12 gauge, pre-galvanized zinc (B-Line or approved substitution), conduit channel trapeze hanger system (racking) consisting of concrete inserts, threaded rods, washers, double nuts for each rod, locknut washers and galvanized "L" angle iron, or Unistrut cross members. Where galvanized "L" angle iron is used, conduits shall be individually fastened to the cross members with malleable iron hangers listed and approved for use on "L" angle iron, bolted with proper size cadmium machine bolts, washers and nuts. Conduits supported to unistrut channel shall be individually fastened with two piece unistrut straps with bolts and nuts listed and approved for such use. Mineralac hangers or one hole type straps fastened to Kindorf racking is not acceptable. Beam clamps shall be malleable iron. All single panelboard, switchboard and motor control center feeder raceway runs shall be supported by means of a trapeze channel hanger support system with provisions for future as specified.

P. All hangers and mounting hardware clamps shall be made of durable material suitable for the application involved. Where excessive corrosive conditions or exterior and damp conditions are encountered, hanger assemblies shall be malleable iron or protected after fabrication by hot dipped galvanizing and where written approval is authorized by the OAR, special paint or other suitable preservative methods may be used.

Q. On concrete or brick construction, an electric or hand drill shall be used for drilling holes for all inserts in brick, concrete or similar construction. In brick, inserts shall be near center of brick, not near edge or in joint. Where steel members occur, same shall be drilled and tapped, and round head machine screws shall be used. All screws, bolts and washers used for supporting conduit or outlets shall be fabricated from rust-resisting metal. Self-tapping power driven fasteners are acceptable on block or brick construction only. Plastic anchors are not acceptable.

R. Spring type conduit clip devices are not acceptable for conduit support.

S. Threaded rod hangers shall be galvanized continuous thread type, minimum 3/8" diameter. Increase size as required to support assembly. Bending of rod hangers is not permitted.

T. Concrete anchors, thread rods, or similar fasteners installed on side or bottom of pre-stressed beams are not acceptable.

U. Group related conduits; support using conduit rack. Construct rack using steel channel in dry locations and galvanized channel or aluminum channel in damp or wet locations (minimum of 24", increase, distance as required for quantity of conduits and spare capacity) provide space on each rack for Building Automation Systems (BAS) raceways and 25 percent additional conduits. Group conduits on channel racking adjacent to each other at one side, allowing all remaining unused space as spare capacity. Spacing between conduits shall not exceed 1" unless written permission is granted by OAR.

V. Each rack shall be provided with minimum of two (2) threaded rod hangers located at the ends of the channel. Increase number of hangers as required to support the assembly.

W. Rack Mounted Equipment: Use channel support system for all rack mounted equipment including all free standing rack mounted equipment. Exterior rack support system to be stainless

steel channel. See details on drawings where available. Exterior units shall be thoroughly inspected after installation.

END OF SECTION 26 05 29

SECTION 26 05 33 - CONDUIT

PART 1- GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification sections apply to this section.

1.2 SUMMARY

A. This section includes the requirements for provision and installation of conduit.

1.3 DESCRIPTION

A. Provide and install all equipment, labor, material, accessories, and mounting hardware for a complete and operating system for the following:
   1. Rigid Metal Conduit (RMC) NEC 344
   2. Aluminum Rigid Metallic conduit (RMC) NEC 344
   3. Intermediate Metal Conduit (IMC) NEC 342
   4. PVC coated Metal Conduit.
   5. Flexible metal conduit (FMC) NEC 348
   6. Liquid tight flexible metal conduit (LFMC) NEC 350
   7. Electrical metallic tubing (EMT) NEC 358
   8. Rigid Polyvinyl Chloride Conduit (PVC) (RNC) NEC 352
   9. Flexible Metal Clad Cable (MC/HCF)
   10. Fittings and conduit bodies.

B. Raceways and conduits shall begin at an acceptable enclosure and terminate only in another such enclosure except conduit/raceway stub-outs.

C. A raceway shall be provided for all electrical power, lighting and electrical systems.

D. Where the Contract Documents refer to the terms "raceway" or "conduit" the materials shall be as listed above in conjunction with NEC 100 definition of "raceway" MC and HCF flexible metal cables shall not be considered a substitute for raceway or conduit.

1.4 SUBMITTALS

A. Submit catalog cut sheet showing brand of conduit to be used and showing that conduit is UL listed and labeled, and manufactured in the United States.

B. Submit catalog cut sheet on all types of conduit bodies, and fittings.

C. Submit product data on:

   1. Conduits.
   2. Fitting entering and leaving the ground or pavement.

3. Expansion/deflection fittings.
4. Coatings.
5. Strap wrenches that will be utilized to minimize damage to conduit finishes.

D. Submit UL listed fire and smoke stopping assemblies for each applicable application. Provide details from UL Fire Directory and manufacturer's corresponding product data and details.

E. Product data shall prove compliance with Specifications, National Electrical Code, National Board of Fire Underwriters, manufacturer's specifications and written installation data.

1.5 PROJECT AS-BUILT DOCUMENTS

A. As-built documents shall accurately record actual routing of conduits.

1.6 REFERENCE AND REGULATORY REQUIREMENTS

A. Furnish products listed and classified by Underwriters Laboratories as suitable for purpose specified and shown.

B. Conform to the following:

1. ANSI/NFPA 70 - National Electrical Code
2. ANSI C80.1 - Electrical Rigid Steel Conduit
3. ANSI C80.3 – Steel Electrical Metallic Tubing
4. ANSI C80.5 – Electrical Rigid Aluminum Conduit
5. ANSI C80.6 – Electrical Intermediate Metal conduit
6. ANSI/UL 651 – Schedule 40, 80, Type EB and A Rigid (PVC Conduit and Fittings)
7. ANSI/NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable Assemblies
8. NECA National Electrical "Installation Standards"
9. ANSI C80.1/NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
10. NEMA TC 2 Electrical Polyvinyl Chloride (PVC) conduit
11. NEMA TC 3 – Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing
12. ANSI/Federal Specification A-A-59544 Cable and Wire, Electrical (Power Fixed Installation)
13. ANSI/Federal Specification J-C-30B – Flexible Metal Cables, Galvanized steel jacket

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

B. Protect PVC conduit from sunlight.

1.8 PROJECT CONDITIONS

A. Verify that field measurements are as shown on Drawings.

B. Verify routing and termination locations of conduit prior to rough-in.

C. Conduit routing is shown on Drawings in approximate locations unless dimensioned. Route as

required to complete wiring system.

PART 2 - PRODUCTS

2.1 GENERAL

A. All conduits shall bear UL label (or other nationally recognized testing agency and shall be manufactured in the United States).

B. Conduit systems and all related fittings, boxes, supports, and hangers must meet all the requirements of national, state, requirements and all related FAA codes and other Federal codes where applicable.

2.2 MINIMUM TRADE SIZE

A. Power/Lighting Homeruns 3/4 inch.

B. Underground Branch Circuits 3/4 inch.

C. Aboveground Power/Lighting Branch Circuits between Devices and Fixtures 1/2 inch.

D. Flexible and Seal-tite metallic conduit 1/2 inch C (maximum 6 feet long).

2.3 RIGID METAL CONDUIT(RMC)

A. Comply with:

1. ANSI C80.1
2. UL 6
3. NEC 344
4. Fed. Specification WW-C-581e

B. Conduit material:

1. Hot galvanized steel.

C. Fittings:

1. Threaded.
2. Insulated bushings shall be used on all rigid metal conduits terminating in panels, boxes, wire gutters, or cabinets, and shall be impact resistant plastic molded in an irregular shape at the top to provide smooth insulating surface at top and inner edge. Material in these bushings must not melt or support flame.
3. Hot galvanized malleable iron or steel.

D. Conduit Bodies:

a) Comply with ANSI/NEMA FB 1
b) Threaded hubs.
c) Hot galvanized malleable iron.

2.4 ALUMINUM RIGID METAL CONDUIT (RMC)

A. Comply with:

1. ANSI C80.5
2. UL 6
3. NEC 344
4. Federal Specification WW-C-540A

B. Conduit material: Aluminum.

C. Fittings:

1. Threaded.
2. Aluminum.
3. Insulated bushings on terminations.

D. Conduit bodies:

1. Comply with ANSI/NEMA FB1
2. Threaded hubs.
3. Aluminum.

2.5 INTERMEDIATE METAL CONDUIT (IMC)

A. Comply with:

1. UL Standard 1242
2. ANSI C80.3
3. NEC 342
4. Fed. Specification WW-C-581e

B. Conduit material: Zinc coated steel.

C. Fittings:

1. Threaded.
2. Zinc plated malleable iron.
3. Insulated bushings on terminations.

D. Conduit bodies:

1. Comply with ANSI/NEMA FB1
2. Threaded hubs.
3. Hot galvanized malleable iron

2.6 PVC COATED METAL CONDUIT

A. Comply with:

1. UL 6
2. NSI C80.1
3. NEC 344
4. NEMA RN 1
5. Fed. Specification WW-C-581E

B. Conduit material: Hot galvanized rigid steel with external PVC coating, 20 mil. thick.

C. Fittings:

1. Threaded.
2. Insulated bushings on terminations.
3. Hot galvanized malleable iron or steel with external PVC coating, 20 mil. thick.

D. Conduit bodies:

1. Comply with:

a) ANSI/NEMA FB 1
b) Threaded hubs
c) Hot galvanized malleable iron.

2.7 FLEXIBLE METAL CONDUIT (FMC)

A. Comply with:

1. NEC 348
2. ANSI/UL 1
3. Fed. Specification WW-C-566

B. Conduit material: Hot galvanized Steel, interlocked.

C. Fittings:

1. ANSI/NEMA FB 1
2. ANSI/UL 514B
3. Malleable iron, zinc plated.
4. Direct flexible conduit bearing set screw type not acceptable.
5. Insulated throat on terminations.
6. Compression EMT to flexible conduit coupling is not acceptable unless special written permission is granted by OAR.
7. Comply also with Fed. Specification W-F-406

2.8 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

A. Comply with:

1. NEC 350
2. ANSI/UL 360

B. Conduit material:

1. Flexible hot galvanized steel core, interlocked.
2. Continuous copper ground, built into core up to 1-1/4 inch size.
3. Extruded polyvinyl gray jacket.

C. Fittings:

1. Threaded for IMC/rigid conduit connections.

2. Approved for hazardous locations where so installed.
3. Provide sealing washer in wet/damp locations.
4. Compression type.
5. ANSI/NEMA FB 1
6. ANSI/UL 514B
7. Hot galvanized malleable iron or steel.
8. Insulated throat on terminations.
9. Comply with Fed. Specification W-F-406.
10. Connections to vibrating equipment and transformers.
    a) Connectors to have wire mesh conduit grip.

2.9 ELECTRICAL METALLIC TUBING (EMT)

A. Comply with:

1. UL 797
2. ANSI C80.3
3. NEC 358
4. ANSI/UL 797
5. Fed. Specification WWC-563

B. Conduit material: Hot Galvanized steel tubing (Electrogalvanized zinc is not acceptable).

C. Fittings:

1. ANSI/NEMA FB 1
2. Compression type.
3. Insulated throat on terminations.
4. Hot galvanized malleable iron or steel.
5. Fed. Specification WF 408

2.10 RIGID POLYVINYL CHLORIDE CONDUIT (PVC) (RNC)

A. Comply with:

1. NEMA TC-2
2. UL 651
3. NEC 352
4. Fed. Specification WC 1094A

B. Conduit material:

1. Shall be high impact PVC - tensile strength 55 PSI, flexural strength 11000 PSI.

C. Fittings:
1. Comply with: NEMA TC-3 and UL 514B

D. General:

1. Shall be UL listed.
2. Fittings and elbows shall be by the same manufacture as conduit.

2.11 FLEXIBLE METAL CLAD CABLE (MC/HCF-90)

A. Comply with:
1. NEC 330
2. NEC 517
3. NEC 250.96
4. ANSI/UL 4
5. ANSI/UL 83
6. UL 1479
7. Federal Specification WC 1094C

B. Cable material:

1. Jacket material:

a) Galvanized Steel, interlocked.

2. Conductor Material:

a) Copper, Solid, THHN.
b) Minimum #12 gauge.
c) Maximum #8 gauge.
d) 90 degree C, 600 volt.
e) Full size insulted grounding conductor, green.
f) Conductor color coding to match system voltage. Comply with Section 26 05 19 Building Wire and Cable, “Color Coding”.

C. Fittings:

1. ANSI/NEMA FB 1
2. ANSI/UL 514B
3. Zinc plated Malleable iron, or steel.
4. Direct flexible conduit bearing set screw type not acceptable.
5. Install insulated bushings or equivalent protection (i.e., anti-short) between core conductors and outer jacket.

2.12 EXPANSION FITTINGS

A. For all exterior locations as defined by the National Electrical Code and these specifications, Expansion/deflection fittings shall be:

1. Listed, hot galvanized inside and outside providing a 4 inch expansion chamber and deflection (where applicable) when used with rigid conduit, intermediate metal conduit and electrical metallic conduit.
2. Expansion fittings shall be UL listed, polyvinyl chloride providing a minimum 6 inch expansion chamber when used with non-metallic conduit (PVC), and shall meet the requirements of and as specified elsewhere for non-metallic conduit.
3. Fittings shall be provided with an external braided grounding and bonding jumper with approved clamps UL Listed for the application.
4. Expansion fittings with an internal bonding jumper that are UL Listed for the application and in compliance with the National Electrical Code may be considered. Submit fitting with manufacturer’s data and UL Listing for approval prior to installation.
5. Expansion/deflection fittings installed in interior/dry locations as defined by the National Electrical Code and these specifications shall comply with all of the above and outside when used with electrical metallic conduit.
6. Where expansion fittings are installed under an expansion joint which is exposed to the

weather from floor above, expansion fittings shall be exterior type.

7. Sleeves intended for use for expansion fittings shall be flagged and inspected by O.A.R. prior to pour to verify size/alignment.

2.13 CONDUIT COATINGS FOR METAL CONDUITS BELOW GRADE

A. Coating shall be an ultra-high build, single-component coal tar mastic for protecting steel subject to aggressive conditions.

B. Coating shall be applied in two coats achieving a minimum dry thickness of 25 mils.

C. Basis of Design:

1. Carboline: Bitumastic 50

2.14 COLD GALVANIZING COMPOUND

A. Coating shall be a coating that provides a dry film with a 93% pure zinc content.

B. Coating shall be applied in two in two light coats a few minutes apart and an additional two light coats after the initial coat has dried.

C. Basis of Design:

1. Rust-Oleum® Stops Rust® Cold Galvanizing Spray

PART 3- EXECUTION

3.1 LOCATION REQUIREMENTS

A. Underground Installations:

1. Use Schedule 40 thickwall nonmetallic conduit only unless local authority having jurisdiction or applicable codes/utility requirements, etc. require rigid steel conduit.
2. Encase conduit in a concrete envelope of not less than 3 inch thickness on all sides and not less than 1-1/2 inches between conduits (where more than one conduit is installed together) for:

a) All conduits installed under roads, taxiways, and runways.

b) All conduits installed for primary electric circuits, main feeders, and data/communications systems (i.e. Telephone, data, parking revenue, radio, flight information, air traffic control systems, security, fiber optic).

3. All conduits or elbows entering or leaving any slab or the ground shall be rigid steel conduit coated with black mastic.
4. Where rigid metallic conduit is installed underground as noted above it shall be coated with waterproofing black mastic before installation, and all joints shall be re-coated after installation.
5. All PVC runs over 100 feet in length shall utilize rigid steel 90 degree elbows at each horizontal change in direction. All PVC risers shall utilize rigid steel 90 degree elbows. Elbows shall be coated with black mastic or PVC coating. Bond all metal elbows per NEC 250.80 and NEC 300.5
6. Underground raceway systems shall conform to all national, state, local and FAA regulations, in general and NEC 300.5

a) Depth of conduits shall be not less than 24 inches with the following exceptions:

1) Conduits installed in concrete floors of buildings to have a minimum concrete cover not less than 2 inches.
2) Conduits passing under taxiways, runways, ramps, holding areas, and docking areas, must be installed below the concrete pour, in the sub base, and shall be encased in not less than 3 inches of concrete, the specifications of which shall meet the same standards required for runways and taxiways except that slump shall be 3 inches to 4 inches.

7. Verify finished lines in areas where raceways will be installed underground before the grading is complete.

B. In Slab, Above or On Grade:

1. Use coated rigid steel conduit, coated intermediate metal conduit (if approved) or thickwall nonmetallic conduit.
2. In slab conduit is permitted only where written consent is granted by Architect and Structural Engineer, regardless of that shown or noted by drawings. Install as directed by Architect/Structural Engineer.

C. Penetration of Slab:

1. Exposed Location:

a) Where penetrating a floor in an exposed location from underground or in slab, a black mastic coated galvanized rigid steel conduit shall be used.

2. Concealed Location:

a) Where penetrating a floor in a location concealed in block wall and acceptable by applicable codes, non-metallic conduit may be used up to first outlet box, provided outlet box is at a maximum height of 40 inches above finished floor.
b) Where penetrating a floor from underground or in slab, a black mastic coated galvanized rigid steel conduit shall be used.

D. Outdoor Location:

1. Above Grade:

a) Where penetrating the finished grade, a coated galvanized rigid steel conduit shall be used.
b) All exterior conduit runs shall be rigid conduit and threaded connectors as specified elsewhere.
c) All areas subject to exterior conditions such as overhangs, galvanized rigid steel conduit shall be used.

2. Roofs:

a) Conduit is not to be installed on roofs, without written authorization by OAR for specific conditions.
b) When approved by written authorization conduit shall comply with the following:

1) Be PVC coated rigid galvanized metal conduit.
2) All fittings, etc. are to be PVC coated.
3) Conduit shall be supported above roof at least 6 inches using approved conduit supporting devices. Refer to applicable roofing specifications.
4) Fasten supports to roof per roofing manufacturer's recommendations.

3. Cooling Towers:

a) Conduit installed at cooling towers shall be PVC coated rigid galvanized conduit.

E. Interior Dry Locations:

1. Concealed:
a.) Use rigid galvanized steel and electrical metallic tubing. Thickwall non-metallic conduit (PVC) may be used inside block walls up to first outlet to a maximum of 40 inches AFF except where prohibited by the NEC.
b.) The use of metal clad cables and HCF-90 armored cables are permitted in very limited applications as specified herein, provided acceptable by the local inspecting authority having jurisdiction and applicable codes and standards. Refer to "Additional Requirements for Metal Clad/Armor HCF-90 Cables" below.

2. Exposed:

a) Use rigid galvanized steel and electrical metallic tubing. EMT may only be used where not subject to damage which is interpreted by this specification in Electrical Rooms, Mechanical Rooms, and Communication Rooms, or where otherwise installed, to be above 96 inch AFF and exiting the top of panelboards, terminal cabinets, and control panels. In Electrical, Mechanical, and Communication Rooms,

Rigid Conduit shall extend 18" above finished floor, before being changed over to EMT.

3. Concealed or exposed flexible conduit:

a) Concealed: Flexible steel conduit or seal tight flexible steel conduit shall be in lengths not longer than 6 feet in length with a ground conductor firmly attached to the terminating fitting at the extreme end of the flex. Direct change over from conduit to flexible conduit is not acceptable unless written permission is granted by OAR or specifically noted on drawings.
b) Exposed: Liquid tight flexible steel conduit shall be used for connections to motors, movable equipment, or vibration equipment (transformers, pumps, AHU's, loading bridges, etc.) as specified herein. Lengths shall not exceed 6 feet in length unless written authorization by OAR for specific conduits is granted. Connections to vibration equipment, motors, etc., shall be made with wire mesh grip fittings as specified herein. Flexible steel conduit is not acceptable in exposed locations. All exposed flexible metal conduit shall be liquid tight.

F. Interior Wet and Damp Locations:

1. Use rigid galvanized steel in interior wet and damp locations. Areas which are subject to direct exterior conditions such as parking garages, open ramp overhangs and areas within 100 feet of building openings, etc., shall be classified "WET EXTERIOR LOCATION." Areas containing equipment requiring wash-down with hose, such as trash compactors, shall be considered a "Wet Interior Location" for all space within four (4) feet of the equipment under eight (8) feet above finished floor (AFF).

G. Concrete Columns or Poured in-place Concrete Wall Locations:

1. Use thickwall non-metallic conduit. Penetration shall be by approved metal raceway (i.e. metal conduit as required elsewhere in these specifications).
2. Locations Near 400 Hz Distribution Systems
3. Metal ferrous conduit or support equipment is not to be installed within 6 inches of any 400 Hz distribution system conduit or wire. Increase distance if so required by 400 Hz system manufacturer.

H. Corrosive Locations:

1. Comply with all codes and standards.
2. Retail Concession Spaces
3. The use of metal clad cable for the wiring of power, lighting, control and signal circuits in these spaces is permitted except where otherwise specified.

3.2 ADDITIONAL REQUIREMENTS FOR RIGID METAL STEEL CONDUIT

A. Rigid metal conduit shall be cut and threaded with tools approved for the purpose and by qualified personnel.

1. Approved pipe vise.
2. Roller/bade type cutter or band saw.
3. Reamer capable of completely removing all ridges or burrs left by the cutter. Reaming with pliers is not acceptable.

B. Hangers shall be installed 8 feet apart.

C. Conduits stubbed through floor slabs, above grade and not contained inside walls, shall be rigid galvanized metallic conduit.

D. One-hole pipe straps shall be malleable iron. Wet location applications shall include malleable iron back clamp spacers.

E. Use of two piece threaded union fittings and rigid set screw fittings are not permitted. Threaded unions may be acceptable where required for special field conditions only when special written permission is granted by OAR.

F. Conduit threads and scratches in galvanizing shall be treated with not less than two coats of zinc rich coating.

3.3 ADDITIONAL REQUIREMENTS FOR INTERMEDIATE METAL CONDUIT (IMC)

A. May be installed only by special written permission.
B. If written approval is received then IMC may be used in locations acceptable by NEC and elsewhere in these specifications, whichever is most stringent.

3.4 ADDITIONAL REQUIREMENTS FOR ELECTRICAL METALLIC TUBING (EMT)

A. Electric metallic tubing (thin wall) may be installed inside buildings above ground floor where not subject to mechanical injury.
B. All cuts shall be reamed smooth and free of sharp and abrasive areas by use of an approved

reamer.

C. Cut conduit square using approved hacksaw with 32 tooth per inch blade; de-burr cut ends. Roller/blade type pipe cutter is not acceptable.
D. One-hole pipe straps, where specified herein, shall be heavy duty type.

3.5 ADDITIONAL REQUIREMENTS FOR ALUMINUM CONDUIT

A. May be used only for 400 Hz electrical distribution system.

3.6 ADDITIONAL REQUIREMENTS FOR FLEXIBLE STEEL CONDUIT AND LIQUID-TITE FLEXIBLE METAL CONDUIT

A. Shall be properly grounded.
B. Shall be installed with approved fittings.
C. Shall be used for final connections to vibrating equipment such as motors, pumps, transformers, etc.
D. Liquid-tight conduit termination connectors at vibration equipment (i.e. pumps, AHU's, motors, moveable equipment, etc.) shall be provided with wire mesh grips.

3.7 ADDITIONAL REQUIREMENTS FOR NON METALLIC CONDUIT (PVC)

A. PVC conduit is not allowed anywhere inside building(s) except underground, in slab, in poured in place concrete, and in block wall up to first outlet box (if not over 40 inches AFF) if allowed by codes. In elevated slabs, conduit is permitted only where written consent is granted by Structural Engineer, regardless of that shown or noted by drawings. Install as directed by Architect/Structural Engineer.

B. 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 20 minutes, minimum.

C. Threads will not be permitted on PVC conduit and fittings, except for rigid steel to PVC couplings.

D. Installation of PVC conduit shall be in accordance with manufacturer's recommendations.

E. PVC conduit shall not be used to support fixture or equipment.

F. Field bends or direction changes shall be by manufactured bends only. Heating with flame and hand held dryers are prohibited.

G. PVC fittings and elbows shall be by same manufacturer as conduit.

3.8 ADDITIONAL REQUIREMENTS FOR METAL CLAD/ARMOR HCF-90 CABLES

A. MC Cable will be allowed to be installed for flexible lighting fixture whips of six (6) feet or less. Where warranted, OAR may approve longer whips. MC Cable may also be installed within interior, dry-location, stud wall partitions between devices. All homeruns shall remain conduit in their entirety.
B. Anti-Short Bushings shall be installed at all MC Cable ends to prevent damage to the conductors and insulation.

C. Cables shall not be used for Life Safety Emergency Branch Circuits (NEC 700) or legally required branch circuits (NEC 701).

D. Connectors and supporting components shall be UL listed for such use.

E. Cut cables with UL listed tolls intended for such use. Ream smooth and free of sharp and abrasive areas. Install bushing between conductors and outer jacket. The use of side cutters, hacksaws or other tools is not acceptable.

F. Maintain minimum 1/2 inch separation between each cable and support per NEC 334. The practice of bundling cables is not acceptable.

G. Support maximum of 1 foot-0 inches from every box, cabinet, etc., secure at intervals not to exceed 5 feet-0 inches.

H. Install parallel and perpendicular to building lines. Required metal stud openings shall be made with an approved stud punch tool.

I. Install metal sleeves where cables pass through rated walls, one sleeve per cable with minimum 2 inches between each. Increase spacing as required per applicable UL fire stopping detail/assembly.

J. Maintain 1 foot of separation between MC Cable and Systems Cables.

K. The use of standard type A/C cables in lieu of MC cables is not permitted unless cable is HCF-90 as specified herein.

L. Attachment of cables to ceiling system is prohibited. Secure cables in strict accordance with NEC 300.11.

M. Attachment of cables to, on, or from mechanical (HVAC) equipment, supports, etc., is not permitted.

N. MC Cable that penetrates drywall must penetrate via a conduit sleeve.

O. Install additional supports as necessary to omit cable sagging.

P. Complete installation shall be in a neat and workmanlike manner to the satisfaction of the OAR per NEC 110.12.

Q. Zigzagging cables through building elements, as method of support is not acceptable.

R. Cable with outer metal sheath damaged by construction elements and/or improper installation shall be replaced at no additional cost to owner.

S. Observe fire-rating requirements for quantity of cables in wall cavities.

T. MC Cable shall not be allowed where exposed to heat or subject to physical damage.

3.9 ADDITIONAL REQUIREMENTS FOR PVC COATED CONDUIT

A. All cuts, pinholes and ends shall be sealed using liquid PVC patch. PVC coated conduit shall be thoroughly inspected after installation to assure all voids, cuts, pinholes or other violation of the integrity of the PVC coating are sealed.

3.10 SUPPORTS

A. Comply with the requirements of Section 26 05 29 Hangers and Supports.
B. Arrange supports to prevent misalignment during wiring installation.

3.11 EXPANSION/DEFLECTION FITTINGS

A. Provide suitable fittings to accommodate expansion and deflection where conduit crosses, control and expansion joints.
B. Expansion fittings shall be installed in the following cases:

1. In each conduit run wherever it crosses an expansion joint in the concrete structure.
2. On one side of joint with its sliding sleeve end flush with joint, and with a length of bonding jumper in expansion/deflection equal to at least three times the normal width of joints.
3. In each conduit run which mechanically attaches to separate structures to relieve strain caused by shift on one structure in relation to the other.
4. In straight conduit run above ground that is more than one hundred feet long and interval between expansion/deflection fittings in such runs shall not be greater than 100 feet.

3.12 GROUNDING

A. All raceways shall have a copper system grounding conductor throughout the entire length of circuit installed within conduit in strict accordance with NEC codes.
B. Grounding conductor shall be included in total conduit fill determining conduit sizes, even though not included or shown on drawings.
C. Grounding conductors run with exterior/ underground feeders shall be bare only.
D. Grounding conductors run with feeders shall be bonded to portions of conduit that are metal by approved ground bushings.
E. See other sections of these specifications for additional requirements.
F. Grounding conductors (including lightning protection down conductors) run in metal conduit shall be bonded to metal conduit at both ends.

3.13 CONDUITS PENETRATING TWO HOUR ASSEMBLIES OR GREATER

A. Conduits with conductors penetrating the wall shall have blow-out patches on each side of the wall.
B. Multiple conduits run through rated walls side by side shall have blow-out patches on each side of the wall.
C. Data or telephone conductors run exposed and penetrating a wall rated 2 hour for fire, smoke or smoke/fire shall be sleeved with steel conduits 30 inches each side of the wall and conduit ends packed with approved fire sealant.

3.14 FIRE AND SMOKE STOPPING

A. Contractor is to provide fire stopping and smoke sealing for all penetrations of existing (or new applicable) fire or smoke assemblies as required to maintain rating of assembly.
B. All penetrations shall be fire stopped in strict accordance with UL Fire Directory. Submit applicable details for acceptance. Prepare and install as delineated by UL detail(s).
C. Each penetration shall be identified with the corresponding UL fire assembly number. Labels shall be typed or computer generated minimum 1/2 inch high black lettering, self-adhesive type.
D. Comply with UL Fire Directory "F" and "T" ratings respectfully.

3.15 FIRE PROTECTION

A. Emergency life safety feeder-circuit wiring shall be installed either in spaces fully protected by an approved automatic fire suppression system or shall be a listed electrical circuit protection system with a 1-hour fire rating. Fire circuit protection shall be in accordance with UL Fire Protection equipment Directory and UL Building Materials Directory (latest edition).

3.16 VERTICAL RACEWAYS

A. Cables in vertical raceways shall be supported per NEC 300.19. Provide supporting devices for cables, including any necessary accessible pull boxes as required regardless if shown on drawings or not. Provide and install access panels as required. Coordinate location of pull box and access panel with designer prior to installation. This includes empty raceways for future use.

3.17 GENERAL

A. Install conduit in accordance with NECA 1-2009 Standard Practice of Good Workmanship in Electrical Contracting" Contractor shall lay out all work prior to rough-in.

B. Utilize strap wrenches to tighten conduits and fittings so as to prevent damage to galvanized finishes.

C. Install nonmetallic conduit in accordance with manufacturer's instructions.

D. Arrange conduit to maintain headroom and present neat appearance.

E. Route conduit installed above accessible ceilings or exposed to view parallel or perpendicular to walls. Do not run from point to point.

F. Route conduit in and under slab from point-to-point.

G. Do not cross conduits in slab.

H. Maintain adequate clearance between conduit and piping.

I. Maintain 12 inch clearance between conduit and surfaces with temperatures exceeding 104 degrees F (40 degrees C).

J. Maintain minimum of 3 inch separation between power and communications raceways. Increase separation if so required to comply with EIA/TIA referenced standards.

K. Systems raceways shall be installed in accordance with ANSI/EIA/TIA Communications Standards.

1. Maintain proper separation between PDS system cables and all power and unshielded cables, as required to prevent noise or crosstalk interference.
2. Raceway bends shall have minimum inside radius of 6 times the internal diameter. Increase bend radius to 10 times for raceway larger than 2 inch size. Provide proper bend for all changes of direction. Pull and splice boxes shall not be used in lieu of a bend.
3. Install raceways so no more than two 90 degree bends are in any raceway section without a pullbox. Install additional pull boxes as required to maintain maximum of two 90 degree bends between pull boxes and

termination points.

4. Install boxes in straight sections of raceway.

L. Cut conduit square using saw or pipecutter; de-burr cut ends.

M. Bring conduit to shoulder of fittings; fasten securely.

N. Use conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp locations and to cast boxes. Use threaded conduit hubs to fasten conduit to sheet metal boxes, disconnects switches and equipment control panels in wet and exterior locations.

O. Install no more than equivalent of three 90-degree bends between boxes for power and lighting systems. Use conduit bodies to make sharp changes in direction, as around beams, Use appropriate boxes and conduit bodies for fire alarm, voice/data and sound/paging systems. Use factory elbows for bends in metal conduit larger than 2- inch size.

P. Avoid moisture traps; provide junction box with drain fitting at low points in conduit system.

Q. Provide pull boxes, junction boxes and fire barrier at fire rated walls as required by NEC 300, whether shown on drawings or not.

R. Provide continuous fiber polyline 1000 lb. minimum tensile strength pull string in each empty conduit except sleeves and nipples. This includes all raceways which do not have furnished conductors. Pull cords must be fastened to prevent accidental removal. A phenolic or brass nameplate shall be attached to each end indicating the location of both ends of conduit as follows: THIS END = "LOCATION," OTHER END = "LOCATION."

S. Use suitable seals to protect installed conduit against entrance of dirt and moisture and insects.

T. Ground and bond conduit under provisions of Section 26 05 26 Grounding and Bonding.

U. Identify conduit under provisions of Section 26 05 53 Identification for Electrical Systems.

V. Install all conduit concealed from view unless specifically shown otherwise on drawings

W. Rigid steel box connections shall be made with double locknuts and bushings.

X. All wire raceways shall be kept clear of plumbing fixtures to facilitate future repair or replacement of said plumbing fixtures without disturbing wire raceways. Except where it is necessary for control purposes, all raceways shall be kept away from items producing heat.

Y. All raceway runs in masonry shall be installed at the same time as the masonry so that no face cutting is required, except to accommodate boxes.

AA. All raceways shall be run from outlet to outlet as shown on the drawings, unless permission is granted, to alter arrangement shown. If permission is granted arrangement shall be marked on red lined As-Built drawings as previously specified.

BB. Spare conduit stubs shall be capped and location and use marked with concrete marker set flush with finish grade. Marker shall be 6" round x 6" deep with appropriate symbol embedded into top to indicate use. Also, tag conduits in panels where originating.

CC. All conduit stubbed above floor shall be strapped to a metal channel supported by conduit driven into ground or tied to steel. Spare conduit stubs shall be capped with a UL listed and approved cap or plug for the specific intended use and identified with ink markers as to source and labeled

"Spare".

DD. All connections to motors or other vibrating equipment including transformers or at other locations where required shall be made with not less than 12" nor more than 36" of flexible liquid-tight steel conduit, with nylon insulated throat connectors and wire mesh grip fittings at both terminations of conduit. Use angle connectors wherever necessary to relieve angle strain on flex conduit.

EE. Provide a conduit sealing fitting or pliable compound wherever conduit system is exposed to widely temperature changes which may cause condensation within the raceway; as from the inside to the outside of coolers orfreezers.

FF. Route conduit through roof openings for piping and ductwork or through suitable roof jack with pitch pocket. Coordinate location with roofing installation specified under other Sections of these specifications.

GG. All raceways shall be run in neat and workmanlike manner per NEC 110.12 and shall be properly installed in accordance with the latest edition of NEC with approved conduit clamps, hanger rods and structural fasteners.

HH. All raceway runs, whether terminated in boxes or not, shall be capped during the course of construction until wires are pulled in, and covers are in place. No conductors shall be pulled into raceways until construction work which might damage the raceways has been completed.

II. Electrical raceways shall be supported independently of all other systems and supports, and shall in every case avoid proximity to other systems which might cause confusion with such systems or might provide a chance of electrolytic actions, contact with live parts or excessive induced heat.

JJ. Raceways, boxes, etc. shall not be attached to an acoustical grid ceiling system or support wire per NEC 300.11. Support all components directly from building structure.

END OF SECTION 26 05 33

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SECTION 26 05 34 - OUTLET BOXES

PART 1- GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification sections apply to this section.

1.2 SUMMARY

A. This section includes the requirements for provision and installation of all boxes used as outlet, device, junction, or outlet.

1.3 DESCRIPTION

A. Provide and install all outlet boxes (flush or surface) complete with all accessories as required to facilitate installation of electrical system and as required by the NEC.

1.4 SUBMITTALS

A. Submit catalog cut sheet/product data on:

1. Outlet and device boxes
2. Junction and pull boxes
3. Surface and flush boxes
4. Surface cast boxes
5. All outlet boxes to be used on project.

1.5 PROJECT AS-BUILT DOCUMENTS

A. Record actual locations and junction boxes not covered in Section 26 05 35 pull and junction boxes (surface, flush mounted). Submit product data showing dimensions, covers, and construction.

1.6 REFERENCES AND REGULATORY REQUIREMENTS

A. Furnish products listed and classified by Underwriters Laboratories as suitable for purpose specified and shown.

B. Conform to the requirements of the following:

1. ANSI/NEMA FB 1 – Fittings, Cast Metal Boxes and Conduit Bodies Supports for Conduit, Electrical Metallic Tubing and Cable Assemblies.
2. ANSI/NEMA OS 1 - Sheet-steel Outlet Boxes, Device Boxes, Covers, and Box Supports.

3. ANSI/NFPA 70 - National Electrical Code.
4. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.7 PROJECT CONDITIONS

A. Verify field measurements are as shown on Drawings.

B. Verify locations of outlets in offices and work areas prior to rough-in.

C. Electrical boxes are shown on Drawings in approximate locations unless dimensioned. Install at location required for box to serve intended purpose.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide box accessories as required for each installation, including mounting brackets, wallboard hangers, extension rings, outlet boxes, and corrosion-resistant knockout closures compatible with outlet boxes being used and meeting requirements of individual wiring situations.

B. All boxes shall be of the size and shape required by NFPA 70 for their respective locations.

C. Boxes shall be of such form and dimensions as to be adapted to the specific use and location, type of device or fixtures to be used, and number and size of conductors and arrangement, size and number of conduits connecting thereto.

D. Handy boxes shall not be used.

E. Outlet Boxes for outlets and devices shall be one-piece drawn boxes.

F. 4 inch x 4 inch boxes and 4 11/16 inch x 4 11/16 inch boxes used as junction boxes shall be one piece drawn boxes.

2.2 SHEET METAL OUTLET BOXES:

A. ANSI/NEMA OS 1, Galvanized Steel.

B. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 1/2 inch (13 mm) male fixture studs where required.

C. Concrete Ceiling Boxes: For concrete location installation, providing fire resistance rating as required.

D. Interior flush outlet boxes shall be galvanized steel constructed with stamped knockouts in back and sides, and threaded holes with screws for securing box coverplates or wiring devices. T & B, Steel City, Raco or approved substitution.

E. Ceiling outlet boxes shall be 4 inch octagonal or 4 inch square X 1 1/2 inch deep or larger as required for number and size of conductors and arrangement, size and number of conduits terminating at them one piece.

F. Switch, wall receptacle, telephone and other recessed wall outlet boxes in drywall shall be 4 inch square X 1 1/2 inch deep one piece. For recessing in exposed masonry, provide one piece 4 inch square x 1 1/2 inch deep wall boxes with appropriate 4 inch square cut tile wall covers Steel City series #52-C-49/52-C-52 or approved substitution. For recessing in furred-out block walls, provide one piece 4 inch square box with required extension for block depth and required extension for drywall depth.

G. For Communication/Systems Telephone, Data, TV, CCTV, Video, and Computer device outlet boxes shall be one piece 4 inch square x 2 1/8 inch deep, minimum. Increase outlet box to 4-11/16 inch with single gang plaster ring as required for special devices respectfully.

2.3 CAST BOXES:

A. NEMA FB 1

B. Interior surface outlet boxes and conduit bodies installed from 0 inch AFF to 90 inch AFF (including fire alarm device backbox) shall be heavy cast aluminum or iron with external threaded hubs for power devices and threaded parts for low voltage devices - Appleton, Crouse Hinds or approved substitution. Trim rings shall also be of one piece construction.

C. Weatherproof outlet boxes shall be constructed of corrosion-resistant cast iron suited to each application and having threaded conduit hubs, cast metal face plate with spring-hinged waterproof cap suitable configured, gasket, and corrosion-proof fasteners.

D. Boxes to be Type FD unless otherwise noted on drawings.

E. Free standing cast boxes are to be type FSY (with flange). Other cast zinc boxes are not acceptable.

PART 3- EXECUTION

3.1 GENERAL

A. Install electrical boxes as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.

B. Install electrical boxes to maintain headroom and to present neat mechanical appearance.

C. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.

D. Above ceiling outlet and junction boxes shall be install to permit readily accessible access from ladder or staging from corresponding floor without the need to extend ladder up through ceiling system to facilitate ease of maintenance.

E. Install boxes to preserve fire resistance rating of partitions and other elements.

F. Align adjacent wall-mounted outlet boxes for switches, thermostats, and similar devices with each other.

G. Outlets for 120V clocks shall be recessed so that the clock will hang flush with the finished surface of the wall.

H. Use flush mounting outlet boxes in finished areas.

I. Do not install flush mounting boxes back-to-back in walls; provide minimum 6 inch separation. Provide minimum 24 inches (one stud space) separation in acoustic and rated walls.

J. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.

K. Use stamped steel bridges to fasten flush mounting outlet box between studs.

L. Install flush mounting box without damaging wall insulation or reducing its effectiveness.

M. Lighting control switches shall be located at the latch side of door. If the drawings indicate otherwise, issue a request for clarification prior to rough-in.

N. Support all outlet boxes from structure with minimum of one 3/8 inch all-thread rod hangers. Boxes larger than 25 square inches shall be supported with two all-thread rod hangers, minimum.

O. Do not fasten boxes to ceiling support wires.

P. Support boxes independently of conduit.

Q. Use gang box where more than one device is mounted together. Do not use sectional box.

R. Use gang box with plaster ring for single device outlets.

S. Comply with applicable portions of the National Electrical Contractors Association (NECA) Standard of Installation.

T. Install outlets in the locations shown on the drawings; however, the OAR shall have the right to make, prior to rough-in, slight changes in locations to reflect room furniture layouts.

U. Coordinate each electrical box so that the type is suitable for the wall or ceiling construction anticipated and suitable fireproofing is built into fire rated assemblies.

V. Relocate electrical boxes as required so that electrical devices, once installed, will be symmetrically located with respect to the room layout.

W. All boxes shall be installed in a flush rigid manner with box lines at perpendicular and parallel angles to finished surfaces. Boxes shall be supported by appropriate hardware selected for the type of surface from which the box shall be supported. For example, provide metal screws for metal, wood screws for wood, and expansion devices for masonry or concrete. No surface mounted boxes will be allowed without OAR approval.

X. For damp and wet locations provide weatherproof boxes and accessories.

Y. As a minimum, provide pull boxes in all raceways over 150 feet long. The pull box shall be located near the midpoint of the raceway length.

Z. Provide knockout closures to cap unused knockout holes where blanks have been removed, and plugs for unused threaded hubs.

AA. Provide conduit locknuts and bushings of the type and size to suit each respective use and installation.

BB. Boxes and conduit bodies shall be located so that all electrical wiring is accessible.

CC. Avoid using round boxes where conduit must enter box through side of box which would result in a difficult and insecure connection with a locknut or bushing on the rounded surface.

DD. All flush outlets shall be mounted so that covers and plates will finish flush with finished surfaces without the use of shims, mats or other devices not submitted or approved for the purpose. Add-a-Depth rings or switch box extension rings (Steel City #SBEX) are not acceptable. Plates shall not support wiring devices. Gang switches with common plate where two or more are indicated in the same location. Wall-mounted devices of different systems (switches, thermostats, etc.) shall be coordinated for symmetry when located near each other on the same wall. Outlets on each side of walls shall have separate boxes. Through-wall type boxes shall not be permitted. Back-to-back mounting shall not be permitted. Trim rings shall be extended to within 1/8 inch of finish wall surface.

EE. Outlet Boxes mounted in metal stud walls, are to be supported to studs with minimum of two self-tapping screws inside, at the back of outlet box, to a horizontal stud brace between vertical studs or pre-manufactured heavy duty box bracket equal to Caddy Corporation # SGB/TSGB series, to prevent movement of outlet box after wall is finished.

FF. All outlet boxes that do not receive devices in this contract are to have blank plates installed matching wiring device plates.

GG. Mount Height.

1. Height of wall outlets to bottom above finished floors shall be as follows, unless specifically noted otherwise, or unless otherwise required by applicable codes including ADA. Verify with the Architectural plans and shop drawings.

    a) Switches: 4'-0" AFF to top
    b) Receptacles: 1'-4" AFF to bottom
    c) Lighting Panels: 6'-6" AFF maximum to centerline of highest breaker/fuse
    d) Phone Outlets: 1'-4" AFF to bottom
    e) ADA Wall Phones: (See part 3.1, Item HH.(4.) below)
    f) Fire Alarm Pull Stations: 4'-0" AFF to top
    g) Fire Alarm Strobe Lights: 80" AFF to bottom of globe or 6" below ceiling to top, whichever is lower

2. Bottoms of outlets and switches above counter tops or base cabinets shall be minimum 2 inch above counter top or backsplash, whichever is highest. Outlets and switches may be raised so that bottom rests on top of concrete block course, but all outlets above counters in same area shall be at the same height. Coordinate outlet locations in relation to all casework shown on Architectural plans, prior to rough-in, regardless of height shown on Electrical drawings.

3. Height of wall-mounted fixtures shall be as shown on the drawings. Fixture outlet boxes shall be equipped with fixture studs when supporting fixtures.
4. Coordinate locations and mounting heights of outlet boxes for all phones with architect, phone system installer and approved shop drawings prior to rough-in. Install as directed, including requirements of ADA. In general, ADA wall phones shall be at a maximum of 54

inch to highest operable part essential to basic operation of telephone with side reach and maximum of 48 inch forward reach as defined by 3.1 HH.1.

HH. Special Purpose Outlets.

1. Locate special purpose outlets as indicated on the drawings for the equipment served. Location and type of outlets shall be coordinated with appropriate trades involved. Coordinate roughing-in locations. Provide plug for each outlet.

II. Outlets in Rated Assemblies and Smoke Barriers.

1. Metallic and approved non-metallic electrical outlet boxes may be installed in vertical fire resistive assemblies or smoke barriers without affecting the classification, provided such openings occur on one side only in each framing space and that openings do not exceed 16 sq. inches.
2. All clearances between such outlet boxes and the gypsum board must be completely filled with joint compound or other approved materials.
3. The wall must be built around outlets of larger size so as not to interfere with the integrity of the wall rating.

3.2 INTERFACE WITH OTHER PRODUCTS

A. Coordinate installation of outlet box for products furnished under all Sections of these specifications.

B. Coordinate locations and sizes of required access doors with applicable sections in these specifications.

C. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.

D. Coordinate mounting heights and locations of outlets mounted above counters, benches and backsplashes.

E. Position outlet boxes to locate luminaires as shown on reflected ceiling plan.

3.3 ADJUSTING

A. Adjust flush-mounting outlets to make front flush with finished wall material.

B. Install knockout closure in unused box opening.

END OF SECTION 26 05 34

SECTION 26 05 35 - PULL AND JUNCTION BOXES

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Provide and install pull and junction boxes as shown on drawings or as required by the NEC.

B. Provide and install pull and junction boxes wherever required for a complete and operating distribution system whether shown on drawings or not.

C. Where outlet boxes are used for pull and/or junction boxes, they shall meet the requirements of Section 26 05 34 Outlet Boxes.

1.3 REFERENCES

A. ANSI/NEMA FB 1 Fittings and Supports for Conduit and Cable Assemblies

B. ANSI/NEMA OS 1 Sheet-steel Outlet Boxes, Device Boxes, Covers, and Box Supports

C. ANSI/NEMA OS 2 Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports

D. ANSI/NFPA 70 National Electrical Code

E. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum)

1.4 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories as suitable for purpose specified and shown.

1.5 SUBMITTALS

A. Submit actual shop drawings of all pull boxes showing:

1. Covers.
2. Dimensions - inside and out.
3. Rating of concrete or gauge of metal.
4. Manufacturer.

1.6 PROJECT RECORD DOCUMENTS

A. Accurately record actual locations and mounting heights of pull and junction boxes.

1.7 PROJECT CONDITIONS

A. Verify field measurements are as shown on Drawings.

B. Verify locations of pull and junction boxes prior to rough-in.

C. Electrical boxes are shown on Drawings in approximate locations unless dimensioned. Install at location required for box to serve intended purpose and to maintain required access.

PART 2 - PRODUCTS

2.1 GENERAL

A. Dimensions of pull and junction boxes shall meet dimensions shown on Drawings or dimensions required by NEC, whichever is largest.

B. Pull and junction boxes shall meet all requirements of UL and NEC.

C. Small pull boxes (i.e. 4" x 4") shall meet the requirements of these Specifications for outlet boxes as a minimum.

D. All boxes (above ground) of 100 cubic inches or more shall be constructed of 14 gauge steel with hot dip galvanized coating.

2.2 SHEET METAL BOXES

A. NEMA OS 1, galvanized steel.

B. Box to be fully weatherproof and watertight where installed outside.

2.3 SURFACE-MOUNTED CAST METAL BOX

A. NEMA 250, Type 4; flat-flanged, surface-mounted junction box.

B. Material: Cast aluminum.

C. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.

D. Provide all hubs as required for conduit connections.

2.4 IN-GROUND PULL BOXES

A. Material: Precast concrete, or composolite.

B. Bottom: Open with 6" of gravel for drainage.

C. Cover: Meet Florida Dept. of Transportation requirements for installed location (pedestrian, heavy traffic, light traffic).

D. Solid sides constructed to facilitate conduit entries.

PART 3- EXECUTION

3.1 GENERAL

A. Install per NEC.

B. Install electrical boxes as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.

C. Install electrical boxes to maintain headroom and to present neat mechanical appearance.

D. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.

E. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6” from ceiling access panel or from removable recessed luminaire.

F. Install boxes to preserve fire resistance rating of partitions and other elements.

G. Align adjacent wall-mounted boxes with each other.

H. Use flush mounting boxes in finished areas.

I. Do not install flush mounting boxes back-to-back in walls; provide minimum 6” separation. Provide minimum 24” separation in acoustic rated walls.

J. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.

K. Install flush mounting box without damaging wall insulation or reducing its effectiveness.

L. Pull and junction boxes larger than 25 square inches shall be supported with two 3/8" all-thread rod hangers minimum.

M. Pull and junction boxes used for Systems Divisions 27, 28 larger than 25 square inches shall be hinged cover type.

N. Do not fasten boxes to ceiling support wires.

O. Support boxes independently of conduit.

P. Large Pull Boxes:

1. Boxes larger than 100 cubic inches in volume or 12” in any dimension:

a) Interior dry locations per NEC with screw covers.

b) Other locations use hinged enclosure under provisions of Section 26 27 16 Cabinets and Enclosures.

Q. Outdoor Locations: All boxes installed outdoors to be NEMA 4, fully weatherproof and watertight.

3.2 IN-GROUND PULL BOXES

A. Provide and install ground rod in each pull box. Connect #2 copper ground wires (counterpoise) to ground rod, run out pullbox 6" over conduits to next pull box; tie to respective building electrical ground rod at each building.

B. Install pull boxes flush with finished grade. Provide extensions as required.

3.3 INTERFACE WITH OTHER PRODUCTS

A. Coordinate locations and sizes of required access doors with applicable sections in these Specifications.

B. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.

3.4 ADJUSTING

A. Install knockout closure in unused box opening.

END OF SECTION 26 05 35

SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1- GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification sections apply to this section.

1.2 SUMMARY

A. This section includes the requirements for provision and installation of identification for electrical equipment.

1.3 DESCRIPTION

A. Provide and install all equipment, labor and material for a complete identification system, including but not limited to:

1. Nameplates and labels.
2. Wire and cable markers.
3. Conduit markers.
4. Identify all new and existing conduits, boxes, equipment, etc. as specified herein.

1.4 REFERENCES AND REGULATORY REQUIREMENTS

A. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

B. Conform to the requirements of the following:

1. ANSI/NFPA 70 - National Electrical Code.
2. Americans with Disabilities Act – 1990

1.5 ACTION SUBMITTALS

A. Sustainable Design Documentation Submittals: Refer to section 01 8113.14 “Sustainable Design Requirements – LEED V4 BD+C”.

1. Product Data: Documentation for Low Emitting Materials
   a) Low Emitting Materials for Paints and Coatings
   b) Low Emitting Materials for Adhesives and Sealants

PART 2 - PRODUCTS

2.1 NAMEPLATES

A. Nameplates for Life Safety Branch Power shall be laminated red phenolic plastic with chamfered edges and white engraved lettering. Orange phenolic plastic border to be added around nameplate to denote branch.

B. Nameplates for Critical (Legally Required) Branch Power shall be laminated red phenolic plastic with chamfered edges and white engraved lettering. Green phenolic plastic border to be added around nameplate to denote branch.

C. Nameplates for Security Branch Power shall be laminated red phenolic plastic with chamfered edges and white engraved lettering. Purple phenolic plastic border to be added around nameplate to denote branch.

D. Nameplates for Equipment Branch Power shall be laminated red phenolic plastic with chamfered edges and white engraved lettering. Blue phenolic plastic border to be added around nameplate to denote branch.

E. Nameplates for Normal Branch Power shall be laminated black phenolic plastic with chamfered edges and white engraved lettering.

F. Letter Size:

1. 1/8 inch for identifying individual equipment and loads.
2. 1/4 inch for identifying grouped equipment and loads.

G. Nameplates shall adequately describe the function of the particular equipment involved. Where nameplates are detailed on the drawings, inscription and size of letters shall be as shown and shop drawing submitted for approval. Nameplates for panelboards and switchboards shall include the panel designation, voltage and phase of the supply. For example, "Panel A, 120/208V, 3-phase, 4-wire". In addition, provide phenolic label in panel to describe where the panel is fed from. For example, "Fed from MDP-1:3:5". The name of the machine on the nameplates for a particular machine shall be the same as the one used on all motor starters, disconnect and P.B. station nameplates for that machine.

H. The following items shall be equipped with nameplates: All motors, motor starters, motor-control centers, push-button stations, control panels, time switches, disconnect switches, transformers, panelboards, circuit breakers (i.e., all 2 pole, 3 pole C.B.'s), contactors or relays in separate enclosures, power receptacles where the nominal voltage between any pair of contacts is greater than 150V, wall switches controlling outlets that are not located within sight of the controlling switch, high voltage boxes and cabinets, large electrical, and electrical systems junction and pull boxes (larger than 4 11/16"), terminal cabinets, terminal boards, and equipment racks. Nameplates shall also describe the associated panel and circuit number (if applicable).

I. All Electrical System panels, transfer switches, etc. shall be labeled per branch, i.e.: "Panel ABC-Life Safety Branch" (similar for critical or equipment branch).

J. All receptacles shall be clearly labeled with panel/circuit designation.

K. All junction/pull boxes shall receive phenolic labels clearly labeling circuitry/cabling/etc., within.

2.2 WIRE MARKERS

A. Description: Cloth, tape, split sleeve, or tubing type wire markers.

B. Locations: Each conductor at panelboard gutters, pull boxes, outlet and junction boxes, and each load connection.

C. Legend:

1. Power and Lighting Circuits: Branch circuit or feeder number indicated on drawings including neutral conductor.
2. Low voltage circuits (circuits under 120V):

D. Control wire number indicated on schematic and interconnection diagrams on shop drawings.

2.3 CONDUIT/JUNCTION BOX COLOR CODE

A. All conduit system junction boxes (except those subject to view in public areas) shall be color coded as listed below:

Color Code for Junction Boxes	Krylon Paint Number
System Emergency 277/480 volt	Cherry Red K02101
System Emergency 120/208 volt	Zinger Pink S01150
Fire Alarm	Popsicle Orange K02410
Normal Power 277/480 Volt	Leather Brown K02501
Normal Power 120/208 Volt	Glossy Black K01601
Fiber Optics	Plum Purple K01929
Sound System	Daisy Yellow K01813
Clock	Light Blue S01540
Intercom	True Blue K01910
PDS/WIFI	Gold K01701
TV	Glossy White K01501
BAS	Cameo White K04129
FIDS/BIDS	Saddle Tan K03554
Security/CCTV	John Deer Green K01817
Telephone	Clover Green K02012
Grounding	Fluorescent Green K03106
Access Control System	John Deer Green K01817
Lightning Detection & Notification	Global Blue K03546
Elevator Status	Georgia Clay K03531
800 Mhz Radio	Copper Metallic K02203
FCIC	Clover Green K02012
Positron	Clover Green K02012
DC Controls	Clover Green K02012
Duress	Fresh Salmon K03536

Fire Pump Status	Popsicle Orange K02410
Emergency Generator Status	Zinger Pink S01150

B. Conduits (not subject to public view) longer than 20 feet shall be painted with above color paint band 20 ft. on center. Paint band shall be 4" in length. Where conduit are parallel and on conduit racking, the paint bands shall be evenly aligned. Paint shall be neatly applied and uniformed. Paint boxes and raceways prior to installation or tape conduits and surrounding surfaces to avoid overspray. Paint overspray shall be removed.

C. Emergency (Backed by Generator). Conduit shall be painted red 20 ft. on center. Paint band shall be 4” in length. A smaller band, 1” in length, centered over the 4” red band shall be applied to denote Emergency Branch as follows:

Emergency Branch	Color Band
Life Safety	Orange
Critical	Green
Security	Purple
Equipment	Blue

D. Junction boxes and conduit located in public areas (i.e. areas that can be seen by the public) shall be painted to match surface attached to. Provide written request to DESIGNER for interpretation of those public areas which may be in question.

E. Where two colors apply to the same raceway, paint on opposite corners leaving room for panel/ckt./system/etc., labeling in center.

F. The Contractor may utilize conduit banding tape instead of paint, on interior conduits only, where specified colors are available. Surface of conduits shall be thoroughly cleaned prior to tape application, and tape shall be applied in a neat and workmanlike manner. Tape to be manufactured by Seton Identification Products only.

2.4 CONDUIT/JUNCTION BOX MARKER

A. All new and existing junction boxes/cover plates for power, lighting and systems (except those installed in public areas) shall adequately identify its associated systems panel and circuit number. Identification shall be by means of black permanent marker. (Paint one-half cover plate with appropriate color above, and one-half with associated panel/circuit or system as described above.)

2.5 DEVICE COVER PLATE IDENTIFICATION

A. Description: Self-adhesive clear printed labels with Black typed letters (pre-printed, dot matrix, or laser).

B. Locations:

1. Each new receptacle cover plate.
2. Each existing receptacle cover plate in areas of remodel/renovation.

C. Legend:

1. Receptacle plates shall adequately describe its associated panelboard and circuit reference.
2. System plates shall adequately describe its terminal board, or terminal cabinet, termination cable identifier and assigned user code number.

2.6 UNDERGROUND WARNING TAPE

A. Description: 6 inch wide plastic tape, detectable type, colored red with suitable warning legend describing buried electrical lines, one strip per 24" of duct.

PART 3 - EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive nameplates and labels.

3.2 APPLICATION

A. Install nameplate parallel to equipment lines.

B. Secure nameplate to equipment front using stainless steel pop rivets.

C. Secure nameplate to inside surface of door on panelboard that is recessed in finished locations.

D. Nameplates installed inside on dead front cover shall be self adhesive tape. (Do not drill or install screws in dead front.)

E. Identify new and existing conduit, junction boxes, and outlet boxes using field painting.

F. Identify new underground conduits using underground warning tape. Install one tape per 24 inches of trench at 3 inches below finished grade.

G. Install wire markers at all new and existing connections and terminations.

END OF SECTION 26 05 53

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SECTION 26 05 73 – POWER SYSTEMS STUDY WITH ARC FLASH ANALYSIS

PART 1- GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification sections apply to this section.

1.2 SCOPE

A. The Contractor shall perform an Arc Flash Analysis per IEEE Standard 1584-2002 equations, as presented in NFPA 70E – Standard for Electrical Safety in Workplace- 2009 Annex D.

B. The Contractor shall perform a short-circuit analysis per ANSI Standard C37 and IEEE Standard 141-1993 (Red Book) for each electrical component as defined in Section A.

C. The Contractor shall perform a Coordination Study per IEEE 242-2001 “Buff” to determine proper overcurrent device settings for selective coordination.

D. The scope of the above studies shall include all distribution equipment/wiring being provided under this project, as well as all existing equipment/wiring back to both the normal (utility) source and the emergency (generator) source, where applicable.

1.3 DESCRIPTION

A. Provide all labor, materials, and equipment necessary to properly and completely perform a Power Systems Study for the electrical distribution and control equipment and submit results in a report.

B. Electrical distribution and control equipment is to include all equipment installed under this contract and all existing equipment that this project is connecting to, complete from new equipment to existing power company transformer(s) via all applicable existing power distribution and control equipment.

C. Provide an up to date electrical system single-line diagram as required by NFPA 70E, “Standard for Electrical Safety in the Workplace,” as referenced in OSHA 29 CFR 1910 Subpart S, Appendix A. This information shall include nameplate data for electrical components (e.g. transformers, medium voltage switchgear, panelboards, switchboards, motor control centers, etc.) for all portions of the electrical system from the utility intertie through the lowest rated panel or piece of equipment.

D. Cable sizes, types and lengths between electrical equipment components and up to date utility source data shall be provided for an accurate single-line representation of the electrical system. Unique characteristics of the equipment installation shall be provided which may impact the magnitude of the potential hazard (e.g. open space versus enclosure). Overcurrent device settings shall be verified.

E. Data collection may require removal of barriers, opening of front panels, etc. while equipment is energized. The Contractor must provide proof (written documentation) that its employees working on the premises of the Landside Building have been properly trained in the use and application of personal protective equipment (PPE) and the hazards of working on or near energized equipment. The Contractor must provide its own PPE protection with a minimum arc thermal performance rating (ATPV) of 40 calories/cm2.

F. The contractor shall be responsible for obtaining all required data of all equipment.

G. The study shall verify adequacy of all equipment implemented under these specifications and to verify the correct application of circuit protective devices and other system components specified completely coordinated with the existing system.

H. A comprehensive analysis of the electrical system shall be performed for all equipment up to 480 volts and by a 125kVA or larger transformer based on the up to date single-line diagram provided from “Section A”. This analysis shall include the following:

1. Short Circuit Study – A short circuit analysis shall be performed in accordance with ANSI standard C37 and IEEE standard 141-1993 (Red Book) for each electrical component as defined in “Section A. “
2. Coordination Study – A coordination study shall be performed in accordance with IEEE 242-2001 “Buff” to determine the proper overcurrent device settings that will balance system reliability through selective coordination while minimizing the magnitude of an electrical arc flash hazard incident.
3. Incident Energy Study – An incident energy study shall be done in accordance with the IEEE 1584-2004a, ”IEEE Guide for Performing Arc Flash Hazard Calculations” as referenced in NFPA 70, “Standard for Electrical Safety in the Workplace”, latest revision, in order to quantify the hazard for selection of personal protective equipment (PPE). Tables that assume fault current levels and clearing time for proper PPE selection are not acceptable.

I. Reconcile arc flash protective device setting recommendations with the protective device time-current coordination study.

J. Adjust the System Design to optimize the results of the study as it relates to safety and reliable electrical system operation (e.g. overcurrent device settings, working distances, current limiting devices). This includes mitigation, where possible, of incident energy levels that exceed 40 calories/cm2. A qualified engineer with power systems design experience shall provide this assistance

K. The intent /goal of the protective system included herein is to establish arc flash levels that result in PPE levels of Category 2 or less.

L. Identify locations where Category 2 cannot be achieved.

M. The study shall address the case when the system is being powered from the normal source as well as from the on-site generating source.

N. Minimum as well as maximum possible fault conditions shall be covered in the study.

O. Fault conditions of all motors shall be considered.

1.4 REFERENCES

A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems
2. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
3. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis
4. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings
5. IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems.
6. IEEE 1584 - Guide for Performing Arc-Flash Hazard Calculations

B. American National Standards Institute (ANSI):

1. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
2. ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures
3. ANSI C37.010 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis
4. ANSI C 37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories.

C. The National Fire Protection Association (NFPA)

1. NFPA 70 - National Electrical Code, latest edition
2. NFPA 70E – Standard for Electrical Safety in the Workplace

1.5 SUBMITTALS FOR REVIEW/APPROVAL

A. The short-circuit and protective device coordination results shall be submitted prior to receiving final approval of the distribution equipment shop drawings and prior to release of equipment drawings for manufacturing. This preliminary submittal of study data shall be sufficient to ensure that the selection of device and characteristics will be satisfactory.

B. SUBMITTALS FOR CONSTRUCTION

C. The results of the short-circuit, protective device coordination and arc flash hazard analysis studies shall be summarized in a final report. For large system studies, submittals requiring more than five (5) copies of the report will be provided without the section containing the computer printout of the short-circuit input and output data. Additional copies of the short-circuit input and output data, where required, shall be provided on CD in PDF format.

D. For large system studies with more than 200 bus locations, the contractor is required to provide the study project files to the Owner in electronic format. In addition, a copy of the computer analysis software viewer program is required to accompany the electronic project files, to allow the Owner to review all aspects of the project and print arc flash labels, oneline diagrams, etc.

E. The report shall include the following sections:

1. Executive Summary.
2. Descriptions, purpose, basis and scope of the study
3. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties
4. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip unit settings, fuse selection
5. Fault current calculations including a definition of terms and guide for interpretation of the computer printout
6. Details of the incident energy and flash protection boundary calculations
7. Recommendations for system improvements, where needed
8. One-line diagram

F. Arc flash labels shall be provided in hard copy and label images shall be provided in electronic format. Vinyl arc flash labels shall be placed on all pieces of equipment. Separate vinyl label shall show available fault current, date of calculation, and contact information for all panels/ switchboards.

G. Report shall include:

1. Available fault current at each equipment location with comparison to equipment rating
2. Overcurrent device settings (e.g. pick-up, time delay, curve), “as found” and “as recommended”
3. Incident energy level (calories/cm2) for each equipment location and recommended PPE
4. Overcurrent device coordination curves including related section of the single-line diagram
5. List of prohibited energized work locations based on arc flash results.

1.6 QUALIFICATIONS

A. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the supervision and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies.

B. The Registered Professional Electrical Engineer shall be a full-time employee of the equipment manufacturer or an approved engineering firm.

C. The Registered Professional Electrical Engineer shall have a minimum of five (5) years of experience in performing power system studies.

D. The equipment manufacturer or approved engineering firm shall demonstrate experience with Arc Flash Hazard Analysis by submitting names of at least ten actual arc flash hazard analysis it has performed in the past year.

1.7 COMPUTER ANALYSIS SOFTWARE

A. The studies shall be performed using the latest revision of the SKM Systems Analysis Power*Tools for Windows (PTW) software program or prior approved equal.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 STUDIES

A. Contractor to furnish short-circuit and protective device coordination studies as prepared by equipment manufacturer or an approved engineering firm.

B. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E - Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D.

3.2 DATA COLLECTION

A. Contractor shall furnish all data as required by the power system studies. The Engineer performing the short-circuit, protective device coordination and arc flash hazard analysis studies shall furnish the Contractor with a listing of required data after award of the contract. The Contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.

B. Source combination shall include present and future motors and generators.

C. Load data utilized may include existing and proposed loads obtained from Contract Documents provided by Owner, or Contractor when available.

D. Include fault contribution of existing motors in the study. The Contractor shall obtain required existing equipment data, if necessary, to satisfy the study requirements.

3.3 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY

A. Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE Standard 141-1993.

B. Minimum transformer design impedances shall be used when test impedances are not available.

C. Provide the following:

1. Calculation methods and assumptions
2. Selected base per unit quantities
3. One-line diagram of the system being evaluated
4. Source impedance data, including electric utility system and motor fault contribution characteristics
5. Tabulations of calculated quantities
6. Results, conclusions, and recommendations.

D. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each:

1. Electric utility’s supply termination point

2. Incoming switchgear
3. Unit substation primary and secondary terminals
4. Low voltage switchgear
5. Motor control centers
6. Standby generators and automatic transfer switches
7. Branch circuit panelboards
8. Other significant locations throughout the system.

E. 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.

F. 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. Notify Owner in writing, of existing, circuit protective devices improperly rated for the calculated available fault current.

3.4 PROTECTIVE DEVICE COORDINATION STUDY

A. Proposed protective device coordination time-current curves (TCC) shall be displayed on log-log scale graphs.

B. Include on each TCC graph, a complete title and one-line diagram with legend identifying the specific portion of the system covered.

C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.

D. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

E. Plot the following characteristics on the TCC graphs, where applicable:

1. Electric utility’s overcurrent protective device
2. Medium voltage equipment overcurrent relays
3. Medium and low voltage fuses including manufacturer’s minimum melt, total clearing, tolerance, and damage bands
4. Low voltage equipment circuit breaker trip devices, including manufacturer’s tolerance bands
5. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves
6. Conductor damage curves
7. Ground fault protective devices, as applicable
8. Pertinent motor starting characteristics and motor damage points, where applicable
9. Pertinent generator short-circuit decrement curve and generator damage point
10. The largest feeder circuit breaker in each motor control center and applicable panelboard.

F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

3.5 ARC FLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed according to the IEEE Std. 1584-2002 equations that are presented in NFPA70E-2009, Annex D.

B. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.

C. The Arc-Flash Hazard Analysis shall include all significant locations in 240 volt and 208 volt systems fed from transformers equal to or greater than 125 kVA where work could be performed on energized parts.

D. Safe working distances shall be based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm2.

E. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations

F. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable.

G. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:

1. Fault contribution from induction motors should not be considered beyond 3-5 cycles.
2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g. contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).

H. For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location),

calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.

I. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.

J. Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.

K. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE Std. 1584-2002 section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

3.6 REPORT SECTIONS

A. Input data shall include, but not be limited to the following:

1. Feeder input data including feeder type (cable or bus), size, length, number per phase, conduit type (magnetic or non-magnetic) and conductor material (copper or aluminum).
2. Transformer input data, including winding connections, secondary neutral-ground connection, primary and secondary voltage ratings, kVA rating, impedance, % taps and phase shift.
3. Reactor data, including voltage rating, and impedance.
4. Generation contribution data, (synchronous generators and Utility), including short-circuit reactance (X'd), rated MVA, rated voltage, three-phase and single line-ground contribution (for Utility sources) and X/R ratio.
5. Motor contribution data (induction motors and synchronous motors), including short-circuit reactance, rated horsepower or kVA, rated voltage, and X/R ratio.

B. Short-Circuit Output Data shall include, but not be limited to the following reports:

1. Low Voltage Fault Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:

    a) Voltage
    b) Calculated fault current magnitude and angle
    c) Fault point X/R ratio
    d) Equivalent impedance

2. Momentary Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable 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

e) Equivalent impedance

3. Interrupting Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable 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

C. Recommended Protective Device Settings:

1. Phase and Ground Relays:

a) Current transformer ratio
b) Current setting
c) Time setting
d) Instantaneous setting
e) Recommendations on improved relaying systems, if applicable.

2. Circuit Breakers:

a) Adjustable pickups and time delays (long time, short time, ground)
b) Adjustable time-current characteristic
c) Adjustable instantaneous pickup
d) Recommendations on improved trip systems, if applicable.

D. 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. Working distance
6. Incident energy
7. Hazard risk category
8. Recommendations for arc flash energy reduction

3.7 FIELD ADJUSTMENT

A. Adjust relay and protective device settings according to the recommended settings table provided by the coordination study. Field adjustments to be completed by the contractor and/or electrical equipment manufacturer's field service personnel.

B. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.

C. Notify Owner in writing of any required major equipment modifications.

3.8 ARC FLASH WARNING LABELS

A. The contractor of the Arc Flash Hazard Analysis shall provide a 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each work location analyzed.

B. All labels will be based on recommended overcurrent device settings and will be provided after the results of the analysis have been presented to the owner and after any system changes, upgrades or modifications have been incorporated in the system.

C. The label shall include the following information, at a minimum:

1. Location designation
2. Nominal voltage
3. Flash protection boundary
4. Incident energy or energy range corresponding to reported Hazard risk category.
5. Working distance
6. Engineering report number, revision number and issue date.

D. Labels shall be machine printed, with no field markings.

E. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.

1. For each 600, 480 and applicable 208 volt panelboard, at least one arc flash label shall be provided.
2. For each motor control center, one arc flash label shall be provided.
3. For each switchboard, one arc flash label shall be provided.
4. For each main switchboard with Utility Service, one flash label shall be provided for each section.

F. Labels shall be field installed by the contractor.

3.9 ARC FLASH TRAINING

A. The contractor of the Arc Flash Hazard Analysis shall train the owner's qualified electrical personnel of the potential arc flash hazards associated with working on energized equipment

(minimum of 4 hours). The training shall be certified for continuing education units (CEUs) by the International Association for Continuing Education Training (IACET) or equivalent.

END OF SECTION 26 05 73

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SECTION 26 05 83 - WIRING DEVICES

PART 1- GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification sections apply to this section.

1.2 SUMMARY

A. This section includes the requirements for provision and installation of wiring devices.

1.3 DESCRIPTION

A. Provide and install all equipment, labor, material, accessories, and mounting hardware for a complete and operating system for thefollowing:

1. Wall switches.
2. Wall dimmers.
3. Receptacles.
4. Device plates and decorative boxcovers.

1.4 SUBMITTALS

A. Submit Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations including all types of wiring devices, plates and engraving.

B. Submit Manufacturer's Instructions:

1. Indicate application conditions and limitations of use stipulated by product testing agency specified under regulatoryrequirements.
2. Include instructions for storage, handling, protection, examination, preparation, operation and installation of product.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years experience.

1.6 REFERENCES AND REGULATORYREQUIREMENTS

A. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

B. Conform to the requirements of thefollowing:

1. ANSI/NFPA 70 - National Electrical Code
2. NEMA WD 1 - General Color Requirements for Wiring Devices.
3. NEMA WD 6 - Wiring Devices Dimensional Specifications.
4. UL 20 - General Use Snap Switches
5. UL 498 - Standard For Attachment Plugs and Receptacles
6. UL 1472 - Solid State Dimming Controls

1.7 EXTRA MATERIALS

A. Provide a minimum of two (2) screw drivers of each type of tamper proof screw used on project. Turn over to OAR. Include receipt in O&M manual.

PART 2 - PRODUCTS

2.1 GENERAL

A. All devices shall be Specification Grade as minimum.

B. General and Special purpose wiring devices shall meet NEMA standard WD 1 and WD 6.

C. All wiring devices shall bear UL labels.

D. All devices of one type shall be by the same Manufacturer.

1. "Hazardous Location" and special purpose devices as may not be available from the same manufacturer shall constitute the only exception to this requirement of single source.

E. Corrosion resistant devices shall be as specified for normal usages, and fabricated of yellow color melamine plastic. Where "Weatherproof" type is indicated for exterior or wet locations, provide matching self-closing cover, with gasketed seals at plate/wall junctions and for cover.

1. Provide factory packaged wiring devices having high impact strength molded plastic bodies.

F. Except where specifically required, the use of interchangeable type or combination switch-receptacle-pilot devices are not acceptable.

2.2 WALL SWITCHES

A. General:

1. Snap switches for general use shall be maintained contact types, and shall be single-pole, double-pole, three-way, or four-way as required for the specific switching arrangements shown on the drawings. They shall be quiet tumbler operation types, having silver alloy contacts, and meeting all NEMA performance standards. Color to match plates unless specifically noted otherwise.
2. Switches shall be toggle or key-operated types, as indicated on the drawings. All key-operated switches shall be keyed alike.
3. Where switches are denoted as having pilot lights, pilot lights shall glow when the switches

are "ON". Provide pilot light switch with lamp and miniature step-down transformer. The pilot light shall have a red lens, and the lamp shall be long-life type.

4. Jewels for use with switches controlling motors shall be green, and jewels for other purposes shall be amber. All units shall be front relampable.
5. Snap switches installed in hazardous locations shall be UL listed for the type of location (class and division).
6. Switches connected to emergency power shall have red lighted handles which shall illuminate when the switches are "Off".
7. Voltage and ampere rating of switches shall be marked on switch, and shall conform to voltage of system to which applied.
8. Switches shall have back and side wired screw pressure terminals.

B. Description: Heavy-duty, AC only general-use snap switch.

C. Voltage Rating: 120-277 volts, AC.

D. Current Rating: 20 amperes minimum.

E. Ratings: Match branch circuit and load characteristics.

F. Regulatory Requirements: Comply with applicable NEMA and UL standards/requirements including UL 20 and NEMA WD 1 and 6.

2.3 WALL DIMMERS

A. Description: Semiconductor dimmer for incandescent lamps, type as indicated on Drawings.

B. Device Body: Present, linear slide as called for on drawings.

C. Voltage: 120 volts or 277 volts as required to match application.

D. Power Rating: Match load shown on Drawings; 600 Watts minimum.

E. Accessory Wall Switch:

1. Match dimmer appearance.

F. Same manufacturer and style as dimmer switch.

G. Regulatory Requirements: Comply with applicable NEMA and UL standards/requirements including UL 1472

2.4 RECEPTACLES

A. General:

1. All receptacles shall be of standard NEMA configuration, as indicated on the drawings, and shall comply with the respective ANSI C73 series standard for the NEMA configuration. Color to match plates unless specifically noted otherwise.
2. Duplex receptacles shall have integral UL listed self-grounding clips. Similar, single

receptacles shall be provided for plug-in connections of industrial fluorescent light fixtures on the same switching circuit. Receptacle face to be impact resistant nylon.

3. Weatherproof duplex receptacles shall be provided in all exterior locations, and shall be Ground Fault Circuit Interrupting (GFCI) types, with weatherproof stainless steel cover plates.
4. Special purpose receptacles for specific equipment shall be grounding types, having the number of poles, voltage and ampere ratings, and NEMA configurations required by the equipment. For each special purpose receptacle, provide an identical mating plug equipped with cord grip, secured to cord.
5. Duplex receptacles shall have back and side wired screw pressure terminals.
6. Receptacles to be installed in shower rooms, locker rooms, toilet rooms, janitors closets, exterior, elevator pit and machine rooms, escalator pits, within six (6) feet of a sink, and other areas as required by NEC, and OSHA Standards shall be ground fault circuit interrupting (GFCI) type, whether specified or not.
7. Receptacles installed for water coolers shall be GFCI type, or a single receptacle as permitted by NEC.

B. Description: Heavy-duty general use receptacle.

C. Configuration: Heavy-duty, general use type as specified and indicated.

D. Convenience Receptacle: NEMA Type 5-20.

E. GFCI Receptacle: Convenience receptacle with integral ground fault circuit interrupter, and automatic “self-testing feature” to meet regulatory requirements.

F. Controlled Receptacle: Convenience receptacle automatically controlled with NEMA approved controlled receptacle marking pad printed on the face of receptacle for superior abrasion resistance. Half or dual controlled.

G. Regulatory Requirements: Comply with applicable NEMA and UL standards/requirements including UL 498 and NEMA WD 1 and 6.

2.5 COVER PLATES

A. All wiring devices shall be provided with standard size one-piece cover plates of suitable configuration for the number and type of devices to be covered.

B. Metallic cover plates shall be used in interior spaces, except as noted below, and shall be fabricated of corrosion-resistant #302 stainless steel, having a nominal thickness of .04", and a brushed finish. Screws securing the plates shall have flush (when installed) heads with finish to match plates. Metallic cover plates shall meet all requirements of the National Electrical Code and Federal Specifications.

C. Cover plates for switches located in corrosive atmospheres (where vaporproof is not indicated) shall consist of a one piece neoprene boot with matching presswitch.

D. Cover plates for exterior receptacles shall be gasketed covers with hinge allowing plug and cord to be plugged in and activated with cover closed..

E. Cover plate engraving, where required, shall be accomplished by cover plate manufacturer in accordance with instructions given on the drawings. Metallic plates and nylon plates in ivory, beige, gray, and white shall be engraved with black fill. Red, brown, and black nylon plates shall be engraved with white fill.

F. Plates for devices connected to emergency power shall be as specified for devices connected to normal circuits, but shall be engraved reading "Emergency", see drawings for other engraving requirements.

G. Plates for devices connected to computer power panels shall be engraved reading “Computer”. Devices connected to emergency computer power panels shall be red in color.

H. Plates for devices connected to UPS power systems shall be as specified for devices connected to normal circuits, but shall be engraved reading "UPS POWER", see drawings for other engraving requirements.

I. Unless specifically noted otherwise in specs or on drawings all outlets for telephone and other communications and data systems shall be provided with standard size one-piece cover plates having a minimum 3/4 inch diameter, with bushing, in the center unless specifically noted otherwise. Where telephone conductors are installed, plates shall contain telephone type, polarized plug-in receptacles.

J. Device plates located in secure areas, as noted on drawings, shall have security wall plates (10 gauge) with 12 gauge galvanized steel backplate. All device plates shall have tamperproof screws.

K. Regulatory Requirements: Comply with applicable NEMA and UL standards/requirements

2.6 COLOR

A. Wiring devices connected to normal power shall be gray unless specifically noted otherwise.

B. All devices and coverplates in paneled walls shall have finish to match paneling.

C. Devices connected to emergency power shall be red color. (Including devices connected to emergency computer power panels).

D. Devices connected to separate computer power panels shall be black in color.

E. Modify any given catalog numbers as required to procure devices and plates of the proper color.

F. Devices connected to UPS systems shall be orange (isolated ground).

G. Regulatory Requirements: Comply with applicable NEMA and UL standards/requirements

2.7 FLUORESCENT DIMMERS

A. Dimmers shall be electronic type and include a remote control where required. Special dimming ballasts shall be included on fixtures to be dimmed. Ballasts shall be compatible with dimmer being provided.

B. Regulatory Requirements: Comply with applicable NEMA and UL standards/requirements

2.8 LED DIMMERS

A. Dimmers shall be electronic and compatible with light fixtures and drivers provided.

B. Regulatory Requirements: Comply with applicable NEMA and UL standards/requirements

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify outlet boxes are installed at proper height.

B. Verify wall openings are neatly cut and will be completely covered by wall plates.

C. Verify floor boxes are adjusted properly.

D. Verify branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.2 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean debris from outlet boxes.

3.3 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install devices plumb and level.

C. Install switches with OFF position down.

D. In general. lighting control switches shall be located at the lock/strike plate side of door(s). If the drawings indicate otherwise, issue a request for clarification prior to rough-in.

E. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.

F. Do not share neutral conductor on load side of dimmers.

G. Install receptacles with grounding pole on bottom.

H. Where 2 or more switches or receptacles are to be installed adjacent to one another, provide a multi-gang coverplate. Provide proper NEC barriers in boxes which serve devices for both the Normal and Emergency Systems or a combined system voltage of 480 volt.

I. Provide device coverplates for every device installed. Cover plates shall be installed so that they appear straight with no gaps between plate edges and the wall. Maintain vertical and horizontal to within 1/16 of an inch.

J. In finished areas, provide same type of plate for all surface mounted devices as for recessed mounted devices.

K. In any room, where new and existing construction is present, all receptacles, switches, and coverplates which are existing to remain shall be changed, to match new work.

L. Wiring devices shall not be installed in exposed masonry until cleaning of masonry with acids has been completed.

M. All receptacles and switches shall be grounded by means of a ground wire from device ground screw to outlet box screw and branch circuit ground conductor. Strap alone will not constitute an acceptable ground.

N. All wiring devices, relays, contactors, pushbuttons, selector switches, pilot lights, etc. shall be installed in approved enclosures rated for the appropriate NEMA classified environment.

O. All devices shall be installed so that only one wire is connected to each terminal.

P. Once construction is substantially completed, replace all damaged, burned, or scorched wiring devices.

Q. Receptacles shown to be floor mounted shall be installed in floor boxes (with coverplates) which are approved for this use.

R. Connect wiring devices by back wiring conductor into compression terminal.

S. Install protective rings and split nozzle on active flush cover service fittings.

3.4 NEUTRAL CONDUCTOR CONNECTIONS

A. At each receptacle "in" and "out" phase and neutral conductors shall have an additional conductor “pigtail” for connection to device. The practice of "looping" conductors through receptacle boxes shall not be acceptable.

B. Provide and install a neutral conductor for each circuit in all wall switch outlet locations.

3.5 INTERFACE WITH OTHER PRODUCTS

A. Coordinate locations of outlet boxes to obtain specified mounting heights.

3.6 FIELD QUALITY CONTROL

A. Inspect each wiring device for defects.

B. Operate each wall switch with circuit energized and verify proper operation.

C. Verify that each receptacle device is energized.

D. Test each receptacle device for proper polarity.

E. Test each GFCI receptacle device for proper operation.

3.7 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

END OF SECTION 26 05 83

SECTION 26 07 17- SCADA MONITORING AND CONTROL SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies the furnishing, installation, connection and testing of the SCADA Monitoring and Control System.

1.2 RELATED WORK

A. Section 26 05 26, Grounding and Bonding for Electrical Systems

B. Section 26 32 18, Engine Generators

C. Section 26 23 00, Low Voltage Transfer Switchgear

D. Section 26 23 25, Medium-Voltage Emergency Switchgear

1.3 QUALITY ASSURANCE

A. System Responsibility:
1. All equipment specified in this section shall be provided by the Medium-Voltage Switchgear and Controls supplier (as detailed in spec section 26 23 25) to provide for a fully coordinated power system and single source responsibility. The supplier shall be responsible for all coordination of this entire scope including technical interfacing, interconnects, scheduling, testing, training, and documentation.

B. Factory Testing:
1. The 12.47KV Emergency Switchgear lineups shall be manufactured together with the Low Voltage Transfer Switchgear lineups and SCADA System specified herein to provide for single source responsibility for the primary power management system. A complete factory witness test and demonstration shall be performed with ALL of these lineups and components connected to simulate an installed operation. Representatives of the Owner and engineers shall be invited to attend a formal demonstration of the entire system at the factory and prior to shipment to site. Any defects or corrections identified by the Owner's representatives during this witness test shall be corrected and re-demonstrated prior to shipment.
2. The Owner and/or its appointed representatives shall have an option to witness the factory tests. Switchgear and Controls System vendor shall cover all transportation and living expenses for six (6) persons to attend comprehensive factory witness testing prior to shipment. Notify the Owner through the Engineer not less than 30 days prior to making witness tests at the factory.

D. Field Testing:
1. Field tests shall be in accordance with IEEE C37.09 and shall include the following:
a) Tests After Delivery
b) Field Tests

E. Warranty:
1. All switchgear, controls and SCADA system shall be covered by a 2-year full coverage warranty. Warranty shall commence 6 months after shipment or upon successful completion of startup, commissioning, demonstration and acceptance by the Owner and Engineer, whichever occurs first. Warranty shall cover all parts and on-site labor to repair and/or replace any defective component.

F. SCADA System:
1. System shall be supplied by the manufacturer of the Generator Medium Voltage Switchgear and Controls and as specified in this section.
2. Manufacturer must be able to demonstrate previous experience implementing a site wide SCADA system supporting a central power plant, multiple remote buildings, and major electrical infrastructure. Experience must include a minimum of five (5) previous projects of identical or similar scope as defined herein, including a comprehensive simulator for operator training. Supplier will be required to provide proof of previous experience as a condition for acceptance including project name, description of scope, examples of graphic screens provided for each screen type specified herein, name and phone number of user contact for five (5) projects.
3. SCADA system must be able to completely integrate with various manufacturers of equipment including but not limited to switchgear controls, PLCs, generators, transfer switchgear, digital protective relays, breaker trip units and digital metering/monitoring systems.

1.4 SUBMITTALS: In accordance with Division 26 Section, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:

A. SCADA System Shop Drawings and Submittals: Prior to ordering and installation, submit engineering shop drawings and equipment technical information sheets on the SCADA for review by the Engineer. The Shop Drawings and submittal shall be of sufficient detail that they enable the Owner and Engineer to determine if all requirements of the Contract Documents are being met.
1. Shop Drawing and Submittals shall include sufficient detail to enable the design, manufacture, installation and commissioning of all components of the SCADA, including hardware and software, in accordance with the requirements of the Contract Documents.
2. Shop Drawing and Submittals shall comprise all drawings, schematics, equipment schedules, equipment specification sheets, printed descriptions, examples of each screen graphic (color) with detailed description and information in other forms as necessary to fully represent the work to be undertaken by the Contractor.
3. Shop Drawings and Submittals shall include information on all hardware and software elements of the SCADA including, at minimum, the following:
a) SCADA network architecture schematics showing the interconnection of all PLCs, Workstation Computers, Automatic Transfer Switchgear, 15 KV Switchgear, and devices contained therein.
b) Full technical specifications for all items of equipment to be furnished under this Contract including quantities and dimensions.
c) Complete information regarding the installation of all equipment.
d) Descriptions of all software, firmware and applications packages furnished under this Contract.
e) Narrative of all sequences of operation.
f) Complete information on wiring to be provided under this Contract including, at minimum, details of cable function, cable type, cable size, coloring coding and identification.
g) Descriptions and diagrams of software and hardwired interlocks.

h) Representation of each screen as specified herein in full color.
i) Equipment naming convention spreadsheet listing each: Building, Switchgear, Device, Feeder, Alarm point.
j) Alarm convention spreadsheet listing each: Alarm, Warning, Time-Date Stamp.
k) Automated Load Bank Testing

C. A submittal review conference will be held at the manufacturer's facility. The Contractor, SCADA factory representative, Engineer and Owner shall be in attendance.

D. Provide "as-built" record documents for the entire system suitable for instruction, operation, procurement, installation and maintenance. Include descriptions of all unique devices, circuitry, software or applications.
1. Periodically update all documentation in order to reflect all SCADA changes made during design, construction, and commissioning.
2. All SCADA changes made during testing shall be incorporated into the final record documents.

E. Emergency Power Supply System Controls: Submit a complete sequence of operation for the entire system. The sequence of operation shall be specific for this project and include all functions of the system (i.e. single utility failure, two or more utility failures, site wide outage, load testing, load demand, load shed, manual operation, load bank testing, etc.) generic control sequences are not acceptable. Include all set points for the generator load demand mode.

1.5 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.

C37.55-89	Switchgear-Metal-Clad Switchgear Assemblies Conformance Test Procedures
C39.1-81	Electrical Analog Indicating Instruments,
C37.20.2-99	Standard for Metal-Clad Switchgear
C37.90-89	Standard for Relays and Relay Systems Associated with Electric Power Apparatus
C57.13-93	Standard Requirements for Instrument Transformers

Elements in Metal-Enclosed Switchgear Assemblies - Conformance Test Procedures

LA 1-92	Surge Arrestors
SG 4-00	Alternating-Current High-Voltage Circuit Breakers
NFPA 70	National Electrical Code (NEC)

PART 2 - PRODUCTS

2.1 DESCRIPTION-SCADA SYSTEM

A. This Section specifies the requirements for the following elements of the Supervisory Control and Data Acquisition System (herein referred to as the SCADA) which are to be provided as part of this Contract:
1. Central Workstations.
2. Programmable Logic Controllers, remote I/O modules, Ethernet modules.

3. Software and firmware as necessary to perform the monitoring, control and other functions as specified.
4. Communications Networks, Ethernet / Fiber Optic.
5. Interfaces between the SCADA and the Medium and Low Voltage Transfer Switchgear, Generator Sets and Auxiliary Systems.
6. Simulator System.
7. Owner training.
8. Record documentation.

B. Refer to contract drawings for additional information on equipment locations, routings, and diagrams.

2.2 SYSTEM OVERVIEW

A. The SCADA system shall consist of an integrated network of a Server PC, Operator Workstations, Operator Interface Terminals, Mimic PC's, Remote I/O and networking hardware as shown on the SCADA drawings.

B. All hardware, software and accessory equipment shall be consistent throughout the system.

C. The SCADA communication network shall pass data in digital format only using token-passing protocols.

D. The SCADA shall be configured such that all PLC monitoring and control functions are maintained in the event of workstation computer component failure, including the transfer of data from PLC.

2.3 OPERATOR WORKSTATIONS (OWS)

A. The Operator Workstations shall each be comprised of a computer, together with Operator terminals, i.e. printers, monitors, and communication devices. Each OWS shall be a fully integrated node on the SCADA network. One OWSs shall be located in the Switchgear Control Room and one OWS shall be located in the Engineering Office. The OWS (located in the Switchgear Control Room) shall serve as the server. The remaining OWSs shall be clients. All OWS shall include:
1. 24" LCD Color Monitor (16 x 9 aspect ratio)
2. Alarm printer (total of two (2) shared by both OWS at each location)
3. Report printer (total of two (2) shared by both OWS at each location)
4. Ethernet network communications
5. Keyboard
6. Mouse

B. Each workstation computer shall consist of a computer-based central processing unit together with the associated storage, operational, arithmetic, interfacing, power conditioning, operator communication and software facilities, as required to meet the requirements of these Contract Documents.

C. Each workstation computer, at minimum, shall provide the following services to the SCADA networked configuration:
1. Storage, analysis and presentation of data and information.
2. Operator capability to modify, add and delete workstation computer and PLC database elements, schedules and displays, etc.
3. Real-time observation of events monitored and controlled by the SCADA, which require workstation computer involvement in the annunciation and/or archiving of

these events when applicable.

D. The server computer provided shall be a computer system as required to meet the requirements of the Contract Documents and, at minimum, shall be comprised the following (NOTE: this is a minimum standard, supplier is responsible to select equipment capable of the performance required in these specifications):
1. Dual Quad Core Xeon E544 Intel CPUs with minimum 2.83 GHz clock speed.
2. Minimum 16 Gbyte SDRAM memory
3. (2) 500 GB, 7200 RPM Hard Disk Drive
4. Ethernet Port 1 GB
5. 512MB nVidia Quadro FX1700, dual monitor DVI capable graphics card
6. Internal chassis speaker with audio output
7. 16x DVD-ROM, Cyberlink Power DVD8.1
8. Microsoft Windows Server
9. USB Keyboard, USB optical mouse

E. The OWS client computers provided shall be a personal computer system as required to meet the requirements of the Contract Documents and, at minimum, shall be comprised the following:
1. Core 2 Duo E8500 Intel CPUs with minimum 3.16 GHz clock speed.
2. Minimum 4 Gbyte SDRAM memory
3. (2) 73 GB, 3.0 Gbps, 15k RPM Hard Disk Drives
4. Ethernet Port 1 GB
5. 256MB nVidia NVS 290, dual monitor DVI capable graphics card
6. Audio output port
7. 48x CD-RW/DVD-ROM, Cyberlink Power DVD
8. Microsoft Windows Server 2008
9. USB Keyboard, USB optical mouse

2.4 MIMIC PANEL PC

A. The mimic client computers provided shall be a personal computer system as required to meet the requirements of the Contract Documents and, at minimum, shall be comprised the following:
1. Core 2 Duo E8500 Intel CPUs with minimum 3.16 GHz clock speed.
2. Minimum 2 Gbyte SDRAM memory
3. (2) 80 GB, 3.0 Gbps, with NCQ and 8MB DataBurst Cache
4. Ethernet Port 1 GB
5. 256MB nVidia NVS 290, dual monitor DVI capable graphics card
6. Audio output port
7. 48x CD-RW/DVD-ROM, Cyberlink Power DVD
8. Microsoft Windows latest edition
9. MX3200 cordless laser Keyboard and mouse

B. The Mimic PC will drive a 42” monitor located in each Switchgear Control lineup. The monitor shall be LCD flat panel, 1280 x 1024 resolution, 120 VAC.

2.5 OPERATOR INTERFACE TERMINALS (OIT)

A. The Operator Interface Terminals (located within each Master cubicle in the Switchgear Controls) shall be a client to the SCADA and shall consist of the following:
1. 21” color touch screen panel
2. Intel Pentium CPU, 1.1 GHz
3. 1 GB RAM
4. 40 GB Hard Drive

5. Windows XP

B. The OITs shall be networked such that any loss in communications with the SCADA SHALL NOT affect the ability of the OITs to continue to communicate with the Switchgear Control PLCs and perform all functions associated with control, monitoring and graphic displays of the Normal and Emergency Switchgear.

C. Loss of communication with the SCADA shall only result in the loss of the ability to display those graphical screens that rely on data input from the remote SCADA SRTC's.

2.6 WORKSTATION PERIPHERALS

A. Provide a color laser report printer, shared at each of two locations (Gen CEP Control room and Engineering Office), that meets the following specifications:
1. Minimum print speed of 8 pages per minute.
2. Adjustable fonts and scaling.
3. Operated via a standard parallel, USB or network interface.
4. Printer shall accept screen dumps including graphics from associated monitor in black and white and in color as selected by the Operator.

B. Provide a monitor for each workstation that shall meet the following specifications:
1. Minimum screen diagonal measurement as listed above.
2. Capable of displaying both schematic and alphanumeric data at the same time.
3. Minimum of two hundred fifty-six (256) discrete colors shall be available for display selection.

C. Provide a local self-contained UPS module to provide backup power for each SCADA workstation/monitor.

2.7 SCADA REMOTE COMMUNICATIONS

A. Provide status input monitoring and control of all the points as identified in the SCADA Points List. Refer to the Drawings for system architecture. All communications shall be via either Ethernet/Fiber Optic and/or RS 232/485 communications integrated into the SCADA network or hard-wired directly to a network connected redundant PLC I/O card within a switchgear cubicle. Provide Ethernet switch, serial to Ethernet bridges, fiber patch panel, fiber-to-copper media converter, interconnecting cabling, power supplies, and wiring terminations for field connections.

C. The system shall consist of components designed specifically for the environment that the system is to be installed.

D. All components of the controllers and modules shall be identified using permanent labels which indicate the manufacturer's catalog number, product manufacturing date code, UL and CSA certifications and are cross referenced on the as-built wiring diagrams. Provide complete wiring diagrams of the controllers or monitoring modules.

E. Power for the Scada Communication components shall be from local critical branch 120v, 20amp circuits to rack mounted UPS modules as specified. Provide sufficient receptacle output for each piece of equipment served.

F. Terminal blocks shall be easily removable, and common to all discrete and analog I/O to allow for convenient pre-wiring of field devices. Each I/O module shall contain a hinged, clear plastic, terminal block cover (door) with a removable label. The inside of the label shall have the module description, catalog number, and circuit wiring diagram for that

module type, and the outside of the label shall have a user legend space to record circuit identification information.

G. The SCADA communications network shall be separate from the PLC control network.

2.8 COMMUNICATION NETWORK

A. Provide all communication and control wiring as required by the SCADA system. All communication wiring shall be installed in dedicated conduits.

B. Communication between switchgear PLC's and each workstation computer shall be at a minimum transmission speed of 153 kbaud.

C. The SCADA communication networks shall be Ethernet / Fiber Optic. All communication wiring external to each building shall be fiber optic. Signals and data within a specific building can be copper wire. Serial Modbus to Ethernet bridges shall be provided as necessary. Ethernet switches shall be equipped with the necessary number of ports, including fiber optic ports as needed for all building to building transmissions. All devices shall be DC powered from 2 sources (A&B). The local DC supplies shall be powered by the local UPS.

D. SCADA network communications shall utilize Modbus TCP Ethernet protocol and allow the facility power management system to communicate with Circuit Monitors, Power Meters, protective relays, trip units, and engine generator set controllers.

2.9 INTERFACE BETWEEN SCADA AND GENERATOR SET, AND SWITCHGEAR SYSTEMS

A. As part of this contract, interface Control Switchgear PLC’s with SCADA System such that all data and screens available at the switchgear OITs can also be viewed on the SCADA workstations. This integration shall include all points, database and graphical display information as detailed herein.

B. All engine generator monitoring points and alarms shall be interfaced with the SCADA System.

2.10 SCADA SOFTWARE

A. Where reference is made to functions that can be performed by an Operator, these functions shall be protected by multi-level password access control.

B. All operator monitoring and/or control procedures shall be graphical and user interactive. Procedures shall not require a knowledge or previous use of the SCADA control language.

C. Provide Operator definable analog input engineering unit alarms on a per point basis. These shall comprise, at minimum; input high alarm limit, approach input high alarm limit, input low alarm limit, approach input low alarm limit and defective sensor. All alarm set points shall be capable of being set at each workstation computer, given proper password authorization.

D. Provide dead band limits or time limits on analog alarm points in order to minimize the occurrence of nuisance alarms. Dead bands and/or time limits shall be operator definable on a per point basis.

E. Each input point on the SCADA shall be in one of the following three (3) possible operator manually selected, or automatically programmed states:
   1. ENABLED - Point with monitoring and alarm annunciation active.
   2. DISABLED - Point with alarm annunciation disabled.
   3. ALARM LOCKOUT - Point with alarm annunciation disabled.

F. Each enabled output point on the SCADA shall be in one of the following two (2) possible operator selected, or automatically programmed states:
   1. MANUAL - Scanning, alarm monitoring and associated interlock protection operational. Programmed control actions not to be automatically applied to controlled points with the exception of protection interlocks. Digital output and analog output changes to be executed manually by SCADA operator; subject to protection interlocks.
   2. AUTOMATIC - All automatic scanning, alarm monitoring, interlock and control software features functioning under program control. Digital output and analog output changes not executable manually by operator. All automatic protection interlocks functioning. It shall not be possible to place an output in automatic mode when the output is software dependent on any point that is disabled, in alarm or "sensor bad".

G. Workstation software and graphical operator interface shall be In-Touch Wonderware software.

H. Provide one (1) full development software license. Also, provide additional runtime licenses to be installed on the operator workstations, Mimic computer and Operator Interface Terminals in the Switchgear Controls.

2.11 OPERATOR WORKSTATION CAPABILITY

A. Reports shall be produced on demand when requested by the Operator. Selected reports shall be generated on a scheduled basis. Schedules shall be entered by the Operator using an interactive procedure. The time and date shall be recorded on all reports.

B. The Operator Interface shall be in the English language, using readily understood English language abbreviations, mnemonics and cursor (mouse) control.

C. The SCADA shall annunciate a sensed alarm within one (1) second of the alarm being detected. Operator access to the SCADA shall be available within one (1) second of the Operator initiating the access process for any function.

D. All operator initiated equipment energize/de-energize, ON/OFF, OPEN/CLOSE, etc. and commands or changes to the data base such as set points, alarm limits, schedules, etc., shall be executed within two (2) seconds from the completion of the entry by the Operator.

E. The operator interface shall require minimal Operator referencing to instruction manuals. Help menus or directories of both available commands and details of their use shall be available, on-line.

F. When an alarm occurs it shall be annunciated on the alarm printer and shall be displayed on the monitor at the workstation by one of two methods:
   1. A description of the alarm shall appear in a dedicated area of the monitor. When the Operator acknowledges the alarm it will be replaced by the next alarm of highest priority. The monitor display of graphics, trends, etc. shall not be affected by this alarm display. A means shall be provided to indicate when an alarm is awaiting acknowledgment.

2. An alarm icon shall indicate when an alarm is awaiting display. This icon shall allow the Operator to acknowledge alarms, access alarms and return to the previous display.

G. Provide password access control as protection against unauthorized access to SCADA operations from any Operator I/O device.

H. Provide automatic annunciation to Operators of internal SCADA component/system/ communication/software failures via an approved worded message on monitor and printer.

I. All SCADA alarm messages, at minimum, shall contain:
1. Time and date of occurrence.
2. Full, clear, unique and concise details of the alarm condition.
3. Associated point/system address and expanded descriptors if applicable.
4. Other information as defined in the submittal process.

J. A report shall be available to the Operator on a scheduled basis and on an on-demand basis detailing existing alarms. The report shall clearly identify alarms that have not been acknowledged by the Operator. All reports shall be displayed and/or printed out in Excel spreadsheet format.

K. Reports shall be available including, at minimum:
1. Point report showing all of the points in the system and their current value.
2. Complete point definition reports showing all of the points in the system and their current configuration (alarm limits, address, etc.).
3. Alarm disables status reports.
4. Alarm summary reports.
5. EPSS Testing Report.
6. Transfer Testing of LV Transfer Switchgears.

L. Provide real-time color monitor graphic schematic displays. One schematic, at minimum, shall be provided for the following systems:
1. Each generator set; PLC and display of all points identified within the SCADA Points List and individual generator kilowatts.
2. All 15 KV Switchgear, unit substations, and all downstream LV Transfer Switchgears, including main bus kilowatts, circuit breaker status, source status, front views for 15 KV switchgear complete with individual elevation of each cubicle.
3. System one-line diagram of the entire system and all downstream LV transfer switchgears, indicating system transfer and retransfer conditions, system load shed and load add set points, system overload set points, load shed and bypass control, load demand engine selection and generator engine start/stop control. System diagram shall indicate by color the flow of power and the position of all circuit operating devices.
4. Graphic screens indicating all points monitored as identified in the SCADA Points List.

M. The graphical displays shall be configured to emulate the physical layout of each 15KV control switchgear cubicle door, and generator arrangement. Each display shall have active control and monitoring capability.

N. The graphical schematics shall be displayed in their completed form with all dynamic data within three (3) seconds of the display command being entered by the Operator.

O. Submit graphical system schematics to the Engineer and Owner as a shop drawing for approval.

P. Provide modem and email interface to send email alarm/status messages or trouble codes.

2.12 SCADA SCREENS

A. Each workstation and operator interface terminal shall be programmed with the following graphic user interface screens:

1. Navigation/Status Bar: This shall be present on all displays. A status bar shall be present across the top of the display to show date, time, operator, access level, general status of the Normal and Emergency Power System:
   Status of each Utility source
   Load Test on/off
   Master Controls: auto/manual
   Load Bank Test: on/off
   Load Control mode: auto/manual
   Retransfer mode: auto/manual
   Gen Demand Mode: on/off
   On-line Test: active/off

   A Navigation bar shall be present down the left side of the display to allow the user to navigate to other screens with an easy to use menu. A legend shall also be displayed to indicate status of symbols used on the graphics such as color and symbol for breaker open, breaker closed, engine locked out, etc.
2. Security/log screen - allows five (5) levels of password-protected access to the SCADA system for different levels of authorized personnel.
3. System Single-line Diagram screen - a single-line diagram of the system including detail as shown on the drawings including down to each building main transfer switchboard. The single line shall change color for energized or de-energized condition. Energized shall be red, de-energized shall be green and a locked out breaker or one with an active alarm shall be displayed as flashing yellow. Clicking on the icon for any breaker (generator, utility, distribution, Substation Main, etc), or transfer switchgear shall display a pop-up window with all monitored values as currently be seen by that device. Monitored values shall be instantaneous values monitored by the multifunction relays, circuit breaker trip units, power monitors and generator SCADA interface. The screen may use a separate block to represent the continuation of the one line to a specific remote building. Clicking on that block will bring up another window that displays the one line for that building only. Remote building one-lines are to be active using the same color coding as noted above.
4. Active Alarm Window Screen lists all active unacknowledged alarms, time stamped to the millisecond that requires immediate attention.
5. Event Log Screen's screen shall provide a running log of all monitored and alarm events, both acknowledged and unacknowledged. This shall include all of generator, switchgear, and system alarms as well as breaker positions etc. Events include test operations, changes to timers or set points, and power losses. Each event or alarm shall be time stamped with the exact time of the event or alarm. System events and alarms shall be saved to the hard drive and shall capable of being downloaded in report form to the system printer.
6. System Control Screens highest level of security access screen capable of initiating all manual functions and load test sequences. Provide a minimum of two steps with a confirmation of each action to initiate any system control or to

terminate any operation. All manual control shall be enabled via the local PLC so SCADA cannot put the system in an unacceptable configuration by overriding each piece of equipment local interlocks. Include the following individual System Control Screens:

a) MASTER CONTROL and Set points Screen:
Includes buttons and controls as provided on the Master cubicle door plus a listing of set points associated with system operation.

b) GENERATOR DEMAND Control Screen:
Includes buttons and displays to perform the following functions:
When the system is running in the emergency mode and the generator demand mode button is in the select position and at least two (2) generator breakers are closed, the controls continuously monitor the total load on the generator bus and controls load and generation.

c) LOAD CONTROL MODE Screen:
Includes buttons and displays to perform the following plus a listing of set points associated with these functions:
Auto load control mode is accomplished by controlling the breakers in the transfer switchgear. During a normal power failure, after the required engine-generators have synchronized to the generator bus the generator main breaker(s) are closed. The transfer switchgear distribution breakers are sequenced back on based on their priority. The priority of distribution breakers can be adjusted through the load priority screen. Bypassing the load control mode would require manually adding or shedding of load.
The LOAD ADD / LOAD SHED buttons provide the following operations: Lower priority loads can be programmed for smaller steps (i.e. 2A, 2B, 2C ...) while using the load add and load shed non-essential load push buttons. This enables more flexibility in loading up the generators while in bypass mode of operation. Pressing the load add push button on the SCADA screen adds lower priority load to the emergency generator system. Each time the push button is pressed the next priority is added. Pressing the load shed push button on the SCADA screen immediately sheds load of the next lowest priority. Each time the push button is pressed the next priority load is shed. This button remains functional in both manual and automatic operation; however, in the automatic mode, any shed load is re-added once the button is released, provided the bus is capable of increased load. Load priority set points shall be settable from this screen to assign priority and expected KW for each step.

d) LOAD BANK TEST SCREEN
Provide separate screen to select any generator or combination of generators for load test using the permanently installed load bank. Once generators are selected, a start pushbutton will automatically start the selected generators and close/parallel them to the generator bus. The load bank breaker will be closed and the operator can add load using the soft keys on the screen. If utility fails during load bank test, then the load bank breaker will open and the Gen Main breakers will close for immediate transfer of priority one loads, followed by the resumption of adding additional generators and loads as per the same sequence as a utility failure when no gens are running.

e) ADDITIONAL SETPOINT SCREENS
Provide individual screens to allow adjust of set points for the following: Utility Timers Under voltage failure, Voltage available, Open Transition time, Engine Set points Cool down time, Fail to Sync time, Any set point change will initiate a pop-up window requiring operator to save changes or to reload default values in the PLCs.

7. Engine Metering Screen: Provide screen with individual pop-up window for each Engine Generator which displays analog meter simulations for Oil Pressure,

Water Temp, RPM, Power Factor, Frequency, KW, Battery Voltage, Generator Voltage with phase to phase selector buttons, Current with phase selector buttons. Also display total accumulated operating hours for the unit.

8. Relay Metering Screens: Provide an individual pop-up window that displays all of the power monitoring data available from each and every protective relay in the 15KV Emergency Switchgear as shown on the drawings. Access to a specific pop-up shall be by either of two methods. First, by clicking on the associated breaker on the one-line graphic, or second by clicking on the device as shown on the switchgear virtual elevation front views of each lineup as available in the SCADA.
9. Power Metering Screens - Provide an individual pop-up window that displays all of the power monitoring data available from each and every Power Meter in the Emergency Switchgear, and in the downstream LV Transfer Switchgear. Access to a specific pop-up shall be by either of two methods. First, by clicking on the associated lineup on the one-line graphic, or second by clicking on the device as shown on the switchgear virtual elevation front views of each lineup as available in the SCADA.
10. LV Transfer Switchgear Status Screen Selectable from the main menu bar, this screen will display a summary of each Transfer Switchgear in the facility. The following status shall be displayed in a table for each Transfer Switchgear:
    Source connected (normal/emergency)
    Start Signal Present
11. LV Transfer Switchgear Data Screen - Provide an individual pop-up window that displays all of the data available from each and every Transfer Switchgear in the facility, as shown on the drawings. Window shall display power monitoring data, source voltages, load in amperes and kW, source breakers position, and including a live one-line graphic of the switchgear and its associated load breakers showing current status of each breaker (open or closed). Access to a specific pop-up shall be by either of two methods. First, by clicking on the associated Transfer Switchgear on the one-line graphic, or second by clicking on the specific Transfer Switchgear as listed on the Transfer Switchgear Status Screen listed above.
12. Plan View Site: Provide a main screen that is a complete plan view of the entire Site with each building outlined in a color with the name and building number displayed within each buildings outline. This will serve as another means to navigate to specific screens associated with each building. When the cursor is moved within a building outline, that outline will highlight and clicking the mouse will bring up the associated main electrical one line of that building as described in the One-Line Screen above. The one line will include each Transfer Switchgear contained within the building. Clicking on any transfer switchboard main breaker, power meter or ATS will bring up the Data Screen listed above.
13. Plan View CEP: Provide a plan view of the CEP building showing all rooms with outlines of all generators, switchgear, controls, and any other major electrical equipment. Highlighting any piece of equipment, such as a generator of switchgear lineup, will bring up a screen associated with that unit. For example, clicking on a generator will bring up the Generator metering screen for that unit. Clicking on a switchgear lineup will bring up the virtual front view of that lineup.
14. Virtual Switchgear Front View Interactive Screens Front view elevations shall be provided for each 15 KV (13.2 KV) switchgear line-up (Normal & Emergency) and each Switchgear Controls Lineup. Each virtual representation shall replicate exactly the actual appearance of particular equipment including all controls, meters, annunciators, switches, pushbuttons, relays, and labeling. Colors shall replicate the actual colors of the gear and each door mounted device. From the main front view of any lineup, it shall be possible to zoom into the lineup at several levels. First, highlighting and clicking on any cubicle will bring up a view of that cubicle only. From any cubicle front view, it shall be possible to highlight

small groups of devices (such as meters or control switches or an annunciator) and click to display a close up of that group of devices only. The displays shall show replications of each device (analog meter, selector switch, annunciator panel, etc.) and the actual state of that device in a live presentation. Analog meters shall show actual current readings. Switches shall be shown in their actual positions at any time. Annunciators shall show lighted windows in the same color as is currently being displayed on the actual equipment.

15. All other screens as listed in the Emergency Switchgear specifications as required for the Master OIP shall be duplicated on the Scada Operator Workstations.

B. Screens shall function in real-time with a maximum update time of 1.0 second.

C. Screen functions shall not be capable of overriding any safety functions.

2.13 ADVANCED TRAINING AND FAULT ANNALYSIS SIMULATOR

A. Provide a standalone workstation and PLC with system software for training, failure analysis and simulation of entire Emergency Power System. The workstation will consist of a PC based workstation, desk top type, with a separate PLC mounted to the Display stand and all required accessories, including power supply and connections to the workstation.

B. Simulator hardware and software shall match the SCADA Operator Workstations (OWS) including (3) 24" flat screen monitors in workstation configuration and including a desktop stand. The monitor shall display as follows:

Left screen: shall display an active one line of the system plus all of the menu screens as available on the actual system OIP
Center screen: Animated Virtual front views of the entire Switchgear and Controls lineup, showing every cubicle detail and door mounted device
Right screen: Simulator Control Screen where the operator can enter simulation variables (fail a breaker coil, change setpoints, etc)

Power flow shall be displayed by color changes in the single line graphic. An open breaker and a de-energized bus is to be green, a closed breaker and an energized bus shall be red, and a locked out breaker condition shall be displayed in yellow. The simulator PLC shall be the same make and model as being provided in the Generator System Master controls. Control functions of the low voltage switchgear shall not be included in simulator system program.

C. Provide the ability to simulate real operating conditions and failure scenarios for entire 13.2 KV Emergency Power System. These simulations will be performed off-line and in no way affect the real-time operations of the systems. Operators shall be able to initiate all functions as if they were standing in front of the actual switchgear and controls, using the virtual front view graphic screens. They shall be able to push buttons, move switches and enter parameters with real time simulation to show the actual results of their actions under normal and abnormal conditions.

D Simulator shall have security log on protection, Menu driven pop-up windows for different operational scenario screens shall be provided. Multicolored graphical displays that change colors to reflect different operational conditions, such as open and closed breaker operation, energized and de-energized buses and sources.

E. Simulate, using duplicate switchgear Operator Interface Panel (OIP) controls, operation and control of the paralleling switchgear and allow operator interaction with setting adjustments and interjecting failures to see how the system will react to different events such as breaker failure, engine/generator failure, power failure, etc. Operator shall be able to create specific failure conditions such as, breaker close coil failure, breaker trip coil failure, breaker lock-out, engine failure, & power failures. The simulator will then run the system in the same manner as it would on the actual gear given the induced failures being present. Operators can then learn "work around" solutions to a given scenario.

F. Simulate and display data and functions for each individual generator such as engine start/stop and monitoring that is performed by the system PLC including but not limited to: all pre-alarms; alarms; engine status; engine selector switch status and control; generator circuit breaker position and generator volts; amps; kilowatts, and frequency. Simulation of generator load bank testing shall also be provided.

G. Simulate and display the operational functions of the control system including but not limited to: system annunciation; generator bus voltage; generator bus kilowatts; generator bus frequency; load demand setpoint and timer settings; manual/auto selector switch position and all remaining master control settings. The complete manual operation of the switchgear controls shall be simulated, including manual generator start, manual synchronizing of generators to the bus, manual open & closing of breakers, and manual transfers.

H. All simulated data displayed by the SDS shall appear as it would be seen on the actual system. Simulated operations when using the training simulator shall include:

- various system tests (load/no load, load bank)
- set point adjustment
- frequency meter switch interlocking (keyed removable switch can be moved among generator controls)
- synchroscope meter switch interlocking & manual sync control
- manual breaker control hardwired interlocks
- metering for all hardwired analog meters
- generator demand enable/disable and setpoint adjustments
- load shed and block transfer controls
- utility source failure and restoration
- individual generator disabling
- external tripping of circuit breakers
- protective relay or breaker initiated trip of circuit breakers
- individual generator control (pre-alarm, shutdown, cooldown, not in auto)

I. A simulated system log shall provide a history of alarm; kilowatt consumption, control and setup events including data and time stamp the same as the event log would be displayed on the actual system operator interface panel.

The simulated data shall be displayed in daily, weekly, monthly or quarterly intervals.

J. The Simulator System shall consist of a Dell Precision T5810 personal computer and PLC and must include the following basic minimum features:

Intel Xeon Processor E5-1603 v3 (4C, 2.8GHz, 10M, 140W)
16GB (2x4GB) 2133MHz DDR4 RDIMM ECC

Dual AMD FirePro W5100 4GB (2 cards, 2 DP each) (1 DP to SL-DVI adapter)
500GB 3.5" Serial-ATA (7,200 RPM) Hard Drive
C1 SATA 3.5 Inch, 1-2 Hard Drives
US English (QWERTY) Dell KB212-B QuietKey USB Keyboard Black
Dell MS111 USB Optical Mouse
Integrated Intel AHCI chipset SATA controller (6 x 6.0Gb/s) - SW RAID 0/1/5/10
8x Slimline DVD-ROM Drive
Precision Tower 5810 Resource DVD

(3) Dell 23" touch screen monitor with 3 year warranty
Ergotech Horizontal Monitor stand with PLC mounting plate
Display Port to 4K HDMI Converter
4K UHD High Speed HDMI – 10ft
Fellowes Gel Crystal - Mouse pad with wrist pillow – blue
32GB USB Flash Drive
Stereo Speaker System

Include the following software loaded and fully configured for simulator operation:

Windows 10 Professional
Microsoft Office Trial
Windows 10 Recovery – USB
InTouch 2014R2 Runtime 60K Tag with I/O
3 Year ProSupport Warranty

The SDS shall also include a GE RX3i PLC equivalent to the PLCs used for the critical medium voltage system including:

universal backplane
7-slot rack
Ethernet interface module with (2) 10Base-T/100Base-TX Ethernet cards 300 watt power supply.

D. The simulator will serve as the training tool for current and future operators and shall be comprehensive in its scope and abilities. Final acceptance of the proposed simulator will be upon demonstration conducted by the vendor, and acceptance by the engineer, that the simulation system meets all of the requirements as stated in this specification.

2.14 PROTECTIVE RELAYS METERING UNITS

A. Protective relay metering units shall be capable of communicating on four wire MODBUS networks without software interfaces (black boxes) or by Ethernet over 8 wire UTP.

2.15 ETHERNET SOLUTIONS

A. Power Circuit Monitors and circuit breaker trip units shall be connected to the campus wide power monitoring and control system.
   1. LC fiber optic connection for multimode fiber (100BaseFX) The ECC shall have an embedded web server inside the unit, capable of serving HTML pages with dynamic meter data displays.
   2. The protocol used over Ethernet shall be Modbus/TCP an international industry standard which is an open and well defined protocol.
   3. All Ethernet cabling shall be Category 6 rated for 100baseT, or Fiber Optics rated for 100baseFX.
   4. Coordinate specific needs with Eaton Powernet System

PART 3 - EXECUTION

3.1 INSTALLATION

A. Furnish and install all communications wiring and conduit to provide a complete and operational monitoring system.

3.2 INSPECTION AND TESTING

A. Components and operation of the SCADA shall be thoroughly tested and inspected as follows:
   1. Factory Witness Testing: Prior to delivery to the site, all transfer switchgears and 15 KV switchgear systems, shall be inspected and tested with the SCADA system in one location by the Engineer and the Owners designated representatives. The Owner, Commissioning Agent and Engineer shall schedule and witness a comprehensive factory simulation test that shall simulate the actual operation of the transfer swithgears, 15 KV switchgear and all their components. Provide a digital relay and MODBUS to Fiber Optic converters to simulate and demonstrate communications and control functionality. Provide a minimum of three (3) business days for witness testing. Travel and living expenses for up to six (6) owners' representatives shall be furnished by the SCADA manufacturer.
   2. On-site Progress Testing: During installation on site, the Contractor shall test all sub-systems and sub-components of the SCADA and shall furnish reports to the Owner and Engineer of the results of testing. Contractor shall provide 30 days notification to Owner and Engineer to permit observation of partial system testing.
   3. Final Acceptance Testing: Prior to acceptance by Owner, the entire SCADA systems control and monitoring functions shall be demonstrated to the Owner and Engineer, complete with the 15 KV switchgear and transfers switchgears. Submit detailed testing procedures for approval by the Engineer.

3.3 FACILITY MONITORING SYSTEM (SCADA) POINTS LIST

A. The SCADA Points List indicates the input and output points that will be monitored by the SCADA. Complete monitoring and integration of all SCADA points is required as part of this contract. The SCADA system shall also duplicate all generators, paralleling system and fuel system alarms as indicated on the drawings.

B. The designations within the SCADA Point List are as follows:
   1. Point Name: Indicates the variable to be monitored.
   2. Digital Input (DI): Indicates the variable will be monitored as a digital input.
   3. Analog Input (AI): Indicates the variable will be monitored as an analog input.
   4. Remarks: Provides additional information associated with the point.
   5. Building Management System (BMS): Indicates a common alarm point to be terminated on a separate terminal block designated BMS to be monitored by the Owners facility/building management system.

B. Provide all wiring, tubing/piping, sensing equipment, sensors, transducers, transmitters, power supplies, interposing and control relays and interconnection facilities except where the device code indicates that the device is provided by another contract. Provide additional DI and AI provisions as required to provide the required monitoring and control. The points list is as follows:

POINTS	DI	AI	REMARKS
Commercial Power Fail	X		One for each utility service at each transfer switchgear
Switchgear, Current, Voltage, Watts, VARS, Power Factor Frequency, THD		X	Typical for each switchgear medium voltage emergency bus
Generator, Current, Voltage, Watts, VARS Power Factor Frequency, THD		X	Typical for each engine generator
Generator Winding Temperature		X	Typical for each generator
Generator Bearing Temperature		X	Typical for each generator
Engine RPM, Fuel Pressure, Oil pressure, Coolant Temp		X	Typical for each engine
Generator Battery Starting System Alarm	X		Typical for each engine generator
Generator Alarms		X	Typical for each engine generator (BMS)
Generator Pre-Alarms		X	Typical for each engine generator (BMS)
Switchgear Control Alarms		X	
Generator Neutral Grounding Resistor Failure	X		Typical for each engine generator
Switchgear and Generator Control Set Points		X	All available set points as required for system operation
15 KV Circuit Breaker Trip Unit – All Available Functions and Power Monitoring Parameters		X	Typical for each 15 KV circuit breaker protective relay
Breaker Position Open-Closed-Trip	X		Typical for each 15KV breaker, low voltage draw out breaker (transfer switchgear), and prepared space
Station Battery System Alarms	X		Typical for each battery/charging system
Switchboard Main Breaker Open	X		Typical for all LV transfer switchgears (BMS)
Power Monitoring		X	Typical for each power meter shown

Current, Voltage, Watts, VARS, Power Factor, THD, 30-day kW Demand			on the drawings
Emergency Power Switchboard Ground Fault Alarm	X		Typical for each transfer switchgear
Main Switchboard TVSS Alarm	X		Typical for each transfer switchgear
Critical Low Fuel	X		Typical for each fuel storage tank (BMS)
Critical High Fuel	X		Typical for each fuel storage tank (BMS)
Interstitial Leak	X		Typical for each fuel storage tank
Fuel Tank Level		X	Typical for each fuel storage tank (BMS)
Fuel Pump Running		X	Typical for each fuel transfer pump
Fuel Pump Alarm		X	Typical for each fuel transfer pump (BMS)
Pump Run Time		X	Typical for each fuel transfer pump
Current, Voltage, Watts, Power factor, THD, 30-day kW Demand		X	Typical for each Transfer Switchgear
Gear connected to Alternate Source		X	Typical for each Transfer Switchgear (BMS)
Utility Source Available		X	Typical for each Transfer Switchgear
Emergency Source Available		X	Typical for each Transfer Switchgear

3.4 INSTALLATION

A. Install equipment in accordance with the NEC, manufacturer's recommendations and instructions.

B. Anchor terminal cabinets to the concrete floor by cadmium plated bolts, nuts and washers, not less than 13 mm (1/2-inch) diameter. Furnish 100 mm (4-inch) channel iron sills for new concrete floors and level flush into the floor.

3.5 TECHNICAL SERVICES DURING INSTALLATION AND FIELD TESTING

A. An authorized representative of the SCADA manufacturer shall technically supervise and conduct all of the field adjustments and tests. Major adjustments and field tests shall be completed prior to demonstration. The completed system demonstration shall be witnessed by the Engineer and owner prior to acceptance.

B. When any defects are detected, make corrections and repeat all tests as requested by the Engineer, at no additional cost to the Owner.

3.6 INSTRUCTIONS AND FINAL INSPECTION

A. A complete set of operating instructions for the SCADA shall be included in the O&M manuals.

B. Conduct a final inspection, in the presence of an Owner's representative, to assure that the switchgear and SCADA operate properly in all respects.

C. Furnish the services of a factory-trained engineer for two, 8-hour training periods for instructing personnel in the maintenance and operation of the equipment, on the dates requested by the Owner.

3.7 TRAINING

A. Provide training directed towards the requirements of the Owner. Provide, at minimum, one week (five 8-hr days) of formal training for the entire system, including SCADA and Simulator at the site.

B. Submit proposed training schedule, format, content, location and name and position of training personnel to the Engineer and Owner for comment at least three (3) weeks prior to the proposed commencement of the training session. Provide all equipment and supplies to execute the training program.

END OF SECTION 27 07 17

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SECTION 26 08 03 - DEMONSTRATION OF COMPLETED ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification sections apply to this section.

1.2 SUMMARY

A. This section includes the requirements for demonstration of completed electrical system.

1.3 DESCRIPTION

A. Demonstrate to Owner/Designer/OAR the essential features of the following electrical systems:

1. Systems specified in Divisions 27, 28
2. Electrical Entrance Equipment
    a) Circuit breakers
    b) Fuses and fuseholders
    c) Meters (where applicable)
3. Miscellaneous Electrical Equipment
    a) Kitchen exhaust hood shut down
    b) Electrical systems controls and equipment
    c) Electrical power equipment
    d) Motor control centers
    e) Motor control devices
    f) Relays
    g) Special transformers
    h) Starting devices
    i) Surge suppression equipment
4. Lighting Fixtures (include relamping and replacing lenses)
    a) Exit and safety fixtures
    b) Fixtures, indoor and outdoor
5. Lightning Protection System
6. Distribution Equipment
    a) Lighting and appliance panelboards
    b) Distribution panels
    c) Switchboard
    d) Voltage stabilizers
7. Standby Electrical Equipment
    a) Batteries
    b) Battery chargers

c) Controls and alarms

d) Emergency generators, transfer switches

e) UPS systems

8. Wiring Devices

a) Low-voltage controls

b) Switches: regular, time, occupancy

B. After the completion of testing, each system shall be demonstrated to operate successfully as intended.

1.4 TIME

A. The demonstration shall be held upon completion of all systems at a date to be agreed upon in writing by the OAR.

1.5 ATTENDING PARTIES

A. Provide the demonstration in the presence of the Owner, OAR and the manufacturer's representative.

1.6 DEMONSTRATION

A. Demonstrate the function and location (in the structure) of each system, and indicate its relationship to the riser diagrams and drawings.

B. Demonstrate by "start-stop operation" how to work the controls, how to reset protective devices, how to replace fuses, and what to do in case of emergency.

C. Certificate of Completed Demonstration

1. Submit Performance Verification and Demonstration to Owner Form in Section Project Closeout, signed by the Contractor, Subcontractor and OAR for "each" type of equipment and system. Complete an individual form for each item, equipment and system. Insert one copy in each O & M Manual.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 26 08 03

SECTION 26 08 13 - TESTS AND PERFORMANCE VERIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification sections apply to this section.

1.2 SUMMARY

A. This section includes the requirements for the furnishing of all labor, materials, equipment and services necessary to test and prove performance of the electrical system.

1.3 DESCRIPTION

A. Operate system for a 3-day period. Do performance verification work as required to show that the system is operating correctly in accordance with design. Supply instruments required to read data. Adjust system to operate at the required performance levels.

PART 2 - PRODUCTS – (not applicable)

PART 3 – EXECUTION

3.1 TESTS

A. System:

1. General: After installation of all conductors, and before final acceptance, make required tests to determine proper function of all circuits. Furnish all necessary instruments required to make tests, and correct any deficiencies found. Prior to energizing, circuits shall be tested to verify opens, intentional and non-intentional grounds, and continuity and detect short circuits by approved constant "megger".
2. Procedure:

    a. Insulation resistance of all circuit conductors shall be tested. This is to include all new conductors and all existing conductors that are connected or extended. Each conductor shall have its insulation resistance tested after the installation is completed and all splices, taps, and connections are made except connection to source and point of final termination at distribution or utilization equipment.
    b. Insulation resistance of conductors that are to operate at 600 volts or less shall be tested by using a megohmmeter at not less than 1000 volts DC. Resistance shall be measured from each conductor to all other conductors and from each conductor to conduit (ground).Test duration shall be one minute. Investigate any values which deviate from similar connections by more than 50 percent of the lowest value. Testing methodology shall conform to National Electrical Testing Association

(NETA). Acceptable insulation resistance of conductors rated at 600 volts shall not be less than the recommended wire manufactures accepted values and test equipment manufacture, or 50 megohms, which ever is greater.

c. Conductors that do not satisfy test requirements (b. above) shall be removed, replaced, and testing repeated on new cable, at no additional costs to the Owner. All tests shall be performed by a licensed electrician trained in the use of the test instrument.

d. Contractor shall furnish all instruments and personnel required for tests, shall tabulate readings observed and complete "Conductor Insulation Resistance Test" form (found in Division 01) and submit five (5) copies to Designer/OAR for approval. Test shall be witnessed by OAR and designer (if designer so desires). Final approval data is to be submitted in O&M Manual.

e. Test reports shall identify each feeder conductor tested, date, time, and result of test, weather conditions, and range, test voltage, and serial number of the megger instrument used. Any conductor or splice that is found defective shall be promptly removed and replaced, and additional test shall be performed.

f. Observe all safety instructions set by testing equipment manufacturer to minimize risk of electric shock and sparking.

3. Take readings of voltage and amperage at building main disconnect switch and at main for each panel (panelboard, distribution panel, switchboard), at primary and secondary side of each transformer, at each major item of equipment, and at the end of the longest branch circuit at each panel. The above readings shall be taken (1) "no load" conditions and (2) "full load" conditions with all equipment using electricity. Tabulate readings, complete "TABULATED DATA VOLTAGE AND AMPERAGE READINGS" form included in Division 01. Final approved data is to be submitted in O & M manual.

B. Motors:

1. Test run each motor via motor's control unit in both manual mode and automatic mode. Verify proper operation and voltage.
2. Test run each motor furnished in the Work and all existing motors specifically noted in the Contract Documents to be tested:

a. With the system energized, line-to-line voltage and line current measurements shall be made at the motors under full load conditions. Should measured values deviate +/- 5% from the nameplate ratings, the condition shall be corrected. Notify the designer immediately should deviations occur.

b. Record results of existing motors tested and submit values to OAR in writing.

c. Tabulate readings, complete "Motor Test Information" form included in Division 01 of the General Requirements. Final approved data is to be submitted in O & M manual.

C. Grounds:

1. Test each raceway for raceway continuity as called for in Section 26 05 26.
2. Test each grounding system used in the project as called for in Section 26 05 26
3. Submit "GROUND TEST INFORMATION" form included in Division 01 of the General Requirements for each and every grounding system in the project including but not limited to: each ground rod installation; each water pipe and ground installation (test water pipe to ground and test water pipe to building service equipment); and each building steel ground connection (test building steel to ground and test building steel to building service equipment). Final approved data is to be submitted in O & M manual.
4. Grounding resistance shall be as called for in Section 26 05 26.

5. Testing shall be three (3) point method in accordance with IEEE recommended practice.

D. Communications:

1. See specific sections of these specifications for requirements.

E. Equipment:

1. Equipment items requiring check-out memos are all major items of equipment such as (but not limited to):

a. Panelboards, switchboards.
b. Paralleling Low-Voltage Switchgear.
c. Transformers.
d. UPS equipment.
e. Generator equipment.
f. Checkout and test any other equipment the designer/OAR deems necessary to insure system integrity and safety during construction, regardless if previous testing has been performed.

2. At completion of construction after all performance verification and testing information has been gathered, submitted, and approved, provide one copy of this information to the authorized manufacturer's representative of the equipment.

a. Manufacturer's authorized representative must be trained by the manufacturer and authorized to inspect, adjust, test, and repair equipment.

3. Manufacturer’s authorized representative shall examine the performance verification information, check the equipment in the field while it is operating, and sign a check-out memo for a record.

a. Check out of equipment is to include examining performance and certifying equipment has been installed per manufacturer's recommendations, that all necessary adjustments have been performed and that equipment is operating properly.

4. Submit memo on each major item of equipment. Approved memos shall be scanned and copied onto each O & M CD with the performance verification information and submittal data. Memos shall be submitted and approved before instruction to Owner or a request for final inspection.

5. Do not submit Check-out Memo form at the time Submittal Brochures are submitted.

6. Completion of Construction “Check Out Memo” form included in Division 01.

3.2 DATA PROCESSING

A. Tabulate data for submission.

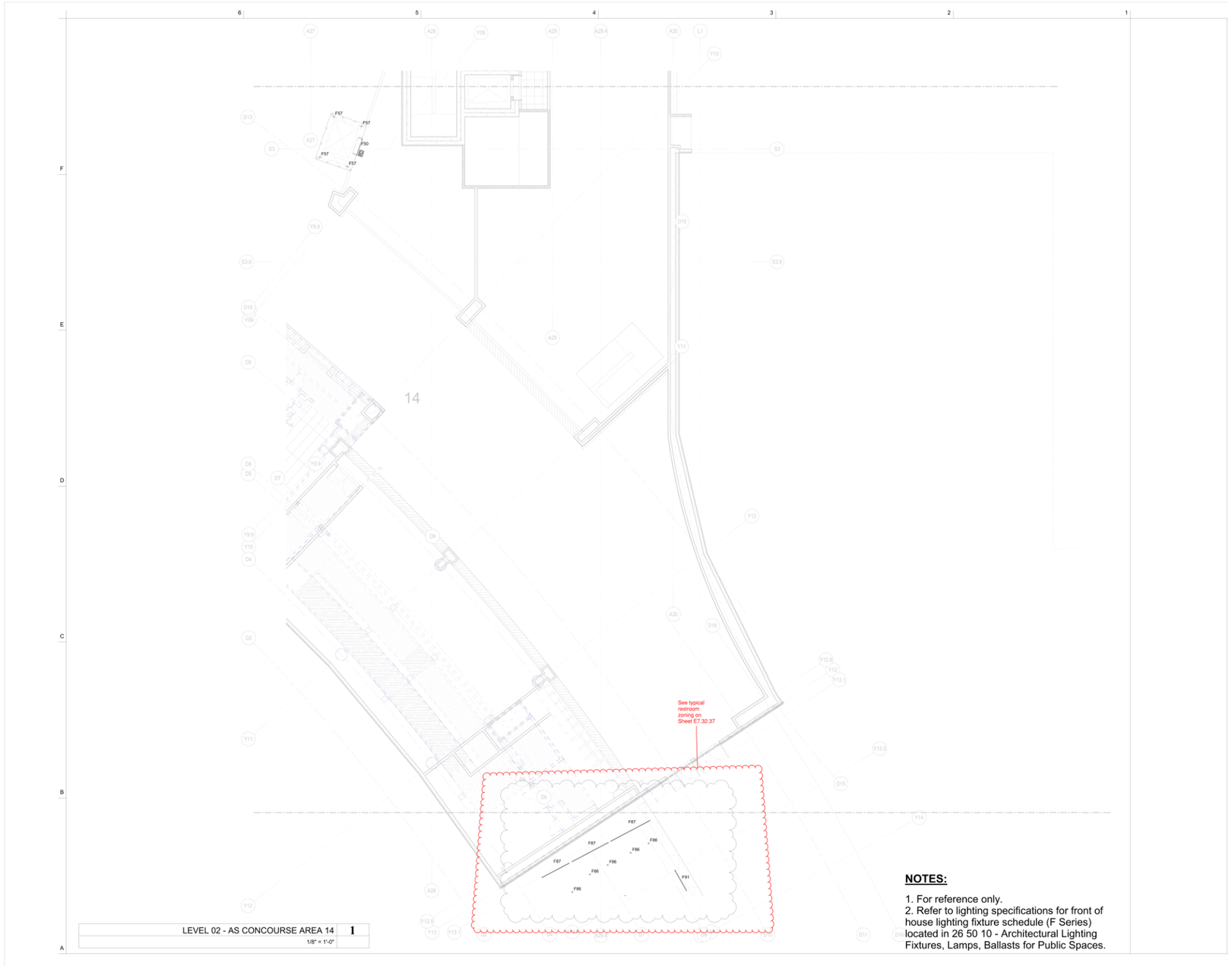
B. Submit data on 8 1/2" x 11" sheets with date and name of checker with one copy for each operation and maintenance CD.

C. Where specific performance verification information is called for in the specifications, use copies of the sheets provided for recording readings.

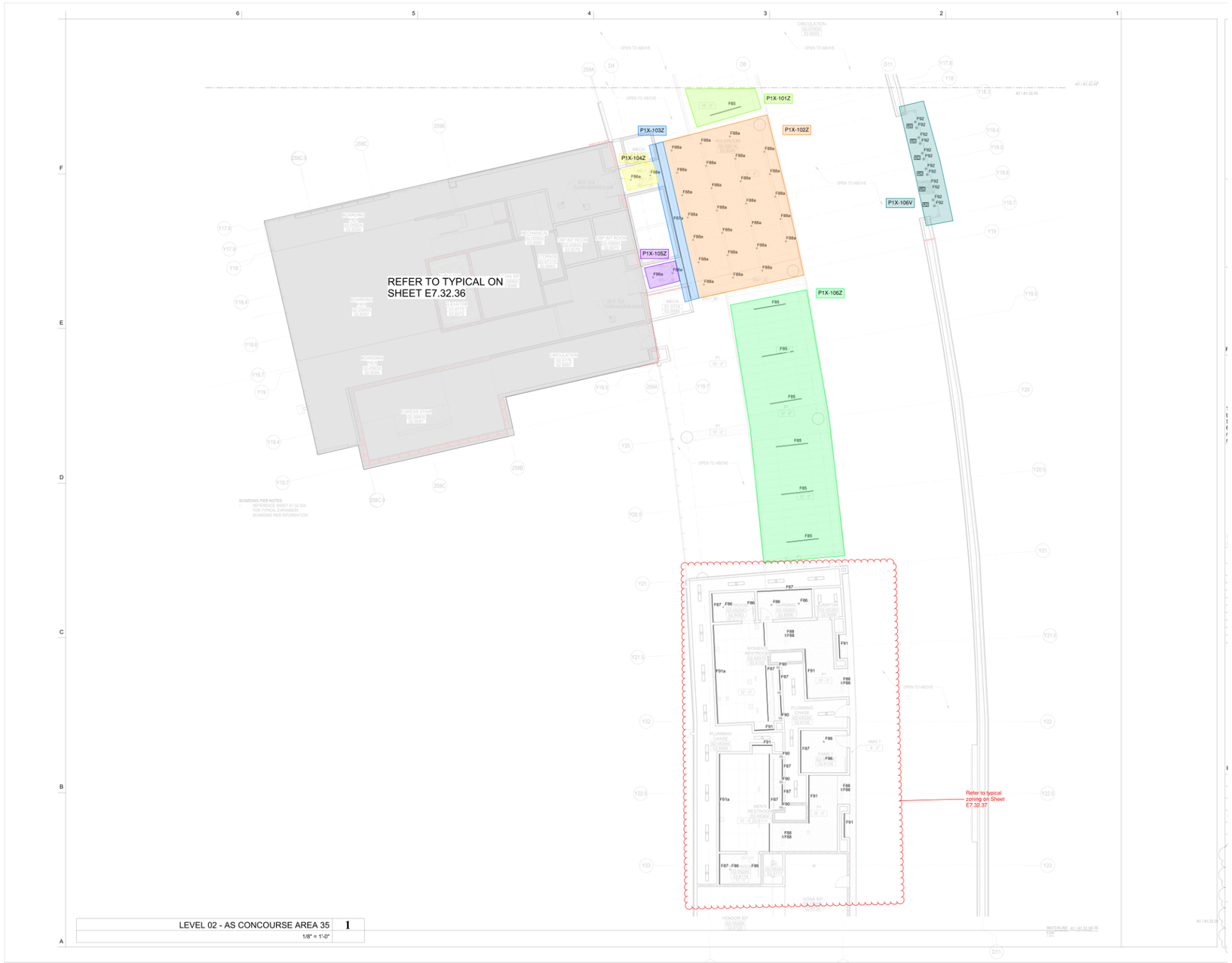
D. Data shall be submitted and approved before Check Out memos are signed or a request for final inspection is made.

END OF SECTION 26 08 13

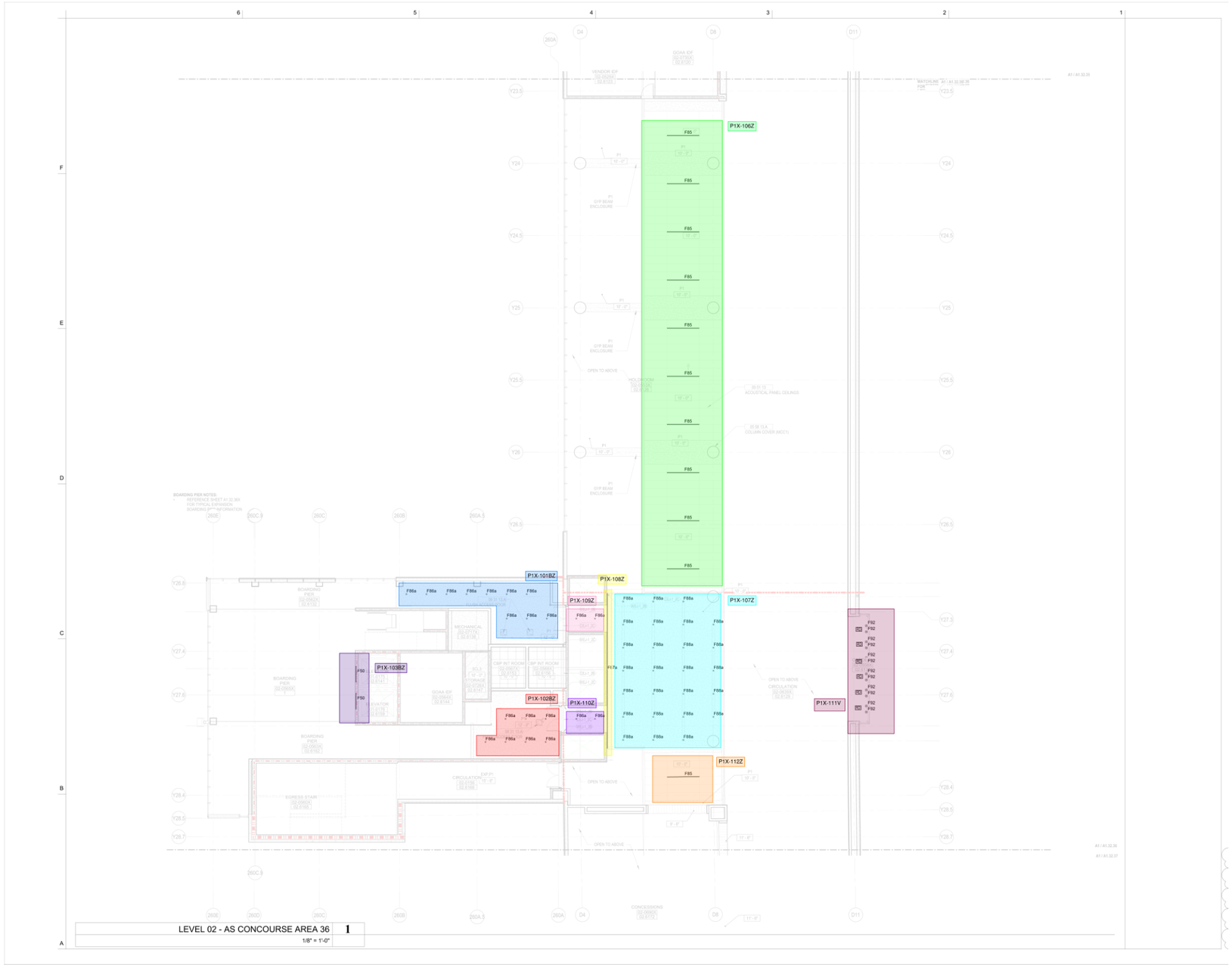
APPENDIX A – LIGHTING CONTROL ZONE DIAGRAMS


14
See typical restroom zoning on Sheet E7.32.37
LEVEL 02 - AS CONCOURSE AREA 14
1/8" = 1'-0"
1
NOTES:
1. For reference only.
2. Refer to lighting specifications for front of house lighting fixture schedule (F Series) located in 26 50 10 - Architectural Lighting Fixtures, Lamps, Ballasts for Public Spaces.

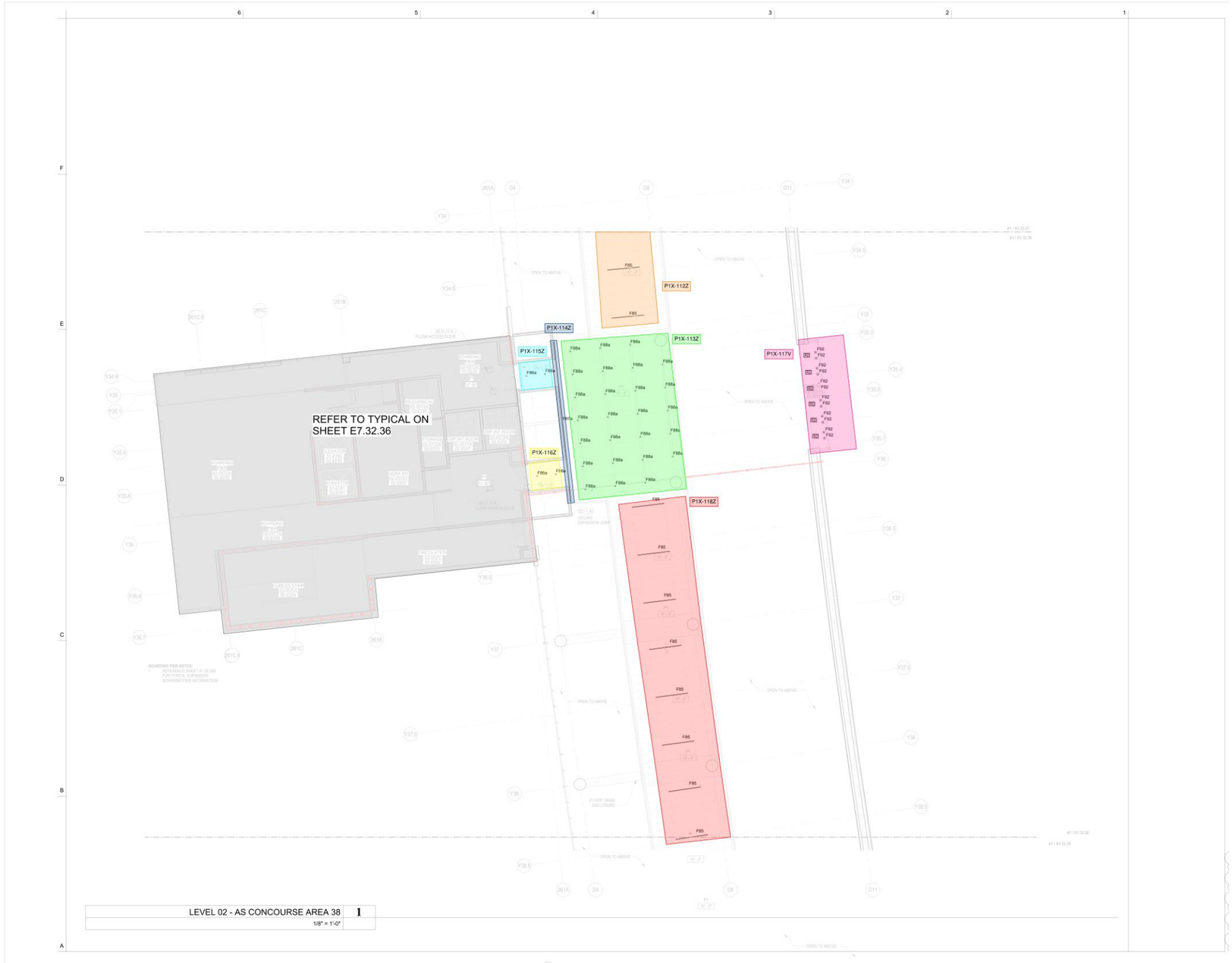
LEVEL 02 - AS CONCOURSE AREA 34 **1**
1/8" = 1'-0"

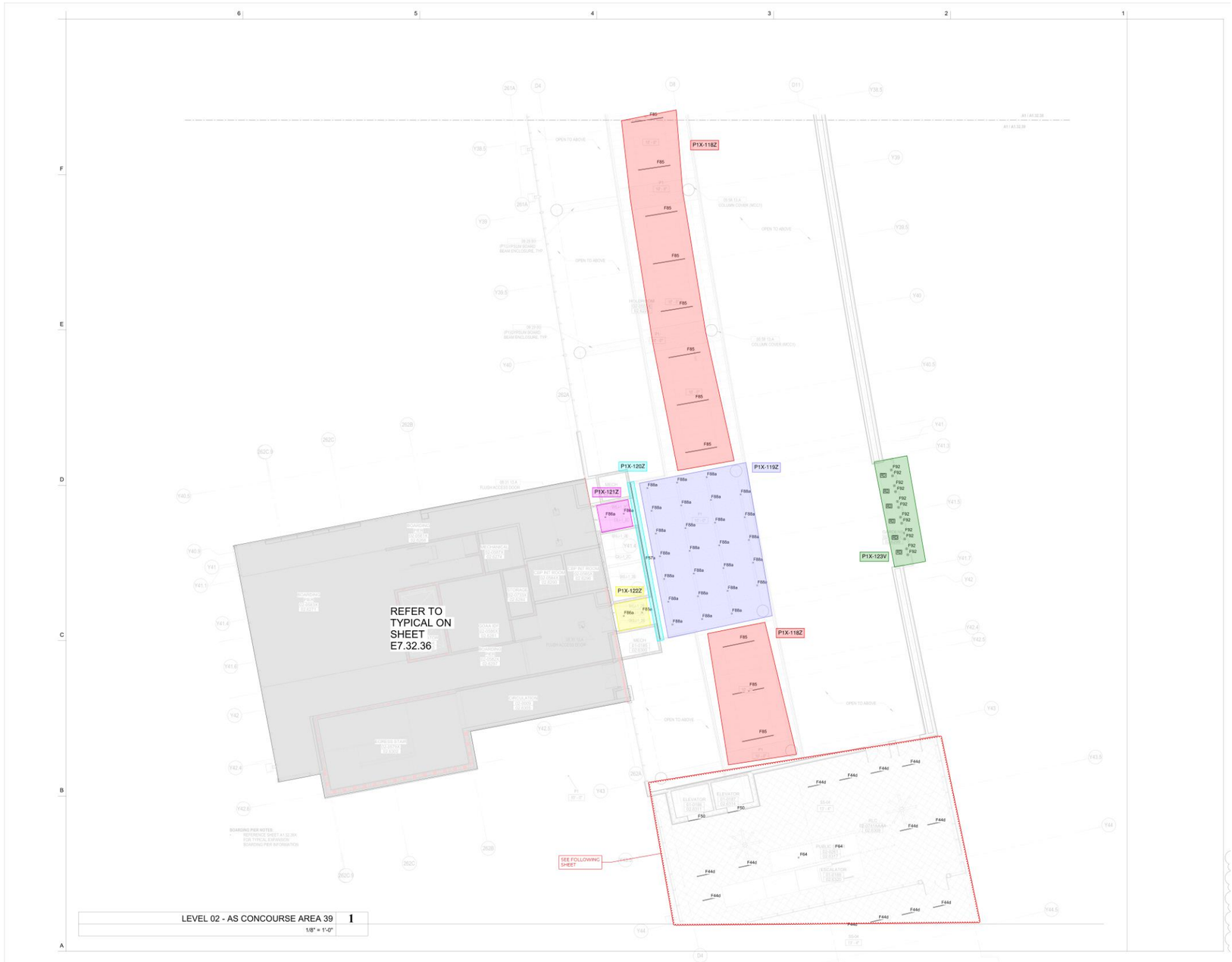


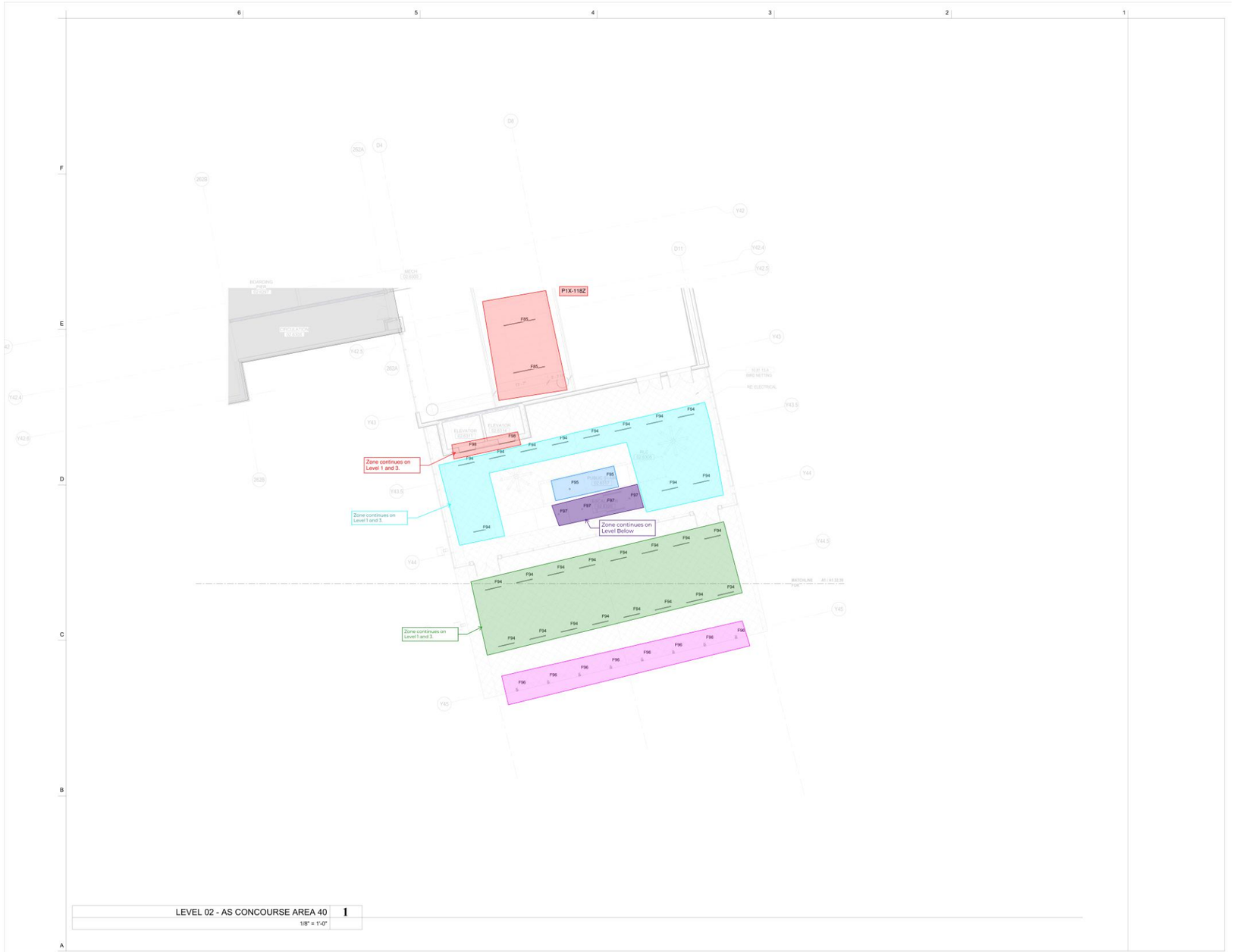
LEVEL 02 - AS CONCOURSE AREA 35 1
1/8" = 1'-0"


P1X-106Z
P1X-101BZ
P1X-108Z
P1X-105Z
P1X-107Z
P1X-103BZ
P1X-102BZ
P1X-110Z
P1X-111V
P1X-112Z
LEVEL 02 - AS CONCOURSE AREA 36
1/8" = 1'-0"

P1X-101AZ
P1X-102AZ
P1X-103AV
P1X-105AZ
P1X-107AV
P1X-108AZ
P1X-104AV
P1X-106AZ
P1X-111AZ
P1X-109AV
P1X-110AZ
P1X-116AZ
P1X-112AV
P1X-113AV
P1X-117AZ
P1X-114AV
P1X-115AZ
P1X-119AV
P1X-120AV
P1X-118AZ
P1X-122AZ
P1X-121AZ
P1X-112ZZ
LEVEL 02 - AS CONCOURSE AREA 37
1
1/8" = 1'-0"

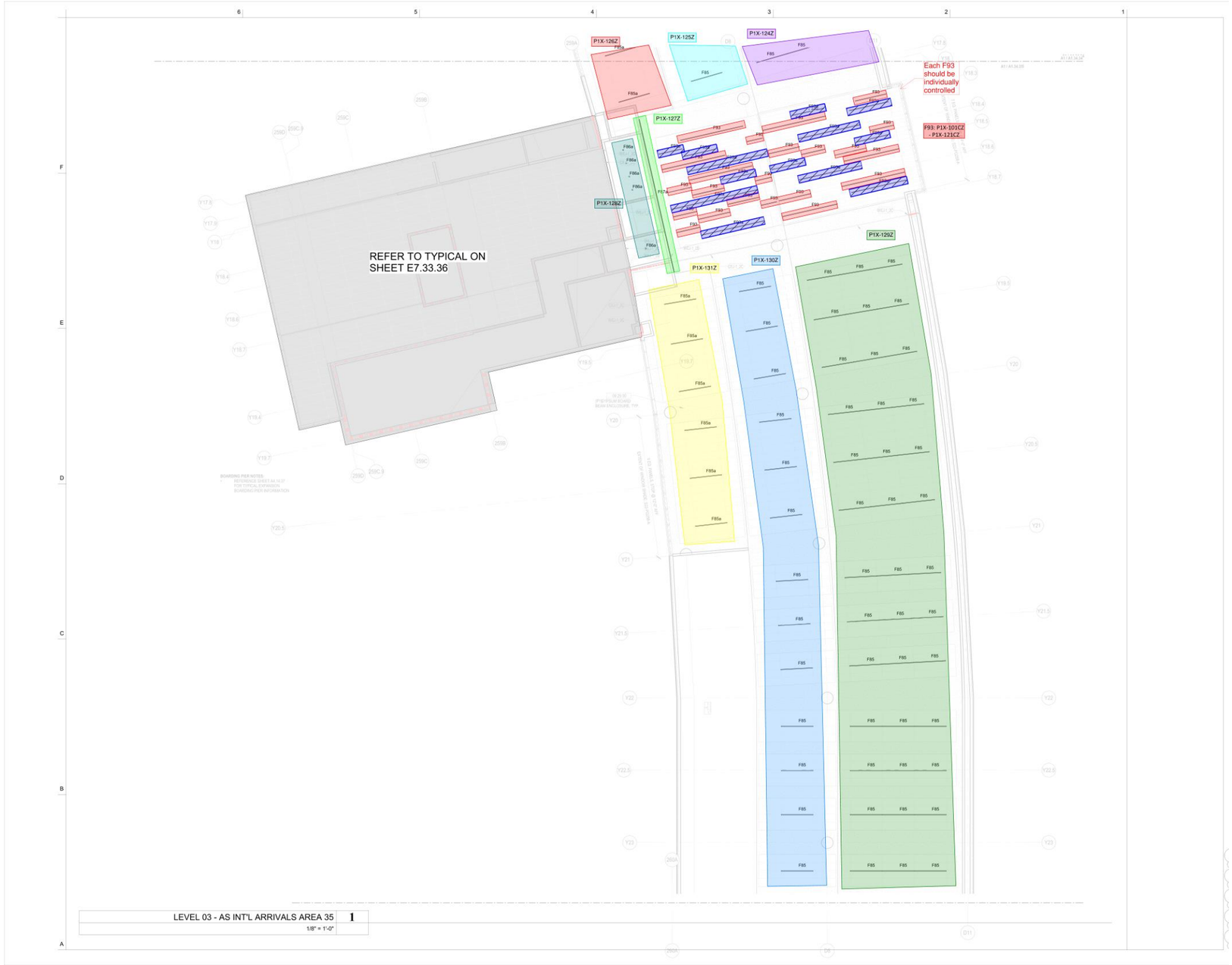

REFER TO TYPICAL ON SHEET E7.32.36
P1X-112Z
P1X-113Z
P1X-114Z
P1X-115Z
P1X-116Z
P1X-117V
P1X-118Z
F85
F88a
F92
LEVEL 02 - AS CONCOURSE AREA 38
1/8" = 1'-0"

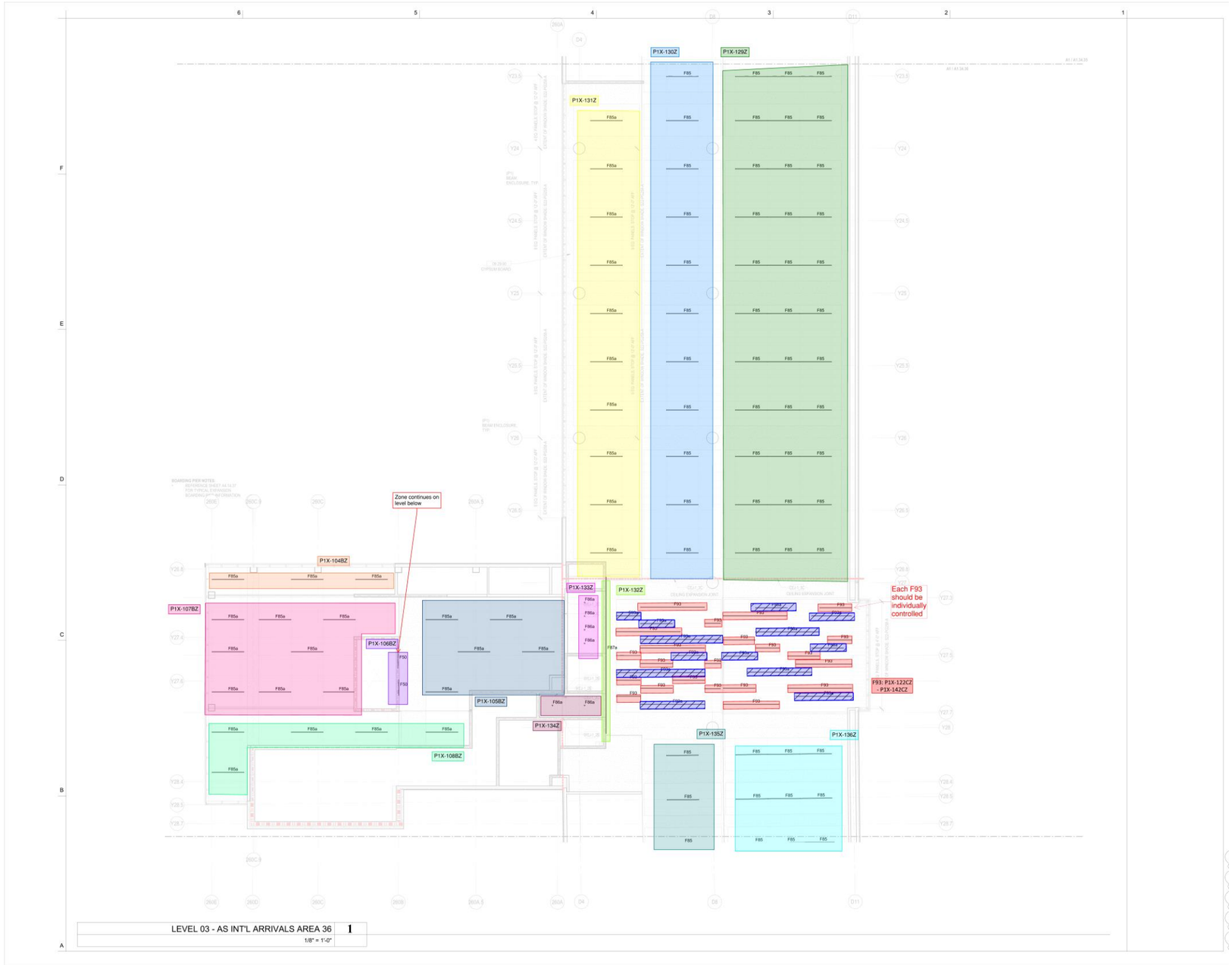

P1X-118Z
P1X-120Z
P1X-119Z
P1X-121Z
P1X-122Z
P1X-123V
REFER TO TYPICAL ON SHEET E7.32.36
SEE FOLLOWING SHEET
LEVEL 02 - AS CONCOURSE AREA 39
1/8" = 1'-0"


P1X-118Z
Zone continues on Level 1 and 3.
Zone continues on Level 1 and 3.
Zone continues on Level Below
Zone continues on Level 1 and 3.
LEVEL 02 - AS CONCOURSE AREA 40
1/8" = 1'-0"
1

F50
F9a
F8a
F85
P1X-125Z
LEVEL 03 - AS INT'L ARRIVALS AREA 14
1
1/8" = 1'-0"
NOTES:
1. For reference only.
2. Refer to lighting specifications for front of house lighting fixture schedule (F Series) located in 26 50 10 - Architectural Lighting Fixtures, Lamps, Ballasts for Public Spaces.

P1X-125Z
P1X-124Z
P1X-126Z
F85
F85a
OPEN TO ABOVE
LEVEL 03 - AS INT'L ARRIVALS AREA 34
1/8" = 1'-0"


P1X-126Z
P1X-125Z
P1X-124Z
Each F93 should be individually controlled
F93: P1X-101CZ - P1X-121CZ
P1X-127Z
P1X-128Z
REFER TO TYPICAL ON SHEET E7.33.36
P1X-129Z
P1X-131Z
P1X-130Z
LEVEL 03 - AS INT'L ARRIVALS AREA 35
1/8" = 1'-0"


P1X-130Z
P1X-129Z
P1X-131Z
Zone continues on level below
P1X-104BZ
P1X-133Z
P1X-132Z
Each F93 should be individually controlled
P1X-107BZ
P1X-106BZ
P1X-105BZ
P1X-134Z
P1X-135Z
P1X-136Z
P1X-108BZ
F93: P1X-122CZ - P1X-142CZ
LEVEL 03 - AS INT'L ARRIVALS AREA 36
1/8" = 1'-0"

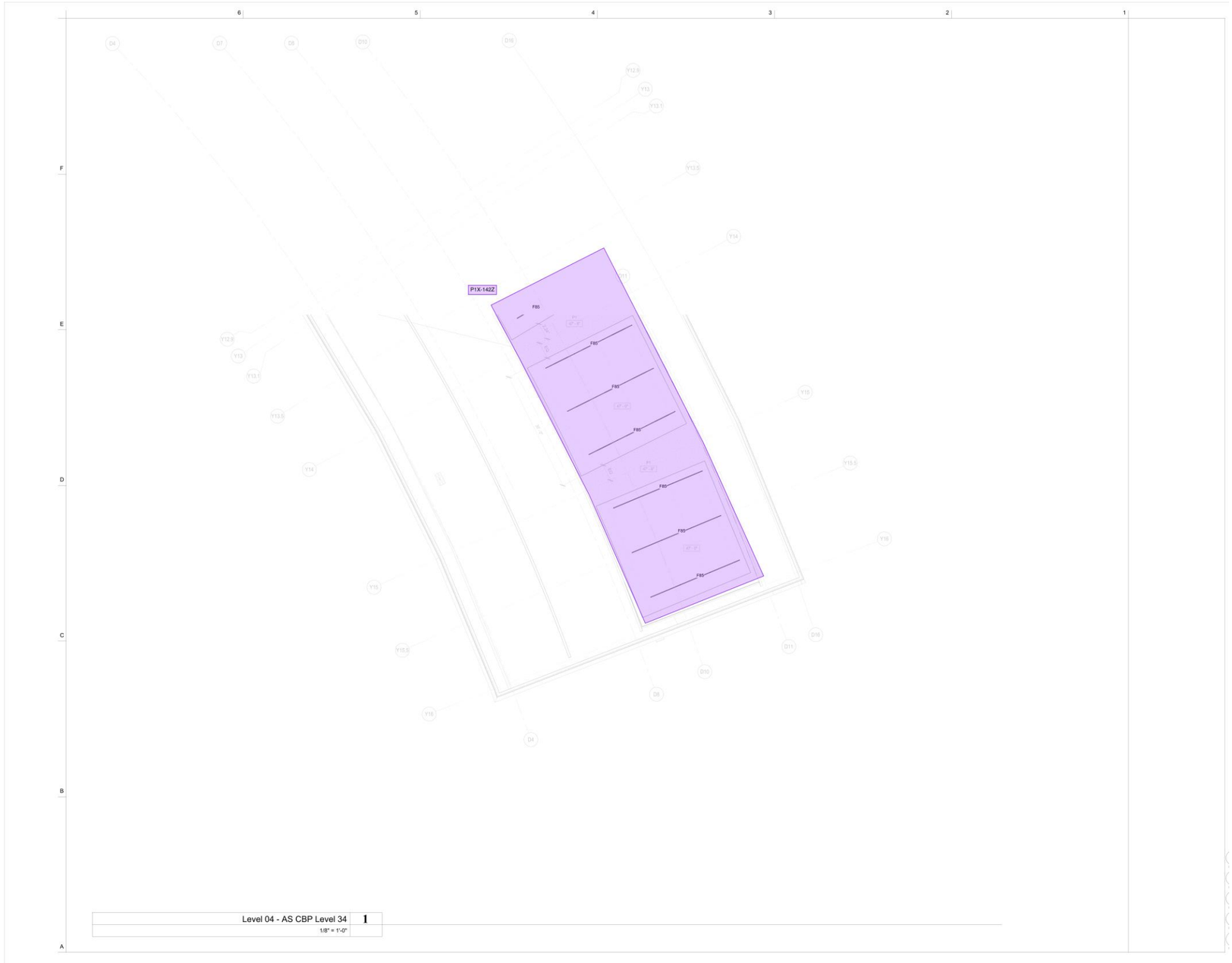
P1X-135Z
P1X-136Z
P1X-134Z
F85
F85a
LEVEL 03 - AS INT'L ARRIVALS AREA 37
1/8" = 1'-0"

P1X-134Z
P1X-135Z
P1X-136Z
P1X-137Z
P1X-138Z
P1X-139Z
P1X-140Z
P1X-141Z
REFER TO TYPICAL ON SHEET E7.33.36
Each F93 should be individually controlled
F93: P1X-143CZ - P1X-163CZ
LEVEL 03 - AS INT'L ARRIVALS AREA 38
1/8" = 1'-0"

P1X-141Z
P1X-140Z
P1X-139Z
P1X-142Z
P1X-143Z
Each F93 should be individually controlled
F93: P1X-164CZ - P1X-184CZ
REFER TO TYPICAL ON SHEET E7.33.36
SEE FOLLOWING SHEET
P1X-130Z
LEVEL 03 - AS INT'L ARRIVALS AREA 39
1/8" = 1'-0"

LEVEL 03 - AS INT'L ARRIVALS AREA 40 — 1
1/8" = 1'-0"

Continues from Phase 1 Zone "221Z"
P1X-142Z
Level 04 - AS CBP Level 14
1/8" = 1'-0"
1
NOTES:
1. For reference only.
2. Refer to lighting specifications for front of house lighting fixture schedule (F Series) located in 26 50 10 - Architectural Lighting Fixtures, Lamps, Ballasts for Public Spaces.



END OF 26 09 24 APPENDIX A

APPENDIX B – LIGHTING CONTROL INTENT NARRATIVE

LIGHTING CONTROL SEQUENCE OF OPERATIONS: PUBLIC SPACES								
AREA	OCCUPANCY / VACANCY / TIMESWITCH				DIMMING, DAYLIGHTING AND LUMEN MAINTENANCE			DYNAMIC LIGHTING
TYPICAL ROOM TYPE	SENSOR TYPE	VACANT TIMEOUT	TECHNOLOGY	NOTES	PHOTOSENSOR	FC TARGET	DAYLIGHTING NOTES	DYNAMIC LIGHTING REQUIREMENTS
HOLDROOM	NONE	N/A	N/A	DURING NORMAL OPERATING HOURS, TIMESWITCHES HOLD ELECTRIC LIGHTING ON, SUBJECT TO DAYLIGHT RESPONSIVE CONTROLS IN THE PERIMETER WINDOW ZONE. DURING DORMANT HOURS, TIMESWITCHES TURN TO EVENING LEVEL AT PREDETERMINED SCHEDULED TIME, INDICATED BELOW. OVERRIDE BY PORTABLE CONTROL DEVICE OR MASTER CONTROL STATION ONLY.	DIM DAYLIGHT RESPONSIVE AND LUMEN MAINTENANCE	25+ FC DAYLIGHT ZONE 15 FC DAYTIME 10 FC EVENING 2 FC DORMANT HOURS	-DURING NORMAL OPERATING HOURS BETWEEN SUNRISE AND SUNSET, LIGHTING ZONE NEXT TO WINDOW IS CONTROLLED BY DAYLIGHT RESPONSIVE PHOTOSENSOR TO MAINTAIN 30 FC. - DAYLIGHT SENSOR SHALL BE SET TO REDUCE ELECTRIC LIGHTING BY LINEAR CONTINUOUS DIMMING. - ONCE THE COMBINED ILLUMINANCE REACHES 50 FC FOR 10 MINUTES, ELECTRIC LIGHTS SHALL TURN OFF COMPLETELY. WHEN DAYLIGHT ALONE DROPS BELOW 30 FC, ELECTRIC LIGHTS SHALL COME ON AT A DIMMED LEVEL TO MAINTAIN DAYTIME ILLUMINANCE LEVEL.	NONE
CIRCULATION / MEZZANINE (DAYLIGHTED)	NONE	N/A	N/A	DURING NORMAL OPERATING HOURS, TIMESWITCHES HOLD ELECTRIC LIGHTING ON, SUBJECT TO DAYLIGHT RESPONSIVE CONTROLS IN THE PERIMETER WINDOW ZONE. DURING DORMANT HOURS, TIMESWITCHES TURN TO EVENING LEVEL AT PREDETERMINED SCHEDULED TIME, INDICATED BELOW. OVERRIDE BY PORTABLE CONTROL DEVICE OR MASTER CONTROL STATION ONLY.	DIM DAYLIGHT RESPONSIVE AND LUMEN MAINTENANCE	25+ FC DAYLIGHT ZONE. 10 FC OCCUPIED. 4 FC DORMANT HOURS	-DURING NORMAL OPERATING HOURS BETWEEN SUNRISE AND SUNSET, LIGHTING ZONE NEXT TO WINDOW IS CONTROLLED BY DAYLIGHT RESPONSIVE PHOTOSENSOR TO MAINTAIN 30 FC. - DAYLIGHT SENSOR SHALL BE SET TO REDUCE ELECTRIC LIGHTING BY LINEAR CONTINUOUS DIMMING. - ONCE THE COMBINED ILLUMINANCE REACHES 50 FC FOR 10 MINUTES, ELECTRIC LIGHTS SHALL TURN OFF COMPLETELY. WHEN DAYLIGHT ALONE DROPS BELOW 30 FC, ELECTRIC LIGHTS SHALL COME ON AT A DIMMED LEVEL TO MAINTAIN DAYTIME ILLUMINANCE LEVEL.	NONE
CIRCULATION (NO DAYLIGHT)	NONE	N/A	N/A	DURING NORMAL OPERATING HOURS, TIMESWITCHES HOLD ELECTRIC LIGHTING ON, DURING DORMANT HOURS, TIMESWITCHES TURN TO EVENING LEVEL AT PREDETERMINED SCHEDULED TIME, INDICATED BELOW. OVERRIDE BY PORTABLE CONTROL DEVICE OR MASTER CONTROL STATION ONLY.	NONE	10 FC OCCUPIED; 4 FC DORMANT HOURS	NO DAYLIGHTING CONTROLS.	NONE
BOARDING PIER	NONE	N/A	N/A	DURING NORMAL OPERATING HOURS, TIMESWITCHES HOLD ELECTRIC LIGHTING ON, SUBJECT TO DAYLIGHT RESPONSIVE CONTROLS IN THE PERIMETER WINDOW ZONE. DURING DORMANT HOURS, TIMESWITCHES TURN TO EVENING LEVEL AT PREDETERMINED SCHEDULED TIME, INDICATED BELOW. OVERRIDE BY PORTABLE CONTROL DEVICE OR MASTER CONTROL STATION ONLY.	NONE	15 FC OCCUPIED; 2 FC DORMANT HOURS	NO DAYLIGHTING CONTROLS.	NONE

LIGHTING CONTROL SEQUENCE OF OPERATIONS: PUBLIC SPACES								
AREA	OCCUPANCY / VACANCY / TIMESWITCH				DIMMING, DAYLIGHTING AND LUMEN MAINTENANCE			DYNAMIC LIGHTING
TYPICAL ROOM TYPE	SENSOR TYPE	VACANT TIMEOUT	TECHNOLOGY	NOTES	PHOTOSENSOR	FC TARGET	DAYLIGHTING NOTES	DYNAMIC LIGHTING REQUIREMENTS
RESTROOMS, SARAs	OCCUPANCY	30 MIN	DUAL TECHNOLOGY	TIMESWITCHES SHALL HOLD ON LIGHTS IN RESTROOMS DURING NORMAL HOURS OF OPERATION, AND TURN OVER CONTROL TO OCCUPANCY SENSORS DURING DORMANT HOURS. LIGHTS SHALL BE REDUCED TO THE DORMANT FC TARGET WHEN UNOCCUPIED DURING DORMANT PERIOD, AND RETURN TO FULL ON WHEN MOTION IS DETECTED. OVERRIDE BY PORTABLE CONTROL DEVICE OR MASTER CONTROL STATION ONLY.	NONE	15 FC OCCUPIED; 2 FC UNOCCUPIED	NO DAYLIGHTING CONTROLS.	NONE
DYNAMIC LIGHTING - AIRSIDE GATES	NONE	N/A	N/A	OVERRIDE BY PORTABLE CONTROL DEVICE OR MASTER CONTROL STATION ONLY. TIMESWITCH TURN OFF DURING DORMANT PERIOD.	N/A	N/A		PER FOOT CONTROL OF COLOR-CHANING FIXTURES. ALLOW FOR EIGHT DYNAMIC SHOWS TO BE PROGRAMMED DURING INITIAL PHASE. SHOWS TO BE TRIGGERED BY EME AND/OR BY SHOW RECALL AT RECALL STATIONS. EACH SHOW IS ANTICIPATED TO HAVE A ONE HOUR DURATION.
NORMAL OPERATING HOURS: **5AM - 1AM** "LOW ACTIVITY" / DORMANT PERIOD: **1AM - 5AM**								

END OF 26 09 24 APPENDIX B

SECTION 26 09 24 - ARCHITECTURAL LIGHTING CONTROL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Commissioning of equipment or systems specified in this section is part of the construction process. Documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel, is required in cooperation with the Commissioning Authority. Project Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure. Refer to Closeout Submittals, Section 01 78 00, for substantial completion details. Refer to Section01 91 13, 23 08 00, and 26 08 00 for detailed commissioning requirements. Refer to 01 78 00 for Operations and Maintenance Data requirements. The systems integrator shall coordinate with the contractor for commissioning process.

C. Relevant requirements of Division 26 and Section 26 50 10 Architectural Lighting Fixtures, Lamps, Ballasts for Public Space also apply to the work of this Section.

1.2 SUMMARY

A. Furnish install, test, calibrate, commission and place into operation Lighting Control Systems as specified herein, as indicated on the drawings, and as required by the job conditions. When work of this section is complete, fully functional preset lighting control systems shall be turned over to the Owner.

B. Types of controls covered in this section include:

1. Whole building digital dimming and switching, including presets and integral timeclock.
2. Local stand-alone room occupancy sensing.
3. Daylight Harvesting – photosensor controls
4. DMX Controls and interfaces
5. Automated shading controls
6. Interfaces with BMS systems

C. Furnish and install a complete system for the control of lighting and other equipment as indicated on the plans, detailed in the manufacturer submittal and as further defined herein. Verify quantity installation locations, and wiring requirements for this project. Specific manufacture's catalog numbers, when listed in this section are for reference only. It is the responsibility of the contractor to verify with the lighting control manufacturer all catalog information, specific product acceptability and compatibility.

D. Coordinate all of the work in this section with all of the trades covered in other sections of the specification to provide a complete and operable system. System Integrator shall coordinate all DMX and Network devices for the contractor.

1.3 SYSTEM DESCRIPTION

A. The lighting control system shall be designed for the control of architectural and special effects lighting and consists of:

1. Factory pre-wired lighting control panels containing dimmers, dimming interfaces, relays, power supplies, breakers, terminals and/or control electronics
2. Processing rack enclosures containing processors, DMX interfaces, alternate system interfaces, and system monitoring equipment.
3. Power loss detection equipment.
4. Field mounted responsive control equipment (sensors).

B. The lighting control system shall be rated for and control life safety lighting where required.

C. The lighting control system shall utilize a network backbone which will be designed to support all lighting control system communication traffic. This network backbone shall be provided as part of IT infrastructure and will be a dedicated VLAN for lighting control.

D. The lighting control system shall be capable of manual and automated control.

1. Manual control shall be via (2)18” master control touchscreens.
2. Automated control shall consist of but not be limited to:
   a. BAS system
   b. Alternate system interfaces via dry contact interfaces or digital input signals
   c. Responsive Control (Sensors)
   d. Astronomical Time Clock

E. The lighting control system shall interface with the following systems:

1. Facility BAS system via BACnet IP protocol – bi-directional.
2. Security System via local dry contact interface
3. Fire Alarm System via local dry contact interface
4. Access control system via local dry contact interface
5. Animation control systems at Tourbillon and Monument Vault via UDP signal over Ethernet – bi-directional.
6. Power loss detection systems via local dry contact
7. Other systems as identified via local dry contact interface.

1.4 SYSTEM INTEGRATOR

A. The lighting control system shall be provided to the electrical contractor through a factory authorized local systems integrator.

B. The System Integrator shall be acknowledged in business as a Lighting Control Systems Integration Company, hereafter referred to as LCSI.

C. The LCSI Company shall employ project managers, factory authorized field service technicians, factory authorized system programmers, and other experienced specialty

personnel required to complete work, experienced in projects of similar or greater size and scope.

D. The LCSI shall be a lighting system contractor who regularly engages in the furnishing, installation and servicing of systems of similar nature, size, scope, and complexity.

E. LCSI shall maintain following certifications:

1. Certified Limited Energy Electrical License with Greater Orlando Airport Authority.
2. LCSI shall be a U.L. Listed 508A panel shop.
3. At least (2) staff members on the project team who are manufacturer certified as advanced systems programmers for the manufacturer of the hardware supplied.
4. Appropriate Insurance coverage to meet the project requirements.

F. The LCSI shall supply all required equipment for the lighting control system to provide a full and completely functioning system.

G. The LCSI shall provide but not be limited to the following services for the project:

1. Provide full technical integration services for lighting control system
2. Coordinate lighting control system panel schedules with approved lighting fixtures
3. Develop and present lighting control system submittal and integration drawings in compliance with the contract documents, submittal requirements as listed in other areas of this specification, and shall include:
   a. Contact sheet for lighting control system technical project team to include:
      1) Manufacturer's project manager
      2) LCSI team – their roles and contact information
      3) Lighting Control System Manufacturer's Agent for jobsite territory
      4) 24/7/365 Manufacturer's Service Hotline
      5) 24/7/365 LCSI Service Hotline
   b. System Narrative and Operational Sequence
   c. Complete Hardware Bill of Materials & Services Bill of Materials
   d. A written document included with the shop drawings, indicating that the equipment submitted meets the drawings and each line item in the Specification and Lighting Control Intent Narrative, and if not, noting any exceptions. Document shall indicate how the proposed product exceptions still meet or exceed the intended performance described, specified or provided by the "basis of design." Submit all relevant UL file cards or test reports which cover the equipment submitted, to demonstrate compliance with the Specifications
   e. Lighting Control System riser diagram
   f. Lighting Control Panel Schedules
   g. Lighting Control DMX patch chart
   h. Plan view drawings with all lighting control equipment locations identified
   i. Plan view drawing showing DMX wire routing.
   j. Hardware data sheets for each piece of hardware supplied

k. Graphics submittal package for touchscreen user interfaces
   1) provide screen flow chart
   2) provide pdf screen shots of pages with narrative of page operational intent.

4. Supply lighting control equipment to job site and perform room by room job walk with contractor prior to mechanical and electrical installation of lighting control equipment by contractor.
5. Terminate lighting control system digital control wire
6. Terminate DMX wire at DMX controlled lighting fixture driver
7. Set DMX address of DMX controlled fixtures
8. Test DMX lighting control fixtures for proper operation prior to connection to lighting control system
9. Test 0-10V controlled fixtures prior to connection to lighting control system
10. Coordinate lighting control system IT VLAN routing with IT staff/vendor
11. Set photo cell address, control zone, response mode
12. Coordinate and program interface points and methods with other trades to include but not be limited to BAS, fire alarm, security, access control, and special effects animation control.
13. Provide and coordinate the services of a manufacturer's certified advanced systems programmer to energize and program lighting control system.
14. Test and verify all lighting control system functions.
15. Assist the lighting designer in setting/programming system light levels in all areas.
16. Provide documentation of all final settings and programming, and DMX preset "show" characteristics.
17. Coordinate and perform lighting control system testing and verification with Cx agent
18. Provde initial 4 hour training of owner's staff over O&M of lighting control system in conjunction with manufacturer's project manager. This training shall occur after system has been energized, configured, checked out, light levels are set with lighting designer and accepted by owner.
19. Provide 2 additional 4 hour training sessions for owner's staff over O&M of lighting control system during first year of operation.
20. Provide an annual maintenance plan to the owner at conclusion of project.
21. Produce an as-built version of system submittal documentation and present to the owner.
22. Provide owner as built software configuration files for entire system for all hardware in system.

H. Preapproved LCSI

1. Candela Controls, 751 Business Park Boulevard, Winter Garden, Florida

I. Other LCSI wishing to be approved to bid this project shall submit the following information 15 days prior to the bid date for consideration to be listed as a qualified LCSI by addenda:

1. Company contact information
2. Proposed project team with credentials, bios, certifications

3. Company Insurance Coverage
4. State of Florida license for business and Low Voltage license number
5. U.L. shop status
6. Proposed Manufacturer of lighting control products
7. Complete Proposed Bill of Materials of hardware and services
8. Detailed specification variances of proposed system per 1.4.G.3 d above.
9. Specification variances of LCSI capabilities
10. A listing of 5 projects of similar scope with current site references

1.5 CONTRACTOR'S SCOPE

A. Contractor shall purchase the lighting control system and LCSI services through a prequalified LCSI.

B. Contractor shall be solely responsible for ensuring entire scope of work associated with providing, installing, programming, and training on the lighting control system is complete, timely and carefully coordinated with the LCSI.

C. Contractor shall perform all mechanical, electrical installation of the lighting control system equipment with advisement of LCSI.

D. Contractor shall provide all wire, conduit, mounting hardware necessary to mechanically and electrically install the lighting control system.

E. Contractor shall coordinate all IT requirements for lighting control system.

F. Contractor shall utilize the services of LCSI to provide LCSI services detailed herein.

1.6 MANUFACTURER SYSTEM SERVICES

A. Manufacturer of equipment shall include a complete system of hardware and factory services in their system Bill of Materials and Services.

B. Manufacturer of equipment shall include the services of a factory project manager who will be engaged in this project from start to finish. Factory project manager shall not be omitted in favor of LCSI or local systems integrator.

C. Manufacturer shall utilize the services of a LCSI for local site services, however, manufacturer shall remain responsible for entire system bill of materials, system submittal drawings, site services, system software configuration, as built drawing set, and system warranty.

D. System software configuration shall be developed by factory special projects support group via a factory qualified advanced systems programmer. Local integration and adjustment of configuration may be performed by local systems LCSI under the direct advisement of factory advanced systems programmer. Manufacturer shall carry system software warranty and store backup of active system software configuration.

1.7 DEFINITIONS

A. In this specification, the term "Architect" includes the Architect, Construction Manager, Engineer, GOAA, Owner's representative, Commissioning Agent and/or the lighting specifier, together or individually, as they shall decide.

B. The use of the word "Approved" shall not extend the Architect's responsibilities beyond that as defined in the General Conditions.

C. BAS: Building automation system. BMS: Building Management System

D. DMX: as per ANSI standard

E. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50V or for remote-control, signaling, and power limited circuits.

F. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.

1.8 GENERAL REQUIREMENTS

A. Provide labor, materials, and equipment for the installation, testing, and calibration of lighting control systems as shown on the drawings and specified herein. Provide training for Owner’s maintenance personnel as specified herein.

B. Refer to drawings for dimensions and details. Check and verify dimensions and details on drawings before proceeding with the Work. Report any inconsistencies or discrepancies at once to the Architect. Should it appear that the Work intended is not sufficiently detailed or explained on the drawings or in the specifications, apply to the Architect for further drawings or explanations, as may be necessary. Conform to these explanations in the work. If any question arises about the true meaning of the drawings or specifications, refer the matter to the Architect, whose decision is final and conclusive. Under no circumstances shall any request for extra compensation be honored where the basis of claim is such a clarification by the Architect or Owner. In no case submit a bid, or proceed with any Work with uncertainty. The intention of this specification and the accompanying or applicable drawings is to provide completely functioning lighting control systems. The Contractor for this Work shall take full responsibility for this result.

1.9 COORDINATION

A. Coordinate Work with all other applicable plans and specifications, including but not limited to wiring, conduit, luminaire and dimming schedules, emergency power, A/V systems, fire alarm systems, security systems, and building-wide energy management systems. Bring conflicts to the Architect’s attention before proceeding with the Work. Although the location of equipment included in the Work of this Section may be shown on the Contract Drawings in a certain place, actual construction may disclose that the location for the Work does not make its position easily and quickly accessible. In such cases, call the Architect’s attention to this situation before installing this Work, and comply with Architect’s installation instructions.

B. Clearly indicate the work to be performed by other trades' contractors, and the materials that are adjacent to or abutting the Work of this Section. Coordinate as required. Give ample notice of special openings required for placing equipment in the building, in order to avoid damaging other trades’ work. Furnish the materials and labor for Work of this Section in ample time and in sufficient quantities so that all of the Work may be completed in proper sequence. Schedule the Work to prevent Work

of this Section being damaged by other trades' work. Remove and replace any Work so damaged at no cost to Owner. Coordinate and schedule the Work of this Section with other trades' work and with utility companies so that there shall be no delay in the proper installation and completion of any part of the job.

C. Contractor shall specifically ensure that all lighting load types are compatible with and coordinated with the lighting control system before placing release orders for lighting and/or controls.

1.10 QUALITY ASSURANCES

A. Comply with the General Requirements related to Quality Control, in addition to the provisions herein.

B. Acceptable manufacturers are listed herein. See Paragraph 2.1, below, for more information.

C. Statement of Application:

1. By commencing the Work of this Section, the Contractor assumes overall responsibility, as a part of the warranty of the Work, to assure that assemblies, components and parts shown or required within the Work of this Section, comply with the Contract Documents.
2. Warranty: In addition to any warranties required by the General Requirements, the Contractor for the Work of this Section shall:
   a. For a period of one year after Owner's initial acceptance and establishment of the beginning date of the warranty period, and at no additional cost, promptly provide and install replacements for any lighting control system components that in the opinion of the Owner are defective in materials or workmanship under normal operating conditions; or repair installed equipment at the job site to Owner's satisfaction. Contractor also warrants replacement components to be free of defects in workmanship and materials for a period of one year following replacement, and shall replace any defective replacements.
   b. Contractor shall not be held responsible for acts of vandalism or for abnormal or accidental abuse of the lighting control systems occurring after the beginning of the warranty period, nor shall the Contractor be held responsible for deleterious effects caused by maintenance procedures performed without the concurrence of the Contractor.

D. In addition to standards that may be referenced in Division 1, all items of equipment and individual components shall comply with the applicable standards of the following organizations:

1. Underwriters Laboratories (UL).
2. National Electrical Code (NEC).
3. National Electrical Manufacturer's Association (NEMA).
4. United States Institute of Theater Technology (USITT).

E. Substitutions:

1. Furnish equipment exactly as specified, unless substitutions are mutually agreed upon by Owner, Architects, Engineer and Lighting Designer.
2. The manufacturers' products listed below form the basis of design. Any proposals for substitutions must be submitted at least three weeks prior to the end of the bid period. The substituted product must meet every criterion of the performance specifications and the characteristics of the specified manufacturer. Further, the submittal package for substitutions shall be comprehensive and convincing. Any differences in achieving the intended results, between the proposed manufacturer and the named manufacturer's products shall be clearly delineated and the consequences thoroughly explained. Substitution submittal shall include detailed wiring diagrams specifically tailored for this project.
3. Manufacturer's lead time shall not be a justification for substitutions. The schedule below must be followed to ensure that product is ordered in a timely manner.

1.11 SUBMITTALS

A. General:

1. Shop drawings, samples, test data and certificates shall be submitted for approval in accordance with the requirements of the Contract Documents and General Requirements. Lighting control system components shall not be shipped, stored or installed into the Work unless prior approval has been received, based upon the submittal of shop drawings, samples, catalogue cuts, test data, certificates or other material submitted for approval.
2. Submit samples of all finishes and all visible faceplates, outlets, and trim for components installed in finished spaces, when requested by Architect.
3. After the final inspection, provide a complete set of as-built control drawings as part of the Operating and Maintenance Manual. See Part 3, below, for more information.

B. Submittal Schedule (Note: All days, week or months listed are "calendar " days, weeks or months, and not working days, weeks or months):

1. Submit shop drawings not less than twenty-six (26) weeks before lighting control system components are required on the site. Clearly indicate manufacturer's lead times for fabrication of all components.
2. Within twenty (20) days after receipt of shop drawings marked "No Exceptions Taken" or "Make Corrections Noted", Contractor shall release the lighting control systems for fabrication and forward to the Architect and Owner verification that the lighting control systems have been released for fabrication and a guaranteed shipment date for each component.
3. All samples shall be received by the Architect within fourteen (14) days after Contractor's receipt of shop drawings marked "No Exceptions Taken" or "Make Corrections Noted".
4. Within fourteen (14) days after Contractor's receipt of shop drawings marked "Revise and Resubmit" or "Rejected", Contractor shall resubmit revised shop

drawings to the Architect, in accordance with the General Requirements regarding re-submissions.

5. Contractor shall notify the Architect of any potential scheduling problems, or of any submittals that have not been returned to the Contractor which are required to maintain the installation schedule. Such notification shall be in a timely manner and well in advance of the time such delay might affect the fabrication schedule or appropriate delivery of lighting control system components.

C. Shop Drawings:

1. Submit a one-line diagram showing all components of the lighting control system. Show all panels, dimmers, controls, input and output jacks, back box sizes, the interconnect wiring between all components, and any special installation considerations.
2. Submit a dimming load schedule that clearly lists the actual loads per circuit, which circuits are wired for emergency power, and the corresponding circuit numbers (per the electrical drawings). Each load schedule shall be arranged (by zone and circuit number) to match as closely as possible the panels / schedules shown in these specifications or on the drawings
3. Submit a complete and detailed list (bill of materials) for all hardware and services provided.
4. Submit a one-line diagram showing all components of the lighting control system. Show all panels, dimmers, controls, input and output jacks, back box sizes, the interconnect wiring between all components, and any special installation considerations.
5. Submit full set of technical data sheets.
6. Each control manufacturer shall substantiate conformance to the Specifications by submitting a written document included with the shop drawings, indicating that the equipment submitted meets each line item in the Specification and Lighting Control Intent Narrative, and if not, note any exceptions. Indicate how the proposed product exceptions still meet the intended performance described, specified or provided by the “basis of design.” Submit all relevant UL file cards or test reports which cover the equipment submitted, to demonstrate compliance with the Specifications.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Provide materials, equipment, appurtenances and workmanship for the Work of this Section conforming to the highest commercial standards, as specified and indicated on the drawings.

B. Named manufacturers, when listed below, are representative of an adequate level of quality and reputation, and are allowed to submit a product, provided that they are capable of satisfying the provisions of the specifications in every respect. This does not mean that any standard product provided by that manufacturer is automatically qualified. Manufacturers not on this list may be proposed during the substitution period if they can provide substantiation that their product meets every particular of the relevant specification, and are of comparable quality, experience and reputation.

See the paragraph titled "Substitutions", above. The Architect may reject any product without detailed explanation.

C. Dimming and relay panels, dimmers, relays, and lighting control stations shall be fabricated by a single primary manufacturer. System components are not fabricated by the primary manufacturer shall be included in the primary manufacturer's shop drawings, and explicitly endorsed and warranted by the primary manufacturer. The primary manufacturer shall assume overall responsibility for compatibility of their system with any other manufacturer's components. The primary manufacturer shall have at least ten (10) years experience manufacturing lighting control systems for LED sources, and shall offer telephone support 24 hours per day, 365 days per year. Manufacturer shall ship repair and replacement parts overnight, and shall have service engineers available within 48 hours of any service request.

D. Acceptable Primary Manufacturers: Electronic Theater Controls (ETC) with Net3, Unision Paradigm, Virtual Touchscreen, Light Designer Software, and DMX Shows.

E. Additional Named Manufacturers: Crestron

2.2 GENERAL LIGHTING NETWORK

A. General

1. The network shall provide data distribution over TCP/IP Ethernet networks. Data shall be layer 3 routable. Systems using proprietary formats or formats other than 10/100/1000Mbit wired Ethernet or non-layer 3 routable networks shall not be accepted.
2. Connections shall be made between consoles, face panels, architectural processors, dimmers, network gateways, and computers over standard Ethernet distribution systems using 100BaseT, 100BaseFL, or greater wiring. All installations shall conform to established Ethernet wiring practice, and installation shall be performed by contractors qualified to do this type of work. All wiring shall be tested at Category 5e or higher for full bandwidth operation to the appropriate IEEE standard.
3. The Lighting Control system must be supplied by a single manufacturer and must have seamless integration over Ethernet between the Entertainment and Architectural lighting control.

B. Capacities.

1. T The network shall support DMX routing, patching, and prioritization for up to approximately 64,000 universes (over 32,000,000 DMX addresses). Each address may be input or output from any port on any DMX gateway in the system. DMX input, routing and output shall be specifically supported on the system from multiple sources and locations up to the maximum number of gateways supported by the Ethernet topology.
2. The network shall support multiple network hosts including consoles, gateways, dimming racks, computers, file servers, printers, and architectural control processors with discrete command lines and control. The lighting

network shall support multiple venues within a system and discrete systems on the same network.

C. System Configuration and Monitoring

1. Network device configuration shall be via software and/or ANSI E1.17 Architecture for Control Networks (ACN).
2. Patch addresses shall support viewing and manipulation via ANSI E1.17 ACN.
   a. The system shall permit complete user flexibility allowing the system operator to patch each DMX input address to any ANSI E1.31 streaming ACN address, and DMX output to span streaming ACN universes.
   b. The lighting system shall support assignment of DMX offsets, truncation of DMX universes, and provide choice of DMX port prioritization.
   c. The lighting system shall support the DD start code extension to ANSI E1.31 which provides priority per address such that multiple control sources can share universes with discrete control per address.
   d. Lighting systems that do not support the above mentioned address patching capabilities shall not be suitable.
3. The system shall allow assignable labels for all network devices to allow easy identification by system users.
4. Each network device shall have a discrete and unique IP address provided automatically by the software. The user may edit this IP address. Systems that do not support automated IP allocation with IP collision avoidance, and systems that do not allow complete reconfiguration of the above mentioned features over ANSI E1.17 ACN shall not be acceptable.
5. All configuration data for each network device shall be held at the device and system operation shall not require continuous on-line operation of the network configuration software.
6. Lighting console operators shall be able to backup the network configurations in the lighting control console. In the event of a network device failure, the operator shall be able to apply the configuration of the failed device to a replacement device of the same type without manually reentering settings. Systems that do not support configuration backup as described above shall not be accepted.
7. Architectural and Entertainment systems connected to the same network shall be capable of arbitrating control over E1.31 Streaming ACN (sACN) level data. The system shall be capable of alternating control of individual address data between architectural and entertainment systems without intervention by the user. The user shall dictate the conditions under which system shall automatically take control. The network shall allow user override of the selected defaults. Systems which require direct user intervention to allocate control of dimmers between architectural and entertainment lighting systems shall not be accepted.
8. The network shall allow multiple DMX input sources to be prioritized on the same universe as network native sources using E1.31 Streaming ACN prioritization. Multiple DMX inputs may be assigned to the same streaming ACN address (this provides multi-source control for a particular address). Likewise, the system shall support E1.31 prioritization of multiple

simultaneous network sources. Systems that cannot prioritize multiple DMX inputs and multiple native network sources on a network shall not be deemed suitable.

9. The lighting network shall allow each DMX input address to be assigned a priority on the network allowing each DMX control level coming into the system to participate in full arbitration. Addresses with the highest priority shall have control, with lower priority addresses being ignored. Addresses assigned the same numeric priority, between 1 and 200, shall respond in highest level takes precedence (HTP) manor. The network shall require a valid DMX signal present at the input to initiate prioritization. Systems that do not allow for prioritized HTP for DMX inputs to the network shall not be allowed.

D. Operational Features

1. Each DMX gateway shall control up to 512 DMX addresses per port, within the confines of up to approximately 64,000 DMX universes (over 32,000,000 DMX address). The specific DMX data input or output by the gateway shall be configurable by the user.
2. Duplicate outputs of DMX data (DMX splitter) and discrete outputs shall be fully supported.
3. Merging of multiple DMX input sources on a single gateway without gateway with DMX output on the same gateway shall be supported without connection to the network. The gateway shall support assignment of priority to each input source independently
4. File transmission, synchronization and access to software shall be supported.

2.3 CENTRAL LIGHTING SERVER RIALS

A. The Architectural Control Server shall be manufacturer by the primary manufacturer.

1. Connections shall be made between lighting system components over standard Ethernet distribution systems using 10/100BaseT.
2. The server shall be tested to UL standards and labeled ETL Listed
3. The server shall be RoHS Compliant (lead-free)
4. The server shall be CE compliant

B. Mechanical

1. The Central Control Server (CCS) assembly shall be designed for use with acceptable and compatible Control Systems.
2. CCS electronics shall be contained in a single assembly.
   a. The assembly shall be housed in a formed steel body
   b. The server shall be fabricated of 16-gauge steel, finished in fine-texture, scratch-resistant, powder coat paint
   c. Mounting holes shall be provided for installation of a rack mount kit
3. User Interface
   a. The CCS power button shall be backlit for use in low-light conditions.
4. The CCS shall provide a Universal Serial Bus (USB) port on the front panel for transfer of configuration data.

5. The CCS shall provide rear-panel connections for (2) RJ45 jack for Ethernet connection to the processor for configuration, virtual touchscreen (VTS) and web-browser-based system access.
6. Architectural Lighting System configuration and program information shall be stored in solid state memory, which does not require battery backup.
    a. The CCS shall provide a hard drive for storage of system configurations.

C. Electrical

1. The CCS shall support 100-240VAC power input and utilize an external transformer power supply
2. The CCS shall allow for nearly silent operation
3. The server shall utilize microprocessor based, solid state technology to provide multi-processor lighting and building control
4. The server shall provide two IEE802.3u Ethernet connections for 100BASE-TX communication with the lighting control system
    a. The Primary Ethernet port shall be reserved for connection to the lighting control system
    b. The Secondary Ethernet connection shall be used for interface with BACnet IP enabled building systems
    c. Both Connections shall support virtual touchscreen (VTS) functionality
5. Following a loss of power, the CCS shall return to its previous power state upon power being restored.

D. Environmental

1. The ambient operating temperature shall be 0° to 40°C (32° to 104°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

E. Functional

1. Capacity
    a. Shall support up to 48 Architectural Control Processors (ACP)
    b. Shall support up to 12 individual projects
2. System
    a. Shall support multiple users' capability to both control and edit content simultaneously.
    b. System shall support the use of Network Time Protocol for real time clock synchronization
    c. System shall support remote firmware upload over an Ethernet connection from a connected PC running the program design software
    d. Failure of a single Processor shall not prohibit continuing operation of the remaining connected system
    e. Shall log system error messages using Syslog
    f. The server shall support ANSI E1.17 Architecture for Control Networks (ACN)
        1) Servers that do not support ANSI E1.17 shall not be acceptable
    g. The server shall support ANSI/ ASHRAE BSR135.1 BACnet IP protocol.
        1) Servers that do not support BSR135.1 shall not be acceptable

3. Diagnostics
    a. Shall output an Event log using Syslog format
    b. Standard log shall store a fixed-length history of recent activity
    c. Separate critical log shall only store important messages (such as boot-up settings)
4. Configuration Data
    a. Configuration Data can be uploaded over an Ethernet connection from a PC running the program designer application
    b. Configuration Data can be retrieved from any connected system Processor
    c. Configuration Data may be loaded to and from removable media (USB) access provided on front panel
    d. Configuration Data for the entire System shall be available for download from any Processor or Central Server
    e. Configuration Data shall be stored on solid-state media
5. Scalability
    a. Adding additional Processors to a Server System shall proportionately increase its overall capabilities up to a maximum System size
    b. The maximum number of Processors configured as a single System shall be at least 12.
    c. The maximum number of Processors supported by a single Server configuration shall be at least 48
    d. Multiple Processors shall utilize the Ethernet network to remain time synchronized and share control information
    e. Multiple Processors shall utilize the Ethernet network to maintain configuration data synchronization as modifications are made
    f. It shall be possible for multiple Systems to coexist on the same physical network with logical isolation between Systems
    g. Shall provide building management interface separate from the Lighting Network using BACnet IP
        1) Shall allow for system Timed Event scheduling from another device
    h. Shall allow remote use of the customized virtual touchscreen Application (VTS)
6. Web User Interface
    a. Shall be an internal web server accessible via the primary Ethernet port
    b. Shall support common web browsers on Windows and Mac OS platforms
    c. Shall provide functionality to Activate and Deactivate Presets
    d. Shall provide functionality to schedule timed events (add/delete)
    e. Shall display status information
    f. Shall display log files
    g. Shall allow for configuration of Processor settings (date, time)
    h. Shall allow for upload and download of configuration data
    i. There shall be links to other web-enabled devices in the System, including other Processors
7. Virtual Touchscreen Stations

a. A virtual touchscreen (VTS) interface shall be supported from the Central Control Server
b. General
    1) Virtual touchscreen stations shall support default and fully graphical control pages.
    2) The virtual touchscreen station shall operate using graphic buttons, faders and other images with support for at least 30 separate programmable control pages.
    3) Virtual touchscreen stations shall also allow programming of page pass-code, lock out and visibility levels.
c. Functional
    1) System
        a) The virtual touchscreen shall support configuration firmware upload from a Central Control Server as proxy
        b) The virtual touchscreen shall support client application download from the Central Control Server
        c) A minimum of 48 virtual touchscreens Stations shall be supported for the Central control Server
        d) Virtual touchscreens shall support user configurable resolutions up to 1080 HD (1920 x 1080)
        e) Virtual touchscreen station shall support configuration from Control Designer Software
    2) Setup Mode
        a) There shall be a setup display that is separate from any user-defined configuration
        b) It shall be possible to view and modify connectivity settings
        c) It shall be possible to view status information
        d) The appearance of the setup display shall be standard and not editable
        e) The setup display may be invoked from within the user-defined configuration and/or physical button on the virtual touchscreen
        f) There shall be a default protected method to invoke the setup display
    3) Configurations
        a) Only one VTS configuration may be active on a single interface
        b) Where multiple configurations are stored there shall be a boot menu to allow selection of a configuration
        c) Each configuration shall be identified as a different Station within the System
    4) Operation
        a) The Control System shall be designed to allow control of lighting and associated systems via virtual touchscreen controls. System shall allow the control of presets, sequences, macros and time clock events.

b) System macros and sequences shall be programmable via program designer system software.
c) System time clock events shall be programmable via the virtual touchscreen, program designer system software, the processor user interface, or the internal web server.
d) Time clock events shall be assigned to system day types. Standard day types include: anyway, weekday, weekend, Sunday, Monday, Tuesday, Wednesday, Thursday, Friday and Saturday. System shall support programming of additional custom or special day types.
e) Time clock events shall be activated based on sunrise, sunset, time of day or periodic event. System shall automatically compensate for regions using a fully configurable daylight saving time.
f) A color picker, supporting Hue, Saturation and Brightness (HSB) color selection shall be available for color selection of color changing fixtures and provide visual feedback of the current color produced by the associated fixture.
    i. The color picker shall be provided with a default layout that requires no user configuration
    ii. The color picker shall provide RGB faders in addition to the default HSB color wheel for color selection
    iii. Color picker values shall allow for numerical value input in addition to color wheel and fader control
    iv. The color picker shall be compatible with color mixing systems that use up to seven discrete color control channels
a) Virtual touchscreen stations shall be designed to operate standard default or custom system functions. Components shall operate default functions unless re-assigned via program designer, the Windows-based configuration program.
    i. Optional button functions include: preset selection, manual mode activation, record mode activation, station lockout, raise, lower, macro activation, and cue light, or room join/separate.
    ii. Optional fader functions include master control, individual channel control, fade rate control or preset master control.

2.4 SHOW CONTROLLER

A. General

1. The Controller shall be a microprocessor-based system specifically designed for control of lighting and related systems in an architectural or entertainment application. A personal computer running emulation software shall not be acceptable.

2. The Controller shall store operating software and “lighting show” data in non-volatile solid-state memory. This memory shall be removable for purposes of backup or disaster-recovery.
3. Show data may be downloaded from a remote personal computer over an Ethernet or USB connection.
4. It shall be possible to update the operating software by download from a remote personal computer over an Ethernet connection.
5. The Controller shall commence show playback automatically on receiving power without additional external inputs.
6. The Controller shall have an internal real-time clock that continues to operate when external power is absent. It shall be capable of adjusting for Daylight Savings Time automatically and can be updated over the Internet using the Network Time Protocol (NTP).
7. The Controller shall be able to calculate sunrise and sunset times based on longitude and latitude information, and use these as triggers for events.
8. The capacity of the controller shall be defined in terms of number of control channels being used, and the maximum capacity of each unit shall be factory-configured to user requirements.
9. There shall be visual indicators on the Controller showing status of the controller and its interfaces.
10. The Controller shall operate a web server on its Ethernet interface. This shall allow status information, control and configuration options to be accessed remotely.
11. The appearance and content of the web interface may be customized by the user.
12. The Controller shall allow lighting to be programmed as separate zones, with independent triggering and manual intensity control.
13. The Controller shall support multiple timelines, crossfades and effects running concurrently.
14. The Controller shall support playback of video media with individual pixels mapped to lighting fixtures in an array.
15. The Controller shall output control data as digital video via Firewire DV and DVI
16. The Controller shall be capable of receiving a live video input via Firewire DV and mapping individual pixels to lighting fixtures in an array.
17. The Controller shall support two full-duplex RS232 Serial Ports for interfacing to show control devices.
18. The Controller shall support DMX-in for receiving triggers
19. The Controller shall support multiple remote modules connected via Ethernet for support of additional show control interfaces, such as contact closures, analogue inputs, relay outputs and serial.
20. The Controller shall support multiple streams of timecode and audio data within a single networked system.
21. The Controller shall have a recessed switch for resetting the unit without removal of power.
22. The Controller shall have an internal watchdog feature that will restart the unit in the event of program failure.

23. Multiple Controllers shall automatically synchronize and share triggers when programmed as part of a single show and linked via Ethernet during playback.
24. The Controller shall support conditional logic and execute user-defined Lua scripts to support advanced show control operations.
25. The Controller shall be provided with a 5 year manufacturer warranty.
26. The Controller shall output control data as ETCNet2, Philips KiNet, Pathport and Art-Net II protocols simultaneously via Ethernet.

B. Mechanical

1. Enclosure and mounting shall comply with IEC 60297
2. The controller shall be a 19" rack mount enclosure (19" x 3.5" x 15"). Bring Architect's attention to enclosures that may exceed these dimensions.
3. The controller shall be entirely solid-state with no moving parts, fans or hard disc drives

C. Electrical

1. The Controller shall be designed to support the following standard connectors:
   a. RJ45 socket for 10/100/1000 Base-TX Ethernet for control data
   b. RJ45 socket for 10/100/1000 Base-TX Ethernet for system management
   c. USB-A Socket for USB 2.0
   d. (2) IEEE 1394 socket for DV input and/or output
   e. (2) 9-pin D plug for RS232 serial input/output
   f. 5-pin XLR for USITT DMX512 input
   g. DVI-I socket for DVI output
   h. Fused IEC socket for 115-250VAC/47-63Hz/2-1A mains input and power cables for North America, Europe and UK shall be provided.

D. Thermal

1. The controller shall operate in a temperature range from 0°C to 50°C (32°F to 122°F)

E. Software

1. The Controller shall be supported by programming software running on either a PC or Mac platform. Programming features shall include:
   a. Comprehensive architectural and automated fixture library
   b. Drag and drop placement of fixtures on plan
   c. Drag and drop patching of fixtures to output addresses
   d. Import of any media for mapping to fixture arrays
   e. Timeline-based programming and playback
   f. Extensive range of editable effect presets
   g. Drag and drop placement of effect presets and media on timeline
   h. Variety of triggering options for firing system-wide events
   i. Each trigger event may be configured to initiate one or more lighting or show control action
   j. Each trigger event may be configured to test one or more conditions before executing its actions
   k. Simulation of individual timelines, and entire project with triggers

l. Live output from software for programming verification purposes
m. Controller and network management tools
n. Export TSV reports for all aspects of programming

2.5 MASTER CONTROL 18” TOUCHSCREEN

A. The Touchscreen Control Stations shall be the an 18” Touchscreen by the Primary Manufacturer

B. General

1. Touchscreen stations shall support fully graphical control pages.
2. The Touchscreen station shall operate using graphic buttons, faders and other images on at least 30 separate programmable control pages.
3. Touchscreen stations shall also allow programming of page pass-code, lock out and visibility levels.

C. Mechanical

1. Touchscreen stations shall consist of an eighteen to nineteen inch, backlit liquid crystal display (LCD) with a minimum resolution of 1366 by 768 pixels and 24-bit color depth with a touch interface.
2. Touchscreen bezels shall be constructed of ABS plastic and shall have no visible means of attachment.
3. The Touchscreen shall have a capacitive touch overlay over the display.
4. The Touchscreen shall support tabletop, wall mount and 19” rack mount mounting.

D. Electrical

1. Touchscreens shall be powered by a 12 volt external power supply
2. The external power supply shall support 120-240 VAC power input.
3. Touchscreens shall connect to the System using an Ethernet network.
   a. Ethernet Network
      1) Ethernet network shall be 10/100BaseTX, auto MDI/MDIX.
      2) Network shall utilize Unshielded Twisted Pair (UTP) Category 5 wiring.

E. Functional

1. System
   a. The Touchscreen shall support configuration firmware upload from the Central Control Server
   b. The Touchscreen shall support configuration or firmware upload from local removable USB media
2. Setup Mode
   a. There shall be a setup display that is separate from any user-defined configuration
   b. It shall be possible to view and modify connectivity settings
   c. It shall be possible to view status information
   d. It shall be possible to view and modify Touchscreen screen settings
   e. It shall be possible to view and modify audio settings

f. The appearance of the setup display shall be standard and not editable
g. The setup display may be invoked from within the user-defined configuration

3. Configurations
   a. It shall be possible to have multiple configurations stored within a touchscreen Station
   b. Only one configuration may be active on the touchscreen Station
   c. It shall be possible for Touchscreen Stations connected via the power network to select a configuration automatically based on the configuration of the physical connection.
   d. Where multiple configurations are stored there shall be a boot menu to allow selection of a configuration
   e. Each configuration shall be identified as a different Station within the System
4. Operation
   a. The Touchscreen shall provide interaction with the lighting system using the Central Control Server (CCS) as an interface.
   b. The Control System shall be designed to allow control of lighting and associated systems via Touchscreen controls. System shall allow the control of presets, sequences, macros and time clock events.
      1) System presets shall be programmable via Button, Button/Fader, Touchscreen, or program designer software.
         a) Presets shall have a discrete fade time, programmable from zero to 84,600 seconds with a resolution of one hundred milliseconds.
         b) Presets shall be selectable via Touchscreen stations.
      2) System macros and sequences shall be programmable via program designer system software.
         a) Macro and sequence steps shall provide user selectable steps, and allow the application of conditional logic.
         b) Macro and sequences shall be activated by button, time clock event or program designer software.
      3) System time clock events shall be programmable via the Touchscreen, program designer system software
         a) Time clock events shall be assigned to system day types. Standard day types include: anyday, weekday, weekend, Sunday, Monday, Tuesday, Wednesday, Thursday, Friday and Saturday. System shall support programming of additional custom or special day types.
         b) Time clock events shall be activated based on sunrise, sunset, time of day or periodic event. System shall automatically compensate for regions using a fully configurable daylight saving time.
      4) A color picker, supporting Hue, Saturation and Brightness (HSB) color selection shall be available for color selection of color changing fixtures and provide visual feedback of the current color produced by the associated fixture.

a) The color picker shall be provided with a default layout that requires no user configuration
b) The color Picker shall provide RGB faders in addition to the default HSB color wheel for color selection
c) Color picker values shall allow for numerical value input in addition to color wheel and fader control
d) The color picker shall be compatible with color mixing systems that use up to seven discrete color control channels plus intensity

c. Touchscreen stations shall be designed to operate standard default or custom system functions.
1) Optional button functions include: preset selection, manual mode activation, record mode activation, station lockout, raise, lower, macro activation, and cue light, or room join/separate.
2) Optional fader functions include master control, individual channel control, fade rate control or preset master control.
d. Touchscreen stations shall allow programming of station and component electronic lockout levels via program designer.
e. It shall be possible to adjust touchscreen contrast and brightness.
f. It shall be possible to program the station to dim during periods of inactivity.

2.6 ARCHITECTURAL CONTROL PROCESSOR MODULES

A. General

1. Provide architectural control processor (ACP) manufactured by the primary manufacturer as follows.

B. Mechanical

1. The Architectural Control Processor (ACP) assembly shall be designed for use in Dimming Enclosures and Control Enclosures.
2. The processor shall utilize microprocessor based, solid state technology to provide multi-scene lighting and building control.
3. ACP module electronics shall be contained in a plug-in assembly.
a. The module shall be housed in a formed steel body and contain no discrete wire connections.
b. No tools shall be required for module removal or insertion.
4. The ACP shall be convection cooled.
5. User Interface
a. The ACP shall utilize a backlit liquid crystal display capable of graphics and eight lines of text.
b. The ACP shall provide an alpha-numeric keypad for data entry and navigation.
c. The ACP shall provide a touch-sensitive control wheel for navigation.
d. The ACP shall provide shortcut buttons to assist in navigation, selection, and data entry.

e. The ACP keypad, buttons, and wheel shall be backlit for use in low-light conditions.
   1) The backlight shall have a user selectable time out, including no time out.
f. The ACP shall provide a front-panel RJ45 jack for Ethernet connection to the processor for configuration, live control, and web-browser-based system access.
   1) The Ethernet port shall be secured behind the locking door.
g. The ACP shall provide a Secure Digital (SD) Removable Media slot on the front panel for transfer of configuration data.
   1) The SD slot shall be secured behind the locking door.
h. The ACP shall provide a Universal Serial Bus (USB) port on the front panel for transfer of configuration data.
   1) The USB port shall be secured behind the locking door.

6. Architectural Lighting System configuration and program information shall be stored in flash memory, which does not require battery backup.
   a. The ACP shall provide a Compact Flash (CF) Card as backup flash memory and storage.
   b. The CF Card is stored in the back of the ACP, and can be accessed only by removing the ACP.
   c. The ACP data can be exchanged by inserting the CF card into another ACP.

C. Electrical

1. The ACP shall require no discrete wiring connections; all wiring shall be terminated into Dimming or Control Enclosure.
2. The ACP shall require low-voltage power supplied by the Dimming or Control enclosure.
3. The ACP shall be hot-swap capable.
4. The ACP shall support Echelon LinkPower communications with remote devices, including button stations, button/fader stations, Touchscreen stations, sensors, and third party LonMARK compliant products.
   a. The LinkPower network shall utilize polarity-independent, low-voltage Class II twisted pair wiring, type Belden 8471 (unshielded) or Belden 8719 (shielded) or equivalent. One # 14 AWG drain wire will be required for system not using grounded metal conduit. Touchscreen stations, interface stations and portable stations connectors will also require (2) #16 AWG wires.
   b. The LinkPower network shall be topology free. Network wiring may be bus, loop, home run, star or any combination of these.
   c. Link power wiring shall permit a total wire run of 1640 ft. (500m) without a repeater. Repeater option modules shall be available to increase wiring maximums in increments of 1640 ft. (500m).
   d. Link power wiring between stations shall not exceed 1313 ft. (400m).
5. The ACP shall support 10/100BaseTX, auto MDI/MDIX, 802.3af compliant Ethernet networking using TCP/IP, ESTA BSR E1.17 Advanced Control

Networks (ACN) and ESTA BSR E1.31 (sACN) Protocols for internal communication and integration with third-party equipment.

6. The ACP shall support EIA-RS232 serial protocol for bi-directional command and communication with third-party equipment.
7. The ACP shall support two discrete ESTA DMX512A ports, configurable as input or output ports.
    a. When used in a Dimming Enclosure, the second port is always an output port.
8. The ACP shall provide four onboard dry contact closure inputs for integration with third-party products.
9. The ACP shall provide four onboard contact closure outputs, rated at 1A@30VDC, for integration with third-party equipment.

D. Functional

1. Capacity
    a. Shall support 1024 channels of control
    b. Shall support 2 physical DMX ports, each of which may be configured as an input or output
2. System
    a. Runtime application shall utilize support network system interoperability
    b. System shall support the use of Network Time Protocol for real time clock synchronization
    c. System shall support remote firmware upload an over Ethernet connection from a connected PC running the Light Designer software or another connected processor.
    d. System shall support local firmware upload from removable media (SD Card, USB Flash Drive)
3. Diagnostics
    a. Shall output an Event log
    b. Standard log shall store a fixed-length history of recent activity
    c. Separate critical log shall only store important messages (such as boot-up settings)
4. Configuration Data
    a. Configuration Data can be uploaded over an Ethernet connection from a PC running Light Designer application
    b. Configuration Data can be retrieved from another Paradigm Processor
    c. A Paradigm Processor shall make its configuration data available for retrieval by another Processor as a backup/recovery mechanism
    d. Configuration Data shall be stored on solid-state media that can be removed to facilitate transfer between Processor units
    e. Configuration Data may be loaded to and from removable media access provided on front panel
    f. Configuration Data for the entire System shall be available for download from any single Processor
    g. Shall store configuration data for Dimming enclosure processors and shall make available for download
5. Scalability

a. Adding additional Processors to a System shall proportionately increase its overall capabilities up to a maximum System size
b. The maximum number of Processors configured as a System shall be at least 12.
c. Multiple Processors shall utilize the Ethernet network to remain time synchronized and share control information
d. Multiple Processors shall utilize the Ethernet network to maintain configuration data synchronization as modifications are made
e. Failure of a single Processor shall not prohibit continuing operation of the remaining Processors
f. It shall be possible for multiple Systems to coexist on the same physical network with logical isolation between Systems

6. Local User Interface
   a. Shall provide access to Processor setup (IP address)
   b. Shall provide access to Processor status and diagnosticsWhere the Processor is installed within a Dimming enclosure, shall provide access to Dimming enclosure setup, status and diagnostics
   c. Shall provide control functionality for Control Channels, Zones, Fixtures, Groups, Presets, Macros, Walls and Sequences within the current configuration.
   d. Shall provide functionality to schedule astronomical and real time events (add/edit/delete)
   e. Shall allow for display of local DMX information
   f. Shall allow for transfer of log files to local removable media
   g. Shall allow to perform firmware upgrades for connected Dimming enclosures
   h. Shall allow for transfer of configuration to and from Dimming enclosures using removable media
   i. Shall allow for transfer of configuration to and from LCD Stations using removable media
   j. Shall allow for binding of Stations
7. Access Controls
   a. There shall be 2 user accounts - Administrator, and User with separate password protection
   b. Account and password settings shall be local to each Processor
   c. Access Controls shall be applied to certain areas of the Paradigm Local User Interface and Web Interface
8. Web User Interface
   a. Shall be an internal web server accessible via Ethernet port
   b. Shall support common web browsers on Windows and Mac platforms
   c. Shall provide functionality to Activate and Deactivate Presets
   d. Shall provide functionality to schedule timed events (add/delete)
   e. Shall display status information
   f. Shall display log files
   g. Shall allow for configuration of Processor settings (date, time)
   h. Shall allow for upload and download of configuration data

i. There shall be links to other web-enabled devices in the System, including other Paradigm Processor.

9. Stations
   a. Stations shall be connected to a Paradigm Processor via a LinkPower network or Ethernet
   b. Station discovery and binding shall be accomplished from the Local User Interface or Light Designer
10. Network and ACN Devices
   a. Network devices shall be connected to and controlled from Processors via Ethernet
   b. Processors shall provide DMX Network gateway functionality
   c. It shall be possible to send and receive Macro triggers defined within the System configuration via Network
   d. There shall be support for Streaming ACN on up to 24 universes per Processor
11. Operation
   a. When contained in an dimming enclosure, a snapshot of the dimming enclosure output data shall be stored in persistent memory so that hardware can access it for immediate output on boot
   b. DMX output refresh rate shall be configurable
   c. There shall be support for 16-bit DMX Attributes
   d. DMX inputs may be patched to DMX and Streaming ACN outputs as external sources
   e. Streaming ACN inputs shall be patched to DMX outputs (gateway) as external sources
   f. Where there are multiple external sources then priority and HTP shall be used to perform arbitration
   g. External and internal sources shall be arbitrated based on user-selection of standard or custom rules
   h. On Preset Record, the values of Attributes within the Preset shall be updated to reflect the current output
   i. The total output may be the combination of many different Presets running concurrently
   j. There shall be no hard limit on number of concurrent cross fades
   k. Multiple Presets controlling the same Attribute shall first interact based on priority and second based on Latest Takes Precedence(LTP) or Highest Takes Precedence (HTP)
   l. LTP and HTP operation shall be supported simultaneously and interact (at the same priority) using HTP
   m. Settings due to LTP Presets may be automatically discarded from operation when overridden
   n. It shall be possible to specify that a Preset or Attribute Control will persist when overridden
   o. A Preset may be designated as an HTP Override and shall cause HTP values to be discarded
   p. It shall be possible to modify the rate of a Preset (Cross fades, Effects) from a Control within the System

q. Each Preset shall have a status that can be Activated, Deactivated or Altered
r. Preset status may be set based on matching levels in the current output as an option
s. On startup the System shall be capable of automatically executing timed events within the previous 24 hours to synchronize its initial output state with the current time of day

12. Serial Input/Output
    a. RS232 shall support 8-bit word length, parity selection and 1 or 2 stop bits
    b. RS232 shall support baud rates from 4800 to 115,200 bps
    c. Serial input and output messages are fully customizable
    d. Serial output messages can be generated by any Control or Event

2.7 DIMMER RACK ENCLOSURES

A. General

1. The rack enclosure shall be manufacturerd by the primary manufacturer.

B. Mechanical

1. The Rack Enclosure shall be a surface mounted, deadfront switchboard, constructed of 18-guage formed steel panels with a hinged, lockable full-height door containing an integral electrostatic air filter.
   a. Filter shall be removable for easy cleaning.
   b. The enclosure shall support one control processor and one station power module plus accessories
   c. The enclosure door shall have an opening to allow limited access to the control module face panel.
2. All rack components shall be properly treated and finished.
   a. Exterior surfaces shall be finished in fine textured, scratch-resistant, epoxy paint.
3. The fully digital rack enclosure shall be available with six, twelve, twenty-four, or forty-eight dimmer module spaces, one processor and a single station power supply, Rack dimensions and weights (without modules) shall not exceed:
   a. 21.9” H x 17” W x 9.6” D 38 lb.
   b. 31.0" H x 17” W x 9.6” D 51 lb.
   c. 16.4”H x 14.8”W x 13.3”D 36 lb.
   d. 25.8”H x 14.8”W x 13.3”D 56 lb.
   e. 45.8”H x 14.8”W x 16.8”D 124 lb.
   f. 83.1”H x 14.8”W x 22.8”D 209 lb.
4. A single low-noise fan shall be located at the top of each rack. The fan shall draw all intake air through the integral electrostatic air filter, over the surfaces of the module housing and out the top of the rack.
   a. The fan shall maintain the temperature of all components at proper operating levels with dimmers under full load, provided the ambient temperature of the dimmer room does not exceed 40°C/104°F.

b. In the event of an over-temperature condition, only the affected dimmer module(s) shall shut down. A red indicator LED will flash and an error message shall appear on the Control Processor.

5. Rack Enclosures shall be designed to allow easy insertion and removal of dimmer and control modules without the use of tools. (230 volt racks with CE certification shall require a screwdriver.)
   a. Supports shall be provided for precise alignment of modules into power and signal connector blocks.
   b. With modules removed, racks shall provide clear front access to all load, neutral and control wire terminations.
6. Rack Enclosures shall support use of any combination of rack option cards designed to provide additional rack features.
7. Optional floor mounting pedestal shall be available for the 12-module rack.
8. Rack enclosures shall be designed for use with AX series auxiliary racks for Main Circuit Breaker, Main Lug, and cross bussing applications.
9. Accessories
   a. RideThru Option (RTO)
      1) The Rack Enclosure shall support an optional, short-term back-up power source for the control electronics.
      2) The short-term back-up power source shall automatically engage upon the loss of normal power, seamlessly transitioning the supply power for the control electronics power to itself.
      3) The short-term back-up power supply shall detect the return of normal power, and seamlessly return the control electronics to normal power.
      4) The short-term back-up power source shall support the control electronics for at least 10 seconds.
   b. BatteryPack Option (BPO)
      1) The Rack Enclosure shall support an optional, long-term back-up power source for the control electronics.
      2) The long-term back-up power source shall automatically engage upon the loss of normal power, seamlessly transitioning the supply power for the control electronics power to itself.
      3) The long-term back-up power supply shall detect the return of normal power, and seamlessly return the control electronics to normal power.
      4) A test switch/indicator shall be available without opening the rack door or removal of any modules/components.
      5) The long-term back-up power source shall supply power to the control electronics for at least 90 minutes.

C. Electrical

1. Rack enclosures shall be available in 100, 120, 230, 240 and 277 volt, three-phase, main lug configurations.
   a. 120 volt rack enclosures shall be field configurable for single phase operation without the need for additional components

2. Rack enclosures shall be completely pre-wired by the manufacturer. The contractor shall provide input feed, load, and control wiring.
3. Standard Short Circuit Current Ratings (SCCR) shall be 22,000 at 100-277 Volt
    a. Higher SCCR ratings, up to 100,000 amps SCCR at 120V, shall be possible when used with an AX series Auxiliary Rack Enclosure.
    b. Higher SCCR ratings, up to 65,000 amps SCCR at 240V and 277V, shall be possible when used with an AX series Auxiliary Rack Enclosure.
4. Sensor racks shall operate at 120V, three phase, four wire + ground, 47-53 or to 57-63 Hz at 800 amps max. Other voltage and phase options are available upon request. Sensor racks shall automatically compensate for frequency variations during operation. Provisions shall be made for optional amp trap devices for fault current protection. Standard SCCR fault current protection shall be 100,000A.
5. All control wire connections shall be terminated via factory provided connectors.
6. Rack enclosures shall support dimming for incandescent, fluorescent, neon, cold cathode, electronic low voltage and magnetic low voltage transformer load types.
7. The rack enclosure shall support 16-bit DMX input
8. The rack enclosure shall support 65,000 steps of dimming.
9. The rack enclosure dimming engine shall support multiple dimmer curves including modified square law, linear, switched, fluorescent, pre-heat and electronic low voltage.
10. The rack enclosure shall support voltage regulation including, minimum and maximum scale voltages with offsets
11. Rack enclosure shall support a UL924 listed contact input for emergency lighting control bypass.
    a. Emergency lighting input shall support load shedding
12. Rack enclosures shall be designed to support the following wire terminations:
    a. AC
    b. Echelon link power (Belden 8471 or equivalent) (DRd only)
    c. 24Vdc (2- 16AWG Wire) (DRd only)
    d. DMX512A Port A (In or Out) (Belden 9729 or equivalent)
    e. DMX512A Port B (Out) (Belden 9729 or equivalent)
    f. RS232 Serial In/Out (Belden 9729 or equivalent) (DRd only)
    g. Unshielded Twisted Pair (UTP) Category 5/5e Ethernet
    h. Contact Closure In (14AWG to 26AWG Wire) (DRd only)
    i. Contact Closure Out (14AWG to 26AWG Wire) (DRd only)
    j. Contact Closure Out shall provide 1A @ 30vDC (DRd only)
13. Station Power Modules (DRd only)
    a. Station power modules shall provide LinkPower for up to 32 stations and 1.5A@24VDC of Auxiliary (AUX) power.
    b. Station power repeater modules shall provide LinkPower for 30 stations and1.5A@24VDC of Auxiliary (AUX) power.

c. Station power module shall support over-current/short protection for LinkPower and Auxiliary (AUX) power. LinkPower shall support fault detection on each leg of the balanced data bus.

14. All control wire connections shall be terminated via factory provided connectors.
15. Main feed lugs shall accept a maximum of 350 MCM wire.
16. Load terminals shall accept a maximum of:
    a. DRd- #6 AWG wire.
    b. SR3- #4 AWG wire
17. Thermal
    a. Ambient room temperature: 0-40°C / 32-104°F
    b. Ambient humidity: 10-90% non-condensing

2.8 DIMMER MODULES

A. Mechanical

1. Dimmer modules shall be designed for use with manufacturer's dimming racks.
2. Dimmer modules shall consist of a heavy-duty, die-cast aluminum chassis with an integral faceplate. All parts shall be properly treated, primed and finished in fine-texture, scratch-resistant gray epoxy powder coat.
3. With the exception of the circuit breaker, the module shall contain no moving parts.
4. Each module shall be labeled with the manufacturer's name, catalog number and rating.
5. All electronic components (current/voltage sensors and indicators) shall be contained in a single field-replaceable housing.

B. Electrical

1. Each dimmer shall consist of the following components:
    a. One or two single-pole circuit breakers
        1) Circuit breakers shall be fully magnetic so the trip current is not affected by ambient temperature.
        2) Circuit breakers shall be rated for tungsten loads having an inrush rating of no less than 20 times normal current.
        3) Circuit breakers shall be rated for 100 percent switching duty applications.
    b. A solid-state switching module
        1) Each dimmer module shall use a solid-state relay (SSR) consisting of two silicon-controlled rectifiers (SCRs) in an inverse parallel configuration, and all required gating circuitry on the high-voltage side of an integral, opto-coupled control voltage isolator. Rectifiers, copper leads and a ceramic substrate shall be reflow soldered to an integral heat sink for maximum heat dissipation. Dimmers employing triac power devices, pulse transformers, or other isolating devices not providing at least 2,500V RMS isolation shall not be acceptable.

2) The SSR shall also contain a control LED, a thermistor for temperature sensing, and silver-plated control and load contacts.
3) The entire SSR shall be sealed in a plastic housing requiring only a screwdriver to replace.
4) Dimmer modules requiring disassembly, heat sink grease, or additional tools for repair shall not be acceptable.

c. Toroidal filters
1) Dimmer modules shall include toroidal filters to reduce the rate of current rise time resulting from switching the SCRs. The filter shall limit objectionable harmonics, reduce lamp filament sing and limit radio frequency interference on line and load conductors.
2) Modules shall be available in models offering 350-800 microsecond filter rise times depending upon model. Rise time shall be measured at the worst case slew rate (about 50 percent) from 10 to 90 percent of the output waveform with the dimmer operating at full load.

d. Power and control connectors.
1) Modules shall not have any protruding pins subject to physical damage when the module is not installed.
2) Power efficiency for standard dimmers shall be at least 97 percent at full load with a no-load loss of 3V RMS.
3) The dimmer shall accept hot patching of a cold incandescent load up to the full rated capacity of the dimmer.
4) Standard AIC fault current protection shall be 10,000 at 120V and 14,000 at 230V/277V.

2.9 ELECTRONIC LOW VOLTAGE DIMMER MODULES

A. General

1. The Electronic Low Voltage (ELV) Dimmer Module shall provide Reverse Phase Control dimming for electronic low-voltage transformers.
2. The ELV module shall be a dual density, fully rated dimmer
   a. ELV10 modules shall provide two 10A dimmers, with each dimmer rated for 1.2kW at 120V.
   b. HEL5V modules shall provide two 5A dimmers, with each dimmer rated for 1.2kW at 240V.
   c. AELV5 modules shall be dual 5A modules, with each dimmer rated for 1.4kW at 277V
3. The module shall be UL and cUL Listed for continuous duty at 100% of rated load.

B. Mechanical

1. Dimmer modules shall be designed for use with manufacturer’s appropriate dimming racks.
2. Dimmer modules shall consist of a heavy-duty, die-cast aluminum chassis with an integral faceplate. All parts shall be properly treated, primed and finished in fine-texture, scratch-resistant gray epoxy powder coat.

3. With the exception of the circuit breaker, the module shall contain no moving parts.
4. Each module shall be labeled with the manufacturer's name, catalog number and rating.
5. All electronic components (current/voltage sensors and indicators) shall be contained in a single field-replaceable housing.

C. Electrical

1. Each dimmer shall consist of the following components:
   a. Two single-pole circuit breakers
      1) Circuit breakers shall be fully magnetic to eliminate nuisance tripping and so the trip current shall not be affected by ambient temperature.
      2) Circuit breakers shall be rated for tungsten loads having an inrush rating of no less than 20 times normal current.
      3) Circuit breakers shall have a 125%, 10-120 seconds, must-trip rating.
      4) Circuit breakers shall be rated for 100 percent switching duty applications.
   b. A solid-state switching module
      1) Each dimmer module shall use a solid-state relay (SSR) consisting of two MOSFET semi-conductors, and all required gating circuitry on the high-voltage side of an integral, opto-coupled control voltage isolator. Dimmers employing triac power devices, pulse transformers, or other isolating devices not providing at least 2,500V RMS isolation shall not be acceptable.
      2) The SSR shall also contain a control LED, an output LED, an error LED, and silver-plated control and load contacts.
      3) The entire SSR shall be sealed in a plastic housing requiring only a screwdriver to replace.
      4) Dimmer modules requiring disassembly, heat sink grease, or additional tools for repair shall not be acceptable.
   c. Power and control connectors
      1) Modules shall not have any protruding pins subject to physical damage when the module is not installed.
      2) Power efficiency for ELV dimmers shall be at least 99 percent at full load with a no-load loss of 3V RMS.
      3) Standard fault current protection shall be 100,000A at 120V, 65,000A at 240 or 277V [Short Circuit Current Rating (SCCR)]

2.10 SURFACE-MOUNT FEED-THROUGH RELAY PANEL

A. General

1. The wall mount relay panel shall be provided by the primary manufacturer and
2. Panel shall be UL Listed (UL508 FILE #E92154) and CSA Approved, and shall be so labeled when delivered.

3. The 24 relay panel shall consist of any quantity between one and twenty-four 20 amp relays, single- or double pole as required, control electronics, sub-panel, and enclosure.
4. The 48 relay panel shall consist of up to forty-eight 20 amp relays, single- or double pole as required, a single control electronics, sub-panel, and enclosure.

B. Mechanical

1. The small panel shall be approximately 26.25” (622 cm) high by 17” (432 cm) wide and 6.3” (161 cm) deep and weigh no more than 45 pounds (20.5kg). The large panel shall be approximately 47.27” (1201 cm) high by 17” (432 cm) wide and 6.3” (161 cm) deep and weigh no more than 81 pounds (36.8 kg).
2. It shall be constructed of 16-gauge steel. All panel components shall be properly treated, primed and finished in fine-textured, scratch resistant paint. The entire unit shall surface mount.
3. Equally sized top, bottom, and side removable knockout panels shall facilitate conduit entry, with an internal pass-through plenum for side-by-side or top-to-bottom mounting. The front panel shall be easily removable as well for full front access to input, output and data connections.
4. The unit shall ship with a cover complete with a locking door, allowing controlled access to the Class 2 wiring only.
   a. Optional center-pin reject security screws shall be available for all accessible screws.
5. The panel enclosure shall be available separately from the sub-panel containing the control electronics to allow for pre-installation. The panel shall be UL Listed to be available in this configuration.

C. Electrical

1. The panel control electronics shall operate on single phase, two wire + ground, 120, 230V, or 277V AC 60Hz, at an amperage sufficient to power the panel (8 amps max). Standard fault current protection shall be 5,000 AIC.
2. The individual relays shall be mechanically latching and capable of switching 20A at up to 300V circuits with no derating required for inductive lighting loads.
3. Optional dual space 277/480V 2 pole relay shall be mechanically latching and capable of switching 20A at up to 500V circuits.
4. Each relay shall have an integral manual override switch with on/off status indication.
5. The relay shall have the following minimum ratings:
   a. 14000A Short Circuit Current Rating at 277V
   b. 1500A short circuit current
   c. 5000V RMS isolation
   d. 300,000 mechanical cycles (600,000 operations)
   e. 30,000 cycles inductive, Tungsten or motor
   f. 20,000 cycles electronic (LED)
6. The panel shall be capable of switching all relays on or off at once, or in a user-selectable delay period of 0.1 to 60 seconds, in 0.1 second increments, per relay.

7. All line terminals shall accept 10-14 AWG wire. The control wiring shall land on a removable header for easy contractor installation (On-board DMX, stations and Emergency Input terminations).
8. A voltage barrier shall be available to separate relays carrying normal and emergency power in the same panel. The barrier shall be capable of installation, without tools, between any two relays, and shall allow up to eight barriers per panel (4 per side).

D. Functional

1. Panel setup shall be user programmable. The control interface shall provide the following relay setup features (per circuit):
   a. Type (1 pole, 2 pole, or 3 pole)
   b. Name
   c. Circuit Number
   d. DMX address
   e. sACN address
   f. Space Number
   g. Circuit Modes
      1) Normal (priority and HTP based activation and dimming)
      2) Latch-lock
      3) Fluorescent
      4) DALI
   h. On threshold level
   i. Off threshold level
   j. Include in UL924 emergency activation
   k. Allow Manual
2. Relay panels shall support discrete addressing of each relay. Panels that are restricted to use of start address with sequential addressing and cannot assign each 0-10V output control to any internal relay shall not be acceptable
3. The panel shall be capable of switching all relays on or off at once, or in a user-selectable delay per relay using a period of 0.1 to 60 seconds, in 0.1 second increments
4. An Ethernet connection shall provide advanced control of relays over streaming ACN (sACN) and transmit status per branch circuit via an internal Web UI or central monitoring interface
   a. Control electronics shall report the following information per branch circuit.
      1) Relay state (Open/Closed)
   b. Panels that do not report this information shall not be acceptable.
5. Built-in Control shall include:
   a. Ability to record up to 16 presets in each space from the control panel, connected control stations, or timed events
   b. Presets shall be programmable by recording current levels (as set by DMX or connected control stations), by entering levels on the control panel directly, manually selecting relay state on each relay or a combination of these methods. From the control panel, stations, or timed events it shall be possible to record values for up to 16 zones per space.

c. Up to 8 spaces in a single rack for total of up to 16 spaces shall be supported per system or system subnet
d. Indication of an active preset shall be visible on the control panel display.
e. One 16-step sequence per space for power up and power down routines
f. The panel shall have a UL924-listed contact input for use in Emergency Lighting systems. The panel shall respond to the contact input by setting included relays to “on”, while setting non-emergency relays “off”. Each relay can be selected for activation upon contact input.
g. Upon Data loss the system shall provide options to hold last look infinitely or hold for a configured time period set by the installing technician then fade/switch to the input of the next available priority.
h. Control electronics shall respond directly to control stations for zone, preset, and sequence control. Systems that require secondary control systems for this functionality are not acceptable.
i. After power loss, electronics shall be capable of holding the system in its previous state until new level data (DMX, architectural presets, sequences and zones, or local overrides) is received to make each relay change state.

6. The control of lighting and associated systems via real time and Astronomical clock controls.
   a. The relay panel shall allow the activation of presets, sequence, and zone programming of up to 50 time clock events via a built in real and astronomical timeclock.
   b. System time events shall be programmable via the control panel.
      1) Time clock events shall be assigned to system day types. Standard day types include: everyday, weekday, weekend, Sunday, Monday, Tuesday, Wednesday, Thursday, Friday and Saturday.
      2) Time clock events shall be activated based on sunrise, sunset, time of day or periodic event.
      3) System shall automatically compensate for regions using a fully configurable daylight saving time.
      4) Presets shall be assigned to events at the time clock.
   c. The time clock shall support event override
      1) It shall be possible to override the timed event schedule form the face panel of the time clock
   d. The time clock shall support timed event hold
      1) It shall be possible to hold a timed event from the face panel of the processor
      2) Timed event hold shall meet California Title 24 requirements
7. The panel shall receive ESTA DMX512-A control protocol. Addressing shall be set via the user interface button keypad with any relay being patched to any DMX control address.
   a. 2,500V of optical isolation shall be provided between the DMX512 inputs and the control electronics as well as between control and power components.
   b. The relays shall respond to control changes (DMX or Stations) in less than 25 milliseconds. DMX512 update speed shall be 40Hz.

c. Setting changes shall be able to be made across all, some, or just one selected relay in a single action from the face panel
d. DMX data loss shall allow for levels/relays to be held for ever or for a specified time before switching to a lower priority source
e. Initial Panel setup
    1) The relay panel shall automatically detect the type of relay or dimmer installed in each location without need for manual configuration of the physical arrangement.
    2) Quick rack setup shall be available to apply address settings across all circuits for rack number, DMX Start Address, sACN universe, and sACN start address.
    3) Emergency Setup Menu shall provide optional delays when emergency is activated or deactivated, and option to turn off non-emergency circuits shall be available. Record function shall allow circuits that are turned on to be added to the emergency setting.

E. Relay Panel Accessories

1. A Low Voltage 0-10V Dimming Option shall link each of the 24 0-10V outputs with a relay circuit in the panel. Each output shall support up to 400mA of current sink for support of at least 50 LED drivers.
2. A Contact Input Option shall allow 24 dry contact inputs to be linked for direct or group relay control, to activate a preset, or to activate a sequence. Controller software shall allow for normally open maintained, normally closed maintained, or momentary toggle.
3. A DALI Control Option shall provide 24 control loops of broadcast DALI control with each loop controlling up to 64 LED drivers. An external DALI loop power supply shall also be provided.
4. A RideThru Option shall provide short-term power backup of control electronics by automatically engaging when power is lost, and recharging when normal power is present
5. A Tamperproof Hardware Kit shall include center reject Torx head screws to prevent access to panel interior by unqualified individuals
6. Main Breaker options shall be available as shown in Section G.2

F. Thermal

1. The panel shall be convection cooled. Panels that require the use of cooling fans shall not be acceptable
2. The panel shall operate safely in an environment having an ambient temperature between 32ºF (0ºC) and 104ºF (40°C), and humidity between 5-95% (non-condensing).

2.11 EMERGENCY BYPASS DETECTION KIT (EBDK)

A. General

1. Where required to detect the loss of normal power and trigger special-purpose lighting presets, the detection means shall be an emergency bypass detection kit as manufactured by the primary manufacturer.

B. Mechanical

1. The Kit Enclosure shall be a surface mounted, constructed of 16-gauge, formed steel panels with a removable front cover.
2. The Emergency Bypass Detection Kit shall include a 3-pole, 10 amp breaker for local over-current protection and simulation of normal power loss.
   a. The enclosure shall have a lockable door to allow limited access to the over-current protection breaker
3. All components shall be properly treated and finished.
   a. Exterior surfaces shall be finished in fine textured, scratch-resistant, powder coat paint
4. The enclosure shall provide discrete high and low voltage wiring compartments with voltage barrier.
5. Dimensions and weights shall not exceed:
   a. 10.5” H x 14” W x 4.2” D 11 lb.
6. Accessories
   a. Emergency Bypass Detection Tap Kit (EBDK-TAP)
      1) The Emergency Bypass Detection Kit shall support an optional tap kit for normally power loss sensing within an appropriate Enclosure
      2) The Tap Kit shall provide fused over-current protection for sense feed wiring without the need for an external circuit breaker
      3) The Tap Kit shall install within the Enclosure
   b. Emergency Bypass Restore Switch (EBDK-SWITCH)
      1) The Emergency Bypass Detection Kit shall support an optional switch kit ,requiring manual override before allowing the EBDK to return to a normal power state
      2) The Restore Switch shall be a single-gang device, fully finished, and supplied with mounting holes.
         a) The EBDK Switch Kit shall be clearly labeled identifying intended operation
         b) The Switch shall be labeled Lighting System Restore
         c) The Switch shall include a red indicator that is illuminated when bypass operation is active
      3) The EBDK Switch shall require two 16-gauge wires for connection to the Emergency Bypass Detection Kit
         a) Up to two Bypass Restore Switches shall be supported per Emergency bypass Detection it

C. Electrical

1. Emergency Bypass Detection enclosures shall support 100 to 277 volt configurations
   a. EBDK enclosures shall be field configurable for single-phase, bi-phase, and three-phase operation without the need for additional components.
2. Phase Loss Detection circuitry shall provide 0.5 second delay to prevent nuisance tripping

3. The EBDK shall provide an integrated circuit breaker for over-current protection and simulation of normal power loss
4. The Emergency bypass detection Kit shall support isolated outputs for connection to multiple dimming products simultaneously
   a. Three isolated contacts shall be provided
   b. Each contact shall support connection of up to four dimming products.
5. The Emergency Bypass Detection Kit shall be completely pre-wired by the manufacturer. The contractor shall provide input feed and control wiring.
   a. All control wire connections shall be terminated via factory provided connectors.
   b. Factory provided connector shall support 12 to 22-gauge wiring
6. Emergency lighting input shall support load shedding
7. The Bypass Detection Kit shall prove a normally-closed input for interface with fire alarm systems
8. The Bypass Detection Kit shall be UL and cUL Section 924 Listed for interaction with similarly listed dimming and switching panels

D. Thermal

1. Ambient room temperature: 0-40°C / 32-104°F
2. Ambient humidity: 10-90% non-condensing

2.12 DMX EMERGENCY BYPASS CONTROLLER

A. Where required to trigger special-purpose lighting presets and bypass normal lighting controls during emergency or panic situations, the bypass means shall be a DMX emergency bypass controller (DEBC) as manufactured by the primary manufacturer.

B. Functional

1. The DMX Emergency Bypass Controller shall be capable of overriding a single universe of ANSI E1.11–2008, USITT DMX512-A control signals from “Normal” to “Bypass” when a trigger signal is detected via a contact closure trigger input
   a. The DMX Emergency Bypass Controller shall output to a single DMX output or up to six optically-isolated DMX outputs
   b. The DMX Emergency Bypass Controller shall poll the bypass trigger input after a power loss and react upon start up
   c. The default or recorded preset shall be recalled immediately on restart if the trigger is also applied at restart
   d. Controllers that do not support E1.11–2008 compliant DMX communication shall not be acceptable
2. The DMX Emergency Bypass Controller shall be capable of recording a single DMX preset (snapshot) of 512 channels for recall during “Bypass” mode
3. The DMX Emergency Bypass Controller (DEBC) shall have internally accessible, labeled DIP switches for configuration of:
   a. DMX Record Mode
      1) All 512 channels (default)
      2) Selected channels, snapshot
   b. Contact input type
      1) Normally open (default)

2) Normally closed
c. Wait Time for Restore incoming DMX (bypass trigger removed)
1) 0 Seconds (default)
2) 10 Second Wait
3) 30 Second Wait
4) 10 Minute Wait

4. The DMX Emergency Bypass Controller shall support a single bypass input using two input modes:
a. Bypass triggering shall be supported via a maintained contact input configurable for normally open (N.O.) or normally closed (N.C.) operation
b. The contact input shall support +12VDC wet input to provide interface with fire alarm or secondary trigging systems. Bypass controllers that do not support a fire alarm input shall not be acceptable.

C. Mechanical

1. The DMX Emergency Bypass Controller (DEBC) enclosure shall be a surface mounted enclosure with a removable cover, constructed of 16-gauge, formed steel with a removable front cover
a. All components shall be properly treated and finished in fine textured, scratch-resistant, powder coat paint
b. DEBC enclosure shall have a minimum of four keyed mounting holes for wall attachment
c. DEBC enclosure shall have a visible label stating the product name, manufacturer name, indicator functions, control functions, ratings and listings
2. The DMX Emergency Bypass Controller (DEBC) enclosure shall provide discrete high and low voltage wiring compartments with voltage barrier
3. The DMX Emergency Bypass Controller (DEBC) shall have a single bi-color LED indicator visible from the exterior of the enclosure
a. LED shall indicate Normal state with a “green” color light
1) Normal state illuminates steady green when Power and DMX are present
2) LED Off indicates Power or DMX are not present
b. LED shall indicate Bypass state with a “red” color light
1) Bypass state includes bypass input contact trigger or ‘test’ active
4. The DMX Emergency Bypass Controller (DEBC) shall have a single test button accessible from the front of the enclosure without removing any panels
a. The test button shall immediately trigger bypass state for as long as it is held down, and release the bypass state immediately upon release of the button
1) The test button shall be momentary only
2) The test button shall be recessed to prevent accidental triggering
5. The DMX Emergency Bypass Controller (DEBC) shall have a single, internally accessible button for DMX Record (snapshot) with an indicator LED for record action
a. The record button shall be momentary only and held for at least 3 seconds before activation to prevent accidental recording

b. The LED indicator will flash rapidly when record function is active
c. The LED indicator will illuminate steady when record function is complete

6. The DMX Emergency Bypass Controller (DEBC) dimensions and weights shall not exceed:
   a. 9” H x 11” W x 2” D,
   b. 8lbs (single output); 14.5lbs (multi-output)

D. Electrical

1. The DMX Emergency Bypass Controller shall be completely internally pre-wired by the manufacturer
2. The contractor shall provide input feed and control wiring to the provided terminals
   a. DMX Emergency Bypass Controllers (DEBC) shall support 100 to 277 volt input power, 50/60 Hz, 150mA maximum current
3. DEBC shall support labeled terminations for two 24 – 10 AWG solid or stranded power wires
4. DEBC shall support one Grounding Lug for 24-14 AWG solid or stranded ground wire
5. DEBC shall support labeled, socketed termination connections for DMX Input and DMX Output wiring
   a. Terminations shall support Belden 9729 cable or equivalent
      1) DMX Termination kits for Belden 9729 shall be supplied with the controller
      2) Optional Termination kits for Belden 1583A (or equivalent Category 5 cable) shall be available from the manufacturer
6. DEBC shall support labeled, socketed termination for the bypass contact input
   a. Termination shall support two, 30-12 AWG low-voltage wires
   b. The bypass input shall support a maintained normally open (N.O.) or normally closed (N.C.) dry contact input
   c. A +12VDC wet contact input shall also be available for interface to fire alarm systems.
   d. DEBC shall support socketed DMX transceiver chips
      1) A spare DMX transceiver chip shall be supplied in a labeled, inactive socket
7. The DMX Emergency Bypass Controller (DEBC) shall internally switch from the normal DMX input (pass through) to the bypass DMX output using electromechanical relays when triggered
   a. The DEBC shall have non-volatile memory for storage of a single recorded sequence of 512 channels
      1) The recorded sequence shall persist through power outages
      2) The default sequence shall have all 512 channels at “full” if no sequence is recorded
   b. The DEBC shall have a DMX baud rate of “Slow” (20 packets per second) for increased compatibility during bypass DMX output
8. The DEBC shall be available in two versions capable of output to a single DMX line or up to six optically-isolated DMX lines

9. The DMX Emergency Bypass Controller shall be UL and cUL Section 924 LISTED for interaction with similarly listed products

E. Thermal

1. Ambient room temperature: 0-40°C / 32-104°F
2. Ambient humidity: 10-95% non-condensing

2.13 TOUCHSCREEN CONTROL STATIONS

A. General

1. The Touchscreen Control Stations shall be manufactured by the primary manufacturer.
2. Touchscreen stations shall support default and fully graphical control pages.
3. The Touchscreen station shall operate using graphic buttons, faders and other images on at least 30 separate programmable control pages.
4. Touchscreen stations shall also allow programming of page pass-code, lock out and visibility levels.

B. Mechanical

1. Touchscreen stations shall consist of a seven inch, backlit liquid crystal display (LCD) with a minimum resolution of 800 by 400 pixels and 24-bit color depth with a capacitive touch interface.
2. Touchscreen bezels shall be constructed of cast aluminum finished in a fine texture powder coat.
3. Touchscreen shall be available in five standard colors
   a. Cream (RAL 9001)
   b. Ivory (RAL 1015)
   c. Gray (RAL 7001)
   d. Black (RAL 9004)
   e. Signal White (RAL 9003)
4. The bezel shall have no visible means of attachment.
5. The bezel shall allow the touchscreen to be installed and removed without the use of tools.
6. The bezel shall provide two working positions for the Touchscreen: service and normal operation.
7. Touchscreen shall offer optional hinged locking covers
   a. Locking covers shall be made from cast aluminum and be painted to match standard touchscreen color options
   b. Locking covers shall allow for viewing of system status on the touchscreen though a smoked Lexan window
8. The manufacturer shall provide back boxes for all LCD stations.
   a. Flush back box for Touchscreens with or without locking covers shall be 7.94” wide x 5.33” high x 3.25” deep
   b. Surface back box dimensions shall be 8.3” wide x 5.6” high x 2.75” deep
   c. Surface back box for Touchscreens with locking cover dimensions shall be 10.0” wide x 6.7” high x 2.75” deep

C. Electrical

1. Touchscreens shall be powered entirely by the System network.
2. Touchscreens shall connect to the System using an Ethernet network with Power over Ethernet (PoE) or the Unison control station Echelon® Link power network.
    a. Ethernet Network
        1) Ethernet network shall be 10/100BaseTX, auto MDI/MDIX, 802.3af (PoE) compliant.
        2) Network shall utilize Unshielded Twisted Pair (UTP) Category 5, or better wiring.
        3) PoE power consumption shall be PoE class 2, consuming no more than 6 watts.
    b. Echelon® Link power network.
        1) Link power shall utilize low-voltage Class II unshielded twisted pair, type Belden 8471 or equivalent, and one #14 ESD drain wire (when not installed in grounded metal conduit).
        2) Touchscreen stations shall also require (2) #16 AWG stranded wires for 24Vdc operating power. 24Vdc wiring shall be topology free.
        3) Network wiring may be bus, loop, home run, star or any combination of these.
        4) Network insulation displacement connectors shall be provided with all stations.

D. Functional

1. System
    a. The Touchscreen shall support configuration firmware upload from a Processor as proxy
    b. The Touchscreen shall support configuration or firmware upload from local removable media
2. Setup Mode
    a. There shall be a setup display that is separate from any user-defined configuration
    b. It shall be possible to view and modify connectivity settings
    c. It shall be possible to view status information
    d. It shall be possible to view and modify LCD screen settings
    e. It shall be possible to perform Touchscreen calibration
    f. It shall be possible to view and modify audio settings
    g. The appearance of the setup display shall be standard and not editable
    h. The setup display may be invoked from within the user-defined configuration and/or physical button on the Touchscreen
    i. There shall be a default protected method to invoke the setup display
3. Configurations
    a. It shall be possible to have multiple configurations stored within an LCD Station
    b. Where multiple configurations are stored there shall be a boot menu to allow selection of a configuration

E. Operation

1. The Control System shall be designed to allow control of lighting and associated systems via Touchscreen controls. System shall allow the control of presets, sequences, macros and time clock events.
   a. System presets shall be programmable via Button, Button/Fader, Touchscreen, or program designer software.
      1) Presets shall have a discrete fade time, programmable from zero to 84,600 seconds with a resolution of one hundred milliseconds.
      2) Presets shall be selectable via Touchscreen stations.
   b. System macros and sequences shall be programmable via program designer system software.
      1) Macro and sequence steps shall provide user selectable steps, and allow the application of conditional logic.
      2) Macro and sequences shall be activated by button, time clock event or program designer software.
   c. System time clock events shall be programmable via the Touchscreen, program designer system software, the processor user interface, or the internal web server.
      1) Time clock events shall be assigned to system day types. Standard day types include: anyway, weekday, weekend, Sunday, Monday, Tuesday, Wednesday, Thursday, Friday and Saturday. System shall support programming of additional custom or special day types.
      2) Time clock events shall be activated based on sunrise, sunset, time of day or periodic event. System shall automatically compensate for regions using a fully configurable daylight saving time.
   d. A color picker, supporting Hue, Saturation and Brightness (HSB) color selection shall be available for color selection of color changing fixtures and provide visual feedback of the current color produced by the associated fixture.
      1) The color picker shall be provided with a default layout that requires no user configuration
      2) The color picker shall provide RGB faders in addition to the default HSB color wheel for color selection
      3) Color picker values shall allow for numerical value input in addition to color wheel and fader control
      4) The color picker shall be compatible with color mixing systems that use up to seven discrete color control channels
2. Touchscreen stations shall be designed to operate standard default or custom system functions. Components shall operate default functions unless re-assigned via program designer, a Windows-based configuration program.
   a. Optional button functions include: preset selection, manual mode activation, record mode activation, station lockout, raise, lower, macro activation, and cue light, or room join/separate.

b. Optional fader functions include master control, individual channel control, fade rate control or preset master control.

3. Touchscreen stations shall allow programming of station and component electronic lockout levels via program designer.
4. It shall be possible to adjust LCD contrast and brightness.
5. It shall be possible to program the station to dim during periods of inactivity.

2.14 RESPONISVE CONTROLS

A. Photo Sensors

1. The Lighting Photo Sensors shall be manufactured by the primary manufacturer.
   a. Manufacturer shall submit recommended locations and specifications for photo sensors based on final system components and shade configuration, as applicable.
2. Mechanical
   a. All sensors shall be constructed of ABS plastic and available in pure white or black
      1) Manufacturer's standard colors shall conform to the RAL CLASSIC Standard
   b. Light Sensors shall consist of two parts that may be mounted together or separately. These parts shall be:
      1) Light Sensor Controller
      2) Light Sensor Head
   c. The Light Sensor Controller shall support local and remote mounting of the Light Sensor Head.
      1) Local mounting shall allow the Sensor Head to be mounted within the Light Sensor Controller.
      2) A color matched filler shall be included for the Controller when the Sensor head is remotely mounted
   d. Light Sensor Heads shall support mounting to ½” or ¾” standard conduit knockouts for remote mounting
   e. Light Sensor Heads shall support indoor or outdoor mounting when used with an appropriately rated backbox.
      1) Light Heads shall be IP65 rated
   f. Sensor Controllers shall provide configuration buttons for:
      1) Linking of station to lighting control system
      2) Recording target light level value
   g. Sensors shall have no visible means of attachment
   h. Sensors Controllers shall include an adjustable mounting base that supports the following mounting options:
      1) Mounting to any standard ceiling box
      2) Mounting to any standard junction box
      3) Mounting to single gang RACO box
      4) Mounting to drywall or soft ceiling tiles using an included wire form adapter

a) Sensors controllers shall include all necessary mounting hardware, wiring connectors, and instructions.

3. Electrical
   a. Sensor wiring shall be low-voltage Class 2 wiring
   b. Paradigm Sensor Controllers shall use link connect control wiring
      1) Wiring shall be an Echelon® Link power network.
      2) Link power shall utilize low-voltage Class II unshielded twisted pair, type Belden 8471 or equivalent, and one #14 ESD drain wire (when not installed in grounded metal conduit).
      3) Network wiring may be bus, loop, home run, star or any combination of these.
      4) Termination connectors shall be provided with all sensors
   c. Sensor Controllers shall use appropriate Class 2, topology free control network
      1) The control network shall utilize unshielded twisted pair, type Belden 8471 or equivalent, and one #14 ESD drain wire (when not installed in grounded metal conduit). Use of Category 5, or better, control network wiring shall also be supported.
      2) Network wiring may be bus, loop, home run, star or any combination of these.
      3) Network termination connectors shall be provided with all sensors
   d. Sensor Light Heads shall utilize low-voltage Class II unshielded twisted pair, type Belden 8471 or equivalent
   e. Sensors shall be designed and tested to withstand discharges without impairment of performance when subjected to discharges of 15,000 volts per IEC 801-2.
   f. Sensors shall be UL and cUL LISTED and CE marked
4. Functional
   a. The control system shall support Lighting Photo Sensors for automated control of electric lighting levels based on measured light levels
   b. Photo Sensors shall use a Light Sensor Controller and up to two Light Sensors for readings
      1) When using multiple light sensors with a single controller, the controller shall automatically average the light readings
   c. The control system shall support Open and Closed Loop daylight harvesting
   d. The control system shall support Switched and Dimmed daylight harvesting
   e. Sensors shall meet ASHRE 90.1 and CA Title 24
   f. Sensor functions shall be programed using program designer configuration software
      1) Dimming daylighting systems shall support
         a) Configurable time delay, fade time and dead band
         b) Configurable Change amount
         c) Software configurable minimum level
         d) Control of channel/zone, group and space control
         e) Overrides

2) Switched daylighting systems shall support:
   a) Dim and Bright thresholds
   b) Configurable delay time

g. Daylight sensors shall utilize a sliding set-point algorithm.
h. Sensor controllers support recording target light level readings using an onboard configuration button
i. All daylight sensor functions and calibrations shall be done remotely, from the floor in the daylit space, and through system software.

B. Ceiling Mount Occupancy/ Vacancy Sensors

1. The Lighting Occupancy and Vacancy Sensors shall be manufactured by the primary manufacturer.
   a. Manufacturer shall submit recommended locations and specifications for ceiling mount occupancy/vacancy sensors based on final system components as applicable.
2. Mechanical
   a. All sensors shall be constructed of ABS plastic and available in pure white or black
      1) Manufacturer's standard colors shall conform to the RAL CLASSIC Standard.
   b. Sensors shall provide configuration buttons for:
      1) Linking of station to lighting control system
      2) Enabling walk-test mode
   c. Sensors shall be configured, tested, and calibrated remotely, from the floor in the space, as well as through system software.
   d. Sensors shall include customizable masks to block unwanted areas from view
      1) Masks shall be field installable without the need to unmount or disassemble the sensors
   e. Sensors shall have no visible means of attachment
   f. Sensors shall include an adjustable mounting base that supports the following mounting options:
      1) Mounting to any standard ceiling box
      2) Mounting to any standard junction box
      3) Mounting to single gang RACO box
      4) Mounting to drywall or soft ceiling tiles using an included wire form adapter
   g. Sensors shall include necessary mounting screws and hardware
   h. Sensors shall include all necessary mounting hardware, wiring connectors, and instructions.
   i. Sensors shall utilize multi-segment lens with internal slots to reduce buildup of dust.
   j. Sensors shall be available with three coverage options for:
      1) Large room: 1800 sq. ft. at 8’ ceiling, 3000 sq. ft. at 12’ ceiling
      2) Small room: 450 sq. ft. at 8’ ceiling, 800 sq. ft. at 12’ ceiling
      3) High Ceiling: 350 sq. ft. at 10’ ceiling, 7000 sq. ft. at 40’ ceiling
3. Electrical

a. Sensor wiring shall be low-voltage Class 2 wiring
b. Paradigm Sensors shall use link connection control wiring
    1) Wiring shall be an Echelon® Link power network.
    2) Link power shall utilize low-voltage Class II unshielded twisted pair, type Belden 8471 or equivalent, and one #14 ESD drain wire (when not installed in grounded metal conduit).
    3) Network wiring may be bus, loop, home run, star or any combination of these.
    4) Network termination connectors shall be provided with all sensors
c. Sensors shall use Class 2 connection in a topology-free control network
    1) The control network shall utilize unshielded twisted pair, type Belden 8471 or equivalent, and one #14 ESD drain wire (when not installed in grounded metal conduit). Use of Category 5, or better, control network wiring shall also be supported.
    2) Network wiring may be bus, loop, home run, star or any combination of these.
    3) Network termination connectors shall be provided with all sensors
d. Sensors shall be designed and tested to withstand discharges without impairment of performance when subjected to discharges of 15,000 volts per IEC 801-2.
e. Sensors shall utilize LED illumination for status feedback of motion detection and for use during programming
f. Sensors shall be UL and cUL LISTED and CE marked

4. Functional
    a. The Control System shall support sensors for occupancy or vacancy detention
        1) A single sensor shall support occupancy or vacancy detection based on software configuration
    b. Sensors shall meet ASHRE 90.1, CA Title 24 and NYC local law 48
    c. Provide 360-degree coverage range and include configurable masking.
    d. Paradigm Sensors functions shall be programed using program designer configuration software
        1) Shall support configurable time delay and sensitivity
        2) Shall support independent programming of any system function as occupied and unoccupied events
        3) Shall support overrides
    e. Sensors shall support walk-thru mode for simple testing of coverage
        1) Illumination of sensor lens shall be used to indicate movement is detected, even with lens masks are installed.
        2) Activation shall not require special tools or software

PART 3 - EXECUTION

3.1 INSTALLATION

A. It shall be the responsibility of the Contractor to receive and store the necessary materials and equipment for installation of the dimmer system. It is the intent of

these specifications and plans to include everything required for proper and complete installation and operation of the dimming system, even though every item may not be specifically mentioned. The contractor shall deliver on a timely basis to other trades any equipment that must be installed during construction.

B. The contractor shall be responsible for field measurements and coordinating physical size of all equipment with the architectural requirements of the spaces into which they are to be installed.

C. The contractor shall install all lighting control and dimming equipment in accordance with manufacturers approved shop drawings.

D. All branch load circuits shall be live tested before connecting the loads to the dimmer system load terminals.

3.2 MANUFACTURER'S SERVICES

A. Upon completion of the installation, including testing of load circuits, the contractor shall notify the dimming system manufacturer that the system is available for formal checkout.

B. Notification shall be provided in writing, two weeks prior to the time that factory-trained personnel are needed on the job site.

C. No power is to be applied to the dimming system unless specifically authorized by written instructions from the manufacturer.

D. When lighting control systems are completely installed and tested, and final adjustments have been made to the satisfaction of the Contractor, systems shall be inspected by a factory-trained engineer representing the manufacturer, in the presence of the Architect and/or the Owner. Architect shall schedule the inspection. Provide labor and tools as necessary for the final inspection and adjustments, whether the inspection is scheduled within or outside of normal working hours, at no additional cost to the Owner. If subsequent inspections are required due to significant failure of the Contractor to meet the requirements of the Specifications, or to prepare adequately for the inspection, Contractor will reimburse Architect for time and expenses, including travel costs, to make any subsequent inspections. Manufacturer's factory-trained engineer shall be present at any subsequent inspections. Promptly correct any deficiencies found during final inspection.

E. Training: At the Owner's convenience, the controls manufacturer's factory technician shall provide a minimum of twelve (12) hours, not to exceed twenty-four (24) hours, of supplemental expertise and training concerning the installation, characteristics, operations and maintenance of the preset lighting control systems. Such training shall take place after the Contractor has provided the Owner with the maintenance and operation manual mentioned above, and after all systems have been inspected and calibrated, as required above.

F. Video: The Contractor shall video-tape the training session, and provide the Owner with two (2) copies of the training videotape or CD. Alternative formats are acceptable if mutually agreed upon. If manufacturers' provide videos containing the

same information, these may be used. All control products must be represented in visual graphic or animated format.

G. Manual: Assemble and submit, in bound 8-1/2"x11" format, an Operation and Maintenance Manual After approval by the Architect, this manual will be kept on site for reference use by facility maintenance personnel. Transfer of the document will include a thorough walk-through and demonstration of equipment by the Contractor for facility personnel. The Architect shall schedule the transfer. The manual shall include the following:

1. Product technical documents and cut sheets;
2. Manufacturer and product representative contacts; and
3. Operation and calibration instructions for all components included in the installation.
4. Manual shall include as-built drawings from the preset lighting control systems manufacturer as a paper record of the final settings.
5. Final settings and levels selected by the Architect.

H. Keys: Provide Owner with four (4) sets of keys for every lockable enclosure or cabinet during transfer of Operation and Maintenance Manual.

3.3 COMMISSIONING

A. Control assignment verification: The contractor shall verify that all zones, circuits, addresses and panel assignments of the lighting system meet the specifications, construction documents and Control Intent Narrative.

B. Initial Calibration: Controls shall be pre-calibrated at the factory by the manufacturer, in the field by the manufacturer's technician, by the Contractor, or in combination, to the initial levels and settings indicated in the contract documents, or by any subsequent instructions provided during the shop drawing phase. If such settings are missing or unclear, the Contractor shall request clarification of the Architect before proceeding with installation. These initial settings shall be completed prior to the final calibration.

C. Final Calibration / Commissioning: Final adjustments, calibrations and commissioning shall be performed to the Owner's satisfaction, with the presence of the Architect, Lighting Design and Owners representative, Commissioning Agent, Construction Manager, and Manufacturer's Technician. Manufacturer's Factory Representative for the control systems shall be engaged by the Contractor to participate in up to 80 (eighty) hours of assistance with calibration of the front-of-house public units. This shall involve at least 4 (four) visits, pre-arranged by the Contractor at least three weeks in advance so that the Lighting Designer can be present for the calibration. If the equipment cannot be calibrated in a timely manner due to incomplete or incorrect work on the part of the Contractor, the Contractor is responsible for additional visits and the associated additional fees of the Manufacturer and Lighting Designer.

D. The manufacturer and/or contractor shall return to the site at least two (2) times in the next year to modify the settings, if requested.

E. Adjustments to calibrations and setting shall not be modified from those that have been established to meet prerequisites, energy analyses or mandatory provisions of Energy Codes, LEED criteria or credits, or similar base requirements of the project.

3.4 ADVANCED PROGRAMMING

A. Factory trained personnel (Programmer), familiar with the installed system(s), shall be provided for the purposes of executing programming services to meet specified requirements. The Programmer will work in close conjunction with the Manufacturer's Factory Certified System's Commissioning Technician who would be providing Turn-On services. Programming services and Turn-On services may, or may not, occur concurrently depending on project specifics.

B. The Programmer, at the direction of the Integrator, Lighting Consultant and/or Owner's Representative, will adjust all programmable components of the lighting and control system to meet the design intent of the project.

C. The Programmer will be factory trained and will hold current certification for all furnished control systems. Re-certification for Programmers will be required at least every five (5) years.

D. The Contractor (not the Programmer) will be required to provide any and all equipment required for the execution of Advanced Programming – including, but not limited to, tables and chairs, site access and necessary support personnel, which will be specified by the Programmer at the time the schedule for Programming Service is determined.

3.5 WARRANTY

A. Manufacturer shall warrant products under normal use and service to be free from defects in materials and workmanship for a minimum period of two (2) years from date of delivery or longer if required in the General Conditions.

B. Warranty shall cover repair or replacement of such parts determined defective upon inspection.

C. Warranty does not cover any product or part of a product subject to accident, negligence, alteration, abuse or misuse. Warranty does not cover any accessories or parts not supplied by the manufacturer.

PART 4 - PART 4 - APPENDICES

4.1 GENERAL: The appendices listed below are integral parts of the specifications and contract documents. If an Appendix is missing or incomplete, notify the Construction Manager. Do not submit a bid based on incomplete information.

4.2 APPENDIX A - LIGHTING CONTROL ZONES DIAGRAMS

A. Quantities and wattages in control zone diagrams are approximate and should not be used to determine luminaire quantities. In addition, zone assignments may change during shop drawing review period.

4.3 APPENDIX B – LIGHTING CONTROL INTENT NARRATIVE

A. Provide lighting control system components that satisfy the above specifications, as well as the Contract Drawings and meet the performance described in the Lighting Control Intent Narrative. If there are any discrepancies between these documents that are unresolved during the bid period, the more costly option will be considered as included in the bid prices.

END OF SECTION 26 09 24

SECTION 26 12 19 – OIL-FILLED PAD MOUNTED TRANSFORMERS

PART 1 – GENERAL

1.1 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publication is referred to in the text by the basic designation only.

1. American National Standards Institute (ANSI):
   a) ANSI C2 National Electrical Safety Code
   b) ANSI C57.12.26: Transformers - Pad-Mounted, Compartmental-Type, Self-Cooled, Three Phase Distribution Transformers for use with Separable Insulated High-Voltage Connectors, High Voltage, 34 500 GrdY/19, 920 Volts and Below; 2500 kVA and Smaller.
   c) ANSI C57.12.28: Switchgear and Transformers - Pad-Mounted Equipment - Enclosure Integrity

2. American Society for Testing and Materials (ASTM):
   a) ASTM A 167: Stainless and Heat-Resisting Chromium Nickel Steel Plate, Sheet, and Strip.
   b) ASTM D 117: Electrical Insulating Oils of Petroleum Origin.
   c) ASTM D 1535: Specifying Color by the Munsell System.
   d) ASTM D 3487: Mineral insulating Oil Used in Electrical Apparatus.

3. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a) IEEE 386: Separable Insulated Connectors System for Power Distribution Systems Above 600 V
   b) ANSI/IEEE, C57.12.00: General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
   c) ANSI/IEEE, C57.12.80: Terminology for Power and Distribution Transformers
   d) IEEE C57.12.90: Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers and Guide for Short-Circuit Testing of Distribution and Power Transformers
   e) ANSI/IEEE, C62.11: Metal Oxide Surge Arrestors for Alternating Current Power Circuits.

4. International Electrical Testing Association (NETA):
   a) NETA ATS: Electrical Power Distribution Equipment and Systems.

5. National Fire Protection Association (NFPA):
   a) NFPA 70: National Electrical Code.

b) NFPA 70B: Electrical Equipment Maintenance.

1.2 RELATED REQUIREMENTS

A. Section Common Work Results applies to this section, with the additions and modifications specified herein.

1.3 SUBMITTALS

A. Submit the following:

1. Data:
   a) Transformer loss calculations.
2. Manufacturer's Catalog Data:
   a) Pad-mounted transformers, dead-front.
   b) Insulated high-voltage load-break connectors.
   c) Insulated high-voltage dead-break connectors
   d) Load-break switch.
   e) Surge arresters.
   f) Current-limiting fuses.
   g) Bushing well inserts.
   h) Insulated standoff bushings.
   i) Insulated protective caps.
3. Drawings:
   a) Pad-mounted transformers, dead-front.
   b) Contents:
      1. Overall dimensions, front view, and sectional views.
      2. Ratings and sizes of lugs, impedance, and taps.
      3. One-line diagram.
4. Reports:
   a) Pad-mounted transformer routine and other tests.
   b) Pad-mounted transformer design tests.
   c) Submit certified copies of the following ANSI/IEEE C57.12.00 and IEEE C57.12.90 transformer tests.
   d) Routine and Other tests: Routine and other tests shall be performed by the manufacturer on the actual transformer prepared for this project to ensure that the design performance is maintained in production. Submit test reports, by serial number, for the following tests and receive acceptance before delivery of equipment to the project site:
      1. Resistance measurements.
      2. Ratio.

3. Polarity and phase relation.
4. No-load losses (NLL) and excitation current.
5. Impedance voltage and load loss (LL).
6. Low frequency dielectric.
7. Leak.
8. Pressure.
9. Lightning impulse test
   (a) State test voltage levels.
   (b) Submit photo copies of output wave shapes.
   (c) Test one of three transformers provided by this contract, as selected by the Engineer.

e) Design Tests: ANSI/IEEE C57.12.80, Section 5.1.2 states that "design tests are made only on representative apparatus of basically the same design." Submit design test reports with catalog data and drawings for one of the three specified transformers. Design tests must have been conducted within five years of the date of award of this contract:
   1. Tests shall be certified and signed by a registered professional engineer.
   2. ANSI/IEEE C57.12.00 and ANSI/IEEE C57.12.90 tests performed on a prototype transformer will be acceptable.
   3. Temperature Rise: "Basically the same design" for the temperature rise test means a pad-mounted transformer with the same coil construction (strip, layer, or disk), the same kVA, and the same insulating liquid as the transformer specified.
   4. Lightning Impulse Test Report: "Basically the same design" for the lightning impulse dielectric test means a pad-mounted transformer with the same BIL, the same coil construction (strip, layer, or disk), and a tap charger (if specified).
      (a) ANSI/IEEE C57.98 and ANSI/IEEE C57.12.90.
      (b) State test voltage levels.
      (c) Provide oscillograms with test report.
   5. Lifting and Moving Devices: "Basically the same design" for the lifting and moving devices test means a pad-mounted transformer in the same weight range as the transformer specified.

f) Corrosion Resistance: Manufacturer shall supply written information describing the paint system and material that will be used. Descriptions of tests and test results that are performed to prove the durability of the system used shall be included in this information. Documentation shall demonstrate that transformer is protected from corrosion for 30 years.

5. Field Test Reports:
   a) Submit report of results of Acceptance checks and tests specified by paragraph entitled "Field Quality Control."
   b) Ground Resistance Test Reports: Upon completion and before final acceptance of

the work, submit the measured ground resistance of each ground rod and grounding system, and soil condition at the same time the measurements were taken.

6. Certificates:

   a) PCB Content: Submit manufacturer's certificate that each transformer contains less than 1 ppm of PCB at shipment for this contract.

7. Records:

   a) Transformer Test Schedule.

   b) Source Quality Control: The Engineer reserves the right to witness tests. Provide transformer test schedule for tests to be performed at the manufacturers test facility. Submit required reports and notify the Engineer 30 days before scheduling test date. Notify Engineer 15 calendar days in advance of changes to scheduled dates and locations for testing.

8. Operation and Maintenance Manuals:

   a) Submit completed operation and maintenance manuals on pad-mounted transformers.

9. Accepted Manufacturers:

   a) ABB

   b) Cooper Power Systems

PART 2 - PRODUCTS

2.1 THREE PHASE PAD MOUNTED TRANSFORMERS, DEAD-FRONT

A. ANSI C57.12.26 and ANSI C57.12.28 with separate high and low voltage compartments, primary switching and fuses, and accessories.

B. Transformer:

1. Oil insulated two winding, 60 hertz, 65 degrees C. rise above a 30 degrees C. average ambient, self-cooled type. Transformer shall be rated as shown on drawings, 95 kV BIL, high voltage of 12,470 GRD Y/7,200 primary, with four 2 1/2 percent full capacity taps, two above and two below rated primary voltage. Secondary voltage shall be 480Y/277 volts unless otherwise noted on drawings. Tap changer shall be externally operated, manual type for changing tap setting when the transformer is de-energized. Accessories shall include drain and sampler valve, filler connection, liquid level gage, grounding pads, top filter press connection, lifting lugs, provisions for jacking under base, diagrammatic nameplate, pressure relief valve, pressure-vacuum gage, and dial type thermometer with maximum temperature indicator. The transformer base shall be of the fabricated type and suitable for using rollers or skidding in any direction. Provide transformer top with an access handhole. The transformer shall have an insulated low voltage neutral bushing with lugs for ground cable, and with removable ground strap.

2. Compartments:

   a) Divide high and low voltage compartments into sections with steel isolating barriers extending the full height and depth of the compartment. The primary and secondary sections shall have separate doors, which can be secured with one padlock. The primary door is to have an additional provision to padlock it within the secondary section. Each door shall have an open door holder. All hinges, pins, and protective pentahead bolt cylinder shall be stainless steel. The enclosure shall conform to the latest American National Standard C57.12.28. Pentahead bolts shall be used to secure the primary side door and the locking mechanism on the main door.

3. High Voltage: High voltage compartment shall contain the incoming line, insulated high voltage load-break connectors, six high-voltage bushing wells with inserts configured for loop feed application, connector parking stands with insulated standoff bushings, protective caps, dead-front surge arresters, load break switch handles, access to oil immersed fuses, tap changer, and ground pad. Provide oversized primary compartment to accommodate devices specified.

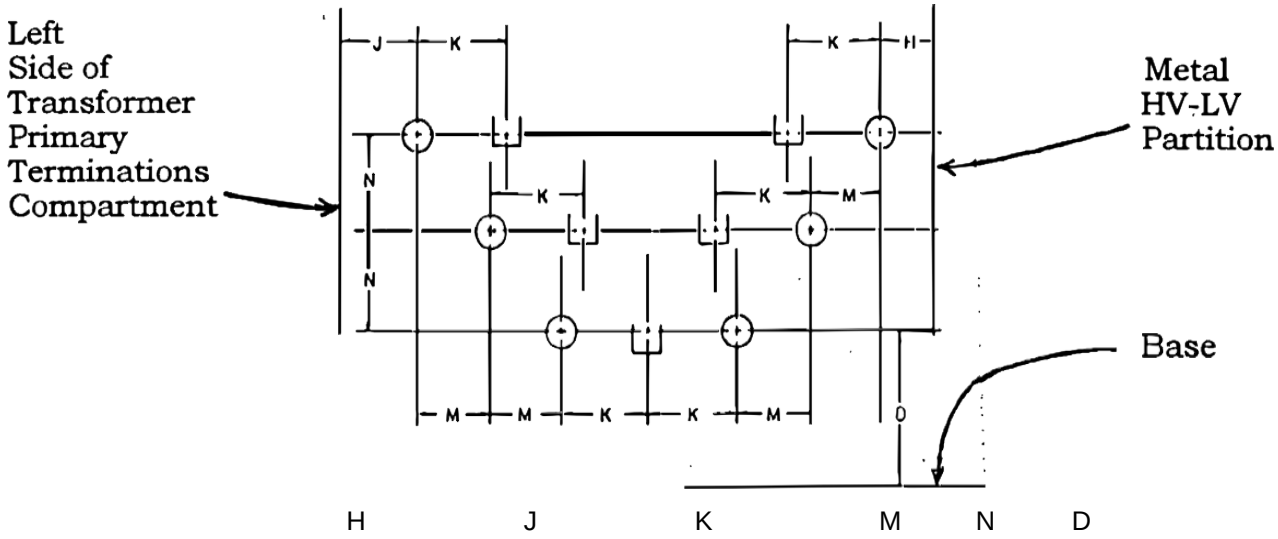
   a) Insulated high voltage load-break connectors: IEEE 386 rated 125 kV BIL, 15 kV. Current rating: 200 amperes rms continuous. Short time rating: 10,000 amperes rms symmetrical for a time duration of 0.17 seconds. Connectors and inserts shall be the product of a single manufacturer. Connector shall have a steel reinforced hook-stick eye, grounding eye, test point and arc-quenching contact material. Provide stainless steel hold down bail assembly.

   b) Replace 200 amp load break connectors with 600 amp dead break connectors when directed by Engineer or required due to circuit configuration. Transformers shall support field conversion between 600 amp and 200 amp connectors.

   c) High voltage entrance shall be via 200 Amp bushing wells with removable studs, compatible with Elastimold type bushing well inserts and bolted tap connectors. The wells shall be externally replaceable, of clamp and gasket design, and arranged in a vee pattern with the parking stands also in a vee pattern.

      (This is a variation of Specific Dimensions for Loop-Feed Transformers of ANSI C57.12.26. Three parking stands are omitted and dimensions are slightly more restrictive - dimension H has a maximum.) Dimensions of the “V” pattern are shown in the diagram on the next page. All five parking stands shall be welded directly to the tank wall (omitting any extension bracket). This will cause them to extend about 7/8 inch from the wall. Any external attachments including reinforcement for the tank wall shall be located so as not to interfere with bushing insert/arrester units or bolted tap connectors when installed in any of the six wells. This requires that no exterior tank bracing be installed for a distance of at least 10 inches below the center of the lowest bushing well. For another 6 inches downward, any reinforcement used must not protrude more than 1.5 inches from the face of the tank wall containing the wells.

   d) The diagram below shows the spacing for the 15kV class.



3.5 to 4.5	3.5 min .	5.0	4.5	6.0	27

e) HO Bushing: An Ho bushing shall be provided on the high voltage side with a removable external copper-grounding strap. Ho also shall be located so as not to interfere with bushing insert/arrester units or bolted tap connectors.

f) Load Break Switches: Two under oil, three phase ganged switches shall be connected in series between the bushing wells - with the feeds to the fuses/coils between the switches. These two independent (ON/OFF) switches shall be of the same type with minimum ratings of 200 amp continuous load and loadbreak current and 6,000 amp symmetrical/9,000 amp asymmetrical currents in any fault situation at 34.5 kV. The tee blade switch is not acceptable because a service interruption - no matter how short - is not acceptable. Switch handles must be readily accessible and operable by a standard hook-stick. The locations shall not be over 60" high or in any area below the entrances or the parking stands.

g) Provide bayonet oil-immersed, expulsion fuses in series with oil-immersed, partial range current-limiting fuses. Coordinate protection with expulsion fuse clearing low-current faults and current-limiting fuse clearing high-current faults.

1. Bayonet Oil-Immersed Expulsion Fuses: Bayonet shall be Cooper Power Systems High Ampere Overload Bay-O-Net which has silver plated contacts along with its inner holder and silver plated integral fuse cartridge (which has a staked end plug). The catalog number for the Silver Plated Bay-O-Net with inner fuse holder is 4038804B03M. Since the entire integral fuse cartridge--not just the element inside the cartridge--must be replaced when the bayonet element melts, the catalog number in the table is for the entire cartridge. The same size is used for all five designs needing this high current cartridge even though the 25 kV class 2500 kVA could use a slightly smaller fuse. 150 kV BIL; 3,500 amperes symmetrical interrupting rating.

2. Oil-Immersed Partial Range Current-Limiting Fuses: ANSI C37.47; 50,000 amperes symmetrical interrupting rating Electrical location of the CL fuse shall be immediately after the switch bus. The nameplate schematic shall include indication of the two fuses and their relationship to each other. Ratings of the CL fuses shall be appropriate for the voltage being used with a maximum asymmetrical interrupting current of 50,000A.

3. Transformer fusing shall comply with the following table:

	Bayonet Fuse or Cartridge		Under Oil CL Fuse	
Trans kVA	Cooper Cat #	Rated Current	ELSP Cat #	#/Rated Current
75	4000353C06B	10	CBUC15030C100	1-30
150	4000353C08B	15	CBUC15050C100	1-50
300	4000353C10B	25	CBUC15100C100	1-100
500	4000353C12B	40	CBUC15150D100	1-150
750	4000353C14B	65	CBUC15150D100	1-150
1000	4000353C16B	100	CBUC15180D100	1-180
1500	4000353C16B	100	CBUC15180D100	1-180
2000	4038361C05CB	125	CBUC15125C100	2-125

2500	4038361C05CB	125	(HiTech) HTDS342125	2-125
3000				

h) Surge arresters: ANSI/IEEE C62.11, rated 18 kV, fully shielded, dead-front, elbow type suitable for plugging into feedthrough inserts. Provide six arresters for loop feed circuits.

i) Bushing Well Inserts: IEEE 386, 200 amp, 25 kV Class. Provide an insert for each bushing well.

j) Protective Caps: IEEE 386, 200 amp, 25 kV Class. Provide insulated protective caps (not shipping caps) for insulating and sealing out moisture from unused bushing inserts and insulated standoff bushings.

k) Parking Stands: Provide a parking stand near each bushing well. Provide insulated standoff bushings for parking of energized loadbreak connectors on parking stands.

4. Low Voltage: Low-voltage compartment shall contain gages, valves, thermometers, drains, cable lugs, low voltage bushings, pressure relief valve, filling provisions, stainless steel transformer nameplate, and ground pad.

a) Pressure Relief: A hook-stick operable automatic pressure relief device is to be provided. This device shall vent at 10 p.s.i.g. and automatically reseal after venting. It shall be able to release at least 50 s.c.f.m., at 15 p.s.i.g. (Qualitrol 202-032-01, BETA 1750K, 1720K & 1712K qualify).

b) Bushings/Spades: The four low voltage bushings shall be externally clamped and gasketed, and arranged in a staggered configuration. Height to center of lower bushings shall be 31 inches on 75 through 500 kVA and 46 inches for larger units. The minimum distance from the center of the higher bushings to the cover shall be 8 inches. The neutral (Xo or X4) bushing shall be fully insulated the same as the phase bushings. The neutral spade shall be bonded through an externally removable copper strap. secondary spades shall be made of copper or bronze, tinned, with minimum dimensions and holes as shown in the table below. Bolt holes below refer to the total number of NEMA spaced holes for bolting connector lugs. Minimum compartment depth (Min. C.D. in the table) is from tank wall to door on the secondary side.

c) For 1000 kVA and larger, spacing of the secondary bushings shall be 8 inches vertically and shall be at least 8.4 inches horizontally center to center with at least 4.5 inches between the compartment left and right walls and the closest bushings to allow extra working space for the installation of cable limiters on each conductor. For 300 kVA and larger, a strip of insulating board shall be attached to the end of each spade and above it as a support to hold the spades against upward and downward forces.

Trans kVA	Min. C.D.	Secondary Voltage	Min. # of Bolt Holes	Minimum Size of Spades
75	18	480 or below	4	3.5 x 5.0 x 0.25
150	18	480 or below	6	3.5 x 6.7 x 0.25
300	24	480 or below	8	4.0 x 8.5 x 0.37
500	24	208 or 240	10	4.0 x 10.2 x 0.37

500	24	480	8	4.0 x 8.5 x 0.37
750	30	208 or 240	12	4.0 x 13 x 0.50
750	30	480	10	4.0 x 10.2 x 0.50
1000	30	208	16	4.0 x 14.7 x 0.50
1000	30	480	10	4.0 x 10.2 x 0.50
1500	30	480	16	4.0 x 14.7 x 0.50
1500	30	480	10	4.0 x 10.2 x 0.50
2000	30	480	12	4.0 x 13 x 0.50
2500	30	480	16	4.0 x 14.7 x 0.50
3000	30	480	20	4.0 x 18.6 x 0.75

d) Drain Valve:

1. A one-inch combination oil drain valve/sampling device shall be installed on the primary side. The drain plug shall be made of brass.

e) Thermometer:

1. On 1000 kVA and larger, a dial type thermometer shall also be provided. On 750 kVA and larger, a dial type magnetic oil level gauge shall also be provided. These shall not obstruct the oil fill hole or conflict with secondary conductors.

C. Nameplates:

1. The location of the nameplate shall be so that it will be easily readable after installation of secondary conductors. The nameplate shall include manufacturer name, month and year of manufacture, transformer kVA, primary and secondary voltages, impedance, BIL, weight, PCB content of mineral oil, gallons of oil capacity, serial number and a schematic. Separate PCB and schematic plates may be used.

D. Impedance:

1. Impedance shall be high enough to limit secondary fault current to a maximum of 65,000 Amps except on a 1500 kVA unit with 208Y/120V secondary, which can have a maximum of 75,000 Amps.

E. Corrosion Protection:

1. Bases and cabinets of transformers shall be corrosion resistant and shall be fabricated of stainless steel conforming to ASTM A 167, Type 302 or 304. Form cabinets of stainless steel sheets no less than No. 13 U.S. gage.

2. The entire unit is to be painted Munsell 7.0 GY 3.29/1.5 (green). The paint system shall conform to the latest American National Standard C57.12.28.

F. Insulating Liquid:

1. Mineral Oil: ASTM D 3487, Type II, tested in accordance with ASTM D 117. Provide identification of transformer as "non-PCB" on the nameplate.

G. Warning/Danger:

1. All labels must meet the latest ANSI Z535 requirements. A standard 4.5” X 8” NEMA “Warning” label (using 3M paper with ultraviolet resistance) shall be centered on the outside upper portion of the primary door. A standard 4.5” X 8” NEMA “Danger” label (using 3M paper with ultraviolet resistance) shall be placed on the inside of the primary

and secondary doors.

H. Transformer Loss Calculations (500 kVA)

1. "A" and "B" are given loss factors. A = 8.712, B = 3.136.

2. "C" is the cost of losses. C = $14,975.

3. "NLL" and "LL" are the transformer no-load losses and load-losses, respectively. See Paragraph titled: "Routine and Other Tests".

I. Transformer Loss Calculations (1,000 kVA)

1. "A" and "B" are given loss factors. A = 8.712, B = 3.136.

2. "C" is the cost of losses. C = $29,863.

3. "NLL" and "LL" are the transformer no-load losses and load-losses, respectively. See Paragraph titled: "Routine and Other Tests".

J. Transformers of sizes larger than 1000 kVA shall be compared to figures scaled on the basis of kVA. Transformers of sizes smaller than 500 kVA shall be compared to figures scaled on the basis of kVA. 750 kVA shall be compared to the average of the 1000 kVA and 500 kVA figures.

K. Deduct Clause:

1. After factory test results are available, Contractor shall calculate actual transformer losses (D) using test result values for NLL and LL, and values specified above for A and B. Calculate using equation D = A(NLL) + B(LL).

a) If $D \leq C$: No adjustment will be made to contract price.

b) If $D > C$: A unilateral contract modification will be issued in the amount of difference between C and D for each transformer.

c) If $D > 1.25(C)$: The transformer is unacceptable.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Electrical installations shall conform to ANSI C2, NFPA 70 and to the requirements specified herein. Provide new equipment and materials unless indicated or specified otherwise.

3.2 GROUNDING

A. NFPA 70 and ANSI C2, except that grounds and grounding systems shall have a resistance to solid earth ground not exceeding 5 ohms.

1. Grounding Electrodes:

a) Provide driven ground rods as specified on electrical detail drawings. Connect ground conductors to the upper end of the ground rods by exothermic weld or compression connector. Provide compression connectors at equipment end of ground conductors.

3.3 INSTALLATION OF EQUIPMENT AND ASSEMBLIES

A. Install and connect pad-mounted transformers furnished under this section as indicated on project drawings, the accepted shop drawings, and as specified herein.

3.4 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

A. Mount transformer on concrete slab. Unless otherwise indicated, the slab shall be at least 8

inches thick, reinforced with a 6 x 6 - W2.9 x W2.9 mesh placed uniformly 4 inches from the top of the slab. Slab shall be placed on a 6 inch thick, well compacted gravel base. The top of the concrete slab shall be approximately 4 inches above the finished grade. Edges above grade shall have 1/2" chamfer. The slab shall be of adequate size to the project at least 8 inches beyond the equipment. Provide conduit turnups and cable entrance space required by the equipment to be mounted. Seal voids around conduit openings in slab with water and oil-resistant caulking or sealant. Cut off and bush conduits 3 inches above slab surface.

3.5 FIELD QUALITY CONTROL

A. Performance of Acceptance Checks and Tests:

1. Perform in accordance with the manufacturer's recommendations, NFPA 70B, NETA AT8, and referenced ANSI standards. Perform visual and mechanical inspections and electrical tests specific to liquid filled transformers and grounding system in accordance with NETA ATS.

B. Follow-up Verification:

1. Upon completion of acceptance checks and tests, the Contractor shall show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. As an exception to requirements stated elsewhere in the contract, the Engineer shall be given 5 working days advance notice of the date and time of checking and testing.

END OF SECTION 26 12 19

SECTION 26 22 13 - DRY TYPE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This section includes the requirements for provision and installation of dry type transformers.

1.3 DESCRIPTION

A. Provide and install all equipment, labor, material, accessories, and mounting hardware for a complete and operating system for dry type transformers.

1.4 SUBMITTALS

A. Product Data: Provide outline and support point dimensions of enclosures and accessories, unit weight, voltage, kVA, and impedance ratings and characteristics, tap configurations, insulation system type, and rated temperature rise.

1.5 QUALIFICATIONS

A. Manufacturer: Same as for products specified in Section 26 24 16 Panelboards.

1.6 REFERENCES AND REGULATORY REQUIREMENTS

A. Furnish products listed and tested by UL as suitable for purpose specified and shown.

B. Conform to requirements of the following:

1. ANSI/NFPA 70 - National Electrical Code
2. NECA - Standard of Installation
3. NEMA ST 1 - Specialty Transformers
4. NEMA ST 20 - Dry Type Transformers for General Applications

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store, protect, and handle products per manufacturer’s recommendations.

B. Deliver transformers individually wrapped for protection and mounted on shipping skids.

C. Accept transformers on site; inspect for damage.

D. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

E. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to internal components, enclosure, and finish.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

1. Landside Building
2. Westinghouse/Cutler Hammer, or approved substitutions.

2.2 TWO-WINDING TRANSFORMERS

A. Description:

1. NEMA ST 20, factory-assembled, air cooled dry type transformers, ratings as indicated.
2. Transformers serving computer loads (whether shown on drawings or not) shall be Non-Linear load K-13 rated.
3. Other Non-Linear load transformers shall be as scheduled and noted on drawing.
4. Isolation and shielded type transformers (if applicable) shall be as scheduled and noted on drawings.

B. Insulation system and average winding temperature rise for rated kVA as follows:

1. 1-15 kVA: Class 185 with 115 degrees C rise.
2. 16-500 kVA: Class 220 with 115 degrees C rise.

C. Case temperature: Do not exceed 35 degrees C rise above ambient at warmest point.

D. Winding Taps:

1. Transformers Less than 15 kVA: Two 5 percent below rated voltage, full capacity taps on primary winding.
2. Transformers 15 kVA and Larger: NEMA ST 20.

E. Sound Levels: NEMA ST 20.

F. Basic Impulse Level: 10 kV.

G. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

H. Mounting: Suitable for wall, floor, or trapeze mounting, except transformers larger than 30 kVA, suitable for floor or trapeze mounting.

I. Coil Conductors: Continuous windings with terminations brazed or welded.

J. Transformer windings shall be continuous wound copper (98% conductivity) construction.

K. Enclosure: NEMA ST 20; Type 1 or Type 3R ventilated as indicated. Provide lifting eyes or brackets.

L. Isolate core and coil from enclosure using vibration-absorbing mounts.

M. Nameplate: Include transformer connection data.

N. Lugs: Suitable for terminating conductors sized for full load ampacity of transformer unit. Transformer lugs and mounting hardware shall be furnished by Manufacturer of transformer and shall be grade 5 with beveled washers. Hardware shall be of suitable size of pad opening per NEMA Standards.

2.3 SOURCE QUALITY CONTROL

A. Provide production testing of each unit in accordance with NEMA ST 20.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify site condition. Do not install NEMA 1 equipment until building has reached the “dried-in” stage.

B. Verify that surfaces are suitable for installing transformer supports.

3.2 PREPARATION

A. Concrete Pad: Design per manufacturer’s requirements plus three inches on all sides.

3.3 INSTALLATION

A. Install Products in accordance with manufacturer's instructions.

B. Set transformer plumb and level.

C. Maintain clearances around enclosure for ventilation in accordance with manufacturer's instructions.

D. Use flexible conduit, under the provisions of Section 26 05 33 Conduit, 1 foot minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.

E. Mount transformers on vibration isolating pads suitable for isolating the transformer noise from the building structure.

F. Provide grounding and bonding in accordance with Section 26 05 26.

G. Ground per NEC 250.26 and to meet local codes as applicable. Grounding lugs shall be multi-conductor type UL listed for quantity and size of conductors terminated.

H. Wall Mounted Transformers: Wall brackets shall be securely attached to concrete or masonry construction only and have supplemental support by means of all-thread rod hangers from superstructure above. Wall mounted transformers at non structural walls shall be supported from superstructure above with all-thread rod hangers, angle iron channel site manufactured structural stand, or combination thereof.

1. Installation of wall mounted transformers shall be installed to maintain clear space about/above panels as defined by NEC.

I. Conduit or piping systems that contain water or liquid of any kind shall not be installed over the top of any electrical equipment, transformers, racks, cabinets, or enclosures without prior written approval from the Owner.

3.4 FIELD QUALITY CONTROL

A. Install field inspect and test per manufacturer recommendations prior to energizing.

B. Measure primary and secondary voltages and make appropriate tap adjustments.

END OF SECTION 26 22 13

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SECTION 26 23 00 - LOW VOLTAGE TRANSFER SWITCHGEAR (SGEMSB1)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 1 Specification sections apply to this section.

B. See specifications Section 26 32 13.06 for Standby Emergency Generator – Radiator Cooled Engine specifications.

C. See specifications Section 26 24 13 for Switchboard specifications.

D. See specifications 26 07 17 for Scada interface requirements

E. See specification 26 23 25 for control interface requirements

1.2 SUMMARY

A. This section includes the requirements for provision and installation of low voltage transfer switchgear and associated controls.

1.3 DESCRIPTION OF WORK

A. Low Voltage Transfer Switchgear shall consist of (but not be limited to):

1. New Switchgear Lineups as shown on the drawings (65 KAIC rated)
2. Automatic controls as described herein, integral to the switchgear
3. All devices, equipment, components, controls, wiring, conduit, feeders, circuits, etc associated with above and as noted herein and below.

B. Switchgear shall be factory-assembled, metal-enclosed switchboard(s) for distribution and control of power from incoming line terminals to outgoing feeder terminals, installed and tested in place.

1. Switchboard shall include all protective devices and equipment as listed on drawings or as included in these specifications, with necessary interconnections, instrumentation, and control wiring.
2. Switchboard shall comply with all requirements of Section 26 24 13 for Switchboard construction, components, equipment, and devices, except as modified herein.

C. Provide and install all equipment, labor, material, accessories, coordination, supervision and testing, including but not limited to the following, as required to perform functions as noted and/or as called for in these specifications and/or drawings:

1. Controls, wiring, conduit, etc.
2. Distribution equipment, devices, wires, conduit, etc.
3. Branch circuit equipment, devices, wires, conduit, etc.
4. Programming, adjustment, etc. of control switchgear.
5. Remote monitoring of each switchgear as described herein.

1.4 FUNCTION/OPERATION

A. All system operation and control functions shall be coordinated and integrated such that during automatic and/or manual operation, no unsafe condition shall occur, no malfunction of intended operation shall occur, and the highest possible reliability of operation shall be maintained.

B. Coordinate and integrate the functions and circuitry of all selector switches to ensure that the various settings available do not cause a malfunction of the intended system operation.

C. The Transfer Switchgear Controls including all metering, monitoring and annunciation shall be designed and integrated with the other specified control components to provide a completely functional total system which shall automatically perform the following generally described sequence of operations:

1. Automatic/Standby (Utility) Mode
   a) The utility mains are closed serving utility power to the bus.
   b) The generator mains are open.
   c) The automation is standing by to act in response to an independent utility failure as sensed at the Transfer Switchgear Main Breaker.

2. Emergency (Generator) Mode (Loss of Utility Service). (Open Transition)
   a) Respective utility protective relaying at switchgear main breaker senses utility voltage or frequency out of tolerance.
   b) Initiate an adjustable time delay of .5 - 10 seconds.
   c) Upon expiration of the time delay, initiate an automatic start sequence.
   d) Respective utility main is Opened.
   e) All load/distribution breakers fed from the respective failed utility service normal main are Opened, except for those breakers feeding Priority One (Life Safety) loads which shall remained closed.
   f) Power for breaker operation is to come from automatically selected best battery source selector system.
   g) A run request is sent to the generator system.
   h) Upon sensing acceptable Emergency Power at the Generator Main breaker, the Generator Main Breaker will close.
   i) Unless a block transfer signal is present from the remote Emergency Generator Switchgear, all remaining load breakers will close. If a block transfer signal is present, then the remaining feeder breakers will close as permitted by their assigned priority level as additional generator capacity becomes available.
   j) All Life Safety (Level 1, Priority 1) breakers remain closed to the bus, so the generator system provides power to these loads within 10 seconds of loss of the normal utility power service.
   k) All Critical (Level 2, Priority 2) loads are to be closed to the bus so the generator system provides power to these loads within 60 seconds of loss of the normal utility power service. If at any time, the generator on line capacity develops an overload condition (or out of tolerance condition) after the level 2, priority 2 loads are connected, the load control system shall shunt trip the level 2 priority 2 loads and wait until additional generator capacity is on line before attempt is made to reconnect these loads to the active generator system bus. Load management

signals to the transfer switchgear will come for the main Emergency Generator Paralleling Switchgear controls located in the CEP.

l) All Security (Priority 3) loads are to be closed to the bus so the generator system provides power to these loads after all Level 1, Priority 1 and Level 2, Priority 2 loads have been connected successfully to the generator system active bus. If at any time, the generator capacity on line develops an overload condition after the Priority 3 loads are connected and fed from the generator system, (drop in voltage or drop in frequency), the load control system shall trip the Priority 3 loads and wait until additional generator capacity is on line before attempt is made to reconnect these loads to the active generator system bus. The Level 2, Priority 2 loads are to remain on line.

m) All feeder breaker priority section/assignment of loads shall be field programmable/selectable by owner at the transfer switchgear OIP. This assignment be capable of being modified in the field at any time.

3. Utility Restoration and Exit from Emergency Mode (Open Transition)
   a) Respective utility protective relaying senses utility voltage and frequency within tolerance.
   b) Following an adjustable 5 to 30-minute time delay (which can be abbreviated by the operator) to assure that the utility power source is stable, the Transfer Switchgear Controls shall transfer to the utility source via open transition. The Generator Main Breaker will open followed immediately by closing of the Utility Main Breaker.
   c) The generators are allowed to run for their programmed cool down period.
   d) The Transfer Switchgear is now in Automatic/Standby (Utility) Mode.

4. Load Test Mode
   a) Load Test Sequence (Actual Building Load) - Open Transition Load Assumption and Return: Provide interconnecting control circuits to produce the following normal operating function when the "Test Normal" switch on the Transfer Switchgear is selected to the "Load Test" position.
      1. Initiate an automatic start sequence.
      2. After the engine generators are operating, the standby system shall be capable of assuming bus load.
      3. With the engine generators able to assume the entire power requirements of the load bus under test, the main utility breaker shall open and, after an adjustable time delay (0 to 10 seconds), the generator main breaker shall close (open transition).
      4. Should a power failure occur while in this condition, the emergency system will continue to operate the emergency load.
      5. When the "Test-Normal" switch is returned to the "Normal" position after a power failure has occurred and the generators are supplying the load, the system shall revert to the automatic loss of utility sequence as described above under Emergency (Generator) Mode.
      6. When the "Test-Normal" switch is returned to the "Normal" position, and a power failure has not occurred, the generator main breaker shall open and, after an adjustable time delay (0 to 10 seconds), the main utility breaker

shall close, providing a break-before-make (open transition) transfer to the utility sources.

7. After the load has been transferred back to the utility, the engine generator shall continue to run no load for an adjustable period of time from 0-30 minutes before complete shutdown.

D. Load Management

1. Provide interface with the Emergency Generator Paralleling Switchgear Controls located in the central CEP. Based on available generator capacity, the paralleling switchgear controls will provide control signals to each remote Low Voltage Transfer Switchgear system to ADD/SHED load breakers based on the breaker's priority level assignment.

E. Monitoring. Low Voltage Transfer Switchgear System shall have a complete monitoring system mounted within the lineup and also provide a remote communications interface for remote monitoring at OIP's at the generator building Operators station and the GOAA engineering office. As a minimum, the Transfer Switchgear OIP shall have the following metering/monitoring:

1. Local/Remote Monitoring and Control System (with annunciation and control)
   a) The OIP shall be independent of the existing Electrical Metering and Monitoring System (EMMS).
   b) Basis of design for this system is a Russelectric 23" color touchscreen Operator Interface Panel (OIP) with Wonderware In-Touch graphic software.
   c) The system is to be a PC based OIP and shall be provided to monitor breaker status, alarms, metering, annunciation and other operating parameters. All control functions, displays, metering and other information described herein these specifications shall be available to the operator of the OIP.
   d) The OIP shall be designed such that its operation will not in any way impede the selected automatic operation of the Transfer System Control. Any failure of the OIP shall have no impact to the automatic operation of the Transfer System Control and operation.
   e) The OIP shall communicate with the Transfer System Control via Ethernet speed network. The OIP shall have a security login screen with assignable access levels for each individual operator.
   f) The PC based Remote Monitoring and Control System shall be provided with color graphic screen presentations as listed below:
      1. Utility Metering Screen that shall contain all of the electrical metering functions listed above utilizing analog meter graphical presentation.
      2. System Metering Screen that shall contain all of the electrical metering functions listed above utilizing analog meter graphical presentation.
      3. System One Line Screen (for LV Transfer Switchgear lineup and any downstream extensions of that lineup) showing breaker position, bus & feeder energization via color, pop-up window for each selected breaker showing all available power data.
      4. PLC Comms Screen: quick reference to show if PLC is faulting or has lost communications to any device

5. Alarm & Event History Screen: displays the last 1024 alarms or events and allow an operator access to logged alarm/event files which can be stored indefinitely
6. System/Utility Annunciation Screen that shall contain all of the Status and Alarm points above.
7. Transfer Control Screen which shall contain Set point entries for all timers
8. Breaker Priority Screen which shall contain a table to enter a priority level for every feeder breaker

F. Hard Wired Controls. The generator paralleling switchgear controls shall have a complete set of hard wired meters, control switches, indicating lights and other devices to enable complete manual operation of the emergency generator paralleling switchgear without availability of any PLC or HMI or network communications. The minimum instrumentation requirements are listed in 2.16 below. In addition, all necessary hard wired interlocks shall be included to prevent possible operator error while in manual operation. Use of a backup OIP DOES NOT SATISFY THIS REQUIREMENT.

G. Annunciation. System shall have a complete annunciation system as required by all applicable codes and standards. As a minimum, the Transfer Control Switchgear system shall have the following annunciation:

1. Individual LED annunciation windows, 1.5” x 1.5” backlit with engraved lenses in a 3-window cluster for each and every breaker showing “Open” (Green) – “Closed” (Red) – “Withdrawn” (Amber
2. Primary LED annunciation windows, 1.5” x 1.5” backlit with engraved lenses in a 14-window cluster, located above the OIP, to indicate: “System NOT in Auto”(R), “Arc Flash Mode Active”(R), “Retransfer Mode Not in Auto”(R), “Utility Available”(G), “Emergency Power Available”(R), “System on Generator Power ”(R), “System on Normal Power”(G), “SPD Alarm”(R), “Load Test Active”(R), “Bus Ground Fault Alarm”(R), (4) spares

1.5 SUBMITTALS

A. Product data shall be submitted on each basic Switchboard construction type, showing manufacturer’s standard construction data, including:

1. Cabinet construction/dimensions.
2. Bus construction.
3. UL labeling.
4. Each overcurrent device.
5. Each component.
6. Provide electrical characteristics including voltage, frame size and trip ratings, fault current withstand ratings, and time-current curves of all equipment and components.
7. Provide data on trip units, IQ Analyzer 6600 and all associated metering/monitoring components, devices, equipment, etc.
8. Installation information.
9. Certified production test reports.
10. SPD (TVSS) equipment.

B. Submit Shop Drawings: Indicate electrical characteristics and connection requirements on all components, equipment, controls, remote equipment, etc including but not limited to:

1. Master drawing index
2. Front view, side view, and plan view of the assembly showing all components including metering, breakers, etc with dimensions.
3. Plan view and Elevation drawings with dimensions, width, height, depth for each section, shipping splits and switchboard as a whole.
4. Schematic diagram. Submit single line diagrams in accordance with ANSI Y332.2 indicating connections and controls.
5. Nameplate schedule and nomenclature
6. Component list
7. Conduit space locations within the assembly. Conduit entrances and available space
8. Assembly ratings including mains and all bus rating:
   a) Short-circuit rating
   b) Voltage
   c) Continuous current rating
   d) Material
9. Major component ratings including all breaker and device ratings:
   a) Voltage
   b) Continuous current rating
   c) Interrupting ratings
   d) Frame size
   e) Trip settings
   f) Trip options provided
10. Each circuit breaker amperage rating, circuit number and position/location in Switchboard.
11. Interrupting capacity of minimum rated breaker.
12. Show all accessories, options, etc included. Submittal to be job specific.
13. Cable terminal sizes
14. Field control wiring diagrams
15. Wiring diagrams of all devices complete with terminal strips, controls. Wire marking/identification, showing interior connections and external connections.
16. Sequence of operation description
17. Busway connections
18. Bus size, arrangement and spacing.
19. Mimic bus size and color.
20. All metering and monitoring equipment.
21. All annunciation equipment.
22. Elevations of each section of switchgear complete with all components shown.
23. SPD (TVSS) equipment.
24. Key interlock scheme drawing and sequence of operations
25. Bus duct connections and sections
26. Concrete pad dimensions.
27. All OIP screen shots for this project.

C. Submit Test Reports: Indicate results of performance testing.

D. Submit Manufacturer's Certificate: Certify that Products meet or exceed specified requirements.

E. Submit Manufacturer's Field Reports: Indicate procedures and findings.

F. Submit Manufacturer's Instructions: Indicating application conditions and limitations of use stipulated by product testing agency specified under regulatory requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

G. Submit coordination drawings of all electrical rooms, showing all electrical (and mechanical) equipment. Comply with requirements of Section 26 05 01.

1.6 PROJECT AS-BUILT DOCUMENTS

A. Record actual locations of switchboards on red lined as-built documents indicating actual circuit arrangement.

B. The drawings shall include the same drawings as the construction drawings and shall incorporate all changes made during the manufacturing and installation process.

1.7 OPERATION AND MAINTENANCE DATA

A. Equipment operation and maintenance manuals shall be provided with each assembly shipped, and shall include instruction leaflets and instruction bulletins for the complete assembly and each major component

B. Submit spare parts data including source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

C. Submit Operation Data: Include instructions for normal operation.

D. Submit Maintenance Data: Include instructions for routine maintenance requirements, and emergency maintenance procedures.

1.8 QUALITY ASSURANCE

A. Perform Work in accordance with NFPA 110.

1.9 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum twenty five years documented experience and with a *Factory employed* service technician permanently based within 25 miles of the Project.

B. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.

C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this

requirement.

1.10 REFERENCES AND REGULATORY REQUIREMENTS

A. The switchgear shall bear a UL 1558 label

B. Furnish Products listed and classified by Underwriters Laboratories as suitable for purpose specified and indicated.

C. Conform to all the requirements of the following:

1. NEMA MG1 - Motors and Generators.
2. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum.)
3. NFPA 30 - Flammable and Combustible Liquids Code.
4. NFPA 70 - National Electrical Code.
5. NFPA 101 - Life Safety Code.
6. NFPA 110 - Emergency and Standby Power Systems.
7. UL 2200 Stationary Engine Generator Assemblies
8. UL 1004 Electric Motors
9. ANSI-C37.20 – Switchgear assemblies
10. ANSI-C37.13 – Low voltage power circuit breakers
11. ANSI-C37.17 – Trip devices
12. NEMA SG-5 – Switchgear assemblies
13. NEMA SG-3 – Low voltage power circuit breakers
14. UL 1558

1.11 DELIVERY, STORAGE, AND HANDLING

A. Deliver in 35 inch maximum width (or dimension required to fit section through doors), individually wrapped for protection and mounted on shipping skids.

B. Accept switchboards on site. Inspect for damage.

C. Store in a clean, dry space as designated by OAR. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

D. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.12 ENVIRONMENTAL REQUIREMENTS

A. Conform to NEMA SG-5 service conditions during and after installation of switchboards.

1.13 FIELD MEASUREMENTS

A. Coordinate field measurements with manufacturer’s requirements.

1.14 MAINTENANCE MATERIALS

A. Provide two of each key.

B. Provide two fuse pullers.

1.15 EXTRA MATERIALS

A. Provide three of each size and type of fuse installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: Russelectric (Breakers must be Cutler Hammer type specified herein and in Section 26 24 13 Switchboards)

B. Approved Substitution: Eaton/ISO (if in full compliance with these specifications)

C. NO others manufacturers are allowed.

2.2 RATINGS

A. Voltage rating shall be as indicated on the drawings. The entire assembly shall be suitable for 600 volts maximum AC service.

B. The assembly shall be rated to withstand mechanical forces exerted during short-circuit conditions when connected directly to a power source having available fault current 65,000 amperes symmetrical at rated voltage.

C. The bus system shall have a minimum ANSI 4-cycle short-circuit withstand rating of 100,000 amperes symmetrical.

D. All circuit breakers shall have a minimum symmetrical interrupting capacity of 65,000 amperes. To ensure a fully selective system, all circuit breakers shall have 30 cycle short-time withstand ratings equal to their symmetrical interrupting ratings through 42,000 amperes, regardless of whether equipped with instantaneous trip protection or not.

E. All ratings shall be tested to the requirements of ANSI C37.20.1, C37.50 and C37.51 and UL witnessed and approved.

2.3 CONSTRUCTION

A. The switchgear shall consist of the required number of vertical sections bolted together to form a rigid assembly. The sides shall be covered with removable bolt-on covers. All edges of front covers or hinged front panels shall be formed. Provide ventilators located on the top of the switchgear over the breaker and bus compartments to ensure adequate ventilation within the enclosure. Hinged rear doors, complete with lockable door handles, shall be provided.

B. The assembly shall be provided with adequate lifting means and shall be capable of being moved into installation position and bolted directly to the floor without the use of floor sills providing the floor is level to 1/8 inch per 3-foot distance in any direction. Provisions shall be made for jacking of shipping groups, for removal of skids or insertion of equipment rollers. Base of assembly shall be suitable for rolling directly on pipes without skids. The base shall be equipped with slots in the base frame members to accommodate the use of pry bars for moving the equipment to its final position.

C. Each vertical steel unit forming part of the switchgear line-up shall be a self-contained housing having one or more individual breaker or instrument compartments, a centralized bus compartment and a rear cable compartment. Each individual circuit breaker compartment, or cell, shall be segregated from adjacent compartments and sections by means of steel barriers to the maximum extent possible. It shall be equipped with drawout rails and primary and secondary disconnecting contacts. Removable hinge pins shall be provided on the breaker compartment door hinges. Current transformers for feeder instrumentation, where shown on the plans, shall be located within the appropriate breaker cells and be front accessible and removable.

D. The stationary part of the primary disconnecting devices for each power circuit breaker shall be breaker mounted and consist of a set of contacts extending to the rear through a glass polyester insulating support barrier; corresponding moving finger contacts, suitably spaced, shall be furnished on the power circuit breaker studs which engage in only the connected position. The assembly shall provide multiple silver-to-silver full floating high pressure point contacts with uniform pressure on each finger maintained by springs. Each circuit shall include the necessary three-phase bus connections between the section bus and the breaker line side studs. Load studs shall be equipped with copper load extension buses terminating in solderless type terminals in the rear cable compartment of each structure. Bus extensions shall be silver-plated where outgoing terminals are attached.

E. The circuit breaker door design shall be such that the following functions may be performed without the need to open the circuit breaker door: lever circuit breaker between positions, operate manual charging system, close and open circuit breaker, examine and adjust trip unit, and read circuit breaker rating nameplate.

F. The secondary disconnecting devices shall consist of floating terminals mounted on the stationary unit and engaging mating contacts at the front of the breaker. The secondary disconnecting devices shall be gold-plated and engagement shall be maintained in the “connected” and “test” positions.

G. The removable power circuit breaker element shall be equipped with disconnecting contacts and interlocks for drawout application. It shall have four positions, “connected,” “test,” “disconnected” and “removed.” The breaker drawout element shall contain a worm gear levering “in” and “out” mechanism with removable lever crank. Levering shall be accomplished via the use of conventional tools. Mechanical interlocking shall be provided so that the breaker is in the tripped position before levering “in” or “out” of the cell. The breaker shall include an optional provision for key locking open to prevent manual or electric closing.

Padlocking shall provide for securing the breaker in the connected, test, or disconnected position by preventing levering.

H. An insulating flash shield shall be mounted above each circuit breaker to prevent flashover from the arc chutes to ground.

I. The switchgear shall be suitable for use as service entrance equipment and be labeled in accordance with UL requirements.

J. Each section of switchgear shall be compartmentalized and totally separate and isolated from adjacent section.

K. Provide a rear compartment barrier between the cable compartment and the main bus to protect against inadvertent contact with main or vertical bus bars.

L. Provide in the cell when the circuit breaker is withdrawn, a safety shutter which automatically covers the line and load stabs and protects against incidental contact.

M. Provide a glass polyester full height and depth barrier between adjacent vertical structures in the bus compartment with appropriate slots for main bus.

2.4 BUS

A. All bus bars shall be silver-plated copper. Bus sizing shall be based on ANSI standard temperature rise criteria of 65 degrees C over a 40 degrees C ambient (outside the enclosure).

B. Provide a full capacity neutral bus where a neutral bus is indicated on the drawings.

C. A copper ground bus shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the switchgear. The ground bus short-time withstand rating shall meet that of the largest circuit breaker within the assembly.

D. All hardware used on conductors shall be high-tensile strength and zinc-plated. All bus joints shall be provided with Belleville-type washers.

2.5 WIRING/TERMINATIONS

A. Small wiring, necessary fuse blocks and terminal blocks within the switchgear shall be furnished as required. Control components mounted within the assembly shall be suitably marked for identification corresponding to the appropriate designations on manufacturer’s wiring diagrams.

B. Provide a front accessible, isolated vertical wireway for routing of factory and field wiring. Factory provisions shall be made for securing field wiring without the need for adhesive wire anchors.

C. Front access to all circuit breaker secondary connection points shall be provided for ease of troubleshooting and connection to external field connections without the need of removing the circuit breaker for access.

D. All control wire shall be type SIS. Control wiring shall be minimum 14 gauge for control circuits and minimum 12 gauge for shunt trip and current transformer circuits. Wire bundles shall be secured with nylon ties and anchored to the assembly with the use of pre-punched wire lances or nylon non-adhesive anchors. All current transformer secondary leads shall first be connected to conveniently accessible shorting terminal blocks before connecting to any other device. Shorting screws with provisions for storage shall be provided. All groups of control wires leaving the switchgear shall be provided with terminal blocks with suitable numbering strips and provisions for #10 AWG field connections. Each control wire shall be clearly identified by means of a heat embossed vinyl sleeve markers at each end. Labeling tape wire markers are not acceptable. Wire numbers shall match the Manufacturer's interconnection, schematic and wiring drawings. Plug-in terminal blocks shall be provided for all shipping split wires. Terminal connections to remote devices or sources shall be front accessible via doors above each circuit breaker.

E. Mechanical type pressure lugs shall be provided for all line and load terminations suitable for copper cable rated for 75 degrees C of the size indicated on the drawings.

F. Lugs shall be provided in the incoming line section for connection of the main grounding conductor. Additional lugs for connection of other grounding conductors shall be provided as indicated on the drawings.

2.6 CIRCUIT BREAKERS

A. All protective devices shall be low voltage power circuit breakers. All breakers shall be UL listed for application in their intended enclosures for 100% of their continuous ampere rating.

B. All power circuit breakers shall be constructed and tested in accordance with ANSI C37.13, C37.16, C37.17, C37.50, UL 1066 and NEMA SG-3 standard. The breaker shall carry a UL label.

C. Breakers shall be provided in drawout configuration. The 800, 1600, and 2000 ampere frame power circuit breakers shall be provided in the same physical frame size, while 3200, 4000 and 5000 ampere frame power circuit breakers shall be provided in a second physical frame size. Both physical frame sizes shall have a common height and depth.

D. Power circuit breakers shall utilize a two-step stored-energy mechanism to charge the closing springs. The closing of the breaker contacts shall automatically charge the opening springs to ensure quick-break operation.

E. All circuit breaker shall be electrically operated and equipped with auxiliary contacts, bell alarm contacts, and microprocessor based trip units.

F. Breakers shall have 24Vdc shunt trip, powered from best battery system integral to switchgear system.

G. Breakers shall be electrically operated (EO) with 120V AC motor operators. The charging time of the motor shall not exceed 6 seconds.

H. To facilitate lifting, the power circuit breaker shall have integral handles on the side of the breaker.

I. The power circuit breaker shall have a closing time of not more than 3 cycles.

J. The primary contacts shall have an easily accessible wear indicator to indicate contact erosion.

K. The power circuit breaker shall have three windows in the front cover to clearly indicate any electrical accessories that are mounted in the breaker. The accessory shall have a label that will indicate its function and voltage.

2.7 TRIP UNITS

A. Each low voltage power circuit breaker shall be equipped with a solid-state tripping system consisting of three current sensors, microprocessor-based trip device and flux-transfer shunt trip. Current sensors shall provide operation and signal function. The trip unit shall use microprocessor-based technology to provide the basic adjustable time-current protection functions. True RMS sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time delay settings are reached. Interchangeable current sensors with their associated rating plug shall establish the continuous trip rating of each circuit breaker. The basis of design is Cutler-Hammer type Digitrip 1150.

B. The trip unit shall have an information system that provides LEDs to indicate mode of trip following an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip. A reset button shall be provided to turn off the LED indication after an automatic trip.

C. The trip unit shall be provided with a display panel, including a representation of the time/current curve that will indicate the protection functions. The unit shall be continuously self-checking and provide a visual indication that the internal circuitry is being monitored and is fully operational.

D. The trip unit shall be provided with a making-current release circuit. The circuit shall be armed for approximately two cycles after breaker closing and shall operate for all peak fault levels above 25 times the ampere value of the rating plug.

E. Trip unit shall have selectable thermal memory for enhanced circuit protection.

F. Complete system selective coordination shall be provided by the addition of the following individually adjustable time/current curve shaping solid-state elements:

1. All circuit breaker shall have adjustments for long delay pickup and time.

2. All circuit breakers shall have individual adjustments for short delay pickup and time, and include I^2t settings and adjustable instantaneous pickup.
3. All circuit breakers shall have individually adjustable ground fault current pickup and time, and include I^2t settings or ground alarm only. GF alarm only on priority one (life safety) feeders, GF trip on all other feeders.
4. All circuit breakers on emergency designated switchboards shall have individually adjustable ground fault alarm (LSIA).

G. The trip unit shall have provisions for a single test kit to test each of the trip functions.

H. The trip unit shall provide zone interlocking for the short-time delay and ground fault delay trip functions for improved system coordination. The zone interlocking system shall restrain the tripping of an upstream breaker and allow the breaker closest to the fault to trip with no intentional time delay. In the event that the downstream breaker does not trip, the upstream breaker shall trip after the present time delay. Factory shall wire for zone interlocking for the power circuit breakers within the switchgear.

I. The trip unit shall have an information system that utilizes battery backup LEDs to indicate mode of trip following an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip. A test pushbutton shall energize a LED to indicate the battery status

J. The trip unit shall have a 4-character LCD display showing phase, neutral, and ground current. The accuracy of these readings shall be +/- 2% of full scale

K. The trip unit shall be equipped to permit communication via twisted pair for remote monitoring and control by existing and new PowerNet system. The trip unit shall include a power/relay module which shall supply control to the readout display. Following an automatic trip operation of the circuit breaker, the trip unit shall maintain the cause of trip history and the mode of trip LED indication as long as its internal power supply is available. An internal relay shall be programmable to provide contacts for remote ground alarm indication.

L. The trip unit shall include a voltage transformer module, suitable for operation up to 600V, 50/60 Hz. The primary of the power relay module shall be connected internally to the line side of the circuit breaker through a dielectric test disconnect plug.

M. An internal relay shall be programmable to provide contacts for remote ground alarm indication.

N. Utility Main, Generator Main and circuit breakers serving Life Safety Loads shall have individually adjustable ground fault alarm only. Circuit breakers serving equipment loads shall have ground fault trip only.

O. The trip unit shall be equipped to permit communication via a network twisted pair for owners remote PowerNet system.

P. The display for the trip units shall be a 24 character LED display.

Q. Metering display accuracy of the complete system, including current sensors, auxiliary CTs, and the trip unit, shall be +/- 1% of full scale for current values. Metering display accuracy of the complete system shall be +/- 2% of full scale for power and energy values.

R. The unit shall be capable of monitoring the following data:

1. Instantaneous value of phase, neutral and ground current.
2. Instantaneous value of line-to-line voltage.
3. Minimum and maximum current values.
4. Watts, vars, VA, watt-hours, var-hours, and VA hours.

S. The energy-monitoring parameter values (peak demand, present demand, and energy consumption) shall be indicated in the trip unit's alphanumeric display panel

T. The trip unit shall display the following power quality values:

1. Crest Factor.
2. Power Factor.
3. Percent total harmonic distortion.
4. Harmonic values of all phases through the 31st harmonic.

U. The main breaker trip unit shall have the following advanced features integral to the trip unit:

1. Adjustable undervoltage release.
2. Adjustable overvoltage release.
3. Reverse load and fault current.
4. Reverse sequence voltage alarm.
5. Under frequency.
6. Over frequency.
7. Voltage phase unbalance and phase loss during current detection.

V. An adjustable high load alarm shall be provided, adjustable from 50 to 100% of the long delay pickup setting.

W. The trip unit shall contain an integral test pushbutton. A keypad shall be provided to enable the user to select the values of test currents within a range of available settings. The protection functions shall not be affected during test operations. The breaker may be tested in the TRIP or NO TRIP test mode.

X. Programming may be done via a keypad at the faceplate of the unit or via the existing communication network.

Y. System coordination shall be provided by the following microprocessor-based programmable time-current curve shaping adjustments. The short-time pickup adjustment shall be dependant on the long delay setting.

1. Programmable long-time setting
2. Programmable long-time delay with selectable I^2T or I^4T curve shaping
3. Programmable short-time setting

4. Programmable short-time delay with selectable flat or I^2T curve shaping, and zone selective interlocking
5. Programmable instantaneous setting
6. Programmable ground fault setting trip or ground fault setting alarm
7. Programmable ground fault delay with selectable flat or I^2T curve shaping and zone selective interlocking.
8. The trip unit shall offer a three-event trip log that will store the trip data, and shall time and date stamp the event

2.8 ENCLOSURE TYPE 1 – GENERAL PURPOSE

A. Align sections at front and rear.

B. Switchboard Height: 96 inches, excluding floor sills, lifting members and pull boxes.

C. Mimic Bus: Show bussing, connections and devices in single line form on the front panels of the switchboard using black color plastic strips, fastened flat against the panel face with screws or rivets.

D. Provide hinged rear doors with provisions for padlocking.

2.9 SURGE SUPPRESSION DEVICE (SPD)

A. Each lineup of switchgear shall include a door mounted surge protector(s). The SPD unit(s) shall be rated Type 1 UL1449, fourth edition. SPD shall be equipped with a fused disconnect for isolation when servicing. Use of a breaker is not acceptable as the breaker limits the surge capacity of the SPD. SPD shall be mounted in an open section nearest to the main incoming power source section with lead length kept to a minimum. The display unit shall be connected via ribbon cable to the main unit and mounted so as to be visible when the door is closed.

B. See specification section 26 43 13 on SPD for additional information.

C. Provide SPD for each bus as shown on the drawings.

2.10 POWER QUALITY METER AND ANALYZER METERS

A. Each lineup of switchgear shall include a Cutler-Hammer IQ Analyzer 6600 with Poni card (or approved substitution) wired with #18 gauge twisted pair shielded cable. Belden 9463 family in a daisy chain and connected to the Digitrip trip units on each circuit breaker to the existing Cutler-Hammer Powernet System. All communications cabling is to be factory installed and terminated to a terminal block for continuation to the Powernet System.

B. Provide meters with appropriate multiplier tags.

2.11 METERING TRANSFORMERS

A. Current Transformers; ANSI C57.13; 5 ampere secondary, primary/ secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.

B. Potential Transformers: ANSI C57.13; 120 volt disconnecting type with integral fuse mountings, primary/secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.

2.12 ACCESSORIES

A. Circuit Breaker Lifting Device: Carriage and track on top of each switchboard with lifting device to serve draw-out circuit breakers in switchboard.

2.13 NAMEPLATES

A. Engraved nameplates, mounted on the face of the assembly, shall be furnished for all main and feeder circuits as indicated on the drawings. Nameplates shall be laminated plastic, white characters on red background, and secured with screws. Characters shall be 3/16-inch high, minimum.

B. Furnish master nameplate giving switchgear designation, voltage ampere rating, short-circuit rating, and manufacturer’s name.

C. Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer’s drawings

2.14 FINISH

A. All exterior and interior steel surfaces of the switchgear shall be properly cleaned and provided with a rust-inhibiting phosphatized coating. Color and finish of the switchgear shall be ANSI 61

2.15 TRANSFER SWITCHGEAR CONTROL SYSTEM

A. A Transfer Switchgear Control System shall be provided to facilitate overall system operation including automatic transfer control, monitoring of the available power sources, engine start command, alarm/fault monitoring, breaker control and monitoring and communication to remote Generator Building CEP controls and remote OIP locations.

B. The Switchgear Control System shall utilize redundant fiber optic communication networks, in ring configuration, to communicate with the redundant PLC controls located in the Generator Building CEP main emergency switchgear controls. Redundant I/O drops shall be provided within each 480V Transfer Switchgear to interface with breakers, meters, annunciators, control switches and other devices as required. The CEP Switchgear Control System shall provide all functions and operations as specified in these specifications and as listed or noted on drawings.

C. Coordination of 480V Transfer Switchgear Controls with the Generator CEP control system shall be the responsibility of the 480V transfer switchgear supplier. Update of the Generator Building Control and SCADA screens, logic software and communication hardware, that may be required for this Transfer Control Switchgear shall be provided by the Transfer Control Switchgear provider. All documentation updates of the Main Generator Switchgear controls and SCADA system that are necessary for implementation and support of the Transfer Switchgear shall also be provided.

D. A third fiber-optic pair shall be provided for SCADA communications between the Generator Building Main Controls and the transfer switchgear.

2.16 HARD WIRED METERING/CONTROLS

A. Each Utility Main Breaker shall have the following discrete hard wired metering:

1. Analog Voltmeter (4”) with phase selector switch
2. Analog Ammeter (4”) with phase selector switch
3. Crompton Integra Multi-function meter (4”) to display selectable values: KW, PF, Freq, THD, etc.

B. Each Feeder Breaker shall have the following discrete hard wired metering and control devices.

1. Analog Voltmeter (4”) with phase selector switch
2. Crompton Integra Multi-function meter (4”) to display selectable values: KW, Amps, PF, Freq, THD, etc.
3. Breaker control switch.
4. The above shall be grouped together on door of the ”B” cubicle compartment for each feeder breaker vertical section together with the 3-lie breaker annunciator (specified elsewhere herein) and breaker control switch. A common lamp test push button shall also be included on the door.

C. Fault Tolerance:

1. Redundant PLC’s -- The Transfer Switchgear Control System shall be designed using redundant PLC’s with redundant I/O drops. In addition it shall be provided with redundant fiber optic communications to the redundant PLC’s in the Generator switchgear controls located in the central generator building. The Transfer Switchgear redundant PLC’s shall provide bumpless transfer on fault and using redundant distributed I/O networks to maximize system fault tolerance.
2. Hard wired manual backup – As described herein, there shall be hard wired manual controls and instrumentation that allow full operation of the system WITHOUT availability of any PLC or OIP. Hard wiring shall include necessary interlocks to prevent operator error.
3. Best Source DC – All DC sources shall be constantly evaluated for suitability to power the System and Generator set control and protection. As standard, this DC system shall include all Generator set batteries and a System Station battery with regulated charger. Should any battery fail, the system shall switch to the next viable DC source with no

interruption of operation. All control, operator interface, and protection shall be powered by this system.

4. Supervisory Control Network – To insure the integrity of the supervisory control network, fiber optic cable shall be used wherever the supervisory network leaves the protection of the switchgear. To assure network fault tolerance, this fiber optic cable is to be in a self-healing ring configuration.

D. Human Machine Interface (OIP)

1. A 23-inch *minimum* (diagonal), color TFT industrial display shall be provided for operator interface panel(s) as standard equipment. This display shall support a minimum resolution of 1280 x 1024 pixels. Interface shall be accomplished via a key protected touch screen permanently affixed to the display. The touch screen shall be clear glass, with light transmission of 95% or better, furnished with a Surface Acoustic Wave touch interface. Resistive or Capacitive touch interfaces are not acceptable. Navigation and operation shall be intuitive such that Help Screens are not required. The Operator Interface will access to system operating parameters, set points, graphical displays and other information as defined elsewhere in this specification.

2.17 ARC REDUCTION MODE (ARM's)

A. Provide Arc Flash Reduction Mode capability for all breakers in the switchgear. A common ARM switch shall be mounted below the OIP and shall illuminate an annunciator window when active.

2.18 BUS GROUND FAULT

A. Provide a Bus Ground Fault Differential scheme for each load bus using ITI (or equivalent) BGFL relays and zero sequence CT's. A detected GF shall not trip any source breakers, rather it will sound an alarm horn on the gear and illuminate an annunciator window when active.

2.19 IR WINDOWS

A. Provide Cutouts in rear doors to accommodate 4" IR windows per GOAA standards, as described on the drawings. Windows shall be provided and factory installed.

2.20 STATION BATTERY SYSTEM

A. Provide 24 VDC Nicad Station Battery System for Switchgear controls that will be connected to the best battery selector

B. Minimum battery capacity shall be 150 amp-hr @ 8-hour rate.

C. Provide rack, cell connectors and power lugs

D. Furnish wall mount charger, 120 VAC input, 25 amp @24 VDC output with AC input breaker, DC output breaker, DC volt meter, DC amp meter, equalizing timer, alarms lights for AC

failure, DC failure, High VDC, Low VDC, positive & negative ground fault and common alarm contact

PART 3 – EXECUTION

3.1 PREPARATION/INSPECTION/EXAMINATION

A. Verify that surface is suitable for switchboard installation.

B. Check that concrete pads are level and free of irregularities

C. Examine area to receive switchboard to assure adequate clearance for switchboard installation.

D. Verify that National Electrical Code clearances will be maintained after installation. Rework equipment locations as required to provide required clearances.

E. Start Work only after unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install all switchboard enclosures in accordance with the manufacturer's written instructions, NECA's "Standard of Installation", the applicable requirements of the National Electrical Code, and recognized industry practices.

B. Mount switchboard on 3” concrete base extending 3” outside all sides.

C. Provide rubber insulating mats on floor in front of board for entire length of board, minimum 4 feet wide.

D. Install switchboards plumb. Provide supports in accordance with Section 26 05 29.

E. Provide doors for unused spaces in switchboards.

F. Install switchboards so that proper working clearances shall be maintained at every switchboard location, both front and back.

G. Clean the interior of each switchboard before installing conductors. At all times, keep the interior trim and exterior surfaces of the switchboard free of rust and debris. Repaint finishes if necessary.

H. Coordinate all raceways and conductors with their respective switchboards so that all connections and conductors routing present an orderly appearance. Conductors in the switchboards shall be laced and arranged in orderly manner.

I. Provide a separate 24vdc circuit as required to power any shunt-trip function/device.

J. All necessary hardware to secure the assembly in place shall be provided by the Contractor.

K. The equipment shall be installed and checked in accordance with the manufacturer's recommendations. This shall include but not limited to:

1. Checking to ensure that the pad location is level to within 0.125 inches per three foot of distance in any direction.
2. Checking to ensure that all bus bars are torqued to the manufacturer's recommendations.
3. Assembling all shipping sections, removing all shipping braces and connecting all shipping split mechanical and electrical connections.
4. Securing assemblies to foundation or floor channels.
5. Measuring and recording Megger readings phase-to-phase, phase-to-ground, and neutral-to-ground (four wire systems only).
6. Inspecting and installing all circuit breakers in their proper compartments.

L. MONITORING/METERING

1. Provide/install all components, wiring, cable (fiber optic and copper), raceways, hubs, switches, patch panel modules, pc cards, communication network devices, converters, etc., as required to connect switchgear to remote OIP's that will be located in Electrical Maintenance Shop/Office and in the CEP.
2. All revisions to software, programming, etc., are to be by manufacturer of the switchgear.

M. IDENTIFICATION

1. Refer to Section 26 05 53 for products and content.
2. Provide engraved plastic nameplates under the provisions of 26 05 53.

N. Conduit or piping systems that contain water or liquid of any kind shall not be installed over the top of any electrical equipment, transformers, racks, cabinets, or enclosures without prior written approval from the Owner.

3.3 FACTORY TESTING

A. The switchgear shall be completely assembled, wired, adjusted and tested at the factory. After assembly, the complete switchgear shall be tested to ensure the accuracy of the wiring and the functioning of all equipment. The main bus system shall be given a dielectric test of 2200 volts for one minute between live parts and ground and between opposite polarities.

B. The wiring and control circuits shall be given a dielectric test of 1500 volts for one minute, or 1800 volts for one second, between live parts and ground, in accordance with ANSI C37.20.1.

C. A certified test report of all standard production tests shall be shipped with each assembly.

D. Testing at factory is to include all interlocking and breaker control functions.

E. Certification of this test must be provided prior to delivery of this equipment.

3.4 MANUFACTURER'S CERTIFICATION

A. A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations.

B. The Contractor shall provide three (3) copies of the manufacturer's representative's certification before final payment.

3.5 FIELD QUALITY CONTROL

A. Perform field inspection and testing.

B. Provide full load test utilizing portable test bank, for four hours minimum. Simulate power failure including operation of transfer between sources, automatic starting cycle, automatic shutdown and return to normal.

C. Record in 20 minute intervals during four hour test:

1. Kilowatts.
2. Amperes.
3. Voltage.
4. Coolant temperature.
5. Room temperature.
6. Frequency.
7. Oil pressure.

D. Test alarm and shutdown circuits by simulating conditions.

E. Provide the services of a qualified factory-trained manufacturer's representative to assist the Contractor in installation and start-up of the equipment specified under this section for a period of not less than 10 working days. The manufacturer's representative shall provide technical direction and assistance to the contractor in general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained therein.

F. The manufacturer's representative shall provide inspection of the final installation. The manufacturer's representative shall perform site start-up and functional checkout of the Switchgear. Upon completion of the manufacturer's start-up and checkout, the manufacturer shall demonstrate to the customer all the automated sequences of operation as specified herein.

G. The Contractor shall provide three (3) copies of the manufacturer's field start-up report.

H. Measure steady state load currents at each switchboard feeder; rearrange circuits to balance the phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.

I. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers, fusible switches, and fuses.

J. All circuits shall be operated to establish a good working order and checked for shorts.

K. All panel directory circuit numbers shall be checked to verify accuracy of the number.

L. Measure insulation resistance of each bus section phase to phase and phase to ground for one minute each, at test voltage of 1000 volts; minimum acceptable value for insulation resistance is 2 megohms. Disconnect all electronic circuitry and TVSS units prior to test.

M. Check tightness of accessible bolted bus joints using calibrated torque wrench.

N. Physically test key interlock systems to insure proper function.

O. Tests:

1. Test Switchboards and switchboard feeders per requirements of Section 26 08 10.
2. Test all operational features of switchboard including interlocking, remote controls, touch screen, remote computer PC control, etc.
3. Feeder conductors shall be checked by approved means to establish the absence of shorts to ground; insulation value, etc. and the result recorded and submitted to the Designer.
4. Submit Conductor Insulation Resistance Test per requirements of Section 26 08 10.
5. Submit Tabulation Data Voltage and Amperage Readings per requirements of Section 26 08 10.

P. Equipment Checkout:

1. When requested by Designer/OAR provide (during construction):
   a) Inspection of equipment by authorized equipment manufacturer technician complete with submittal of statement of findings by technician, and providing any adjustments deemed necessary for a complete and operating system.
2. Submit Equipment Checkout Memo per Section 26 08 10.

3.6 TRAINING

A. The Contractor shall provide training sessions for up to five (5) owner’s representatives. Both training sessions shall be for 2 normal workdays. One shall be held during project close out as required in other sections of these specifications and one shall be held six (6) months after initial training. Both shall be performed at a jobsite location determined by the owner.

B. For both sessions: Upon successful completion of the demonstration of the automated sequences of operation by the manufacturer and acceptance by the customer, the manufacturer shall provide an eight-hour "hands-on" training course for the customer's operating personnel which shall cover the following topics:

1. Overall System Description and Theory of Operation
2. Automatic Operation
3. Manual Operation
4. Safeties and Protective Relaying
5. Recommended System Check Lists and Log Sheets
6. Recommended Preventive Maintenance

C. A manufacturer's qualified representative shall conduct the training session. The training program shall also include instruction on the operation of the assembly, circuit breakers, and major components within the assembly.

D. All training sessions shall be video taped. Tape to be turned over to owner.

3.7 ADJUSTING

A. Adjust all operating mechanisms for free mechanical movement.

B. Tighten bolted bus connections in accordance with manufacturer's instructions.

C. Adjust circuit breaker trip and time delay settings to values determined by approved Contractor provided Power Systems Study, and any manufacturer's recommendation.

3.8 DEMONSTRATION

A. Provide systems demonstration.

B. Describe loads connected to emergency and standby system and restrictions for future load additions.

C. Simulate power outage by interrupting normal source, and demonstrate that system operates to provide emergency and standby power.

SECTION 26 24 13 – SWITCHBOARDS-DRAW OUT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification sections apply to this section.

1.2 SUMMARY

A. This section includes the requirements for provision and installation of switchboards.

B. Normal and emergency switchboards shall comply with these specifications. Emergency switchboards shall also comply with Section 26 07 17 SCADA Monitoring and Control and Section 26 23 25 Medium-Voltage Generator Paralleling Switchgear and Controls.

1.3 DESCRIPTION

A. Factory-assembled, metal-enclosed switchboard for distribution and control of power from incoming line terminals to outgoing feeder terminals, installed and tested in place.

B. Switchboard shall include all protective devices and equipment as listed on drawings or as included in these specifications, with necessary interconnections, instrumentation and control wiring.

C. The terms switchgear and switchboard are used synonymously with each other. Switchgear shall be considered switchboard(s) and vice versa.

D. All breakers in all emergency switchgear shall be controlled by the control logic of the generator switchgear.

E. All main breakers and tie breakers in all emergency switchgear shall be interlocked with the breakers in emergency switchgear so only one source of power is connected to any one bus at any point in time.

1.4 SUBMITTALS

A. Product data shall be submitted on each basic switchboard construction type, showing manufacturer’s standard construction data, including:

1. Cabinet construction/dimensions.
2. Bus construction.
3. UL labeling.
4. Each overcurrent device.
5. Each component.
6. Provide electrical characteristics including voltage, frame size and trip ratings, fault current withstand ratings, and time-current curves of all equipment and components.
7. Provide data on trip units, and all metering/monitoring components, devices, equipment, etc.
8. Installation information.
9. Certified production test reports.
10. Best battery system.

B. Shop drawings shall be submitted for all switchboards. Indicate the following information:

1. Label.
2. Each circuit breaker amperage rating, circuit number and position/location in Switchboard.
3. Electrical characteristics of switchboard.
4. Mains rating.
5. Main device rating.
6. Mounting.
7. Dimension, width, depth, height.
8. Bus material.
9. Schematic diagram.
10. Wiring diagrams of all devices complete with terminal strips, controls, wire marking/identification, showing interior connections and external connections.
11. Interrupting capacity of minimum rated breaker.
12. Switchboard type.
13. Component list.
14. Locations of all components including breakers, metering, monitoring, terminal strips, etc.
15. Nameplate legend for each overcurrent device.
16. Front and side views of enclosures with overall dimensions shown.
17. Conduit entrance locations and requirements.
18. Frame sizes and interrupting capacity of each breaker, and total assembly.
19. Horsepower ratings at rated voltage of fused switches and/or breakers.
20. Switchboard instrument details.
21. Type of labels and labeling for every device and what it feeds.
22. Nameplate on main panelboard giving name of project; Architect, Engineer and Contractor.
23. Bus bar size, arrangement and spacing.
24. Surge Protective Device Equipment
25. Metering/Monitoring Equipment.
26. Layouts showing concrete pad dimensions, conduit entrance and available space, bus duct connections, electrical ratings, nameplate nomenclature, and single-line diagrams in accordance with ANSI Y32.2 indicating connections and controls.
27. Submit coordination drawings of all electrical rooms, showing all electrical (and mechanical) equipment. Comply with requirements of Section 26 05 00 Common Work Results for Electrical.
28. Busway connections.
29. Bus duct connections.

30. Composite front view and plan view of close-coupled assemblies.
31. Key interlock scheme drawing and sequence of operations.
32. Mimic bus size and color.
33. Best battery system.
34. Secondary contact configuration for each breaker type and cubicle type.

C. Manufacturer's Instructions indicating application conditions and limitations of use stipulated by product testing agency specified under regulatory requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

1.5 PROJECT AS-BUILT DOCUMENTS

A. Record actual locations of switchboards on red lined as-built documents indicating actual circuit arrangement.

B. The drawings shall include the same drawings as the construction drawings and shall incorporate all changes made during the manufacturing and installation process.

1.6 OPERATION AND MAINTENANCE DATA

A. Equipment operation and maintenance manuals shall be provided with each assembly shipped, and shall include instruction leaflets and instruction bulletins for the complete assembly and each major component.

B. Submit spare parts data including source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this Section with minimum 10 years of experience.

1.8 REFERENCES AND REGULATORY REQUIREMENTS

A. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

B. Conform to the requirements of the following:

1. ANSI/NFPA 70 - National Electrical Code.
2. ANSI/IEEE C12.1 - Code for Electricity Metering.
3. ANSI C39.1 - Electrical Analog Indicating Instruments.
4. ANSI C56.13 - Instrument Transformers.
5. ANSI C37.20 - Switchgear Assemblies
6. ANSI C37.13 - Low Voltage Power Circuit Breakers
7. ANSI C37.17 - Trip Devices
8. NEMA SG-5 - Switchgear Assemblies
9. NEMA SG-3 - Low Voltage Power Circuit Breaker
10. UL 1558 – Metal Enclosed Low-Voltage Power Circuit Breaker Switchgear

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver in 35 inch maximum width (or dimension required to fit section through doors), individually wrapped for protection and mounted on shipping skids.

B. Accept switchboards on site. Inspect for damage.

C. Store in a clean, dry space as designated by OAR. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

D. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.10 ENVIRONMENTAL REQUIREMENTS

A. Conform to NEMA SG-5 service conditions during and after installation of switchboards.

1.11 FIELD MEASUREMENTS

A. Coordinate field measurements with manufacturer’s requirements.

1.12 MAINTENANCE MATERIALS

A. Provide two of each key (if applicable).

B. Provide two fuse pullers (if applicable).

1.13 EXTRA MATERIALS

A. Provide three of each size and type of fuse installed (if applicable).

B. Provide one spare breaker of each combination of trip unit and frame size used in project. A minimum of five spare breakers are required (1600, 2000, 3200 and 4000 amp). Complete with trip units, options, etc., as specified herein.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Emergency Switchboards/switchgear (All switchgear/switchboards connected to any branch of the emergency distribution system). Manufacturer of emergency switchboards/switchgear shall be the same manufacturer as the manufacturer of the emergency generator GENMV1 switchboard/switchgear.

1. Basis of Design: Russelectric, or approved substitution.

B. Normal Distribution Switchboards/switchgear (All switchgear/switchboards connected only to normal power distribution system)

1. Eaton, or approved substitutions.

2.2 GENERAL

A. Switchboards with circuit breaker branch protective devices shall comply with NEMA SG-5 as a minimum requirement. Switchboard shall meet Underwriter's Laboratories enclosure requirements for service conditions.

B. Each cubicle shall have UL Label affixed, unless special construction prohibits and no labeling or listing is available.

C. The sides and tops shall be covered with removable screw-on code gauge steel plates.

D. Switchboards shall be completely self-supporting structures, 96” high.

E. Minimum integrated short circuit rating: 100,000 amperes RMS symmetrical for 480 volt. Bus shall be braced for minimum capacity equal to or greater than the lowest breaker symmetrical interrupting capacity. Minimum short circuit rating shall be increased to meet the following requirements:

1. Individual C.B. AIC Rating shown on panel schedules indicate lowest AIC rating allowed for individual circuit breaker in panel.

2. Circuit breakers shall be based on a fully rated system. Circuit breaker types are not shown or called for. The contractor must provide breakers in panel or feeder breakers in upstream breakers to comply with the required AIC specified.

F. Main section devices, distribution section devices, and all auxiliary devices shall be individually mounted and compartmented, draw-out construction.

G. Provide best battery system in emergency switchboards to provide shunt trip power to all circuit breakers in boards complete with uninterruptible power supply, battery charger and batteries. System is to be monitored by the Power Xpert metering and monitoring system for proper operation. Provide all electrical to achieve this.

H. Provide complete interlock system between all applicable breakers in normal and emergency switchboards as required to prevent closing of any two sources onto same bus at same time. Submit narrative of interlock.

2.3 SWITCHBOARD

A. Description: NEMA SG-5 with electrical ratings and configurations as indicated.

B. Main Section Devices: Individually mounted and compartmented, draw-out construction.

C. Distribution Section Devices: Individually mounted and compartmented, draw-out construction

D. Auxiliary Section Devices: Individually mounted and compartmented.

E. Bus Material: Copper with tin plating, standard size.

F. Bus connections: Bolted, accessible from rear only for maintenance.

G. Fully insulate bus bars in rear accessible compartments.

H. Ground bus: Extend length of Switchboard, braced for 100,000 amps symmetrical short circuit current.

I. All protective devices shall be low voltage power circuit breakers. Basis of design is Eaton Type Magnum DS. All breakers shall be UL listed for application in their intended enclosures for 100% of their continuous ampere rating.

J. All power circuit breakers shall be constructed and tested in accordance with ANSI C37.13, C37.16, C37.17C37.50, UL 1066 and NEMA SG-3 standard. The breaker shall carry a UL label.

K. Power circuit breakers shall utilize a two-step stored-energy mechanism to charge the closing springs. The closing of the breaker contacts shall automatically charge the opening springs to ensure quick-break operation.

L. Breakers shall be electrically operated (EO) with 120V AC motor operators. The charging time of the motor shall not exceed 6 seconds.

M. Trip Units:

1. Each low voltage power circuit breaker shall be equipped with a solid-state tripping system consisting of three current sensors, microprocessor-based trip device and flux-transfer shunt trip. Current sensors shall provide operation and signal function. The trip unit shall use microprocessor-based technology to provide the basic adjustable time-current protection functions. True RMS sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time delay settings are reached. Interchangeable current sensors with their associated rating plug shall establish the continuous trip rating of each circuit breaker. The basis of design is Eaton type Digitrip 1150 Plus on mains and Digitrip 1150 on feeders and ties.
2. Complete system selective coordination shall be provided by the addition of the following individually adjustable time/current curve shaping solid-state elements:
    a) All circuit breakers shall have adjustments for long delay pickup and time.
    b) All circuit breakers shall have individual adjustments for short delay pickup and time, and include I^2t settings and adjustable instantaneous pickup.
    c) All circuit breakers shall have individually adjustable ground fault current pickup and time, and include I^2t settings or ground alarm only.
    d) All circuit breakers on emergency designated switchboards shall have individually adjustable ground fault alarm (LSIA).
3. The trip unit shall be equipped to permit communication via twisted pair for remote monitoring and control.
4. An internal relay shall be programmable to provide contacts for remote ground alarm indication.
5. The display for the trip units shall be a 24 character LED display.
6. Metering display accuracy of the complete system, including current sensors, auxiliary CTs, and the trip unit, shall be +/- 1% of full scale for current values. Metering display accuracy of the complete system shall be +/- 2% of full scale for power and energy values.
7. The unit shall be capable of monitoring the following data:
    a) Instantaneous value of phase, neutral and ground current.
    b) Instantaneous value of line-to-line voltage.
    c) Minimum and maximum current values.
    d) Watts, vars, VA, watthours, var hours, and VA hours.
8. The trip unit shall display the following power quality values:
    a) Crest Factor.
    b) Power Factor.
    c) Percent total harmonic distortion.
    d) Harmonic values of all phases through the 31st harmonic.
9. The main breaker trip unit shall have the following advanced features integral to the trip unit:

a) Adjustable undervoltage release.

b) Adjustable overvoltage release.

c) Reverse load and fault current.

d) Reverse sequence voltage alarm.

e) Underfrequency.

f) Overfrequency.

g) Voltage phase unbalance and phase loss during current detection.

10. Each breaker shall be provided with arc-flash reduction switches with visual indicator

11. All breakers of common frame size shall have trip units wired to secondary contacts in a consistent manner, including spares, so that breakers are fully interchangeable once settings are updated

N. Pull section: Size as shown on Drawings, having width, depth and height to match switchboard. Arrange as shown on Drawings.

O. Future Provisions: Fully equip spaces for future devices with bussing and bus connections, suitably insulated and braced for short circuit currents. Provide continuous current rating as indicated.

P. Enclosure: Type 1 -- General Purpose.

1. Align sections at front and rear.

2. Switchboard Height: 96 inches, excluding floor sills, lifting members and pull boxes.

3. Finish: Manufacturer's standard light gray enamel over external surfaces. Coat internal surfaces with minimum one coat corrosion-resisting paint, or plate with cadmium or zinc.

4. Mimic Bus: Show bussing, connections and devices in single line form on the front panels of the switchboard using black color plastic strips, fastened flat against the panel face with screws or rivets.

5. Provide hinged rear doors with provisions for padlocking.

6. Provide IR windows for infrared scanning.

2.4 RATINGS

A. Voltage rating shall be as indicated on the drawings. The entire assembly shall be suitable for 600 volts maximum AC service.

B. The assembly shall be rated to withstand mechanical forces exerted during short-circuit conditions when connected directly to a power source having available fault current of minimum of 100,000 amperes symmetrical at rated voltage unless higher amperage is shown on the drawings.

C. The bus system shall have a minimum ANSI 4-cycle short-circuit withstand rating of 100,000 amperes symmetrical.

D. All circuit breakers shall have a minimum symmetrical interrupting capacity of 100,000 amperes. To ensure a fully selective system, all circuit breakers shall have 30 cycle short-time withstand ratings equal to their symmetrical interrupting ratings through 85,000 amperes, regardless of whether equipped with instantaneous trip protection or not.

E. All ratings shall be tested to the requirements of ANSI C37.20.1, C37.50 and C37.51 and UL witnessed and approved.

2.5 CONSTRUCTION

A. The switchgear shall consist of the required number of vertical sections bolted together to form a rigid assembly. The sides shall be covered with removable bolt-on covers. All edges of front covers or hinged front panels shall be formed. Provide ventilators located on the top of the switchgear over the breaker and bus compartments to ensure adequate ventilation within the enclosure. The assembly shall be provided with adequate lifting means and shall be capable of being moved into installation position and bolted directly to the floor without the use of floor sills providing the floor is level to 1/8 inch per 3-foot distance in any direction. Provisions shall be made for jacking of shipping groups, for removal of skids or insertion of equipment rollers. Base of assembly shall be suitable for rolling directly on pipes without skids. The base shall be equipped with slots in the base frame members to accommodate the use of pry bars for moving the equipment to its final position.

B. Each vertical steel unit forming part of the switchgear line-up shall be a self-contained housing having one or more individual breaker or instrument compartments, a centralized bus compartment and a rear cable compartment. Each individual circuit breaker compartment, or cell, shall be segregated from adjacent compartments and sections by means of steel barriers to the maximum extent possible. It shall be equipped with drawout rails and primary and secondary disconnecting contacts. Removable hinge pins shall be provided on the breaker compartment door hinges. Current transformers for feeder instrumentation, where shown on the plans, shall be located within the appropriate breaker cells and be front accessible and removable.

C. The stationary part of the primary disconnecting devices for each power circuit breaker shall be breaker mounted and consist of a set of contacts extending to the rear through a glass polyester insulating support barrier; corresponding moving finger contacts, suitably spaced, shall be furnished on the power circuit breaker studs which engage in only the connected position. The assembly shall provide multiple silver-to-silver full floating high pressure point contacts with uniform pressure on each finger maintained by springs. Each circuit shall include the necessary three-phase bus connections between the section bus and the breaker line side studs. Load studs shall be equipped with insulated copper load extension buses terminating in solderless type terminals in the rear cable compartment of each structure. Bus extensions shall be silver-plated where outgoing terminals are attached.

D. The circuit breaker door design shall be such that the following functions may be performed without the need to open the circuit breaker door: lever circuit breaker between positions, operate manual charging system, close and open circuit breaker, examine and adjust trip unit, and read circuit breaker rating nameplate.

E. The secondary disconnecting devices shall consist of floating terminals mounted on the stationary unit and engaging mating contacts at the front of the breaker. The secondary disconnecting devices shall be gold-plated and engagement shall be maintained in the “connected” and “test” positions.

F. The removable power circuit breaker element shall be equipped with disconnecting contacts and interlocks for drawout application. It shall have four positions, “connected,” “test,” “disconnected” and “removed.” The breaker drawout element shall contain a worm gear levering “in” and “out” mechanism with removable lever crank. Levering shall be accomplished via the use of conventional tools. Mechanical interlocking shall be provided so that the breaker is in the tripped position before levering “in” or “out” of the cell. The breaker shall include an optional provision for key locking open to prevent manual or electric closing. Padlocking shall provide for securing the breaker in the connected, test, or disconnected position by preventing levering.

G. An insulating flash shield shall be mounted above each circuit breaker to prevent flashover from the arc chutes to ground.

H. The switchgear shall be Eaton Magnum DS low voltage metal-enclosed switchgear, utilizing Magnum DS power circuit breakers as herein specified.

I. The switchgear shall be suitable for use as service entrance equipment and be labeled in accordance with UL requirements.

J. Provide a rear compartment barrier between the cable compartment and the main bus to protect against inadvertent contact with main or vertical bus bars.

K. Provide in the cell when the circuit breaker is withdrawn, a safety shutter which automatically covers the line and load stabs and protects against incidental contact.

L. Provide a metal barrier full height and depth between adjacent vertical structures in the cable compartment.

M. Provide a glass polyester full height and depth barrier between adjacent vertical structures in the bus compartment with appropriate slots for main bus.

2.6 BUS

A. All bus bars shall be silver-plated copper. Main horizontal bus bars shall be mounted with all three phases arranged in the same vertical plane. Bus sizing shall be based on ANSI standard temperature rise criteria of 65 degrees C over a 40 degrees C ambient (outside the enclosure).

1. In addition to full UL air clearances, the phase bus shall be insulated with a minimum of 5 mil thickness of epoxy resin coating. Removable boots shall be provided to give access to the cross bus joints for inspection and maintenance.

B. Provide a full capacity neutral bus where a neutral bus is indicated on the drawings.

C. A copper ground bus shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the switchgear. The ground bus short-time withstand rating shall meet that of the largest circuit breaker within the assembly.

D. All hardware used on conductors shall be high-tensile strength and zinc-plated. All bus joints shall be provided with Belleville-type washers.

2.7 WIRING/TERMINATIONS

A. Small wiring, necessary fuse blocks and terminal blocks within the switchgear shall be furnished as required. Control components mounted within the assembly shall be suitably marked for identification corresponding to the appropriate designations on manufacturer’s wiring diagrams.

B. Provide a front accessible, isolated vertical wireway for routing of factory and field wiring. Factory provisions shall be made for securing field wiring without the need for adhesive wire anchors.

C. Front access to all circuit breaker secondary connection points shall be provided for ease of troubleshooting and connection to external field connections without the need of removing the circuit breaker for access.

D. All control wire shall be type SIS. Control wiring shall be 14 ga. for control circuits and 12 ga. for shunt trip and current transformer circuits. Wire bundles shall be secured with nylon ties and anchored to the assembly with the use of pre-punched wire lances or nylon non-adhesive anchors. All current transformer secondary leads shall first be connected to conveniently accessible shorting terminal blocks before connecting to any other device. Shorting screws with provisions for storage shall be provided. All groups of control wires leaving the switchgear shall be provided with terminal blocks with suitable numbering strips

and provisions for #10 AWG field connections. Each control wire shall be marked to the origin zone/wire name/destination zone over the entire length of the wire using a UV cured ink process. Provide wire markers at each end of all control wiring. Plug-in terminal blocks shall be provided for all shipping split wires. Terminal connections to remote devices or sources shall be front accessible via doors above each circuit breaker.

E. NEMA 2-hole mechanical type lugs shall be provided for all line and load terminations suitable for copper or aluminum cable rated for 75 degrees C of the size indicated on the drawings.

F. Lugs shall be provided in the incoming line section for connection of the main grounding conductor. Additional lugs for connection of other grounding conductors shall be provided as indicated on the drawings.

G. Reusable insulating boots shall be provided to cover all power cable terminations.

2.8 CIRCUIT BREAKERS

A. All protective devices shall be low voltage power circuit breakers. Basis of design is Eaton Type Magnum DS. All breakers shall be UL listed for application in their intended enclosures for 100% of their continuous ampere rating.

B. All power circuit breakers shall be constructed and tested in accordance with ANSI C37.13, C37.16, C37.17C37.50, UL 1066 and NEMA SG-3 standard. The breaker shall carry a UL label.

C. Breakers shall be provided in drawout configuration. The 1600, 2000 and 3200 ampere frame power circuit breakers shall be provided in the same physical frame size, while 4000 and 5000 ampere frame power circuit breakers shall be provided in a second physical frame size. Both physical frame sizes shall have a common height and depth.

D. Power circuit breakers shall utilize a two-step stored-energy mechanism to charge the closing springs. The closing of the breaker contacts shall automatically charge the opening springs to ensure quick-break operation.

E. All circuit breaker shall be electrically operated and equipped with auxiliary contacts, bell alarm contacts, and microprocessor based trip units.

F. Breakers shall be electrically operated (EO) with 120V AC motor operators. The charging time of the motor shall not exceed 6 seconds.

G. Breakers shall have 24Vdc shunt trip.

H. To facilitate lifting, the power circuit breaker shall have integral handles on the side of the breaker.

I. The power circuit breaker shall have a closing time of not more than 3 cycles.

J. The primary contacts shall have an easily accessible wear indicator to indicate contact erosion.

K. The power circuit breaker shall have three windows in the front cover to clearly indicate any electrical accessories that are mounted in the breaker. The accessory shall have a label that will indicate its function and voltage.

L. Trip Units:

1. Each low voltage power circuit breaker shall be equipped with a solid-state tripping system consisting of three current sensors, microprocessor-based trip device and flux-transfer shunt trip. Current sensors shall provide operation and signal function. The trip unit shall use microprocessor-based technology to provide the basic adjustable time-

current protection functions. True RMS sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time delay settings are reached. Interchangeable current sensors with their associated rating plug shall establish the continuous trip rating of each circuit breaker. The basis of design is Eaton type Digitrip 1150.

2. The trip unit shall have an information system that provides LEDs to indicate mode of trip following an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip. A reset button shall be provided to turn off the LED indication after an automatic trip.

3. The trip unit shall be provided with a display panel, including a representation of the time/current curve that will indicate the protection functions. The unit shall be continuously self-checking and provide a visual indication that the internal circuitry is being monitored and is fully operational.

4. The trip unit shall be provided with a making-current release circuit. The circuit shall be armed for approximately two cycles after breaker closing and shall operate for all peak fault levels above 25 times the ampere value of the rating plug.

5. Trip unit shall have selectable thermal memory for enhanced circuit protection.

6. Complete system selective coordination shall be provided by the addition of the following individually adjustable time/current curve shaping solid-state elements:

   a) All circuit breaker shall have adjustments for long delay pickup and time.

   b) All circuit breakers shall have individual adjustments for short delay pickup and time, and include I^2t settings and adjustable instantaneous pickup.

   c) All circuit breakers shall have individually adjustable ground fault current pickup and time, and include I^2t settings or ground alarm only.

   d) All circuit NEC 700 (Life Safety) and NEC 701 (legally required) breakers on emergency designated switchboards shall have individually adjustable ground fault alarm (LSIA). All NEC 702 Breakers (Security and Equipment) shall have ground fault trip (LSIG).

7. The trip unit shall have provisions for a single test kit to test each of the trip functions.

8. The trip unit shall provide zone interlocking for the short-time delay and ground fault delay trip functions for improved system coordination. The zone interlocking system shall restrain the tripping of an upstream breaker and allow the breaker closest to the fault to trip with no intentional time delay. In the event that the downstream breaker does not trip, the upstream breaker shall trip after the present time delay. Factory shall wire for zone interlocking for the power circuit breakers within the switchgear.

9. The trip unit shall have an information system that utilizes battery backup LEDs to indicate mode of trip following an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip. A test pushbutton shall energize a LED to indicate the battery status

10. The trip unit shall have a 4-character LCD display showing phase, neutral, and ground current. The accuracy of these readings shall be +/- 2% of full scale

11. The trip unit shall be equipped to permit communication via twisted pair for remote monitoring and control by existing PowerNet System and new Power Xpert System. The trip unit shall include a power/relay module which shall supply control to the readout

display. Following an automatic trip operation of the circuit breaker, the trip unit shall maintain the cause of trip history and the mode of trip LED indication as long as its internal power supply is available. An internal relay shall be programmable to provide contacts for remote ground alarm indication.

12. The trip unit shall include a voltage transformer module, suitable for operation up to 600V, 50/60 Hz. The primary of the power relay module shall be connected internally to the line side of the circuit breaker through a dielectric test disconnect plug.
13. An internal relay shall be programmable to provide contacts for remote ground alarm indication.
14. The display for the trip units shall be a 24 character LED display.
15. Metering display accuracy of the complete system, including current sensors, auxiliary CTs, and the trip unit, shall be +/- 1% of full scale for current values. Metering display accuracy of the complete system shall be +/- 2% of full scale for power and energy values.
16. The unit shall be capable of monitoring the following data:
    a) Instantaneous value of phase, neutral and ground current.
    b) Instantaneous value of line-to-line voltage.
    c) Minimum and maximum current values.
    d) Watts, vars, VA, watt-hours, var-hours, and VA hours.
17. The energy-monitoring parameter values (peak demand, present demand, and energy consumption) shall be indicated in the trip unit's alphanumeric display panel
18. The trip unit shall display the following power quality values:
    a) Crest Factor.
    b) Power Factor.
    c) Percent total harmonic distortion.
    d) Harmonic values of all phases through the 31st harmonic.
19. The main breaker trip unit shall have the following advanced features integral to the trip unit:
    a) Adjustable undervoltage release.
    b) Adjustable overvoltage release.
    c) Reverse load and fault current.
    d) Reverse sequence voltage alarm.
    e) Under frequency.
    f) Over frequency.
    g) Voltage phase unbalance and phase loss during current detection.
20. An adjustable high load alarm shall be provided, adjustable from 50 to 100% of the long delay pickup setting.
21. The trip unit shall contain an integral test pushbutton. A keypad shall be provided to enable the user to select the values of test currents within a range of available settings.

The protection functions shall not be affected during test operations. The breaker may be tested in the TRIP or NO TRIP test mode.

22. Programming may be done via a keypad at the faceplate of the unit or via the existing communication network.

23. System coordination shall be provided by the following microprocessor-based programmable time-current curve shaping adjustments. The short-time pickup adjustment shall be dependant on the long delay setting.

    a) Programmable long-time setting

    b) Programmable long-time delay with selectable I^2T or I^4T curve shaping

    c) Programmable short-time setting

    d) Programmable short-time delay with selectable flat or I^2T curve shaping, and zone selective interlocking

    e) Programmable instantaneous setting

    f) Programmable ground fault setting trip or ground fault setting alarm

    g) Programmable ground fault delay with selectable flat or I^2T curve shaping and zone selective interlocking.

24. The trip unit shall offer a three-event trip log that will store the trip data, and shall time and date stamp the event

M. Pull section: Size as shown on Drawings, having width, depth and height to match switchboard. Arrange as shown on Drawings.

N. Future Provisions: Fully equip spaces for future devices with bussing and bus connections, suitably insulated and braced for short circuit currents. Provide continuous current rating as indicated.

O. Bus Duct connections sections: Provide complete as required for bus duct connection.

P. Enclosure: NEMA Type 1

1. Align sections at front and rear.

2. Switchboard Height: 96 inches, excluding floor sills, lifting members and pull boxes.

3. Mimic Bus: Show bussing, connections and devices in single line form on the front panels of the switchboard using black color plastic strips, fastened flat against the panel face with screws or rivets.

4. Provide hinged rear doors with provisions for padlocking.

2.9 SURGE PROTECTIVE DEVICES

A. Each lineup of switchgear shall include a door mounted surge protector(s). Between the bus and the surge protective device(s) shall be mounted a 30 amp, 3 pole, 480 V circuit breaker type HFD. Surge protective devices shall be mounted in an open section nearest to the main incoming power source section with lead length kept to a minimum. The display unit shall be connected via ribbon cable to the main unit and mounted so as to be visible when the door is closed.

B. See specification Section 26 43 00 Surge Protective Devices for additional information.

C. Provide surge protective devices for each feeder connected between buildings and on each service feeder.

D. Provide disconnect, connections, etc. for surge protective devices as recommended by surge protective devices manufacturer.

2.10 POWER QUALITY METER AND ANALYZER METERS

A. Each lineup of switchgear shall include an Eaton PXM6000 wired with a category 5 data cable. Belden 9463 (blue hose) family in a daisy chain and connected to the Digitrip trip units on each circuit breaker to the existing EATON PowerNet System. All communications cabling is to be factory installed and terminated to a terminal block for continuation to the EMMS Power Xpert System.

B. Provide meters with appropriate multiplier tags.

2.11 ANALOG METERING TRANSFORMERS

A. Current Transformers; ANSI C57.13; 5 ampere secondary, primary/ secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.

B. Potential Transformers: ANSI C57.13; 120 volt disconnecting type with integral fuse mountings, primary/secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.

C. Analog meters shall be provided to indicate Phase to Phase voltage and phase to ground voltage for all 3 phases.

2.12 ACCESSORIES

A. Circuit Breaker Lifting Device: Carriage and track on top of each switchboard with lifting device to serve draw-out circuit breakers in switchboard.

B. Provide integrally mounted transient voltage surge suppression as specified in Section 26 43 00 Surge Protective Devices.

C. Provide remote racking device, Eaton MRR 1000

2.13 SERVICE ENTRANCE EQUIPMENT

A. Switchboards used as service entrance equipment shall be listed and labeled by UL for use as service equipment.

2.14 NAMEPLATES

A. Engraved nameplates, mounted on the face of the assembly, shall be furnished for all main and feeder circuits as indicated on the drawings. Nameplates shall be laminated plastic, black characters on white background, and secured with screws. Characters shall be 3/16-inch high, minimum.

B. Furnish master nameplate giving switchgear designation, voltage ampere rating, short-circuit rating, and manufacturer’s name.

C. Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer’s drawings

2.15 FINISH

A. All exterior and interior steel surfaces of the switchgear shall be properly cleaned and provided with a rust-inhibiting phosphatized coating. Color and finish of the switchgear shall be ANSI 61

2.16 CONTROLS (Emergency Transfer Switchboards Only)

A. A Transfer Switchgear Control System shall be provided to facilitate overall system operation including automatic transfer control, monitoring of the available power sources, engine start command, alarm/fault monitoring, breaker control and monitoring and communication to remote Generator Building CEP controls and remote OIP locations.

B. The Emergency Switchgear Control System shall utilize redundant fiber optic communication networks, in ring configuration, to communicate with the redundant PLC controls located in the Generator Building CEP main emergency switchgear controls. I/O drops shall be provided within each 480V Transfer Switchgear to interface with breakers, meters, annunciators, control switches and other devices as required. The CEP Switchgear Control System shall provide all functions and operations as specified in these specifications and as listed or noted on drawings.

C. Coordination of 480V Emergency Transfer Switchgear Controls with the Generator CEP control system shall be the responsibility of the 480V emergency switchgear supplier. Update of the Generator Building Control and SCADA screens, logic software and communication hardware, that may be required for this Emergency Control Switchgear shall be provided by the Emergency Control Switchgear provider. All documentation updates of the Main Generator Switchgear controls and SCADA system that are necessary for implementation and support of the Emergency Switchgear shall also be provided.

D. A third fiber-optic pair shall be provided for SCADA communications between the Generator Building Main Controls and the emergency switchgear.

E. Controls shall operate from 24VDC as supplied from the station battery system for each Emergency Switchgear. A best battery selector shall be included to enable connection to more than one station batteries should a connection to a battery from another nearby switchgear be possible.

E. Hard Wired Controls: The emergency switchgear controls shall have a complete set of hard wired meters, control switches, indicating lights and other devices to enable complete manual operation of the emergency switchgear without availability of any PLC or OIP or network communications. The minimum instrumentation requirements are listed below. In addition, all necessary hard wired interlocks shall be included to prevent possible operator error while in manual operation. Use of a backup OIP DOES NOT SATISFY THIS REQUIREMENT.

F. Each Main Breaker and Tie Breaker shall have the following discrete hard wired metering:

1. Analog Voltmeter (4”) with phase selector switch
2. Analog Ammeter (4”) with phase selector switch
3. Crompton Integra Multi-function meter (4”) to display selectable values: KW, PF, Freq, THD, etc.
4. Eaton PX-6000 on Main breakers only wired to PX900 Gateway

G. Each Feeder Breaker shall have the following discrete hard wired metering and control devices.

1. Analog Voltmeter (4”) with phase selector switch
2. Crompton Integra Multi-function meter (4”) to display selectable values: KW, Amps, PF, Freq, THD, etc.
3. Breaker control switch.

4. The above shall be grouped together on door of the ”B” cubicle compartment for each feeder breaker vertical section together with the 3-lite breaker annunciator (open-withdrawn-closed) and breaker control switch. A common lamp test push button shall also be included on the door.

H. Human Machine Interface (OIP)

1. A 23-inch *minimum* (diagonal), color TFT industrial display shall be provided for operator interface panel(s) as standard equipment. This display shall support a minimum resolution of 1280 x 1024 pixels. Interface shall be accomplished via a key protected touch screen permanently affixed to the display. The touch screen shall be clear glass, with light transmission of 95% or better, furnished with a Surface Acoustic Wave touch interface. Resistive or Capacitive touch interfaces are not acceptable. Navigation and operation shall be intuitive such that Help Screens are not required. The Operator Interface will access to system operating parameters, set points, graphical displays and other information as defined elsewhere in this specification.

2. OIP screens shall include <u>all</u> of the screens as specified for the OIP’s in the new Generator Control Building. This will include an active one-line for every Emergency Transfer Switchgear installed anywhere on site. The home screen for each Switchgear shall be the active one line for that specific switchgear.

3. Each OIP shall have access as defined by passwords. The level of access shall be limited based on the password entered. Up to 100 different password levels shall be possible.

2.17 SEQUENCE OF OPERATION (Emergency Transfer Switchgear Only)

A. <u>Normal Operation:</u>

1) GENMV1 switchgear
   a. Utility breakers closed
   b. All generator breakers and both General Main breakers are open
   c. Feeder breakers each supplying normal power to the Life Safety loads in downstream LV Transfer Switchgear

2) LV Emergency Transfer switchgear
   a. Utility Main breaker closed
   b. Emergency Main breaker closed
   c. Bus Tie breaker open
   d. Life Safety (Priority 1) loads are being powered via the Utility feeding the associated GENMV1 switchgear bus
   e. Equipment and other loads (Priority 2 & lower) are powered via the Utility substation feeder dedicated to the associated LV Transfer Switchgear

B. <u>Failure of Emergency (Utility via GENMV1) at LV Emergency Transfer switchgear(s)</u>

1) If the Emergency power source (as detected at the LV Transfer switchgear) should fail with the Normal Utility power source (as detected at the LV Transfer switchgear) still available, then the Emergency Main breaker (EM) shall immediately open and the Bus Tie breaker (BT) shall immediately close, placing the Life Safety loads on the Utility feeder coming directly from the utility substation.

2) This state shall remain until such time that the controls have determined that the Utility source feeding the associated Emergency feeder in GENMV1 is connected to that load bus AND the LV Transfer switchgear has detected an acceptable power source at the EM breaker, at which time the system shall initiate a transfer of the Life Safety loads back to its normal source by opening the bus tie (BT) breaker and closing the Emergency Main breaker (EM).

C. Failure of Normal Utility at LV Emergency Transfer switchgear(s)

1) Upon loss of the Normal power source as determined at the LV Transfer switchgear (UM), the controls shall (after a programmable time delay) initiate a start of the emergency generators. This shall occur regardless of whether the Utility source connected to the GENMV1 load bus is still available and connected.

2) Upon the first generator being connected to the generator bus in GENMV1, the controls shall open the Utility Main breaker(s) in GENMV1 feeding the load bus of the associated LV Transfer switchgear, open all non-priority 1 feeder breakers in all LV Transfer Switchgears fed from the same load bus in GENMV1 as the LV Transfer switchgear(s) that is calling for the Emergency start, and then closing the Generator Main breaker(s) (GM) in GENMV1 to place the Priority 1 loads in all of the LV Transfer switchgears (sharing the same load bus in GENMV1) on generator power.

3) Prior to adding any non-priority 1 load to the Emergency system, the controls will open all non-priority 1 breakers in all affected LV Transfer switchgears and then close the Bus Tie breaker in each affected LV Transfer switchgear.

4) As additional generators are paralleled to the generator bus and their generator breakers closed, the system will add load by closing load breakers in all of the affected LV Transfer switchgears in order of their priority, highest to lowest. Priority assignments and anticipated load will be configurable via the system OIP's

.

5) Since there are multiple LV Transfer switchgears with Life Safety loads being normally fed via two (2) separate load buses in the GENMV1 switchgear, it may be possible that only one load bus need be placed on generator power, should none of the LV Transfer switchgears of the other bus have failure of their Normal power source and the Utility feed to that load bus in GENMV1 switchgear be available.

6) Once all available generators have connected to the Emergency bus, the system can then be placed in Load Control Mode, if enabled, so that the controls can automatically remove and add generators to match the overall load requirements with spinning reserve as determined by field settable parameters in the OIP.

7) Upon return of Normal power (as determined at each LV Transfer switchgear) and after an adjustable delay, each LV shall initiate a retransfer sequence back to normal conditions, by first opening its Bus Tie breaker (BT) and then closing its Utility Main breaker, placing all non-life safety loads on Normal Utility power. Life Safety loads at this point remain on generator power.

8) Upon the system determining that the Utility source serving the affected load bus in GENMV1 has returned and after an adjustable time delay, the controls will initiate a closed transition transfer of the load bus from generators to the restored utility by paralleling the load bus to the Utility, closing the Utility Main breaker in GENMV1 and

performing a soft loading of the utility until the load across the associated Generator Main breaker (GM) has reached a minimum set point level at which time the Generator Main breaker (GM) will open.

9) If both load buses are on generator power, then the system will first perform a closed transition soft loading transfer to utility 1 on load bus 1 followed by performing the soft load loading transfer to utility 2 on load bus 2.

10) Once all transfers to utility are complete the system will initiate a cool down cycle for all running generators.

D. Load Shedding

1) Load shedding shall be active whenever the system is in automatic mode

2) Whenever the load exceeds the available on-line generator capacity, the system shall shed downstream loads at the LV Emergency Transfer switchgears, based on the assigned priority for each breaker, lowest priority loads shed first.

3) Once enough load has been shed to stabilize the emergency generator bus, the system shall cease further load shedding.

4) Loads shall be automatically re-added if the available generator capacity increases to a level that permits adding the next highest priority anticipated load.

5) The system shall allow the operator to override the load shed to manually re-add selected load breakers or to alter which breakers remain open.

2.18 STATION BATTERY SYSTEM (Required for Each Emergency Transfer Switchgear ONLY)

A. Provide 24 VDC NiCad Station Battery System for Switchgear controls that will be connected to the best battery selector

B. Minimum battery capacity shall be 150 amp-hr. @ 8-hour rate.

C. Provide rack, cell connectors and power lugs

D. Furnish wall mount charger, 120 VAC input, 25 amp @24 VDC output with AC input breaker, DC output breaker, DC volt meter, DC amp meter, equalizing timer, alarms lights for AC failure, DC failure, High VDC, Low VDC, positive & negative ground fault and common alarm contact

PART 3 - EXECUTION

3.1 PREPARATION/INSPECTION/EXAMINATION

A. Verify that surface is suitable for switchboard installation.

B. Check that concrete pads are level and free of irregularities

C. Examine area to receive switchboard to assure adequate clearance for switchboard installation.

D. Verify that National Electrical Code clearances will be maintained after installation. Rework equipment locations as required to provide required clearances.

E. Start Work only after unsatisfactory conditions are corrected.

F. All magnum DS breakers shall be internally wired in similar fashion for interchangeability.

3.2 INSTALLATION

A. Install all switchboard enclosures in accordance with the manufacturer's written instructions, NECA's "Standard of Installation", the applicable requirements of the National Electrical Code, and recognized industry practices.

B. Mount switchboard on 3” concrete base extending 3” outside all sides.

C. Provide rubber insulating mats on floor in front of board for entire length of board, minimum 4 feet wide.

D. Install switchboards plumb. Provide supports in accordance with Section 16190.

E. Provide doors for unused spaces in switchboards.

F. Install switchboards so that proper working clearances shall be maintained at every switchboard location, both front and back.

G. Clean the interior of each switchboard before installing conductors. At all times, keep the interior trim and exterior surfaces of the switchboard free of rust and debris. Repaint finishes if necessary.

H. Coordinate all raceways and conductors with their respective switchboards so that all connections and conductors routing present an orderly appearance. Conductors in the switchboards shall be laced and arranged in orderly manner.

I. Provide a separate 120 volt, 20 AMP circuit as required to power any shunt-trip function/device for normal switchboards and 24 Vdc for emergency switchboards. Provide complete 120 Vac to 24 Vdc system in each switchboard, including batteries, UPS and charger system to power shunt trip system.

J. All necessary hardware to secure the assembly in place shall be provided by the Contractor.

K. The equipment shall be installed and checked in accordance with the manufacturer’s recommendations. This shall include but not limited to:

1. Checking to ensure that the pad location is level to within 0.125 inches per three foot of distance in any direction.

2. Checking to ensure that all bus bars are torqued to the manufacturer’s recommendations.

3. Assembling all shipping sections, removing all shipping braces and connecting all shipping split mechanical and electrical connections.

4. Securing assemblies to foundation or floor channels.

5. Measuring and recording Megger readings phase-to-phase, phase-to-ground, and neutral-to-ground (four wire systems only).

6. Inspecting and installing all circuit breakers in their proper compartments.

L. Conduit or piping systems that contain water or liquid of any kind shall not be installed over the top of any electrical equipment, transformers, racks, cabinets, or enclosures without prior written approval from the Owner.

3.3 FACTORY TESTING

A. The switchgear shall be completely assembled, wired, adjusted and tested at the factory. After assembly, the complete switchgear shall be tested to ensure the accuracy of the wiring and the functioning of all equipment. The main bus system shall be given a dielectric test of 2200 volts for one minute between live parts and ground and between opposite polarities.

B. The wiring and control circuits shall be given a dielectric test of 1500 volts for one minute, or 1800 volts for one second, between live parts and ground, in accordance with ANSI C37.20.1.

C. A certified test report of all standard production tests shall be shipped with each assembly.

3.4 FIELD QUALITY CONTROL

A. Provide the services of a qualified factory-trained manufacturer's representative to assist the Contractor in installation and start-up of the equipment specified under this section for a period of one working day. The manufacturer's representative shall provide technical direction and assistance to the contractor in general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained therein.

B. The Contractor shall provide three (3) copies of the manufacturer's field start-up report.

C. Provide complete testing of all components including but not limited to metering, monitoring, ground fault systems, interlocking systems, best battery systems, remote operation/tripping features of breakers, etc.

D. Testing in the field is to include all interlocking and breaker control functions within the emergency switchboard and Generator Switchgear systems (both local and remote computer PC control).

E. Measure steady state load currents at each switchboard feeder; rearrange circuits to balance the phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.

F. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers, fusible switches, and fuses.

G. All circuits shall be operated to establish a good working order and checked for shorts.

H. All panel directory circuit numbers shall be checked to verify accuracy of the number.

I. Measure insulation resistance of each bus section phase to phase and phase to ground for one minute each, at test voltage of 1000 volts; minimum acceptable value for insulation resistance is 2 megohms. Disconnect all electronic circuitry and Surge Protective Device units prior to test.

J. Check tightness of accessible bolted bus joints using calibrated torque wrench.

K. Physically test key interlock systems to insure proper function.

L. Tests:

1. Test Switchboards and switchboard feeders per requirements of Section 26 08 13 Tests and Performance Verification.

2. Test all operational features of switchboard including interlocking, remote controls, touch screen, remote computer PC control, etc.

3. Feeder conductors shall be checked by approved means to establish the absence of shorts to ground; insulation value, etc. and the result recorded and submitted to the Designer.

4. Submit Conductor Insulation Resistance Test per requirements of Section 26 08 13 Tests and Performance Verification.

5. Submit Tabulation Data Voltage and Amperage Readings per requirements of Section 26 08 13 Tests and Performance Verification.

M. Equipment Checkout:

1. When requested by Designer/OAR provide (during construction):

a) Inspection of equipment by authorized equipment manufacturer technician complete with submittal of statement of findings by technician, and providing any adjustments deemed necessary for a complete and operating system.

2. Submit Equipment Checkout Memo per Section 26 08 13 Tests and Performance Verification.

3.5 MANUFACTURER'S CERTIFICATION

A. A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations.

B. The Contractor shall provide three (3) copies of the manufacturer's representative's certification before final payment.

3.6 TRAINING

A. The Contractor shall provide a training session for up to five (5) owner's representatives for 1 normal workday at a jobsite location determined by the owner.

B. The training session shall be conducted by a manufacturer's qualified representative. The training program shall consist of the instruction on the operation of the assembly, circuit breakers, metering, monitoring, and major components within the assembly.

3.7 MONITORING/METERING

A. Provide/install all components, wiring, cable (fiber optic and copper), raceways, hubs, switches, patch panel modules, pc cards, communication network devices, converters, etc., as required to connect monitoring/metering equipment in each panelboard (provided with monitoring/metering) to Owner's Power Xpert Computer (PC) located in Electrical Maintenance Shop (Rick Schulz's Office) and to the Central Plant (PC) workstation located in the CEP Control Room.

B. Provide/install all software, programming, etc., to facilitate installation and monitoring of all monitor/meter equipment on GOAA's selected Power Xpert PC System.

C. Integrate all new equipment provided under this contract into existing software including programming/changes required to computer screens, program trending, program event logging, etc.

D. Coordinate with GOAA final approval of screens, trending, and event logging requirements and program system accordingly.

E. All revisions to software, programming, etc., is to be by manufacturer of software.

3.8 IDENTIFICATION

A. Refer to Section 26 05 53 Identification for Electrical Systems for products and content.

B. Provide engraved plastic nameplates under the provisions of Section 26 05 53 Identification for Electrical Systems.

3.9 ADJUSTING

A. Adjust all operating mechanisms for free mechanical movement.

B. Tighten bolted bus connections in accordance with manufacturer's instructions.

C. Adjust circuit breaker trip and time delay settings to values as instructed by the Designer to manufacturer's recommendation.

END OF SECTION 26 24 13

SECTION 26 24 16 - PANELBOARDS

PART 1- GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification sections apply to this section.

1.2 SUMMARY

A. This section includes the requirements for provision and installation of panelboards.

1.3 DESCRIPTION

A. Provide all labor, materials, and equipment necessary to properly and completely install panelboards as scheduled on the drawings and as required by this section.

1.4 SUBMITTALS

A. Submit product data on each basic panelboard construction type, showing manufacturer's standard construction data including:

1. Cabinet construction/dimensions.
2. Bus construction.
3. UL labeling.
4. Each overcurrent device.

B. Shop drawings shall be submitted for each panel and clearly indicate the following information:

1. Label.
2. Each circuit breaker amperage rating, circuit number and position/location in panel.
3. Electrical characteristics of panel.
4. Mains rating.
5. Main device rating.
6. Mounting.
7. Dimension, width, depth, height.
8. Bus material.
9. Interrupting capacity of minimum rated breaker.
10. Panel type.

1.5 PROJECT AS-BUILT DOCUMENTS

A. Record actual locations of Panelboards on red lined as-built documents and indicate actual branch circuit arrangement.

1.6 OPERATION AND MAINTENANCE DATA

A. Provide spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.7 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing products specified for minimum ten years.

1.8 REFERENCES AND REGULATORY REQUIREMENTS

A. Furnish products listed and classified by UL as suitable for purpose specified and indicated.

B. Conform to the requirements of the following:

1. ANSI/NFPA 70 - National Electrical Code.
2. NECA (National Electrical Contractors Association) - "Standard of Installation."
3. NEMA AB 1 - Molded Case Circuit Breakers.
4. NEMA PB 1 - Panelboards.
5. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
6. UL 67 - Panelboards
7. UL 50 - Cabinets and Boxes
8. Fed. Spec. W-P-115C

1.9 FIELD MEASUREMENTS

A. Verify that field measurements are as instructed by manufacturer.

1.10 MAINTENANCE MATERIALS

A. Provide two keys per panelboard.

1.11 DELIVERY, STORAGE AND HANDLING

A. Handle panelboards and enclosures carefully to prevent damage.

B. Store equipment indoors and protect from weather.

C. Deliver tubs and internal assemblies sufficiently in advance of installation period as necessary to prevent delay of work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Eaton, or approved substitutions.

2.2 GENERAL

A. Lighting and Appliance Branch Circuit Panelboards: NEMA PB1, circuit breaker type, dead front, UL 67.

B. Panelboard Bus: Copper ratings as indicated. Provide copper ground bus in each panelboard. Provide isolated full size neutral bus where neutral is applicable. Provide non-linear load panelboards as specified on drawings. Non-linear panelboards shall have 200 percent rated neutral busbar.

C. Short-Circuit Rating:

1. Minimum short circuit interrupting capacity: 10,000 amperes rms symmetrical for 240 volt panelboards; 14,000 amperes rms symmetrical for 480 volt panelboards. Bus shall be braced for minimum capacity equal to or greater than the lowest breaker symmetrical interrupting capacity. Minimum short circuit rating shall be increased to meet the following requirements:

a) Individual C.B. AIC Rating shown on panel schedules indicate lowest AIC rating allowed for individual circuit breaker in panel.
b) Circuit breakers shall be based on a fully rated system.
c) Circuit breaker types are not specified. Provide breakers to comply with the required AIC specified.

D. Enclosure:

1. Enclosures shall be at least 20 inches wide made from galvanized steel. Provide minimum gutter space in accordance with the National Electrical Code. Where feeder cables supplying the mains of a panel are carried through its box to supply other electrical equipment, the box shall be sized to include the additional required wiring space. At least four interior mounting studs with adjustable nuts shall be provided.

2. Enclosures shall be provided with blank ends.

3. Where indicated on the drawings, branch circuit panelboards shall be column width type.

4. Regulatory Requirements:

a) NEMA PB 1, Type 1, Interior dry locations.
b) NEMA PB 1, Type 3R, Interior damp locations.
c) NEMA PB 1, Type 4X stainless steel watertight, Exterior locations including those noted on drawings to be NEMA 3R.
d) NEMA PB 1, Type 4X stainless steel watertight, interior wet locations, and wash-down areas, regardless of that noted on drawings.
e) UL 50

E. Cabinet box:

1. 6 inches (153 mm) deep; width: 20 inches (508 mm), minimum.
2. Interior dry and damp locations shall be constructed of galvanized code gauge steel, to prevent rust.
3. Exterior, wash-down areas, and Interior wet locations shall be constructed of type 4X stainless steel, watertight.

F. Cabinet Front:

1. Flush or surface with concealed trim clamps, concealed hinge, and flush lock all keyed alike.
2. Shall be door-in-door construction.
3. Finish in manufacturer's standard baked enamel finish for interior dry locations. Interior damp location panels to be painted with rust inhibit primer epoxy paint top coat system.
4. Exterior, wash-down areas, and Interior wet locations shall be constructed of type 4X stainless steel, watertight.

G. Panels and breakers shall be rated for voltage and class of service to which applied.

H. Spaces:

1. Space provisions or spaces for future breakers shall be located at the bottom of the panel and be fully bussed complete with all necessary mounting hardware less the breaker.

2.3 MAINS

A. Provide main lug only (MLO) or main circuit breaker (MCB) as noted on drawings either by riser diagram or by schedule. Where conflict exists, provide MCB.

B. Regardless of what is shown on drawings provide the following minimum requirements.

1. Main circuit breaker on each panel serving building main if required by applicable codes.
2. Main circuit breaker on each panel fed directly from a transformer (unless disconnect with overcurrent devices is installed in feeder between transformer and panel).

C. Provide lugs as required for conductors being connected to panelboard lugs, circuit breakers, etc.

D. Main circuit breaker is not to be mounted as branch breaker or subfeed breaker.

2.4 CIRCUIT BREAKERS

A. General

1. Molded Case Circuit Breakers: NEMA AB 1, plug-on type for 250V or less, bolt-on type for over 250V, thermal magnetic trip circuit breakers, with common trip handle for all poles. Provide circuit breakers UL listed as Type SWD for lighting circuits. Provide UL Class A ground fault interrupter circuit breakers where scheduled. Do not use tandem circuit breakers.
2. Current Limiting Molded Case Circuit Breakers: NEMA AB 1. Provide circuit breakers with integral thermal and instantaneous magnetic trip in each pole, coordinated with automatically resetting current limiting elements in each pole.

B. Main Breakers:

1. Main breakers shall be individually mounted separate from branch breakers.
2. Covered by a metal plate, except for operating handle.
3. Connection from the load's side to the panel bus shall be bus bar. Insulated wire not permitted.

C. Branch Breakers:

1. Thermal-magnetic, molded case, with inverse time-current overload and instantaneous magnetic tripping, unless otherwise shown. Breakers shall be calibrated for 40 degrees C or shall be ambient compensating.
2. Quick-make, quick-break, with tripped indication clearly shown by breaker handle taking a position between ON and OFF.
3. Multi-pole breakers shall have common internal trip. No handle ties between single pole breakers are acceptable for this Project.
4. Single pole 15 and 20 ampere circuit breakers shall be rated for switching duty and shall be labeled as "SWD".
5. Rating shall be as called for under "2.2 GENERAL".
6. Ground Fault Circuit Interrupters (GFI):

    a) Provide UL Class (5 milliamp sensitivity) ground fault circuit protection on 120 VAC branch circuits for exterior location receptacles and for interior locations where required by NEC. (These may not be indicated on Panel Schedule.) This protection shall be an integral part of the branch circuit breaker which also provides overload and short circuit protection for branch circuit wiring. Tripping of a branch circuit breaker containing ground fault circuit interruption shall not disturb the feeder circuit to the panelboard. Provide separate neutral for circuits on GFI breakers whether indicated on drawings or otherwise.

7. Breakers feeding heating and air conditioning equipment shall be rated HACR type breaker.

D. Monitoring:

1. Provide Branch Circuit Monitoring on all lighting panels plus all other panels noted as such on Riser Diagram, Refer to 26 27 13 for additional requirements.

2.5 SERVICE ENTRANCE EQUIPMENT

A. Panelboards used as service entrance equipment shall be listed and labeled by UL for use as service equipment.

PART 3 - EXECUTION

3.1 PREPARATION/INSPECTION/EXAMINATION

A. Verify that surface is suitable for panelboard installation. Do not install NEMA 1 equipment until building has reached the “dried-in” stage.

B. Examine area to receive panelboard to assure adequate clearance for panelboard installation.

C. Verify prior to installation that National Electrical Code clearances will be maintained after installation. Rework equipment locations as required to provide electrical code clearances.

D. Start Work only after unsatisfactory conditions are corrected.

E. Submit coordination drawings of all electrical rooms, showing all equipment. Comply with Section 26 05 00.

3.2 INSTALLATION

A. Install panelboards in accordance with NEMA PB 1.1. Install all panelboards and panelboard enclosures in accordance with the manufacturer's written instructions, NECA's "Standard of Installation", the applicable requirements of the National Electrical Code, and recognized industry practices.

B. Install panelboards plumb. Install recessed panelboards flush with wall finishes. Provide supports in accordance with Section 26 05 29 Supporting Devices.

C. Panelboards shall be provided with structural framing located within gypsum board partitions. All enclosures shall be firmly anchored to walls and supporting structures (where used) using appropriate hardware. Provide supporting channels on walls constructed of gypsum board or where otherwise necessary to provide a mechanically secure and permanent installation. Attach channels to framing provided within gypsum board partitions.

D. Enclosures shall be installed so that the top is 6'-6" above finished floor.

1. Where the size of the enclosure is such that the top cannot be installed at 6'-6", the top of the enclosure shall be kept as low as possible.

E. Panelboard backboxes/trim covers mounted adjacent to each other (i.e. multi-section panels, etc) installed in finished areas be of same size.

F. Provide filler plates for unused spaces in panelboards.

G. Provide typed circuit directory from panelboard manufacturers' original card stock, for each branch circuit panelboard. Mount a typewritten directory showing the actual circuit numbers, type of load and room names on inside of door. Room names shall be actual names or numbers used, not necessarily shown on the drawings. Progress Drawings shall show same arrangements as the Directory. Revise directory to reflect circuiting changes required to balance phase loads.

H. Provide four each 1 inch spare conduits out of each recessed panelboard to an accessible location above ceiling. Identify each as SPARE.

I. Clean the interior of each panelboard before installing conductors. At all times, keep the interior trim and exterior surfaces of the panelboard free of rust and debris. Repaint finishes if necessary.

J. Coordinate all raceways and conductors with their respective panelboards so that all connections and conductors routing present an orderly appearance. Conductors in the panelboards shall be neatly laced and arranged in orderly manner.

K. Collect all keys upon delivery of panelboard. Store keys on one ring to be kept by project superintendent. Forward key ring with keys to OAR at substantial completion.

L. Provide a separate neutral conductor for each GFI breaker. These shall not be combined to serve more than 1 circuit, even where on different phases. Increase plan indications of conductors for neutral wires required, as necessary.

M. Conduit or piping systems that contain water or liquid of any kind shall not be installed over the top of any electrical equipment, transformers, racks, cabinets, or enclosures without prior written approval from the Owner.

3.3 IDENTIFICATION

A. Refer to Section 26 05 53 Electrical Identification for products and content.

B. Provide engraved plastic nameplates under the provisions of 26 05 53.

C. Nameplate shall show panel name, voltage and name of panel that feeds this respective panel, and UL short circuit rating.

3.4 FIELD QUALITY CONTROL

A. Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.

B. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers, fusible switches, and fuses.

C. All circuits shall be operated to establish a good working order and checked for shorts.

D. All panel directory circuit numbers shall be checked to verify accuracy of the number.

E. Tests:

1. Test Panelboards and panelboard feeders per requirements of Section 26 08 13 Tests and Performance Verification.
2. Feeder conductors shall be checked by approved means to establish the absence of shorts to ground; insulation value, etc. and the result recorded and submitted to the Designer.
3. Submit Conductor Insulation Resistance Test per requirements of Section 26 08 13.
4. Submit Tabulation Data Voltage and Amperage Readings per requirements of Section 26 08 13.

F. Equipment Checkout:

1. Where and when requested by Designer/OAR provide (during construction):

    a) Inspection of equipment by authorized equipment manufacturer technician complete with submittal of statement of findings by technician, and providing any adjustments deemed necessary for a complete and operating system.
    b) Submit Equipment Checkout Memo per Section 26 08 13.

3.5 ADJUSTMENT AND CLEANING

A. Adjust operating mechanisms for free mechanical movement.

B. Tighten bus connections and mechanical fasteners.

C. Touch up scratched and marred surfaces to match original finish.

END OF SECTION 26 24 16

SECTION 26 24 17 DISTRIBUTION PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specifications sections apply to this section.

1.2 SUMMARY

A. This section includes the requirements for provision and installation of distribution panelboards.

1.3 DESCRIPTION

A. Factory-assembled, metal-enclosed panelboard for distribution and control of power from incoming line terminals to outgoing feeder terminals, installed and tested in place.

B. Distribution panelboard shall include all protective devices and equipment as specified, with necessary interconnections, accessories and control wiring.

1.4 SUBMITTALS

A. Product data shall be submitted on each basic Distribution Panelboard construction type, showing manufacturer's standard construction data, including:

1. Cabinet construction/dimensions.
2. Bus construction.
3. UL labeling.
4. Each overcurrent device.
5. Provide electrical characteristics including voltage, frame size and trip ratings, fault current withstand ratings, and time-current curves of all equipment and components.
6. Provide data on trip units and breaker interface module.

B. Shop drawing shall be submitted for all distribution panelboard for this project clearly indicating the following:

1. Label.
2. Each circuit breaker amperage rating, circuit number and position/location in distribution panelboard.
3. Electrical characteristics of distribution panelboard.
4. Mains rating.
5. Main device rating.
6. Mounting.
7. Dimension, width, depth, height.
8. Bus material.
9. Interrupting capacity of minimum rated breaker.
10. Distribution panelboard type.
11. Engraved nameplate for each overcurrent device.
12. Front and side views of enclosures with overall dimensions shown.

13. Conduit entrance locations and requirements.
14. Frame sizes and Interrupting Capacity of each breaker, and total assembly.
15. Horsepower ratings at rated voltage of fused switches and/or breakers.
16. Labels and labeling.
17. Nameplate on main panelboard only giving name of project; Architect, Engineer and Contractor.
18. Bus bar size, arrangement and spacing.
19. Breaker interface module.
20. Surge Protective Device Equipment
21. Metering/Monitoring Equipment

C. Submit Manufacturer's Instructions indicating application conditions and limitations of use stipulated by product testing agency specified under regulatory requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

D. Submit Maintenance Data: Include spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

E. Submit Spare Parts Certification Memo signifying that the spare parts required by the drawings and/or specifications have been turned over to the Owner.

1.5 PROJECT AS-BUILT DOCUMENTS

A. Record actual locations of distribution panelboards on red lined as-built documents indicating actual circuit arrangement.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum 10 years experience.

1.7 REFERENCES AND REGULATORY REQUIREMENTS

A. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

B. Conform to the requirements of the following:

1. ANSI/NFPA 70 - National Electrical Code.
2. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
3. NEMA KS 1 - Enclosed Switches.
4. NEMA PB 1 - Panelboards.
5. NEMA PB 1.1 - Instructions for safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
6. UL 67 - Panelboards
7. UL 50 - Cabinets and Boxes
8. Fed. Spec. W-P-115C

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver in 35 inch maximum width or depth (or dimension required to fit section through doors), individually wrapped for protection and mounted on shipping skids.

B. Accept distribution panelboards on site. Inspect for damage.

C. Store in a clean, dry space designated by OAR. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

D. Handle in accordance with NEMA PB 1 and manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to distribution panelboard internal components, enclosure, and finish.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Conform to NEMA PB 1 service conditions during and after installation of distribution panelboards.

1.10 FIELD MEASUREMENTS

A. Verify that field measurements are as indicated and comply with instructions by manufacturer.

1.11 MAINTENANCE MATERIALS

A. Provide two of each key (where applicable).

B. Provide two fuse pullers (where applicable).

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Eaton/Cutler Hammer (Basis of Design), or approved substitutions.

2.2 GENERAL

A. Distribution Panelboards shall have circuit breaker branch protective devices complying with NEMA PB1 as a minimum requirement. Panelboards shall be NEMA I and shall meet Underwriter's Laboratories enclosure requirements for service conditions.

B. Distribution panelboards shall have UL label affixed, unless special construction prohibits and no labeling or listing is available.

C. Short-Circuit Rating:

1. Minimum integrated short circuit rating: 22,000 amperes rms symmetrical for 240 volt; 35,000 amperes rms symmetrical for 480 volt. Bus shall be braced for minimum capacity equal to or greater than the lowest breaker symmetrical interrupting capacity. Minimum short circuit rating shall be increased to meet the following requirements:

a) Individual C.B. AIC Rating shown on panel schedules indicate lowest AIC rating allowed for individual circuit breaker in panel.

b) Circuit breakers shall be based on a fully rated system.

c) Circuit breaker types are not shown or called for. The contractor must provide breakers in panel or feeder breakers in upstream breakers to comply with the required AIC specified.

d) Distribution panelboards to be freestanding type construction unless specifically specified otherwise.

2. Short-Circuit Rating Label:

a) Panelboards shall be labeled with a UL short-circuit rating.

b) Series ratings shall not be used to achieve short circuit ratings.

D. Enclosure:

1. Enclosures shall be at least 20 inches wide made from galvanized steel. Provide minimum gutter space in accordance with the National Electrical Code. Where feeder cables supplying the mains of a panel are carried through its box to supply other electrical equipment, the box shall be sized to include the additional required wiring space. At least four interior mounting studs with adjustable nuts shall be provided.
2. Enclosures shall be provided with blank ends.
3. Where indicated on the drawings, branch circuit panelboards shall be column width type.
4. Regulatory Requirements:
    a) NEMA PB 1, Type 1, Interior dry locations.
    b) NEMA BP 1 Type 3R, Interior damp locations
    c) NEMA PB 1, Type 4X stainless steel watertight, Exterior locations including those notes on drawings to be NEMA 3R
    d) NEMA PB 1, Type 4X stainless steel watertight, interior wet locations, and washdown areas, regardless of that noted on drawings.
    e) UL 50

2.3 DISTRIBUTION PANELBOARDS

A. Description: NEMA PB 1 with electrical ratings and configurations as indicated.

B. Overcurrent Devices: Panel mounted.

C. Bus Material: Copper standard size.

D. Bus Connections: Bolted, accessible from front for maintenance.

E. Ground Bus: Extend length of board.

F. Molded Case Circuit Breakers - 1200A and Below:

1. Protective devices shall be molded case circuit breakers with inverse time and instantaneous tripping characteristics.
2. Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make, quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the handle position.
3. Circuit breakers shall have a minimum symmetrical interrupting capacity as indicated on the drawings and as specified herein.
4. Circuit breakers 225 ampere and below shall have thermal-magnetic trip units and inverse time-current characteristics.
5. Circuit breakers above 225 ampere shall have microprocessor based programmable RMS sensing trip units.
6. Ground fault protection shall be provided where indicated.
7. Where indicated circuit breakers shall be current limiting.
8. Where indicated provide UL listed circuit breakers for applications at 100% of their continuous ampere rating in their intended enclosure.

G. Programmable Trip Units: (Circuit Breakers Above 225 Ampere)

1. Each circuit breaker microprocessor-based tripping system shall consist of three (3) current sensors, a trip unit and a flux-transfer shunt trip. The trip unit shall use microprocessor-based technology to provide the adjustable time-current protection

functions. True rms sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time-delay settings are reached Basis of Design is Cutler-Hammer type OPTIM 1050.

2. Interchangeable rating plugs shall establish the continuous trip ratings of each circuit breaker. Rating plugs shall be fixed-type as indicated. Rating plugs shall be interlocked so they are not interchangeable between frames, and interlocked such that a breaker cannot be closed and latched with the rating plug removed.

3. System coordination shall be provided by the following microprocessor-based programmable time/current curve shaping adjustments:

   a) Programmable long-time pickup settings in 1% increments, with +/- 5% band tolerance

   b) Programmable long-time delay with selectable I^2t or I^4t curve shaping.

   c) Programmable short-time settings (dependent on long-time setting) in 1% increments, with +/- 5% band tolerance.

   d) Programmable short-time delay with selectable flat or I^2t curve shaping.

   e) Programmable instantaneous pickup settings in 1% increments.

   f) Programmable ground fault pickup settings trip or alarm in 1% increments.

   g) Programmable ground fault delay with selectable flat or I^2t curve shaping.

4. The microprocessor-based trip unit shall have a powered/unpowered selectable thermal memory to provide protection against cumulative overheating should a number of overload conditions occur in quick succession.

5. When the instantaneous setting has been deselected, a selectable discriminator circuit shall be provided to prevent the breaker being closed and latched on to a faulted circuit.

6. Internal ground fault protection or alarm settings, if specified, shall not exceed 1200 amperes. Provide neutral ground fault sensor for four-wire loads.

7. The trip unit shall have an information system that utilizes battery backed up LEDs to indicate mode of trip following an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip. The LEDs shall be complemented by trip event information stored in non-volatile memory after a trip event. A trip reset button shall be provided to turn off the LED indication and reset the memory after an automatic trip. A test pushbutton shall energize an LED to indicate battery status.

8. A red LED shall be provided on the face of the trip unit and pre-set to flash on and off when an adjustable high-load level is exceeded. A time-delay shall be provided to avoid nuisance alarms. The microprocessor-based trip units shall be capable of monitoring the following data:

   a) Instantaneous value of phase, neutral and ground current.

   b) Minimum and maximum current values.

   c) Average demand current.

   d) System diagnostic information such as alarms and cause of trip.

   e) Approximate level of fault current that initiated an automatic trip operation.

9. The trip unit shall contain test capability. Testing shall be carried out by using a hand-held programmer, a breaker interface module or a remote computer to select the values

of test current within a range of available settings. The basic protection functions shall not be affected during test operations. The breaker may be tested in either the "Trip" or "No Trip" test mode.

10. A hand-held programming unit shall be provided to set/change the network communication breaker address for each device, set the stem baud rate, distribution frequency, display breaker information, and display monitored values. In addition, provide password protection for programming time/current set points and to perform functional testing of phase and ground trip characteristics. The programmer shall be self-powered by an internal battery. Provide two (2) hand-held programming units. Contractor shall submit Spare Parts Certification Memo certifying two hand-held programming units have been turned over to the Owner.
11. The monitored data shall be displayed by a hand-held programmer, a breaker interface module and a remote computer.
12. Circuit breakers, 1200 ampere frame and below, shall be provided with a 24 volt DC power supply mounted within the assembly. In addition, provide a minimum of one (1) auxiliary switch and one (1) bell alarm, each with form C contacts in each breaker. Provide additional auxiliary switches, bell alarms, shunt trips, and undervoltage releases where indicated on the drawings.
13. The trip unit shall be capable of two-way communication via a network twisted pair for remote monitoring and control. The trip unit shall be provided with an address register for identification on the network. All monitored values shall be transmittable over the network.
14. The trip unit shall include zone interlocking capability for the short-time delay and ground fault delay trip functions for improved system coordination. The zone interlocking system shall restrain the tripping of an upstream circuit breaker, and allow the circuit breaker closest to the fault to trip with no intentional time delay. In the event that the downstream breaker does not trip, the upstream breaker shall trip after the pre-set time delay. Factory wire zone interlocking system for breakers within each assembly.
15. Molded case circuit breakers shall be provided with a potential transformer, suitable for operation up to 600 volts. The potential transformer shall be mounted externally to the circuit breakers and provided with a dielectric disconnect fuse.
16. For enhanced system analysis, the following additional parameter values shall be monitored:
    a) Peak demand (kW)
    b) Present demand (kW)
    c) Reverse energy (kWh)
    d) Forward energy (kWh)
    e) Total energy (kWh)
    f) Power factor
    g) Percentage harmonic content
    h) Total Harmonic Distortion (THD).

H. Power Monitoring

1. Panel mounted meter (incoming metering device)

a) All Distribution Panelboards shall be provided with a Power XPert 2000 (or approved substitution) microprocessor based sub-meter complete with C.T.'s and communication to panel mounted monitor/display unit to provide the following data: Volts, amps, watts, watt-hour, vars, power factor, frequency, demand watts. .

b) Provide all interface cabling and connections.

I. Ground Fault Sensor (where called for on drawings): Zero sequence of ground return type.

J. Future Provisions: Fully equip spaces for future devices with bussing and bus connections, suitably insulated and braced for short circuit currents. Provide continuous current rating as indicated.

K. Enclosure: Type 1 - General Purpose for interior locations. Type 2 - Rain tight for damp locations.

1. Align sections at front and rear.

2. Finish:

a) Interior dry locations: Manufacturer's standard light gray enamel over external surfaces. Coat internal surfaces with minimum one coat corrosion-resisting paint, or plate with cadmium or zinc.

b) Interior damp locations: Coat interior and exterior of enclosure with rust inhibiting primer and paint over with epoxy paint.

c) Exterior, wash-down areas, and Interior wet locations: NEMA 4X stainless steel, watertight.

2.4 DISTRIBUTION ENTRANCE EQUIPMENT

A. Panelboards used as service entrance equipment shall be listed and labeled by UL for use as service equipment.

PART 3 - EXECUTION

3.1 PREPARATION, INSPECTION, EXAMINATION

A. Verify that surface is suitable for panelboard installation. Do not install NEMA 1 equipment until building has been "dried-in" stage.

B. Examine area to receive panelboard to assure adequate clearance.

C. Verify National Electrical Code clearances will be maintained after installation. Rework equipment locations as required to provide Electrical code clearances.

D. Start Work only after unsatisfactory conditions have been corrected.

E. Submit coordination drawings of all electrical rooms, showing all electrical (and mechanical) equipment. Comply with requirements of Section 26 05 00 Common work Results for Electrical.

3.2 INSTALLATION

A. Install panelboards in accordance with NEMA PB 1.1. Install all panelboards and distribution panelboard enclosures in accordance with the manufacturer's written instructions, NECA's "Standard of Installation", the applicable requirements of the National Electrical Code, and recognized industry practices.

B. Install panelboards plumb. Install recessed distribution panelboards flush with wall finishes. Provide supports in accordance with Section 26 05 29 Hangers and Supports.

C. Panelboards and terminal cabinets shall be provided with structural framing located within gypsum board partition. All enclosures shall be firmly anchored to walls and supporting structures (where used) using appropriate hardware. Provide supporting (unistrut type) channels on walls constructed of gypsum board or where otherwise necessary to provide a mechanically secure and permanent installation. Attach channels to framing provided within gypsum board partitions

D. Install enclosures so that the top is 6'-6" above finished floor. Where the size of the enclosure is such that the top cannot be installed at 6'-6", the top of the enclosure shall be kept as low as possible.

E. Provide filler plates for unused spaces in distribution panelboards.

F. Provide spare conduits out of each recessed distribution panelboard to an accessible location above ceiling. Minimum spare conduits: 4 empty 1 inch. Identify each as SPARE.

G. Install distribution panelboards so that proper working clearances shall be maintained at every distribution panelboard location.

H. Clean the interior of each distribution panelboard before installing conductors. At all times, keep the interior trim and exterior surfaces of the distribution panelboard free of rust and debris. Repaint finishes if necessary.

I. Coordinate all raceways and conductors with their respective distribution panelboards so that all connections and conductors routing present an orderly appearance. Conductors in the distribution panelboards shall be laced and arranged in orderly manner.

J. Provide a separate neutral conductor for each GFI breaker. These shall not be combined to serve more than 1 circuit, even where on different phases. Increase plan indications of conductors for neutral wires required, as necessary.

K. Provide 3” concrete housekeeping pad.

L. Provide and install separate 120 volt, 20 AMP circuit complete with circuit breaker, transformer, conduit, and wire as required to power any shunt-trip function specified.

A. Conduit or piping systems that contain water or liquid of any kind shall not be installed over the top of any electrical equipment, transformers, racks, cabinets, or enclosures without prior written approval from the Owner.

3.3 MONITORING/METERING

A. Provide/install all components, wiring, cable (fiber optic and copper), raceways, hubs, switches, patch panels modules, pc cards, communication network devices, converters, etc. as required to connect monitoring/metering equipment in each panelboard (provided with monitoring/metering) to GOAA's Power Xpert Computer (PC) located in Electrical Maintenance Shop/Office and in the Central Plant’s operators station.

B. Provide/install all software, programming, etc. to facilitate installation and monitoring of all monitor/meter equipment on GOAA's selected Power Xpert PC System.

C. Integrate all new equipment provided under this contract into existing software including programming/changes required to computer screens, program trending, program event logging, etc.

D. Coordinate with GOAA final approval of screens, trending, and event logging requirements and program system accordingly.

E. All revisions to software, programming, etc is to be by manufacturer of software.

3.4 IDENTIFICATION

A. Refer to Section 26 05 53 Identification for Electrical Systems.

B. Provide engraved plastic nameplates under the provisions of 26 05 53 Identification for Electrical Systems.

3.5 FIELD QUALITY CONTROL

A. Measure steady state load currents at each distribution panelboard feeder; rearrange circuits in the distribution panelboard to balance the phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.

B. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers, fusible switches, and fuses.

C. All circuits shall be operated to establish a good working order and checked for shorts.

D. All panel directory circuit numbers shall be checked to verify accuracy of the number.

E. Measure insulation resistance of each bus section phase to phase and phase to ground for one minute each, at test voltage of 1000 volts; minimum acceptable value for insulation resistance is 2 megohms.

F. Check tightness of accessible bolted bus joints using calibrated torque wrench.

G. Physically test key interlock systems to insure proper function.

H. Tests:

1. Test Distribution panelboards and distribution panelboard feeders per requirements of Section 26 08 13 Tests and Performance Verification.

2. Feeder conductors shall be checked by approved means to establish the absence of shorts to ground; insulation value, etc. and the result recorded and submitted to the Designer.

3. Submit Conductor Insulation Resistance Test per requirements of Section 26 08 13 Tests and Performance Verification.

4. Submit Tabulation Data Voltage and Amperage Readings per requirements of Section 26 08 13 Tests and Performance Verification.

I. Equipment Checkout:

1. When requested by Designer provide (during construction):

a) Inspection of equipment by authorized equipment manufacturer technician complete with submittal of statement of findings by technician, and providing any adjustments deemed necessary for a complete and operating system.

b) Submit Equipment Checkout Memo per Section 26 08 13 Tests and Performance Verification.

3.6 ADJUSTING

A. Adjust all operating mechanisms for free mechanical movement.

B. Tighten bolted bus connections in accordance with manufacturer’s instructions.

C. Adjust circuit breaker trip and time delay settings to values per manufacturer’s recommendation.

END OF SECTION 26 24 17

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SECTION 26 25 00 - BUSWAY – LOW VOLTAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Contractual Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SCOPE

A. The Contractor shall furnish and install the busway system including all necessary fittings, hangers and accessories as specified herein and as shown on the contract drawings.

1.3 REFERENCES

A. The low voltage busway and all components shall be designed, manufactured and tested in accordance with the latest applicable following standards of ANSI, CSA, IEC and NEMA:

1. NEMA BU.1 - Busways
2. ANSI/UL 857 – Underwriter's Busway Standards
3. NFPA 70 – National Electrical Code
4. CSA C22.2 No. 27
5. IEC 60439-1 and 2

1.4 SUBMITTALS FOR REVIEW/APPROVAL

A. The following information shall be submitted to the Engineer:

1. Master drawing index.
2. Shop Drawings: Indicate ratings, dimensions and finishes. Include dimensioned layout diagram, installation details and locations of supports and fittings such as firestops and weatherseals. Include details of wall and floor penetrations.
3. Isometric drawing of each busway run
4. Component list
5. Busway ratings including:
   a) Short-circuit rating
   b) Voltage
   c) Continuous current
6. Major component ratings including:
   a) Voltage
   b) Continuous current
   c) Interrupting ratings
7. Cable terminal sizes

8. Product data sheets on all components including, but not limited to:
   a) Bus
   b) Expansion fittings
   c) Fire Stops (with UL Detail)
9. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

1.5 SUBMITTALS FOR CONSTRUCTION

A. The following information shall be submitted for record purposes:
   1. Final as-built drawings and information for items listed in paragraph 1.4 above.
   2. Certified production test reports.
   3. Installation information.

B. The final (as-built) drawings shall include the same drawings as the construction drawings and shall incorporate all changes made during the manufacturing process.

1.6 QUALIFICATIONS

A. All components shall be of the same manufacturer as the busway.

B. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.

C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of 10 years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

1.7 REGULATORY REQUIREMENTS

A. The busway shall bear a UL label. (Certified copies of production test reports shall be supplied demonstrating compliance with these standards when requested by the Engineer).

B. Conform to requirements of NFPA 70.

1.8 DELIVERY, STORAGE AND HANDLING

A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One copy of these instructions shall be included with the equipment at time of shipment.

B. Refer to NEMA Publication BU 1.1 which is a guide for proper installation, operation, and maintenance of busway products.

C. Accept busway on site in factory containers. Inspect for damage.

D. Protect from moisture by using appropriate coverings. Store in dry interior locations.

1.9 OPERATION AND MAINTENANCE MANUALS

A. Equipment operation and maintenance manuals shall be provided with each assembly shipped, and shall include instruction leaflets and instruction bulletins for the complete assembly and each major component.

B. Operation and maintenance manuals shall include the following information.

1. Instruction books or leaflets
2. Recommended renewal parts list
3. Drawings and information required by Section 1.5

1.10 FIELD MEASUREMENTS

A. Verify that field measurements are as indicated on shop drawings.

1.11 SEQUENCING

A. Sequence work to avoid interferences with building finishes and installation of other products.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design:

1. Eaton

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

2.2 RATINGS

A. The busway shall be Eaton type Pow-R-Way III and shall be copper with:

1. Three-phase, four-wire with 50% integral housing ground and 100% neutral.

B. Voltage and current ratings as indicated on the contract drawings. Provide 100% neutral and 50% capacity integral ground bus.

C. The busway shall, have a minimum of 6-cycle short-circuit rating of 85 kA RMS symmetrical for ratings through 800A, 100 kA RMS symmetrical for ratings through 1350A, 125 kA RMS symmetrical for ratings through 1600A, 150 kA RMS symmetrical ratings through 2500A, and 200 kA RMS symmetrical for ratings through 5000A.

D. The short circuit rating of the busway shall be determined according to UL 857 Standards. This rating must be based upon actual test at the rated short circuit current.

2.3 CONSTRUCTION

A. The busway and associated fittings shall consist of [aluminum] [copper] conductors totally enclosed in a 2-piece extruded aluminum housing. Outdoor feeder, indoor feeder and indoor plug-in busway shall be interchangeable at the same rating without the use of adapters or special splice plates. Where indicated on the contract drawings, provide indoor, sprinkler-proof plug-in busway. Outdoor designs requiring addition of caulking or gasketing in the field are not acceptable. Fittings such as elbows, tees, flanges, etc., shall be identical for use with both the plug-in and feeder types of busway. The busway shall be capable of being mounted flatwise, edgewise, or vertically without derating. The busway shall consist of standard 10 foot sections with special sections and fittings provided to suit the installation. Horizontal runs shall be suitable for hanging on 10 foot maximum centers. Vertical runs shall be suitable for mounting on 16 foot maximum centers. Provide one hanger for every 10 feet of horizontally mounted busway. On vertical runs, provide one spring, adjustable suspension type hanger per floor.

B. Busway shall comply with NEMA BU.1.

2.4 CONDUCTOR BUS BAR

A. Bus bars shall be fabricated from high strength, *[55% conductivity aluminum] [99% conductivity copper] and suitably plated at all electrical contact surfaces.

B. Bus bars shall be insulated over their entire length, except at joints and contact surfaces, with a UL listed insulating material consisting of epoxy applied by fluidized bed process. Tape or heat-shrink sleeve insulation, or any other method of insulation which can allow air-gaps or insulation breakdown, shall not be acceptable.

C. The busway shall be capable of carrying rated current continuously without exceeding a temperature rise of 55 degrees C based on a 40 degrees C ambient.

D. Feeder busway (800 A and above) shall be of sandwich construction, meaning no air gap shall exist between bus bars.

2.5 BUS JOINTS

A. Each busway section shall be furnished complete with joint hardware and covers.

B. The busway joints shall be a single-bolt, non-rotating, removable bridge design.

C. All bridge joints shall be furnished with torque-indicating double head joint bolts and Belleville washers. The bridge joint shall utilize a captive nut retainer on the opposite side of the torque indicating bolt. The bridge joint design shall ensure proper installation without the use of a torque wrench, and provide visual indication that the joint is properly torqued.

D. Each busway joint shall allow for a minimum length adjustment of +/- 0.5 inches.

E. De-energization of busway shall not be required for safe testing of joint tightness.

F. Access shall be required to only one side of the busway for tightening joint bolts.

G. The bridge joint shall be the Eaton Pow-R-Bridge.

2.6 HOUSING

A. The busway housing shall be a two-piece design fabricated from extruded aluminum. The two- piece housing shall be bolted together along the bottom flange using grade 5, 1/4 x 20 zinc plated fasteners on 3 inch centers for maximum mechanical strength.

B. The busway enclosure finish shall be ANSI 61 or 49 gray baked epoxy powder paint applied by an electrostatic process.

C. Outdoor feeder busway housing shall be identical to indoor feeder busway housings, and shall be UL listed for outdoor use. Busway shall be completely weatherized at the factory, and designed such that only protective joint covers are required for outdoor application.

D. The busway housing shall be totally enclosed non-ventilated for protection against mechanical damage and dust accumulation.

E. The totally enclosed housing shall be manufactured by the busway manufacturer. Modifications of busway to make it totally enclosed by other than the busway manufacturer voids the manufacturer's warranty. Busway so modified is unacceptable without the written consent of the manufacturer.

2.7 TRANSIENT VOLTAGE SURGE SUPPRESSION

A. Provide transient voltage surge suppression as specified in Section 26 43 00 Surge Protective Devices.

2.8 FITTINGS

A. Provide fittings in accordance with manufacturer's recommendations.

2.9 FINISH

A. Baked gray enamel.

2.10 VOLTAGE DROP

A. the voltage drop (input voltage minus output voltage) shall be based on the busway operating at full ranted current and at stabilized operating temperature in 30 degree C ambient.

B. The three-phase, line-to-line voltage drop shall not exceed 3.1 volts per hundred feet at 40% power factor concentrated load which may exist during motor starting.

C. The line-to-line voltage drop shall not exceed 4.0 volts per hundred feet at the load power factor which produces maximum voltage drop in the busway.

PART 3 - EXECUTION

3.1 FACTORY TESTING

A. Standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of ANSI and NEMA standards.

B. The manufacturer shall provide three certified copies of factory test reports.

C. Factory tests as outlined above shall be witnessed by the Owner's Representative.

1. The manufacturer shall notify the Owner two weeks prior to the date the tests are performed.

2. The manufacturer shall include the cost of transportation and lodging for up to three Owner's Representatives. The cost of meals and incidental expenses shall be the Owner's responsibility.

3.2 INSTALLATION

A. The Contractors shall install all equipment per the manufacturer's recommendations and the contract drawings.

B. The Contractor shall be responsible for routing the busway to coordinate with the other trades. Final field measurements shall be made by the Contractor prior to release of the busway for fabrication by the manufacturer.

C. Do not install busway when installation location is not protected from moisture.

D. Tighten joints using a torque wrench, to manufacturer's specified values.

E. Install busway length with expansion fittings at each location where busway run crosses building expansion joint.

F. Mounting and Support: Mount horizontal busway runs in position as required to facilitate layout as indicated on Drawings. Support busway at maximum intervals as recommended by manufacturer. Support vertical riser at each floor.

G. Hanger spacing shall be noted on layout drawings and shall not exceed manufacturer's recommendations.

H. Install busway with integral fire stops located where busway penetrates fire-rated walls and floors. Seal around opening to maintain fire-rating equal to wall or floor rating.

I. Provide concrete curb around interior floor penetrations.

J. Install busway with integral weather seal located where busway penetrates exterior wall and/or roof. Provide wall and/or roof flange and seal around opening to maintain weathertight installation.

K. Provide engraved plastic nameplates under the provisions of Section 26 05 53 Identification for Electrical Systems.

L. Provide transformer taps in one vault as required by OUC.

M. Locate bus vault penetration and transformer tap boxes as directed by OUC.

N. Coordinate all work in OUC vault with OUC prior to bid. Bid to include all work required by OUC.

END OF SECTION 26 25 00

SECTION 26 27 13 - ELECTRICAL METERING AND MONITORING SYSTEM

PART 1- GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification Sections apply to this Section.

1.2 SUMMARY

A. This section includes the requirements for provisions and installation of an extension of the existing Electrical Metering and Monitoring System (EMMS).

B. The existing EMMS system is a Power Xpert system by Eaton. This is an extension of that system, with an upgrade to Foreseer platform.

1.3 DESCRIPTION

A. The Contractor shall furnish and install a complete and fully operational extension of the existing EMMS.

B. This section includes requirements for the supply and installation of new devices and electrical distribution equipment to the existing Electrical Metering and Monitoring System (EMMS) as detailed on the drawings and as described in this specification. Insure new components and equipment connected to the existing EMMS interface with all existing components appropriately.

C. The EMMS is defined to include, but not to be limited to, remote devices for metering, monitoring, and protection, device communication interface hardware, intercommunication wiring, ancillary equipment, startup and training services, all software and programming of existing master and client workstations, and ongoing technical support.

D. Coordinate with various sections of these specifications for additional requirements and/or devices, equipment, etc associated with the EMMS. Provide all equipment, devices, programming, software, screens, etc as required to facilitate all work, functions, operations, descriptions, etc associated with the EMMS system as specified in this section and all sections of these specifications and drawings.

E. Switchgear shall have Power Xpert 6000 at each main (utility and emergency) plus Power Xpert 900 gateway. Distribution panels shall have Power Xpert 2000 plus gateway. Panel boards shall be provided with Power Xpert branch circuit monitoring on all breakers, if the panel feeds any lighting or is noted as such on the drawings.

F. Reports shall be generated for peak/ AVG values showing amperage, voltage, watts, power factor for:
   1. Building Total
   2. Heating, Ventilation, and Air Conditioning (HVAC)
   3. Baggage (BHS)
   4. Experiential Media Environment (EME)
   5. Interior Lighting

6. Exterior Lighting
7. Receptacles
8. Elevators
9. Ground Service Equipment (GSE)
10. Security
11. Signage
12. Food & Beverage (FB)
13. Retail (RET)
14. Other

1.4 DEFINITIONS

A. EMMS: The Electrical Metering and Monitoring System used to monitor, alarm, analyze, and trend information from connected, communicating IEDs to allow efficient management of the facility electrical distribution system.

B. IED: Intelligent Electronic Device that provides metering and/or protective functions with communications to the EMMS.

C. LAN: Ethernet Local Area Network

1.5 SUBMITTALS

A. Submit narrative/description of system.

1. Describe overview of system to be provided.
2. Submittal shall include description of all programming to be performed as required to comply with these specifications.
3. Typical software screen displays shall be provided in print-out form and/or disk for each trend, device, etc.

B. Submit product data on each piece of equipment, device, cabinet, enclosure, wire, cable, etc showing manufacturer's standard construction data including:

1. Drawings being supplied under this contract.
2. Description of all devices, equipment, cabinets, and enclosures.
3. Construction/dimensions of all devices and all cabinets/enclosures
4. UL labeling.
5. Wire/cable

C. Submit Shop Drawings.

1. A customized system diagram showing location of computers, repeaters, gateways and assemblies/devices to be connected to the system, as well as specific types of wiring required (showing type or gauge of all twisted pair, coax, fiber, etc.) and a general layout of wiring referencing the specific building/facility layout.
2. Drawings are to show all wiring and conduit to all equipment and all devices in all buildings.
3. Shop drawings shall contain both schematic type drawings showing all devices interconnected with wiring, types, sizes, etc and floor plan of all affected areas of building showing major conduit/interconnections/communications rooms, etc .

4. Hardware and software description shall be provided in detail for all communications hardware, software, including sensor devices and gathering data to be transmitted over the network, and master display unit. This description will include a list of all the communicating devices to be connected to the network.
5. Indicate electrical characteristics and connection requirements. When EMMS components are installed by the power equipment manufacturer, the power equipment shop drawings shall clearly identify the components, the internal connections, and all contractor connections. The EMMS drawings shall show all EMMS components including necessary component dimensions; type, size, and weight; location of conduit entry and exit; single line diagram indicating external wiring requirements. Drawings shall identify terminal blocks used for interconnections and wire type to be used

D. Submit For Operation and Maintenance Manual

1. Final submittal data shall include a systems operation manual which shall include all the information required by the above paragraphs.
2. In addition, the systems operation manual shall include the following information:

    a. Included in the system description section shall be a system description overview, descriptive bulletins and/or sales aids covering each of the components in the system.
    b. A maintenance section including all instruction leaflets and technical data necessary to setup, change setup and maintain the communicating devices and sensors.

3. An original licensed copy of all software manuals shall be included.
4. A section on communication wiring shall include:

    a. Type of communication wire utilized
    b. General cable ratings and communications characteristics
    c. Cable routing diagram including terminations and splicing connections made.

5. A detailed startup report, including a list of customer trained individuals shall be provided.
6. A list of all programming functions provided for this project.
7. An electronic (PDF) copy of the updated “master” one-line for the building(s) being modified under this project shall also be submitted/completed prior to closeout.

1.6 REFERENCES

A. The EMMS shall comply with the applicable portions of ANSI/IEEE 802.3 and NEMA standards. In addition, the master workstation shall comply with FCC Emission Standards specified in Part 15, Subpart J for Class A application.

1.7 Qualifications

A. The manufacturer of the equipment shall have been regularly engaged in the manufacture of the specified remote devices for a period of at least five (5) years and demonstrate that these products have been utilized in satisfactory use in functioning systems for similar applications. The manufacturer shall have at least five (5) years demonstrated capability in EMMS design, installation and start-up.

1.8 PROJECT AS-BUILT DOCUMENTS

A. Record actual locations of each device on red lined as-built documents.

1.9 REFERENCES AND REGULATORY REQUIREMENTS

A. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

B. Conform to the requirements of the following:

1. ADA requirements.
2. ANSI/NFPA 70 - National Electrical Code.

1.10 PRODUCT STORAGE AND HANDLING

A. Physically protect all equipment against damage as recommended by manufacturer.

PART 2- PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: Eaton Power Xpert/Foreseer

2.2 GENERAL

A. Furnish and install components to expand and upgrade (if necessary) the existing Electrical Monitoring and Control System (EMMS) as detailed on the drawings and as described in this specification.

B. The EMMS shall be the Eaton Power Xpert system or approved equal with all the features, characteristics and options as herein specified and/or shown on the drawings.

2.3 EMMS OPERATION

A. The EMMS client applications shall be capable of running on Microsoft Windows 2000 or XP. The EMMS System shall consist of a main LAN network that interconnects a number of local device networks as shown on the drawings.

B. The main LAN network shall be an Ethernet network using TCP/IP protocol communicating at 10 MegaBaud. Any devices connected to the main network shall be equipped with an Ethernet communication card and communicate at 10 MB.

C. The local device network shall be interconnected with #18 gauge twisted pair shielded cable, Belden 9463 family, in properly sized conduit (when run outside of factory assembled equipment for the communication channel. The local device network shall support up to five (5) data lines in a "star" configuration to minimize cable routing cost.

D. All cables shall be in conduit.

E. The network shall support up to 200 devices on the five (5) data lines without repeaters providing the maximum cable distance between the ends of the longest two lines is less than 10,000 feet. The cabling shall be polarity insensitive.

F. The communication speed at the device level shall be a minimum of 9600 baud. Devices shall communicate at their maximum baud rate regardless of the number of devices on the network.

G. The system shall alarm on detected faults in communication servers or remote devices.

H. The system shall have the capability of being programmed and modified on-line. It shall not be necessary to shut down any part of the system during programming operations.

2.4 COMPONENT INTERFACE

A. Furnish and install Ethernet communication modules in each substation or equipment room or as shown on the drawings. The Ethernet links shall provide positive two-way communication between the main Ethernet LAN and the local device network. Each Ethernet link shall be expandable to communicate to up to 200 devices.

B. Furnish and install single device Ethernet links to devices as shown on the drawings. The product operated Ethernet link shall provide communications at 10 MB over the TCP/IP Ethernet network.

C. Suitable enclosure or mounting of Ethernet links shall be provided to prevent physical damage.

D. Remote devices either shall have built-in communication capability or separately mounted communication module capable of communicating information between the remote device and the Ethernet link. Each remote device with built-in communication capability or each separately mounted communication module (PONI card) shall have field-settable addresses capable of providing each remote device on the network with an individual address for identification of each remote device on the network.

E. The local device network communication signal shall be Frequency Shift Keyed (FSK), carrier-based, 115 kHz nominal frequency to ensure no interference from 60-cycle power system.

F. All local device network communication system components shall have a dielectric isolation of a minimum of 2200 volts line-to-ground without damage to communication capability.

2.5 EMMS SOFTWARE

A. Provide an upgrade to the existing software package for the Eaton Power Xpert Suite on both the master workstation located in the Electrical Maintenance shop and client PC located in the Central Energy Plant control room. Upgrade to the current/latest available version of software at the time of Bid. The software system shall have a Client/Server architecture that allows multiple monitoring stations to access data simultaneously over a TCP/IP Ethernet network. The system shall consist of servers and clients as follows:

1. DeviceServer The PowerNet server that enables communications on a TCP/IP network providing PowerNets clients with real time device metering information, event information, waveforms, and historical profile data. The Device Server shall be licensed for the number of devices shown on the drawings.

2. PowerNet Security Manager PowerNet client application that allows an unlimited number of user accounts to be created with specific privileges. Users can be granted privileges, based on their user id and password, to perform various control functions in the system.
3. PowerNet Monitor PowerNet client that provides a spreadsheet like user interface for real time monitoring and control. The software shall have drag and drop configuration with the ability to save multiple views allowing users to view only the information most important to them. Device information shall be displayed using Active X screens.
4. PowerNet Configurator PowerNet client that allows configuration of PowerNet devices across the network. The configurator shall be able to set up custom polling down to the parameter level in each device to optimize polling for the information of most interest by the user.
5. PowerNet Tools PowerNet client that provides tools to configure, schedule, and maintain historical databases. Data shall be stored in ODBC compatible formats
6. PowerNet Setpoints & Trip Curve Display PowerNet client that provides access to current meter and protective relay settings. Devices that allow remote configuration through software shall be able to be configured on line. Meter and protective settings can saved to disk for downloading to other devices. An unlimited number of protective relays shall be able to have their coordination curves displayed graphically in a log-log format for verification of proper system coordination. Trip curve pickups and time delays shall be able to be modified on line.
7. PowerNet Waveform Display PowerNet client that allows reading and displaying of the waveform data collected by the power monitoring devices. The graphic format will display the data in an oscilligraphic format and in a Fourier Amplitude Spectrum graph. The software shall also display the metered values saved at the time of the waveform capture. Up to three (3) oscilligraph windows shall be present on the screen at one time, each capable of overlaying (3) separate current or voltage waveforms within a window.
8. PowerNet OPC / DDE / Modbus Servers PowerNet client that provides compatible software packages access to EMMS data through the OPC or DDE or Modbus Servers.
9. PowerNet Enhanced Graphics The existing EMMS has the Enhanced Graphics software with animated system one-line drawings, site plans, and Main Directory screen. This operator interface shall be expanded to include the new electrical one-line diagrams, trends, and modifications to the site plans and Main Directory for easy access to the data by operators. Provide latest version software update, if necessary.
10. For Eaton devices that directly support the above level(s) of Power Xpert software functionality at the Ethernet communication level, additional modules are not required.

B. For devices that support the above node feature set(s) natively, a direct connection to the Power Xpert architecture is required.

2.6 SYSTEM COMPONENT DETAILED SPECIFICATIONS

A. System shall be capable of communicating with the following devices where shown on the drawings or specified to be included in assembled equipment:

1. Meter Analyzer and Protection (MA&P) device, Eaton PX6000or approved equal
2. Motor Protective Relay (MPR), Cutler-Hammer MP-3000 or approved equal
3. Microprocessor-based Trip Unit (TU), Cutler-Hammer Digitrip RMS, Digitrip Optim or approved equal

2.7 MICROPROCESSOR-BASED METERING EQUIPMENT

A. Power Xpert Meter Series 6000 shall be the basis of design.

1. Where indicated on the drawings, for main breaker metering, provide Power Quality Meters, designated PX-M. The PX-M shall be equal to Eaton type Power Xpert Meter (PXM) Series 6000 having the features and functions as shown on the drawings and herein specified.
2. Complete PX-M shall be have the following minimum listings and/or certifications:

    a. Safety: UL 61010-1, EN 610101.
    b. Accuracy: ANSI C12.20 Class 0.2, IEC/EN60687 0.2 for revenue meters.
    c. EMC: FCC Part 15 Subpart B Class A immunity.
    d. IEC Standards: 50081-2, 61000-3, 61000-4, and 61326.

3. Current inputs for each channel shall be from standard instrument current transformers.

    a. The analog current input shall be converted to 4096 samples per cycle with a delta-sigma converter digitally filtered down to 512 samples per cycle for anti-aliasing.
    b. Overload withstand capability shall be a minimum of 500A for 1 second, non-repeating.
    c. Input range capability shall be 0.005 to 20 amperes.

4. The PX-Metering series shall be capable of monitoring, displaying, and communicating the below true RMS minimum information where applicable with the accuracy as indicated of read or calculated values based on 3 to 300% full scale.

    a. Volts: L-L, L-N, Avg. L-L, Avg. L-N, N-G
    b. Phase neutral and ground currents
    c. Power: real, reactive and apparent
    d. Frequency
    e. Power factor: apparent and displacement
    f. Energy
    g. Demand
    h. % THD Minimum and maximum values
    i. Harmonics
    j. Flicker
    k. Individual harmonics
    l. Inter-harmonics
    m. % TDD
    n. ITIC events plot, duration, magnitude
    o. Energy comparisons
    p. Demand comparisons
    q. Event calendar
    r. Event timeline and sequence
    s. Number of 9s of availability
    t. Phases
    u. Sequence components
    v. Crest factor
    w. K-factor
    x. PQ Index

5. The PX series shall provide the following sampling capabilities:

    a. A/D technology, sampling at 4096 samples per cycle.
    b. Over-sampling and quantizing filtering to eliminate false signal noise.
    c. c) ITIC representation of power events.
    d. d) Waveform recorded at 512 standard samples per cycle

6. The PX series shall provide the following advanced analysis features:

    a. Calculation of harmonic magnitudes and phase angle for each phase voltage and current through the 85th harmonic.
    b. Waveforms shall be available in non-volatile memory and retrievable via file transfer protocol (ftp) in COMTRADE file format over the Internet network.
    c. Historical Trending: Historical trend logging for graphical viewing from the Local display or from an embedded WEB server. The graphical views of historical data shall support both pan and zoom functions. All standard metering parameters shall be logged as part of the standard meter functionality including minimum, maximum and average for each metered parameter.
    d. Event Logging: The PX-M or embedded WEB Server shall allow the user to view a list of triggered events along with any captured parameters, event details, and triggered waveforms.
    e. ITIC Analysis Plot: The PX-M shall include a graphic display of the Information Technology Industry Council (ITIC) plot with counts of disturbances and transients that have occurred.
    f. Sag/Swell and Waveform recording: Sixty (60) cycles of waveform shall be recorded at 512 samples per cycle including 30 cycles of pre and post event data.

7. The PX-M shall have provisions for a digital Input/Output (I/O) card which shall include:

    a. Eight (8) digital inputs – self sourced 24 Vdc.
    b. Three (3) relay outputs – 5A maximum form C continuous, 380Vac maximum, 125Vdc maximum. Outputs shall be suitable for KYX or alarm annunciation.
    c. Two (2) solid state outputs – 80 mA maximum continuous, 30 Vdc maximum.

8. The PX-M shall be provided with multiple communications ports and protocols, including the following capability:

    a. RS-485 Modbus RTU
    b. Modbus TCP using RJ-45 Selectable 100FX or 10/100Base-T Ethernet network port
    c. HTML web pages d) File transfer protocol (ftp) e) NTP(Network Time Protocol) support

9. The PX-M graphical display shall be provided with each meter base.
10. The WEB server shall provide the user with remote WEB access to all the metered, trend and waveform information. The WEB server shall include real time monitored information in both numeric and graphical visual formats

11. Trip Units

    a. Each circuit breaker shall be equipped with a solid-state tripping system consisting of three (3) current sensors, microprocessor-based trip device and flux-transfer shunt trip. Current sensors shall provide operation and signal function. The trip unit shall use microprocessor-based technology to provide the basic adjustable time/current protection functions. True RMS sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors, and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time-delay settings are reached. The trip unit shall be Cutler-Hammer type Digitrip 910.
    b. Interchangeable rating plugs shall establish the continuous trip ratings of each circuit breaker. Rating plugs shall be fixed-type as indicated. Rating plugs shall be interlocked so they are not interchangeable between frames. Removal of the rating

plug shall prevent the breaker from being closed and latched with the rating plug removed or trip the breaker at low current levels.

c. Complete system selective coordination shall be provided by the addition of the following individually adjustable time/current curve shaping solid-state elements:

   1) All circuit breakers shall have adjustment for long delay pickup and time.
   2) Main breakers shall have individual adjustments for short delay pickup and time, and include selective flat or I2t curve shaping.
   3) Feeders shall have adjustable instantaneous pickup.
   4) Circuit breakers, where indicated on the drawings], shall have individually adjustable ground fault current pickup and time, and include selective flat or I2t curve shaping.
   5) The microprocessor-based trip unit shall have both powered and unpowered thermal memory to provide protection against cumulative overheating should a number of overload conditions occur in quick succession.

d. Trip units shall include zone interlocking capability for the short-time delay and ground fault delay trip functions for improved system coordination. The zone interlocking system shall restrain the tripping of an upstream circuit breaker and allow the circuit breaker closest to the fault to trip with no intentional time delay. In the event that the downstream breaker does not trip, the upstream breaker shall trip after the pre-set time delay.

e. For trip units without an instantaneous adjustment, a discriminator circuit shall be provided to prevent the breaker being closed and latched on to a faulted circuit.

f. Where internal ground fault protection is specified, settings shall not exceed 1200 amperes. Provide neutral ground fault sensor for four-wire loads.

g. The trip unit shall have an information system that utilizes battery backed-up LEDs to indicate mode of trip following an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip. A trip reset button shall be provided to turn off the LED indication after an automatic trip. A test pushbutton shall energize an LED to indicate battery status.

h. The trip unit shall be provided with a representation of the time-current curve on the trip unit that indicates the protection function settings. The unit shall be continuously self-checking and provide LED indication that the internal circuitry is being monitored and is operational.

i. The trip unit shall contain an integral test panel with a test selector switch and a test pushbutton. The test selector switch shall enable the user to select the values of test current within a range of available settings. The basic protection functions shall not be affected during test operations. The breaker shall be capable of being tested in either the “Trip” or “No Trip” test mode. Provide a keyed receptacle for use with an auxiliary power module. The auxiliary power module shall allow the breaker trip unit to be tested with a 120-volt external power source

j. A four-digit, 3/4-inch high, LED alphanumeric display shall be provided to indicate the following data:

   1) Cause of trip (long time, short time, instantaneous or ground fault).
   2) Instantaneous value of maximum phase and ground current.
   3) Level of fault current that initiated an automatic trip operation.
   4) Display shall be high output LED for low-level light readability. LCD displays are unacceptable.

k. The trip unit shall include a power/relay module which shall supply control power to the readout display. Following an automatic trip operation of the circuit breaker, it shall maintain the cause of trip history and the mode of trip LED indication as long

as its internal power supply is available. Internal relays shall provide contacts for remote indication of mode of trip and high load.

l. A red LED shall be provided on the face of the trip unit pre-set to turn on when 85% of the trip setting is exceeded (a 40-second delay shall be provided to avoid nuisance alarms).

m. Metering display accuracy of the complete system including current sensors, auxiliary CTs, and the trip unit shall be +/- 2% of full scale for current values in the range of 5% - 100%.

n. The trip unit shall include a potential transformer module, suitable for operation up to 600V, 50/60 Hz. The primary of the PTM shall be connected internally to the load side of the circuit breaker through a dielectric disconnect plug. The unit shall calculate energy monitoring parameters as follows:

1) Peak demand (Megawatts)
2) Present demand (Megawatts)
3) Energy consumption (Megawatt-hours).

o. The energy-monitoring parameter values (peak demand, present demand and energy consumption) shall be indicated in the trip unit alphanumeric display panel.

p. Metering accuracy of the complete system of full scale shall be +/- 4% for power values, +/- 5% of full scale for energy values.

q. The trip unit shall be equipped to permit communication via a network twisted pair for remote monitoring and control. The trip unit shall be provided with an address register for identification on the network. All monitored values shall be transmittable over the network.

r. For enhanced system analysis the following additional parameter values shall be calculated and indicated in the trip unit alphanumeric display panel:

1) Line-to-line voltage
2) Power factor
3) Percentage harmonic content
4) Total Harmonic Distortion (THD).

2.8 THE MICROPROCESSOR-BASED METERING EQUIPMENT.

A. The Power Xpert Meter 2280 series is the basis for design.

B. Where indicated on the drawings, provide multifunction, power and energy meters, and designated (PM) device equal to Eaton type PXM2280 series. The meter device shall be UL listed. All meters shall have the following ratings, features, and functions, unless a specific meter type is designated.

1. Meter shall be designed for Multifunction Electrical Measurement on 3 phase power systems. The Meter shall support 3-Element Wye, 2.5 Element Wye, 2 Element Delta, 4 wire Delta systems.
2. Meter surge withstand shall conform to IEEE C37.90.1 and ANSI C62.41 (6KV)
3. The meter shall be user programmable for voltage range to any PT ratio.
4. The meter shall accept a direct voltage input range of up to 576 Volts Line to Neutral, and a range of up to 721 Volts Line to Line.
5. Meter shall accept a current input of up to 10 amps continuous. Start up current for a 5 Amp input shall be no greater than .005 Amps.

C. The meter shall have the following additional ratings and features:

1. Fault Current Withstand shall be 100 Amps for 10 seconds, 300 Amps for 3 seconds, and 500 Amps for 1 second.
2. Meter shall be programmable for current to any CT ratio. The use of DIP switches for selecting fixed ratios shall not be acceptable

D. The meter shall have an accuracy of +/- 0.1% or better for volts and amps, and 0.2% for power and energy functions. The meter shall meet the accuracy requirements of IEC687 (class 0.2%) and ANSI C12.20 (Class 0.2%).

1. The meter shall provide true RMS measurements of voltage, phase to neutral and phase to phase; current, per phase and neutral.
2. Type PM meters shall provide per phase % THD (Total Harmonic Distortion) and individual harmonic monitoring to the 40th order for voltage (reference to neutral only) and current, and shall provide Volts, Amps, kW, kVAR, PF, kVA, Frequency, kWh, kVAh, kVARh, 1 KYZ pulse output, on board meter limit exceeded alarms, provide a waveform view of real time harmonic distortion from the embedded WEB server, record waveforms up to 64 samples per cycle, and 768 Megabytes for data logging.

E. Type PM meters shall provide a simultaneous voltage and current waveform recorder.

1. Type PM meter shall be capable of recording 64 samples per cycle for a voltage sag or swell or a current fault event.
2. The meter shall provide pre- and post-event recording capability. 3. The meter shall allow up to 1500 events to be recorded. 4. The meter shall store waveform data on the meter ftp server in COMTRADE format and be accessible via a web browser.

F. The meter shall be able to be configured and viewed from the on-board web server without the need for external software

G. The meter shall include a three-line, bright red, .56” LED display. 1. The meter shall fit in both DIN 92mm and ANSI C39.1 Round cut-outs. 2. The meter must display a % of Load Bar on the front panel to provide an analog feel. The % Load Bar shall have not less than 10 segments.

H. The meter shall be available in transducer only version, which shall not include a display. The transducer version shall mount directly to a DIN rail.

I. The meter shall include 2 independent communication ports on the back with multiple protocols, including the following minimum capability:

1. Serial Communication Format

a. Connection Type: RS-485 b) Protocols: Modbus RTU, Modbus ASCII, DNP 3.0 c) Baud rates shall be from 9600 to 57,600 baud 2. Network Communication Format a) Connection Type: RJ-45 10/100 Base-T Ethernet Network port.
b. Ethernet card shall allow auto transmit/receive detection for straight or null RJ45 cables.
c. Protocols: Ethernet TCP/IP, Modbus TCP, BACnet/IP, SNMP v1 & v3 (Network), SMTP (email), HTTP, HTTPS, Atom Feed

J. The meter shall provide user configured fixed window or sliding window demand. This shall allow the user to set up the particular utility demand profile.

1. Readings for kW, kVAR, kVA and PF shall be calculated using utility demand features.

2. All other parameters shall offer max and min capability over the user selectable averaging period.
3. Voltage shall provide an instantaneous max and min reading displaying the highest surge and lowest sag seen by the meter.

K. The meter shall be capable of operating on a power supply of 90 to 265 Volts AC and 100 to 370 Volts DC. Universal Power AC/DC Supply shall be available and shall have a burden of less than 11VA. An option shall also be available to operate on a power supply from 18-60 VDC.

L. The PM meters shall provide the following advanced analysis features:

1. Historical Trending: Historical trend logging for graphical viewing from an embedded WEB server. The graphical views of historical data shall support both pan and zoom functions. All standard metering parameters (42 real-time measures) shall be logged as part of the standard meter functionality including minimum, maximum and average for each metered parameter. The averages shall be calculated over the time interval period. Minimum storage capacity for standard trend plots shall be as follows:

a. Five-minute intervals for 180 days. b) Fifteen-minute intervals for 2 years c) Sixty-minute intervals for 10years d) Data storage up to 768 MB. 2. Event Logging: The embedded WEB Server shall allow the user to view a list of triggered events along with event details.

M. The WEB server shall provide the user with remote WEB access to all the metered and trend information. The WEB server shall include real time monitored information in both numeric and graphical visual formats.

N. The meter shall have a real-time clock with the added capability to synchronize with a network time server to maintain time accuracy.

O. The meter shall have I/O expandability through one Option card slot on the back.

1. The Option card slot shall accept I/O card in all of the following formats: Four channel bi-directional 0-1mA Output Card; Four Channel 4-20mA Output Card; Two Relay Outputs/2 Status Inputs Card; and Four KYZ Pulses/4 Status Inputs Card.

PART 3- EXECUTION

3.1 WARRANTY

A. The manufacturer shall warrant the equipment supplied hereunder. The warranty shall include:

1. Lifetime free telephone technical support.
2. Warranty on all hardware supplied under this system shall be for two (2) years from date of acceptance.

3.2 FACTORY TESTING

A. The following standard factory tests shall be performed on the equipment provided under this section:

1. Configure and load all software
2. Test and operate computer and software in a simulated system mode

3.3 INSTALLATION

A. The contractor shall furnish, install and terminate all communication conductors and associated conduits external to any factory supplied equipment.

B. All communication wiring and routing shall be per the manufacturer's recommendations and as shown on the contract drawings.

C. The contractor or manufacturer’s representative shall configure, address, and verify the proper settings on the IEDs shown on the drawings and referenced in the specification.

D. EMMS components, included within the power equipment lineups shall be factory installed, wired and tested prior to shipment to the job site.

E. All control power, CT, PT and data communications wire shall be factory wired and harnessed within the equipment enclosure.

F. Where external circuit connections are required, terminal blocks shall be provided and the manufacturer's drawings must clearly identify the interconnection requirements including wire type to be used.

G. All wiring required to externally connect equipment lineups shall be installed by the electrical contractor.

H. Contractor interconnection wiring requirements shall be clearly identified on the PMCS system drawings.

I. Provide updated monitor screens depicting electrical distribution system.

3.4 FIELD QUALITY CONTROL

A. The contractor shall furnish the services of a manufacturer's representative for a minimum period of three (3) 8-hour days to assist the owner in starting-up and programming the system. The manufacturer's representative shall be factory-trained and shall have a thorough knowledge of the software, hardware, and system programming. The manufacturer's representative shall provide the following services:

1. Setting all the addresses of all devices in the equipment
2. Verifying and troubleshooting the integrity of the data line (run by others)
3. Assisting the owner in correcting any data line problems
4. Coordinating any possible warranty problems with the EMMS
5. Configure the EMMS software to match the field devices.

3.5 FIELD TESTING

A. Verify complete system operation including all hardware, software and communication devices.

B. Verify LAN and device-level networking performance with all interfacing systems.

3.6 MANUFACTURER'S CERTIFICATION

A. A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations.

B. The Contractor shall provide three (3) copies of the manufacturer's representative's certification.

3.7 TRAINING

A. The contractor shall furnish the services of a manufacturer's representative for a minimum period of one (1) 8-hour day to train the owner's personnel in operation and programming of the system. The manufacturer's representative shall be factory-trained and shall have a thorough knowledge of the software, hardware and system programming. The training session shall be provided for approximately five (5) people and shall include:

1. Hands-on training of site personnel
2. Explanation of system operation
3. Explanation of devices
4. Explanation of owner's system

B. After Startup Support: The EMMS manufacturer shall provide a 24-hour 800 telephone number manned with Engineers/Technicians expert in EMMS devices, software and communication system troubleshooting or capable of providing technical information.

END OF SECTION 26 27 13

SECTION 26 27 16 – ELECTRICAL CABINETS AND ENCLOSURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This section includes the requirements for provision and installation of cabinets and enclosures.

1.3 DESCRIPTION

A. Provide and install all equipment, labor, material, accessories, and mounting hardware for a complete and operating system for the following:

1. Hinged cover enclosures.
2. Cabinets.

B. Cabinets and enclosures are to include:

1. Terminal blocks,
2. Mounting panel,
3. Ground bus/bar, and
4. All accessories as required for a complete and operating system.

C. Provide cabinets and enclosures for all systems specified in Divisions 27, 28.

1.4 REFERENCES AND REGULATORY REQUIREMENTS

A. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

B. Conform to the requirements of the following:

1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)
2. NEMA ICS 4 - Terminal Blocks
3. ANSI/NFPA 70 - National Electrical Code

1.5 SUBMITTALS

A. Submit Product Data: Provide manufacturer's standard data for enclosures and cabinets.

B. Submit Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under regulatory requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

C. Submit shop drawings on all cabinets and enclosures showing:

1. Covers.
2. Dimensions - inside and out.
3. Gauge of metal.
4. Manufacturer.
5. Terminal mounting plate, construction, etc.

6. Ground bus/bar.

1.6 EXTRA MATERIALS

A. Provide two keys for each type of lock.

PART 2 - PRODUCTS

2.1 GENERAL

A. Unless specifically called for otherwise on contract drawings, provide "CABINETS" as specified herein for terminal cabinets mounted indoor. Similarly, provide "HINGED COVER ENCLOSURES" as specified herein for terminal cabinets mounted outdoors or in locations other then NEMA 1 locations. Also, provide "HINGED COVER ENCLOSURES" for locations where size required is not available in "CABINET" construction, or if specifically specified as "enclosure" on contract documents.

B. Size.

1. Dimensions of cabinets and enclosures shall meet the dimensions shown on drawings, dimensions required by NEC, or dimensions sized as required to facilitate all equipment/connections involved installation, whichever is largest.

2. Coordinate sizes required and assure that equipment cabinets or enclosures will house and facilitate proper installation and access to equipment.

C. Provide metal barriers to separate compartments containing control wiring operating at less than 50 volts from power wiring or where wiring from separate systems of Normal and Emergency Power are required to be in one enclosure.

D. Provide accessory feet or mounting brackets for free-standing equipment.

2.2 HINGED COVER ENCLOSURES

A. Construction:

1. Interior Dry Locations: NEMA Type 1 (unless otherwise noted), steel.

2. Exterior and Interior Wet Locations: NEMA Type 4X: Stainless steel.

B. Covers: Continuous hinge.

C. Enclosure Finish:

1. NEMA 1: Manufacturer's standard metallic gray enamel over phosphatized surfaces.

2. NEMA 4X: Stainless steel.

D. Lock/handle.

1. Provide key lock handle on all enclosures mounted in areas that are not dedicated electrical or mechanical rooms. Enclosures installed in electrical rooms are not required to be lockable.

E. Interior mounting plate.

1. Each enclosure is to have interior mounting plate/panel for mounting terminal blocks and electrical components.

2. Plate/panel is to be metal.

F. Ground bus/bar.

1. Each enclosure housing surge suppression equipment or other equipment shall have "local" ground bar/bus installed. See Article "Local Ground Bus/Bar".

2.3 CABINETS

A. Construction: Specified gauge steel with removable enwalls.

B. Finish:

1. Boxes:

a) Surface mounted: Gray baked enamel.

b) Flush mounted: Galvanized steel.

2. Fronts: Gray baked enamel.

C. Fronts:

1. Electrical or Mechanical Room Locations: screw cover with hinged door and flush handle or as noted below.

2. Other Locations: Mono-flat with concealed trim clamps, concealed hinges, flush lock lockable handle, and custom color finish in interior public areas to match mounting surface.

3. Flush or surface type as shown or called for in Contract Documents.

D. Interior mounting plate.

1. Each enclosure is to have interior mounting plate/panel for mounting terminal blocks and electrical components.

2. Panel/plate shall be metal.

E. Ground bus/bar.

1. Each cabinet housing surge suppression equipment or other equipment shall have "local" ground bar/bus installed. See specification for "Local Ground Bus/Bar" included within this section.

2.4 TERMINAL BLOCKS

A. Terminal Blocks: ANSI/NEMA ICS 4.

B. Power Terminals: Unit construction type with closed back and tubular pressure screw connectors, rated 600 volts.

C. Signal and Control Terminals: Modular construction type, suitable for channel mounting, with tubular pressure screw connectors, rated 300 volts.

D. Provide ground bus terminal block, with each connector bonded to enclosure.

2.5 LOCAL GROUND BUS/BAR

A. Size to handle #6 through #14 AWG copper ground wire.

B. Length as required for circuits.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that surfaces are ready to receive work.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install enclosures and cabinets plumb. Anchor securely to wall and structural supports at each corner.

C. Install cabinet fronts plumb.

D. Install per NEC and as required for proper clearance. Coordinate with panels.

E. Provide and install terminal cabinets as shown on drawings or as required by the NEC.

F. Provide terminal cabinets wherever required for a complete and operating distribution system whether shown on drawings or not.

G. Install local ground bus/bar in each terminal cabinet/enclosure that houses surge suppression equipment or other equipment and bond to cabinet enclosure via mounting screws or #6 AWG copper ground wire.

H. Ground local ground bus to "SYSTEMS" ground bus/bar with minimum #6 AWG copper ground wire. Increase size if so required on drawings.

I. Install enclosures.

END OF SECTION 26 27 16

SECTION 26 28 16 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1- GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification sections apply to this section.

1.2 SUMMARY

A. This section includes the requirements for provision and installation of enclosed switches and circuit breakers.

1.3 DESCRIPTION

A. Provide all labor, materials, and equipment necessary to properly install switches as shown on the drawings and as required by codes.

B. Coordinate with Division 23 for disconnect switches for mechanical equipment. Provide all other disconnect switches required for a complete operating system.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver switches in factory wrapped packaging. Handle switches carefully to prevent damage. Store in a clean, dry space protected from dirt, water, and physical damage. Reject damaged switches.

1.5 QUALIFICATIONS

A. Manufacturer: Same manufacturer as that for products specified in Section 26 24 13.

1.6 SUBMITTALS

A. Submit catalog cut sheet on each type of disconnect switch to be used on this project.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Eaton/Cutler Hammer, or approved substitutions.

2.2 CONSTRUCTION

A. Switches shall be heavy-duty type with visible, quick-make, quick-break blades.

B. Units for 2-speed motors shall be 6-pole in a single enclosure. Use of 2, 3-pole units will not be acceptable.

C. Provide ground bus and where required, a solid neutral bus.

D. Switches shall be fusible or non-fusible as noted on the drawings or as required by the equipment served from the switch. Fusible switches shall have rejection type fuse holders.

E. Terminal lugs shall be rated for 75 degrees Centigrade.

F. Enclosures, unless otherwise noted, shall be:

1. Interior dry locations shall be NEMA 1.
2. Wash-down areas, interior wet locations or similar shall be NEMA 4X stainless steel watertight, corrosion resistant.
3. Exterior locations shall be NEMA 4X stainless steel watertight, corrosion resistant, including those noted on drawings to be NEMA 3, minimum.

G. The enclosure shall be interlocked with the switch handle such that the enclosure door or cover cannot be opened with the switch in the "ON" position. The switch handle shall be capable of being padlocked in the "OFF" position but not in the "ON" position.

H. Finish for NEMA I units shall be standard baked gray enamel finish over a rust inhibiting phosphate primer.

2.3 RATING

A. The size, number of poles, and fusing for each switch shall be as noted on the drawings. As a minimum, no less than one pole for each ungrounded conductor shall be provided. Switches shall be rated 250 VAC or 600 VAC as required by the circuit to which it is connected.

B. Switches serving motors with more than one set of windings shall have the number of poles necessary to disconnect all conductors to all windings in a single switch.

C. Switches serving motor loads shall be horsepower rated to match motor and of sufficient size to handle the load regardless if rating noted on drawings is provided in ampere.

2.4 SERVICE ENTRANCE EQUIPMENT

A. Switches used as service entrance equipment shall be listed and labeled by UL for use as service equipment.

2.5 FUSES

A. General:

1. All fuses shall be of the same manufacture to retain selectability as designed. No fuse shall be installed until equipment is ready to be energized and after tightening of all electrical

connections, inspection of all ground and grounding conductors and a megger test of adequate insulation to ground of all circuits.

2. All fuses shall be current limiting with 200,000 amperes interrupting capacity.
3. Fuses rated 601 amperes and larger shall be UL Class L and have a minimum time-delay of 45 seconds at 300% rating and have O-ring gas seals at the end bells.
4. Fuses rated 600 amperes or less, installed ahead of circuit breakers or circuit breaker panels, shall be UL Class K-1.
5. Fuses rated 600 amperes or less for all general power circuits shall be dual-element, UL Class RK-5 time-delay type. They shall be self protecting from extraneous heat.
6. Fuses installed in individual motor circuits shall be dual element time-delay type, UL Class RK-5. Provide fuse reducers when necessary.
7. Fuses called for to be rejection type are to have rejection fuse holders.
8. Fused disconnect switches for elevators and escalators shall have rejection fuse holders.

B. Fuse Requirements:

1. Dimensions and Performance: NEMA FU 1, Class as indicated.
2. Voltage: Rating suitable for circuit phase-to-phase voltage.
3. Power Load Feeder Switches Larger than 600 amperes: Class L (time delay).
4. Power Load Feeder Switches: Class RK1 (time delay) or RK5 (based on load).
5. Motor Load Feeder Switches: Class RK5.
6. Lighting Load Feeder Switches Larger than 600 amperes: Class L time delay.
7. Lighting Load Feeder Switches: Class RK1 (time delay).
8. Other Feeder Switches Larger than 600 amperes: Class L time delay.
9. Other Feeder Switches: Class RK1 (time delay) or RK5 (based on load).
10. Power Branch Circuits: Class RK1 (time delay) or RK5 (based on load).
11. Motor Branch Circuits: Class RK5.
12. Lighting Branch Circuits: Class G.

C. Identification Label:

1. Provide a fuse identification label inside each fused switch, showing type and size of each fuse specified or as recommended by the manufacture of the equipment served.
2. Labeling for rejection type fused switches shall read "Warning-Use Only Current Limiting Fuses Class ___, Type ___, MFR ___".

PART 3- EXECUTION

3.1 INSTALLATION

A. Install all switches in accordance with the manufacturer's written instructions, NECA's "Standard of Installation", the applicable requirements of the National Electrical Code, and recognized industry practice.

B. All switches shall be firmly anchored to walls and supporting structures (where used). Switches shall be installed with the turning axis of their handles approximately 5'-0" above finished floor unless otherwise indicated. Provide rigid steel (galvanized for exterior use) mounting stands, brackets, plates, hardware, and accessories for a complete installation.

C. Switches shall be mounted in accessible locations. Where a switch serves as the disconnecting means for a load, the switch shall be located as close as practical to the load with the switch handle within sight of the load.

D. Provide lugs on disconnect switch as required to accept conductors called for on drawings.

E. Disconnect switches shall not be mounted on equipment, unless specifically noted or required and meet all applicable codes. If switches are noted or required to be mounted on equipment they shall have vibrator clips on fuses and be connected to conduit system with liquid tight flexible conduit.

F. Coordinate all requirements for controls between variable speed drive units and its respective motor with drive specification, manufacturer, provider and installer. Provide auxiliary contacts, relays, etc. as required.

G. Install fuses in accordance with manufacturer's instructions, the NEC, and NEMA Standards.

H. Install fuse with label oriented such that manufacturer, type, and size are easily read.

I. Label each fuse.

J. Conduit or piping systems that contain water or liquid of any kind shall not be installed over the top of any electrical equipment, transformers, racks, cabinets, or enclosures without prior written approval from the Owner.

END OF SECTION 26 28 16

SECTION 26 33 53 - STATIC UNINTERRUPTIBLE POWER SUPPLY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions, Division 01, and other applicable specification sections in the Project Manual apply to the work specified in this Section.

1.2 SUMMARY

A. Scope: Provide design and engineering, labor, material, equipment, related services, and supervision required, including, but not limited to, manufacturing, fabrication, erection, and installation for a solid state uninterruptible power supply (UPS) as required for the complete performance of the work, and as shown on the Drawings and as herein specified.

B. Section Includes: The work specified in this Section includes, but shall not be limited to, a three-phase, on-line, double conversion, solid state UPS. The UPS shall operate in conjunction with the building electrical system to provide high quality power conditioning, back-up power protection, and distribution for electronic equipment loads. The system shall consist of a solid state IGBT rectifier/inverter, power factor corrected rectifier, a 100 percent rated for continuous duty static switch, battery plant, graphical status/control panel, and synchronizing circuitry as described herein.

1.3 REFERENCES

A. General: The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest date as of the date of the Contract Documents, unless otherwise specified.

B. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
1. ANSI/IEEE C62.41, "Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits" (copyrighted by IEEE, ANSI approved).

C. International Organization for Standardization (ISO):
1. ISO 9001, "Quality Management Systems - Requirements."

D. National Electrical Manufacturers Association (NEMA):
1. NEMA PE 1, " Uninterruptible Power Systems (UPS) - Specification and Performance Verification."

E. National Fire Protection Association (NFPA):
1. NFPA 70, "National Electrical Code" (copyrighted by NFPA, ANSI approved) - hereinafter referred to as NEC.

F. Underwriters Laboratories, Inc. (UL):

1. UL 1778, "Standard for Uninterruptible Power Supply Equipment" (copyrighted by UL, ANSI approved). “
2. UL 924, “Emergency Lighting and Power Equipment”
3. The UPS shall be UL and CUL listed as complete system under UL 60950 Standard for Information Technology Equipment.
4. The Specified center shall comply with the latest FCC Part 15 EMI emission limits for Class A computing devices and emission and immunity limits of EN50081-2/EN550022 Class A and EN50082-2.
5. The UPS BDC shall safely withstand without mi-operation or damage.

1.4 SYSTEM DESCRIPTION

A. UPS Design Requirements:

1. Output Power Continuous Rating: The continuous output power rating of the UPS at a 0.9 lagging power factor shall be as called for on drawings.

2. Field-Powered Upgrade: The following power ratings may be upgraded in the field to provide more output power with no increase in footprint:
   a. 100 kVA/90 kW UPS modules shall be capable of an upgrade to 130 kVA/117 kW.

3. Input Current: See chart on drawings.

4. Output Current: See chart on drawings.

5. Battery Autonomy: UPS shall be capable of operating at full load for 30 minutes at 0.9 PF output at a temperature of 77 °F (25 °C) on battery power.
6. Battery Type: Valve regulated sealed lead acid (VRLA).

B. AC Input Characteristics:

1. Voltage: 480 volts AC, -15 percent +10 percent, three-phase, 3 wires, grounded wye, configuration plus ground.
2. Frequency: 60 hertz, ±5 percent.
3. Power Factor: Greater than 0.98 lagging.
4. Total Harmonic Distortion: Less than 5 percent at full load.
5. Inrush Current: Less than nominal input current for less than one cycle.
6. Input Surge Protection: UPS shall be equipped to withstand surges per ANSI/IEEE C62.41.

C. AC Output Characteristics:

1. Voltage: 120/208 volts AC, ±1 percent steady state variation phase-to-phase voltage volts AC, three-phase, 3 wires plus ground. 4 wire output shall be available through provided transformer with breaker(s) provided on output, sized per drawings and built into UPS at factory.
2. Frequency: 60 hertz, ±1.0 percent (or selectable up to 4 percent); 60 hertz, ±0.1 percent when free running.
3. Voltage Regulation: ±1.0 percent for balanced load, ±1.75 percent for 50 percent unbalanced load, ±2.5 percent for 100 percent unbalanced load.
4. Voltage Distortion: Maximum 2 percent total (THD) and 1 percent any single harmonic on 100 percent linear loads.
5. Voltage Transient (Step Load) Response: ±2 percent for load step changes from 100 percent to 0 and from 0 to 100 percent. The system returns to the ±1 percent range in rms value in less than 100 ms.
6. Voltage Recovery Time: Return to within 1 percent of nominal value within 16.67 milliseconds (one cycle).
7. Phase Angle Displacement: 120 degrees, +1 degree for balanced load; 120 degrees, +3 degrees for 100 percent unbalanced load.
8. Non-Linear Load Capability: Output voltage total harmonic distortion shall be less than 3 percent when connected to a 100 percent non-linear load with a crest factor not to exceed 3 percent.
9. Slew Rate: 1.0 hertz/second maximum (or selectable up to 2.0 hertz/second).
10. Power Factor: 0.9 at the rated volt amperes (VA).
11. Inverter Overload Capability: 125 percent of rated load for 10 minutes, 150 percent of rated load for 1 minute.
12. Bypass Overload Capability: Greater than 212 percent for one cycle; greater than 150 percent for 1 minute.

D. Battery:

1. Type: Value regulated lead acid (VRLA)
2. Battery Voltage: 356 volts DC minimum before cutoff; 432 volts DC nominal; 490 volts DC equalization voltage.
3. Maximum DC Current: Maximum DC current at cutoff voltage shall be as recommended by battery manufacturer.
4. The battery charger is equipped with a temperature probe to enable temperature compensated charging.
5. Bypass Input Breaker (BIB)
   a. The UPS shall be equipped with a bypass input circuit breaker to provide overcurrent protection and a means for disconnecting all power to the input of the UPS. The bypass input breaker shall be a thermal-magnetic three-pole molded case circuit breaker sized for 125% of the specified full load input current plus recharge current and rated for 600 VAC. The minimum UL-listed interrupting rating for the main input circuit breaker shall be 65,000 RMS symmetrical amperes at 480 volts AC for 480V UPS and 22,000 symmetrical amperes at 208 volts AC for 208V UPS.
6. Maintenance Bypass:
   a. The UPS shall be equipped with a make-before-break maintenance bypass with key interlock system. Thermal-magnetic three-pole molded case circuit breakers shall be provided for maintenance bypass (MBB) and for maintenance isolation (MIB). Each circuit breaker shall have an interrupting rating of 65,000 RMS symmetrical amperes at 480 volts AC for 480V UPS and 22,000 RMS symmetrical amperes at 208 volts AC for 208V UPS.

1.5 SUBMITTALS

A. General: See General Conditions of these specifications, Div 0 and1
B. Product Data: Submit product data showing material proposed. Submit sufficient information to determine compliance with the Drawings and Specifications. Product data shall include, but shall not be limited to, the following:

1. Catalog sheets and technical data sheets to indicate physical data and electrical performance, electrical characteristics, and connection requirements.
2. Manufacturer's installation instructions indicating application conditions and limitations of use stipulated by product inspecting and testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of the product. Include equipment installation outline, connection diagram for external cabling, internal wiring diagram, and written instruction for installation.

C. Shop Drawings: Submit shop drawings for each product and accessory required. Include information not fully detailed in manufacturer's standard product data, including, but not limited to, complete electrical characteristics and connection requirements. Provide detailed equipment outlines with cabinet dimensions and spacing requirements; location of conduit entry/exit paths; location of floor/seismic mounting; available battery types/sizes; cabinet weights; heat rejection and air flow requirements; single-line diagram; and control and external wiring.

D. Wiring Diagrams: Submit wiring diagrams detailing power, signal, and control systems, clearly differentiating between manufacturer-installed wiring and field-installed wiring, and between components provided by the manufacturer and those provided by others.

E. Contract Closeout Submittals:

1. Project Record Documents: Submit a complete set of installation drawings showing all the information specified elsewhere in this Section.
2. Operation and Maintenance Data: Submit operation and maintenance data to include in operation and maintenance manuals specified in Division 01 - GENERAL

REQUIREMENTS, including, but not limited to, safe and correct operation of UPS functions.

1.6 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer Qualifications: Manufacturer shall be a firm engaged in the manufacture of solid state UPS of types and sizes required, and whose products have been in satisfactory use in similar service for a minimum of 20 years.
   a. The manufacturer shall be ISO 9001 certified and shall be designed to internationally accepted standards.
2. Installer Qualifications: Installer shall be a firm that shall have a minimum of five years of successful installation experience with projects utilizing solid state UPS similar in type and scope to that required for this Project.

B. Regulatory Requirements: Comply with applicable requirements of the laws, codes, ordinances, and regulations of Federal, State, and local authorities having jurisdiction. Obtain necessary approvals from such authorities.

1. The UPS shall meet the requirements of the following standards:
   a. UL-listed under UL 1778.
   b. UL Canada (cUL).
   c. FCC rules and regulations of Part 15, Subpart J, Class A.
   d. ANSI/IEEE C62.41.
   e. ISO 9001.

2. The UPS shall be designed in accordance with the applicable sections of the documents published by:
   a. National Fire Protection Association (NFPA); NEC.
   b. National Electrical Manufacturers Association (NEMA); NEMA PE 1.
   c. Occupational Safety and Health Administration (OSHA).

C. Factory Testing: Prior to shipment the manufacturer shall complete a documented test procedure to test functions of the UPS module and batteries (via a discharge test), when supplied by the UPS manufacturer, and warrant compliance with this Section. The factory test shall be performed in the presence of the Owner providing the manufacturer receives adequate prior notice. The manufacturer shall provide a copy of the test report upon request.

D. Pre-Installation Conference: Conduct pre-installation conference in accordance with all the requirements of these specifications, including Div 0 and 1. Prior to commencing the installation, meet at the Project site to review the material selections, installation procedures, and coordination with other trades. Pre-installation conference shall include, but shall not be limited to, the Contractor, the Installer, and any trade that requires coordination with the work. Date and time of the pre-installation conference shall be acceptable to the Owner's Authorized Representative (OAR).

E. Source Responsibility: Materials and parts comprising the UPS shall be new, of current manufacture, and shall not have been in prior service, except as required during factory testing. Active electronic devices shall be solid state and shall not exceed the manufacturer’s recommended tolerances for temperature or current to ensure maximum reliability. Semiconductor devices shall be sealed. Relays shall be provided with dust covers. The manufacturer shall conduct inspections on incoming parts, modular assemblies, and final products.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the Project site in supplier's or manufacturer's original wrappings and containers, labeled with supplier's or manufacturer's name, material or product brand name, and lot number, if any.

B. Store materials in their original, undamaged packages and containers, inside a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

C. Products shall be packaged in a manner to prevent penetration by debris and to allow safe delivery by modes of ground transportation and air transportation where specified.

D. Prior to shipping, products shall be inspected at the factory for damage.

E. Equipment shall be protected against extreme temperature and humidity and shall be stored in a conditioned or protected environment.

F. Equipment containing batteries shall not be stored for a period exceeding three months without powering up the equipment for a period of eight hours to recharge the batteries.

1.8 PROJECT CONDITIONS

A. Environmental Requirements: Do not install solid state UPS until space is enclosed and weatherproof, wet work in space is completed and nominally dry, work above ceilings is complete, and ambient temperature and humidity conditions are and will be continuously maintained at values near those indicated for final occupancy.

1. The UPS shall operate under the following environmental conditions:
   a. Temperature:
      1) UPS Module Operating: 32 °F (0 °C) to 104 °F (40 °C).
      2) Non-Operating: -4 °F (-20 °C) to 113 °F (45 °C).
   b. Relative Humidity (Operating and Storage): 0 percent to 95 percent non-condensing.
   c. Barometric Pressure: Up to 3281 feet (1000 meters) above sea level (up to 6562 feet [2000 meters] with ambient temperature less than 82 °F [28 °C]) / up to 39,370 feet (12,000 meters) above sea level non-operating.
   d. Audible Noise: 69 dBA at 3 feet (914 mm).

1.9 WARRANTY

A. General: See General Conditions of these specifications, Div 0 and1.

B. Special Warranty: The Contractor shall warrant the work of this Section to be in accordance with the Contract Documents and free from faults and defects in materials and workmanship for period indicated below. This special warranty shall extend the one year period of limitations contained in the General Conditions. The special warranty shall be countersigned by the Installer and the manufacturer.

1. UPS Module: The UPS shall be covered by a full parts and labor warranty from the manufacturer for a period of 12 months from date of installation or acceptance by the Owner or 18 months from date of shipment from the manufacturer, whichever occurs first.
2. Battery: The battery manufacturer's warranty shall be passed through to the final Owner and shall have a minimum period of one year.

C. Additional Owner Rights: The warranty shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to and run concurrent with other warranties made by the Contractor under requirements of the Contract Documents.

1.10 MAINTENANCE

A. The manufacturer shall, upon request, provide spare parts kits for the UPS module in a timely manner as well as provide access to qualified factory-trained first party service personnel to provide preventative maintenance and service on the UPS module when required.

B. UPS subassemblies, as well as the battery, shall be accessible from the front. UPS design shall provide maximum reliability and minimum MTTR (mean time to repair). To that end, the UPS shall be equipped with a self-test function to verify correct system operation. The self-test function shall identify the subassembly requiring repair in the event of a fault. The electronic UPS control and monitoring assembly shall therefore be fully microprocessor-based, thus doing away with potentiometer settings. This shall allow:

1. Auto-compensation of component drift.
2. Self-adjustment of replaced subassemblies.
3. Extensive acquisition of information vital for computer-aided diagnostics (local or remote).
4. Socket connection to interface with computer-aided diagnostics system.

C. The UPS shall be repairable by replacing standard subassemblies requiring no adjustments. Communication via a modem with a remote maintenance system shall be possible.

D. The manufacturer shall offer additional preventative maintenance and service contracts covering both the UPS and the battery bank. Accredited professional service engineers employed exclusively in the field of critical power systems service shall perform maintenance and service. The manufacturer shall also offer extended warranty contracts.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: Product specified is “MGE Galaxy 5000” as manufactured by APC by Schneider Electric unless specifically noted otherwise in drawings. Items specified are to establish a standard of quality for design, function, materials, and appearance. Equivalent products by other manufacturers are acceptable. The OAR will be the sole judge of the basis of what is equivalent.
B. Approved Substitutions: Liebert, Powerware

2.2 MODES OF OPERATION

A. UPS module shall be designed to operate as a double conversion, on-line reverse transfer system in the following modes.

1. Normal: The inverter shall continuously supply power to the critical load. The PFC rectifier shall derive power from the utility AC source and supply DC power to the inverter while simultaneously float charging the battery.
2. Emergency: Upon failure of the utility AC power source, the critical load shall be supplied by the inverter, which, without any interruption, shall obtain its power from the battery.
3. Recharge: Upon restoration of the utility AC power source (prior to complete battery discharge), the PFC rectifier shall power the inverter and simultaneously recharge the battery.
4. Bypass Mode: The static bypass transfer switch shall be used to transfer the load to the bypass without interruption to the critical power load. This shall be accomplished by turning the inverter off. Automatic re-transfer or forward transfer of the load shall be accomplished by turning the inverter on.
5. Internal Mechanical Bypass: As a standard feature, the UPS shall be equipped with an internal, make-before-break, bypass switch. This switch shall mechanically bypass the UPS for times where maintenance is required.

2.3 COMPONENT DESCRIPTION

A. PFC Rectifier and Battery Charger: Incoming AC power shall be converted to a regulated DC output voltage by an IGBT (insulated gate bipolar transistor) power factor correction (PFC) rectifier. The PFC rectifier shall provide high quality DC power to charge the batteries and power the inverter and shall have the following characteristics:

1. Input Power Factor Correction (PFC): The PFC rectifier shall be power factor corrected so as to maintain an input power factor of 0.98 lagging to unity at 75 percent or above load levels to ensure generator compatibility and avoid reflected harmonics from disturbing loads sharing the utility power.
2. Input Harmonic Current Suppression: The PFC rectifier shall produce a sinusoidal input AC current on each phase with low harmonic content, limiting THD on the UPS input to below 5 percent.
3. Battery Charger Current Limiting: The UPS shall be equipped with a system designed to limit the battery recharge current (from 0.05 C10 to 0.1 C10).
4. Charging Levels: The battery charging circuitry shall be capable of being set for automatic battery recharge operation, float service, manual battery charge service, and equalizing or commissioning operation.
5. Intermittent Charging: The battery charge level shall be maintained by an intermittent charging technique between two values Vfmin and Vfmax very close to the floating voltage. This technique shall be based on a cycle made up of a short charge period (a few seconds) from Vfmin to Vfmax followed automatically by a slow discharge period (a few minutes) from Vfmax to Vfmin. This cycle shall be repeated continuously to maintain the battery charge level. In this way the battery shall actually be charging only for a small part of the time, which shall considerably increase its service life.
6. Temperature Compensated Charging: The battery charger shall be equipped with a temperature probe to enable temperature compensated charging and shall adjust the battery float voltage to compensate for the ambient temperature using a negative temperature coefficient of 3 mV per cell per degree Celsius at a nominal temperature of 25 °C.
7. Battery Capacity: The battery charger shall have sufficient capacity to support a fully loaded inverter and shall fully recharge the battery to 95 percent of its full capacity within 6 to 8 hours up to four battery cabinets.

B. Inverter: The UPS output shall be derived from a variable frequency Pulse Width Modulated (PWM) IGBT inverter design. The inverter shall be capable of providing the specified precise output power characteristics while operating over the battery voltage range.

C. Static Bypass - 100 Percent Rated, Continuous Duty: The static bypass transfer switch shall be solid state, rated for 100 percent continuous duty without mechanical contactor device in parallel for higher reliability and consistent response time and shall operate under the following conditions:

1. Uninterrupted Transfer: The static bypass transfer switch shall automatically cause the bypass source to assume the critical load without interruption after the logic senses one of the following conditions:

   a. Inverter overload exceeds unit's rating.
   b. Battery protection period expired and bypass current is available.
   c. Inverter failure.

2. Interrupted Transfer: If the bypass source is beyond the conditions stated below, the UPS shall make an interrupted transfer (not less than 100 milliseconds in duration).

   a. Bypass voltage greater than +10 percent, -10 percent from the UPS rated output voltage.
   b. Bypass frequency greater than ±2 hertz from the UPS rated output frequency.

3. Automatic Uninterrupted Forward Transfer: The static bypass transfer switch shall automatically forward transfer power, without interruption, after the UPS inverter is turned on after an instantaneous overload-induced reverse transfer has occurred and the load current returns the UPS's nominal rating or less.

4. Manual Transfer: A manual static transfer shall be initiated from the UPS control panel by turning the UPS inverter off.

5. Overload Ratings: The static bypass transfer switch shall have the following overload characteristics:

   a. 1000 percent of UPS output rating for 0.016 seconds (one cycle).
   b. 150 percent for 1 second.
   c. 125 percent of UPS for 1 minute.

D. Output Static Switch - 100 percent Rated, Continuous Duty: UPS output shall be equipped with a 100 percent rated output static switch without mechanical contactor device in parallel for higher reliability and consistent response time of 16.66 milliseconds.

2.4 SYSTEM CONTROLS AND INDICATORS

A. Microprocessor-Controlled Logic:

1. The full UPS operation shall be provided through the use of microprocessor-controlled logic. Operation and parameters shall be firmware-controlled, thus eliminating the need for manual adjustments or potentiometers. The logic shall include, but shall not be limited to, a self-test and diagnostic circuitry such that a fault shall be isolated down to the printed circuit assembly or plug-in power assembly level. Every printed circuit assembly or plug-in power assembly shall be monitored. Diagnostics shall be performed via a PC through the local diagnostics port on the UPS. UPS shall be microprocessor-controlled.

2. The UPS shall include, but shall not be limited to, a standard easy-to-use control and indicator panel. Included shall be a backlit, color graphic animated LCD display and LED indicators. The UPS panel shall include, but shall not be limited to, UPS on and UPS off pushbuttons that shall permit the Owner to safely command the UPS on or off without risk of load loss.

3. Display shall facilitate operation by offering the functions listed below:

   a. Operating information supplied on the screens.
   b. The graphic display shall assist the Owner by providing step-by-step help in the Owner's language.
   c. LED mimic diagram. The mimic diagram shall enable display of installation parameters, configuration, operating status and alarms and indication of operator instructions for switching operations (i.e., bypass).
   d. It shall be possible to display the following measurements:

      1) Inverter output phase-to-phase voltages.
      2) Inverter output currents.
      3) Inverter output frequency.
      4) Voltage across battery bank.
      5) Battery charge or discharge current.
      6) Rectifier/charger input phase-to-phase voltages.
      7) Rectifier/charger input currents.
      8) Active and apparent power.
      9) Power factor of the load.

10) Battery temperature.
11) Display of status conditions and events.

e. It shall be possible to display the following indications:
1) Load on battery power.
2) Load on UPS.
3) Load on automatic bypass.
4) General alarm.
5) Battery fault.
6) Remaining battery backup time.
7) Low battery warning.
8) Bypass AC source outside tolerances.

f. Additional information shall be provided in view of accelerating servicing of the system.
g. Log of time-stamped events. This function shall store in memory and make available, for automatic or manually initiated recall, time-stamped logs of important status changes, faults, and malfunctions, complete with an analysis and display of troubleshooting procedures. It shall be possible to time stamp and store at least 2000 events.

B. Front Panel LCD Display: The UPS control panel shall provide a backlit, color graphic display with choice of over 15 operating languages for indication of UPS status, metering, battery status, alarm/event log, and advanced operational features.

1. Access: The display shall provide access to:
a. Mimic diagram indicating UPS power flow.
b. Measurements, status indications, and events.
c. Personalization menu protected by a password, used to make specific settings.
d. Event log with time stamping.
e. Access to measurements.

2. System Parameters Monitored: The visual display shall display the following system parameters based on true RMS metering:
a. Measurements:
1) Input voltage (Ph-Ph).
2) Input current per phase.
3) Bypass voltage.
4) Bypass input frequency.
5) UPS output voltage (Ph-Ph and Ph-N).
6) UPS output current per phase.
7) UPS output frequency.
8) UPS output percent load.
9) UPS output kVA.
10) UPS output power factor.
11) Battery voltage.
12) Crest factor.
13) Battery current.
14) Battery backup time and remaining service life.

b. Status Indications and Events:
1) Load on battery.
2) Load on UPS.
3) Load on automatic bypass.
4) Low battery warning.
5) General alarm.
6) Battery fault.
7) Remaining back-up time during operation on battery power.
8) Bypass source outside tolerances.

9) Additional indications shall provide maintenance assistance.

3. Time-Stamped Historical Events: This function shall time stamp and store important status changes, anomalies, and faults and make this information available for automatic or Owner-requested consultation.

C. LED Status Indicators: The UPS control panel shall provide three LEDs that shall signal the following status conditions:

1. Green LED: Load protected.
2. Yellow LED: Minor fault.
3. Red LED: Major fault, load not protected.

D. On/Off Switch: The UPS shall provide the on and off buttons to start and stop the inverter. The switch shall provide a built-in time delay to eliminate the risk of inadvertent operation (additional confirmation shall be requested). It shall be possible to remotely activate the off function via an isolated dry contact to create an emergency power off function, resulting in:

1. Inverter shutdown.
2. Opening of the automatic bypass.
3. Opening of the input, bypass, output, and battery switches/circuit breakers.
4. Opening of the isolated dry contact on the programmable relay card.

E. Audible Alarm Reset: The UPS shall provide an audible alarm that can be stopped using the user interface. If a new alarm is sensed after the original alarm has been silenced, it shall reactivate the audible alarm.

F. Emergency Power Off (EPO): The UPS shall be equipped with provisions for remote emergency power off and dry contact input that shall be used to command UPS shutdown remotely. Activation of this command shall lead to the following actions:

1. Inverter shutdown.
2. Opening of the static bypass switch and the battery circuit breaker.
3. Opening of an isolated dry contact on the programmable relay board.
4. Provide and locate EPO at door into room.

G. DB-9 Connector: One DB-9 connector with serial output shall be provided for field diagnostics.

H. Dry Contacts: The UPS shall be provided standard with a programmable input/output relay board. This board shall have eight dry contacts (i.e., six for input signals and two for output signals).

1. Contacts shall be programmed as:
   a. UPS on-line.
   b. Load on bypass.
   c. UPS on battery.
   d. UPS battery low.
   e. General alarm.
   f. Battery fault.
   g. Remote UPS on (input).
   h. Remote UPS off (input).

2. The contacts shall be normally open and shall change state to indicate the operating status. The contacts shall be rated at 2.0 amperes (250 volts AC/30 volts DC).

2.5 MECHANICAL DESIGN AND VENTILATION

A. Enclosure: The UPS shall be housed in a freestanding enclosure with dead front construction. The mechanical structure of the UPS shall be sufficiently strong and rigid to withstand handling and installation operations without risk. The sheet metal elements in the structure shall be protected against corrosion by a suitable treatment, such as zinc electroplating, bi-chromating, epoxy paint, or an equivalent.

B. Cable Access: The standard UPS available shall accommodate bottom entry cables (top entry shall be optional).

C. Cabinet Weights and Dimensions: See chart on drawings.

D. Ventilation and Heat Rejection: The UPS shall be designed for forced air cooling. Air inlets shall be provided from the front bottom of the UPS enclosure. Air exhaust shall be from the top portion of the unit.

2.6 BATTERY

A. General: The UPS module shall use a valve-regulated sealed lead acid heavy duty industrial battery, designed for auxiliary power service in an UPS application. The primary battery shall be furnished with impact-resistant plastic cases and housed in a matching cabinet(s) next to the UPS module.

B. Protection against Deep Discharge and Self-Discharge: The UPS shall be equipped with a device designed to protect the battery against deep discharge, depending on discharge conditions, with isolation of the battery by a circuit breaker. In particular, a monitoring device shall adjust the battery shutdown voltage as a function of a discharge coefficient to avoid excessive discharge at less than the rated output. A second device shall avoid self-discharge of the battery into the UPS control circuits during an extended shutdown of the UPS (over two hours).

C. Battery Self-Tests:

1. The battery monitoring system shall be able to perform the following automatic functions:
   a. Battery circuit checks every 12 hours.
   b. Open circuit battery test once a month.
   c. Partial discharge test every three months.
2. This self-test system shall signal faults via LEDs on the front panel and report to building EMMS system (Power Xpert by Eaton) for alarm.

2.7 ACCESSORIES

A. Remote Alarm Status Panel (RASP): A wall-mounted panel, 17.5 inches (445 mm) high by 12 inches (305 mm) wide by 4 inches (102 mm) deep, with eight indicating LED's shall display UPS status and any active alarms. The alarms shall be a latching type, such that if an alarm is triggered, the LED shall stay on (latch) even if the alarm is corrected. This feature shall provide the operator the chance to verify the occurrence of the alarm.

1. The parameters monitored and controls provided on the RASP shall include, but shall not be limited to, the following:
   a. UPS on-line (green LED).
   b. UPS on battery (yellow LED).
   c. Load on bypass (yellow LED).
   d. UPS summary alarm (red LED).
   e. Low battery shutdown.

2. The RASP shall also be equipped with:
   a. Alarm test/reset pushbutton (white LED) to reset the latching alarm.
   b. Audible alarm for alarm annunciation.

c. Audible alarm reset pushbutton (white LED) to silence the audible alarm.

3. The RASP door shall be equipped with a key lock. The recommended maximum distance from the UPS module shall be 500 feet (152 m).
4. Locate/mount at location as directed in the field by OAR..

B. Top Entry Cabinet: 16 inch (406 mm) cabinet shall allow cable entry to UPS unit when MBC or transformer cabinets are not selected.

C. Transformer Cabinet: Provide single or dual K20 transformer, 480volts to 120/208 volts, 3 phase. Top entry power cables to the UPS to be achieved via these cabinets.

D. Provide remote monitoring, a RS-485 port that includes Modbus RTU protocol.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine areas and conditions under which the work is to be installed, and notify the Contractor in writing, with a copy to the Owner and the OAR, of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.
1. Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.

3.2 INSTALLATION

A. Preparation and installation shall be in accordance with reviewed product data, final shop drawings, manufacturer's written recommendations, and as indicated on the Drawings.

3.3 FIELD QUALITY CONTROL

A. General: See Section 01 78 00 closeout submittals and 01 78 10 warranties.

B. Field Service Engineer Qualifications: The manufacturer shall employ a 7 x 24 nationwide (international where applicable) field service organization with rapid access to all regions of the nation. The responding service professionals shall be factory-trained engineers with an accredited and proven competence to service three-phase UPS.

C. Spare Parts: Field Engineers shall have immediate access to recommended spare parts with additional parts storage located in regional depots. Additional spare parts shall be accessible on a 7 x 24 basis from the national depot and shall be expedited on a next available flight basis or via direct courier (whichever mode is quickest).

3.4 DEMONSTRATION

A. Provide the services of a factory-authorized service representative of the manufacturer to provide start-up service and to demonstrate and train the Owner's personnel.
1. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
2. Train the Owner's maintenance personnel on procedures and schedules related to start-up and shutdown, troubleshooting, servicing, and preventive maintenance.
3. Review data in operation and maintenance manuals with the Owner's personnel.
4. Schedule training with the OAR, with at least seven day's advanced notice.

B. See 01 79 00 Demonstration and training for additional requirements.

3.5 PROTECTION

A. Provide final protection and maintain conditions in a manner acceptable to the Installer, which shall ensure that the solid state UPS shall be without damage at time of Substantial Completion.

END OF SECTION 26 33 53

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SECTION 26 36 16 - MAINTENANCE BYPASS SWITCHES

PART 1- GENERAL

1.1 SCOPE

A. Furnish and install the low voltage manual bypass switches having the ratings, features/accessories and enclosures as specified herein and as shown on the contract drawings.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specifications sections apply to this section.

1.3 REFERENCES

A. The manual bypass switches and all components shall be designed, manufactured and tested in accordance with the latest applicable standards of UL and NEMA as follows:

1. UL 1008 – Transfer Switches
2. UL 991
3. NFPA 70 – National Electrical Code
4. NFPA 110 – Emergency and Standby Power Systems
5. NEMA ICS 10 – AC Transfer Switch Equipment
6. IEEE 446 – Recommended Practice for Emergency and Standby Power Systems
7. IEC 801-2, 3, 4, and 5
8. CISPR 11
9. Compliant with FCC Part 15, Subpart B, Class A.

1.4 DESCRIPTION

A. Manual Bypass switches shall be capable of switching all classes of load, and shall be rated for continuous duty when installed in a non-ventilated enclosure.

B. Bypass switches shall be a true four (4) pole type. Normal and emergency full load current and voltage ratings at 60 cycles shall be as shown on plans.

1.5 SUBMITTALS

A. Product Data: Provide catalog sheets showing voltage, switch size, ratings and size of switching and overcurrent protective devices, operating logic, short circuit ratings, dimensions, and enclosure details.

B. Submit shop drawings and product data clearly indicating:

1. All applicable options and accessories

a. Master drawing index
b. Front view and plan view of the assembly
c. Schematic diagram
d. Nameplate schedule
e. Component list
f. Conduit space locations within the assembly.
g. Assembly ratings including:

1) Short-circuit rating
2) Voltage
3) Continuous current rating.

2. Major component ratings including:

a. Voltage
b. Continuous current rating
c. Interrupting ratings
d. Cable terminal sizes and quantity
e. Product Data Sheets.
f. Delivery, storage and handling instructions.

3. Where applicable, the following additional information shall be submitted to the OAR:

a. Busway connection
b. Connection details between close-coupled assemblies
c. Composite front view and plan view of close-coupled assemblies
d. Key interlock schematic drawing and sequence of operations

4. The following information shall be submitted for record purposes:

a. Final as-built drawings and information for items listed in section 1.4
b. Wiring diagrams
c. Certified production test reports
d. Installation information

5. The final (as-built) drawings shall include the same drawings as the construction drawings and shall incorporate all changes made during the manufacturing process.

6. Submittals and record drawings shall be submitted to the Project Manager.

C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under regulatory requirements. Include instructions for storage, handling, protection, examination, preparation, installation and starting of product.

1.6 FIELD MEASUREMENTS

A. Verify that field measurements are as indicated on drawings and as instructed by manufacturer.

1.7 OPERATION AND MAINTENANCE DATA

A. Operation Data:

1. Provide detailed instructions for operating equipment.
2. Include instructions for operating equipment under emergency conditions, including when engine generator is running.

B. Maintenance Data:

1. Provide routine preventative maintenance and lubrication schedule.
2. List special tools, maintenance materials, and replacement parts.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with a minimum of ten years of experience.

B. When requested by the OAR, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

C. Supplier: Authorized distributor of specified manufacturer with a minimum of three years of experience.

1.9 REFERENCES AND REGULATORY REQUIREMENTS

A. Furnish products listed and classified by UL as suitable for purpose specified and indicated.

B. Provide a certificate of compliance with UL 1008 for the manual bypass switches furnished under this section.

C. Conform to the requirements of the following:

1. NFPA 70 - National Electrical Code.
2. NEMA ICS 1 - General Standards for Industrial Control and Systems.
3. NEMA ICS 2 - Standards for Industrial Control Devices, Controllers and Assemblies.
4. NEMA ICS 6 - Enclosures for Industrial Controls and Systems.

1.10 QUALITY ASSURANCE/TESTS

A. When conducting temperature rise tests to paragraph 99 of UL-1008 the manufacturer shall include post-endurance temperature rise tests to verify the ability of the manual switch to carry full rated current after completing the overload and endurance tests.

B. The switch shall meet or exceed the voltage surge withstand capability in accordance with IEEE Standard 472-1974 and the impulse withstand voltage test in accordance with NEMA Standard ICS 1-109.

1.11 DELIVERY, STORAGE AND HANDLING

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris and traffic.

B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to internal components, enclosure and finish.

1.12 FIELD MEASUREMENTS

A. Verify that field measurements are as indicated on drawings and as instructed by manufacturer.

1.13 MAINTENANCE SERVICE

A. Furnish service and maintenance of manual switch for one year from Date of Substantial Completion.

1.14 MAINTENANCE MATERIALS

A. Provide two of each special tool required for maintenance.

1.15 OPERATION AND MAINTENANCE MANUALS

A. Equipment operation and maintenance manuals shall be provided with each assembly shipped, and shall include instruction leaflets and instruction bulletins for the complete assembly and each major component. These manuals shall be incorporated into the O & M manuals submitted to the OAR.

1.16 EXTRA PRODUCTS

A. Furnish and install all incidentals and appurtenances required for a complete and fully operational system to the satisfaction of the OAR. Line and load terminals shall be capable of accepting the quantity and size of conductors as specified on the plans.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Russelectric (basis of design).

B. Eaton Cutler-Hammer (Contactor type only)

C. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. The manufacturer listed above is not relieved from meeting these specifications in their entirety. Equivalent products determined by the OAR to be in full compliance with the specification may be acceptable.

2.2 GENERAL

A. The manual maintenance bypass switch shall be double throw, actuated by two electrical operators, momentarily energized and connected to the transfer mechanism by a simple over center linkage with time delay relays to control contact transition time on transfer to either source, adjustable 0-300 seconds. Time delay between the opening of the closed contacts and the closing of the open contacts shall be adjusted to allow for voltage decay before transfer as required to allow re-energization of motor and transformer loads at normal in rush currents.

B. The manual switch shall be capable of transferring successfully in either direction with 70% of the rated voltage applied to the switch terminals. The normal and emergency contacts shall be positively interlocked mechanically and electrically to prevent simultaneous closing. Main contacts shall be mechanically locked in position in both the normal and emergency positions without the use of hooks, latches, magnet, or springs and shall be silver-tungsten alloy protected by arcing contacts, with magnetic blowouts on each pole. Parallel main contacts are not acceptable.

C. The transfer switch shall be equipped with a safe manual operator designed to be operated in the loaded condition and to prevent injury to operating personnel. The manual operator shall provide the same contact-to-contact transfer speed as the electrical operator to prevent a flashover from switching the main contacts slowly. Manual operator shall be usable with the front door of the MTS closed for maximum personnel protection.

D. Elevator pre-transfer contacts shall be provided to signal the elevators that a power source transfer is about to take place. When the door mounted push button is depressed to signal the MTS to transfer to the secondary source, a timer shall be activated that will delay the actual transfer until the timer had expired (based on the adjustable timer setpoint entered) and only then allowing the transfer to complete. Likewise, when the button is depressed to signal the MTS to return to its normal source, a timer shall be activated that will delay the actual transfer until that time has expired (base on the adjustable timer setpoint entered) and only then allowing the transfer to complete. Timers shall be adjustable from 0-30 seconds, air diaphragm type.

E. The manual switch shall be UL listed for withstand and close-in values at least equal to the interrupting rating of the circuit breaker and/or fuse that is specified to protect the circuit, and available short circuit amps from either source, but in no case less than 65,000 amperes symmetrical for 3 cycles.

F. Switch maximum dimensions shall be as shown on drawings.

2.3 CONSTRUCTION

A. The switching panel shall consist of completely enclosed contact assemblies and a separate control logic panel. Control power for all transfer operations shall be derived from the line side of the source to which the load is being transferred.

B. Each manual switch shall be positively interlocked both mechanically and electrically to prevent simultaneous closing of both sources under manual operation. Main contacts shall be mechanically locked in position in both normal and emergency positions. A delayed neutral position shall be possible for switching highly inductive loads. Timers shall be furnished to set the duration of the neutral position delay.

C. Switches shall be capable of being operated manually under full rated load conditions. In addition to the push button initiated electrical operation, Manual operation shall be accomplished by a permanently attached or removable manual operator. The operation of the manual handle shall be possible with the front door of the MTS CLOSED to maximize safety to personnel. Manual operators requiring source or load disconnection prior to manual operation are not acceptable.

2.4 OPERATOR CONTROLS

A. The front of the MTS shall have a pushbutton to initiate transfer to either source.

B. A backlit LED annunciator panel shall be located above the pushbuttons to show:

1. Source 1 available
2. Source 1 connected
3. Source 2 available
4. Source 2 connected

2.5 WIRING/TERMINATIONS

A. Terminal blocks shall conform to NEMA ICS 4. Terminal facilities shall be arranged for entrance of external conductors from the top or bottom of the enclosure. The automatic transfer switch terminals shall be suitable for the termination of conductors shown on the plans.

2.6 RATINGS

A. The Manual Maintenance Bypass switches shall have equal withstand, closing and interrupting ratings as noted below, 3 cycle “any breaker rating.” Series ratings are NOT acceptable. The automatic transfer switches shall be service rated for continuous duty. Unless shown otherwise on the plans and drawings, the minimum withstand rating shall be as follows:

100 – 800 amp	65,000 amps symmetrical
1000 – 1200 amp	85,000 amps symmetrical
1600 – 4000 amp	100,000 amps symmetrical

B. The voltage rating of the switches shall be no less than the system voltage rating. The continuous current rating of the switches shall be no less than the maximum continuous current requirements of the system.

C. The switches shall be fully rated to operate all types of loads, inductive and resistive, from loss of continuity of power, without derating, either open or enclosed.

2.7 ENCLOSURE

A. Enclosure: ICS 6, Type 1.

B. Finish: Manufacturer’s standard gray enamel.

C. NEMA 1 unless shown otherwise on the project drawings.

PART 3 - EXECUTION

3.1 FACTORY TESTING

A. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of UL and NEMA standards.

B. Insulation check to ensure the integrity of insulation and continuity of the entire system.

C. Visual inspection to ensure that the switch matches the specification requirements and to verify that the fit and finish meet quality standards

D. Mechanical tests to verify that the switch's power sections are free of mechanical hindrances.

E. Electrical tests to verify the complete electrical operation of the switch and to set up time delays and voltage sensing settings of the logic

F. The manufacturer shall provide six (6) certified copies of factory test reports.

3.2 FIELD QUALITY CONTROL

A. Provide the services of a qualified factory-trained manufacturer’s representative to assist the contractor in installation and start-up of the equipment specified under this section for a period of one (1) working day. The manufacturer’s representative shall provide technical direction and assistance to the contractor in general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained therein.

B. The contractor shall provide six (6) copies of the manufacturer’s field start-up report.

3.3 MANUFACTURER’S CERTIFICATION

A. A qualified factory-trained manufacturer’s representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer’s recommendations.

B. The Contractor shall provide six (6) copies of the manufacturer’s representative’s certification.

3.4 EXAMINATION

A. Verify that surface is suitable for switch installation.

B. Provide housekeeping pads for all floor mounted switches.

3.5 INSTALLATION

A. The switch shall be installed as shown on the plans, in accordance with the manufacturer's recommendations and all applicable codes.

B. Provide and install maintenance bypass switches with the number of poles and accessories noted on the drawings. Maintain required NEC safe working clearances.

C. All necessary hardware to secure the assembly in place shall be provided by the Contractor.

D. The equipment shall be installed and checked in accordance with the manufacturer’s recommendations.

E. Provide engraved plastic nameplates under the provisions of Section 26 05 53.

F. Conduit or piping systems that contain water or liquid of any kind shall not be installed over the top of any electrical equipment, transformers, racks, cabinets, or enclosures without prior written approval from the Owner.

3.6 DEMONSTRATION

A. Demonstrate operation of manual switch in normal and emergency modes.

B. Instruct owner’s personnel in the proper operation of the manual switch

3.7 FIELD SERVICE ORGANIZATION

A. The manufacturer of the MTS shall also have a national service organization that is available throughout the contiguous United States and is available on call 24 hours a day, 365 days a year.

3.11 WARRANTY

A. The Maintenance Bypass switch shall be warranty for a period of five (5) years from date of shipment. 100% of all parts and labor shall be covered to repair/replace faulty components or failures that occur during the five (5) year period.

END OF SECTION 26 36 16

SECTION 26 36 23 - AUTOMATIC TRANSFER SWITCHES

PART 1- GENERAL

1.1 SCOPE

A. Furnish and install the low voltage automatic transfer switches having the ratings, features/accessories and enclosures as specified herein and as shown on the contract drawings.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specifications sections apply to this section.

1.3 RELATED SECTIONS

A. Section 26 23 25, Medium- Voltage Generator Paralleling Switchgear & Controls

B. Section 26 32 18, Medium Voltage Diesel Engine Drive Generator

1.4 REFERENCES

A. The automatic transfer switches and all components shall be designed, manufactured and tested in accordance with the latest applicable standards of UL and NEMA as follows:

1. UL 1008 – Transfer Switches
2. UL 991
3. NFPA 70 – National Electrical Code
4. NFPA 110 – Emergency and Standby Power Systems
5. NEMA ICS 10 – AC Transfer Switch Equipment
6. IEEE 446 – Recommended Practice for Emergency and Standby Power Systems
7. IEC 801-2, 3, 4, and 5
8. CISPR 11
9. Compliant with FCC Part 15, Subpart B, Class A.

1.5 DESCRIPTION

A. Automatic transfer switches shall be capable of switching all classes of load, and shall be rated for continuous duty when installed in a non-ventilated enclosure.

B. Transfer switches shall be a true four (4) pole type. Normal and emergency full load current and voltage ratings at 60 cycles shall be as shown on plans.

1.6 SUBMITTALS

A. Product Data: Provide catalog sheets showing voltage, switch size, ratings and size of switching and overcurrent protective devices, operating logic, short circuit ratings, dimensions, and enclosure details.

B. Submit shop drawings and product data clearly indicating:

1. All applicable options and accessories

a. Master drawing index
b. Front view and plan view of the assembly
c. Schematic diagram
d. Nameplate schedule
e. Component list
f. Conduit space locations within the assembly.
g. Assembly ratings including:

1) Short-circuit rating
2) Voltage
3) Continuous current rating.

2. Major component ratings including:

a. Voltage
b. Continuous current rating
c. Interrupting ratings
d. Cable terminal sizes and quantity
e. Product Data Sheets.
f. Delivery, storage and handling instructions.

3. Where applicable, the following additional information shall be submitted to the OAR:

a. Busway connection
b. Connection details between close-coupled assemblies
c. Composite front view and plan view of close-coupled assemblies
d. Key interlock schematic drawing and sequence of operations

4. The following information shall be submitted for record purposes:

a. Final as-built drawings and information for items listed in section 1.4
b. Wiring diagrams
c. Certified production test reports
d. Installation information

5. The final (as-built) drawings shall include the same drawings as the construction drawings and shall incorporate all changes made during the manufacturing process.

6. Submittals and record drawings shall be submitted to the Project Manager.

C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under regulatory requirements. Include instructions for storage, handling, protection, examination, preparation, installation and starting of product.

1.7 FIELD MEASUREMENTS

A. Verify that field measurements are as indicated on drawings and as instructed by manufacturer.

1.8 OPERATION AND MAINTENANCE DATA

A. Operation Data:

1. Provide detailed instructions for operating equipment.
2. Include instructions for operating equipment under emergency conditions, including when engine generator is running.

B. Maintenance Data:

1. Provide routine preventative maintenance and lubrication schedule.
2. List special tools, maintenance materials, and replacement parts.

1.9 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with a minimum of ten years of experience.

B. When requested by the OAR, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

C. Supplier: Authorized distributor of specified manufacturer with a minimum of three years of experience.

1.10 REFERENCES AND REGULATORY REQUIREMENTS

A. Furnish products listed and classified by UL as suitable for purpose specified and indicated.

B. Provide a certificate of compliance with UL 1008 for the automatic transfer switches furnished under this section.

C. Conform to the requirements of the following:

1. NFPA 70 - National Electrical Code.
2. NEMA ICS 1 - General Standards for Industrial Control and Systems.
3. NEMA ICS 2 - Standards for Industrial Control Devices, Controllers and Assemblies.
4. NEMA ICS 6 - Enclosures for Industrial Controls and Systems.

1.11 QUALITY ASSURANCE/TESTS

A. When conducting temperature rise tests to paragraph 99 of UL-1008 the manufacturer shall include post-endurance temperature rise tests to verify the ability of the transfer switch to carry full rated current after completing the overload and endurance tests.

B. The switch shall meet or exceed the voltage surge withstand capability in accordance with IEEE Standard 472-1974 and the impulse withstand voltage test in accordance with NEMA Standard ICS 1-109.

1.12 DELIVERY, STORAGE AND HANDLING

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris and traffic.

B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to internal components, enclosure and finish.

1.13 FIELD MEASUREMENTS

A. Verify that field measurements are as indicated on drawings and as instructed by manufacturer.

1.14 MAINTENANCE SERVICE

A. Furnish service and maintenance of transfer switch for one year from Date of Substantial Completion.

1.15 MAINTENANCE MATERIALS

A. Provide two of each special tool required for maintenance.

1.16 OPERATION AND MAINTENANCE MANUALS

A. Equipment operation and maintenance manuals shall be provided with each assembly shipped, and shall include instruction leaflets and instruction bulletins for the complete assembly and each major component. These manuals shall be incorporated into the O & M manuals submitted to the OAR.

1.17 EXTRA PRODUCTS

A. Furnish and install all incidentals and appurtenances required for a complete and fully operational system to the satisfaction of the OAR. Line and load terminals shall be capable of accepting the quantity and size of conductors as specified on the plans.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Russelectric (basis of design).

B. Eaton Cutler-Hammer (Contactor type only)

C. No substitutions.

D. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. The manufacturer listed above is not relieved from meeting these specifications in their entirety. Equivalent products determined by the OAR to be in full compliance with the specification may be acceptable.

E. All power and control equipment as specified in the contract documents shall be considered an integral part of the Standby Power System and shall be supplied by the Standby Power System Supplier. The Standby Power System Supplier shall be responsible for coordination of the entire Standby Power System to provide for unit responsibility.

2.2 GENERAL

A. The transfer switch shall be double throw, actuated by two electrical operators, momentarily energized and connected to the transfer mechanism by a simple over center linkage with time delay relays to control contact transition time on transfer to either source, adjustable 0-300 seconds. Time delay between the opening of the closed contacts and the closing of the open contacts shall be adjusted to allow for voltage decay before transfer as required to allow re-energization of motor and transformer loads at normal in rush currents. Single throw, actuated by single electric operator shall be allowed in lieu of double throw operator if in phase monitor is used which allows for re-energization as noted above.

B. The transfer switch shall be capable of transferring successfully in either direction with 70% of the rated voltage applied to the switch terminals. The normal and emergency contacts shall be positively interlocked mechanically and electrically to prevent simultaneous closing. Main contacts shall be mechanically locked in position in both the normal and emergency positions without the use of hooks, latches, magnet, or springs and shall be silver-tungsten alloy protected by arcing contacts, with magnetic blowouts on each pole. Parallel main contacts are not acceptable.

C. The transfer switch shall be equipped with a safe manual operator designed to be operated in the loaded condition and to prevent injury to operating personnel. The manual operator shall provide the same contact-to-contact transfer speed as the electrical operator to prevent a flashover from switching the main contacts slowly. Manual operator shall be usable with the front door of the ATS closed for maximum personnel protection.

D. Engine starting contacts shall be provided in transfer switch to start the generating plant if any phase of the normal source drops below 80% of rated voltage, after an adjustable time delay period of 0.5-3 seconds, to allow for momentary dips. The transfer switch shall not transfer to emergency until the generator source voltage and frequency have reached 90% of rated. After restoration of normal power on all phases to 90% of rated voltage, adjustable time delay period of 0-25 minutes shall delay transfer to normal power until it has had time to stabilize. If the emergency power source should fail during the time delay period, the time delay shall be by-passed, and the switch shall return immediately to the normal source. Whenever the switch has retransferred to normal, the engine-generator shall be allowed to operate at no load for a fixed period of time (5 minutes) to allow it to cool before shut-down. The transfer switch shall include a test switch to simulate normal power failure with actual load transfer. Pilot lights shall be included on the cabinet door to indicate the main switch closed on normal or emergency, and two auxiliary contacts on the main shaft; one closed on normal, the other closed on emergency. In addition, two sets of relay contacts shall be provided to open and close upon loss of the normal power supply. All relays, timers, control wiring and accessories to be front accessible and be rated for the load and voltage as required for auxiliary control functions.

E. The transfer switch shall be UL listed for withstand and close-in values at least equal to the interrupting rating of the circuit breaker and/or fuse that is specified to protect the circuit, and available short circuit amps from the generator set.

F. The transfer switch shall automatically exercise the generating plant a no load or loaded condition. Exerciser shall be adjustable in 15 minute increments. Refer to Contract Documents for specific programming.

G. Transfer switches shall transfer normal supply to emergency within the time limits as required by the National Electrical Code for emergency loads (10 seconds for life safety, 60 seconds for critical).

H. When more than one emergency branch is shown, time delay relays shall be provided on the transfer to emergency operation for critical and equipment branch transfer switches. Time delay shall be adjustable 1-300 seconds and shall be adjusted in stages with the limits of the N.E.C. and as follows:

1. Life Safety Branch - no time delay on transfer to emergency.
2. Legally Required (Critical) Branch - shall transfer to emergency after the life safety branch has transferred to emergency and generator has recovered to 90% of rated voltage and frequency.
3. Security Branch - shall transfer to emergency after the legally required branch has transferred to EMG and GEN has recovered to 90% of rated voltage and frequency.
4. Equipment Branch - shall transfer to emergency after the legally required and security branches have transferred to emergency and generator has recovered to 90% of rated voltage and frequency.
5. These time delays shall not effect or be a function of contact transition time as required in A above.

I. Transfer switch maximum dimensions shall be as shown on drawings.

2.3 CONSTRUCTION

A. The switching panel shall consist of completely enclosed contact assemblies and a separate control logic panel. Control power for all transfer operations shall be derived from the line side of the source to which the load is being transferred.

B. Each automatic transfer switch shall be positively interlocked both mechanically and electrically to prevent simultaneous closing of both sources under either automatic or manual operation. Main contacts shall be mechanically locked in position in both normal and emergency positions. A neutral position shall not be possible under normal electrical operation unless a delayed transition accessory is required for switching highly inductive loads.

C. Automatic transfer switches shall be capable of being operated manually under full rated load conditions. Manual operation shall be accomplished by a permanently attached or removable manual operator, or by integrally mounted pushbuttons. The operation of the manual handle shall be possible with the front door of the ATS CLOSED to maximize safety to personnel. Removable manual operating handles, and handles that may move in the event of an electrical operation during the manual operation, are not acceptable. Manual operators requiring source or load disconnection prior to manual operation are not acceptable.

D. The automatic transfer switches shall have a multi-tap voltage selection plug for ease of voltage adjustment in the field.

E. Automatic transfer switches that are applied as service entrance switches shall provided with a service entrance label. Indicators shall be provided to show the availability of each source as well as the service entrance breaker in a tripped or disconnected position. Provide a switched neutral contact of identical construction and rating as the power poles mounted on the power contact shaft integral to the completed assembly, and a neutral-to-ground main bonding jumper for all switches to meet UL service entrance requirements. Service Entrance breaker shall include GF trip for units 1000 amps and higher.

2.4 MICROPROCESSOR-BASED CONTROLLER

A. The microprocessor-based logic controller shall be door mounted and shall provide the operator with an overview of the automatic transfer switch status, parameters, and diagnostic data. The controller shall have a voltage range of 0-790 volts (50/60 Hz) and an accuracy of +/- 2% of nominal input voltage. The controller shall have a frequency range of 40-70 Hz and an accuracy of +/- .1 Hz. Control power input range shall be from 65V AC – 145V AC RMS 50/60 Hz. The controller shall be listed under UL Standard 1008.

B. The microprocessor-based controller shall include an LCD display, and shall display the following:

1. Line-to-line voltages for each source and the load
2. Line frequency for each source
3. Timer countdown for each timer while functioning
4. Real-time clock
5. Set points.

C. The microprocessor-based controller shall include mimic bus and individual LEDs for indicating the following:

1. Source 1 available
2. Source 1 connected
3. Source 2 available
4. Source 2 connected

D. The microprocessor-based controller shall contain the following features:

1. Password programming protection.
2. Set points shall be stored in Non-Volatile memory, and use of an external battery source to maintain operation during “dead” periods shall not be required.
3. Program/run switch.

E. The microprocessor-based controller shall contain the following voltage and frequency features:

1. The voltage of each phase of the normal source and the alternate source shall be monitored, with undervoltage dropout adjustable from 50% to 90% of nominal and pickup adjustable from dropout setting +/-2% to 99% of nominal.
2. The voltage of each phase of the normal source and the alternate source shall be monitored, with overvoltage dropout adjustable from 105% to 120% of nominal and pickup adjustable from dropout setting +2% to 103% of nominal.

3. The frequency of the normal source and the alternate source shall be monitored, with underfrequency dropout adjustable from 90% to 100% of nominal and pickup adjustable from dropout setting +1 Hz to 99% of nominal.
4. The frequency of the normal source and the alternate source shall be monitored, with overfrequency dropout adjustable from 100% to 120% of nominal and pickup adjustable from dropout setting +1 Hz to 101% of nominal.

F. The microprocessor-based controller shall contain the following time delay features:

1. A time delay shall be provided to override a momentary power outage or voltage fluctuation, adjustable from 0 to 120 seconds.
2. A time delay shall be provided on transfer to alternate source, adjustable from 0 to 1800 seconds.
3. A time delay shall be provided on retransfer from alternate source to normal source, adjustable from 0 to 1800 seconds. This time delay shall be bypassed if emergency source fails and normal source is available.
4. A time delay shall be provided after retransfer that allows the generator to run unloaded prior to shutdown, adjustable from 0 to 1800 seconds.
5. A time delay shall be provided for the neutral position, adjustable from 0 to 120 seconds.
6. A time delay shall be provided for engine failure to start, adjustable from 0 to 6 seconds.
7. All delays shall be field adjustable from the microprocessor-based controller without the use of special tools.

G. The microprocessor-based controller shall contain the following features:

1. Pre-transfer signal, range 0-120 seconds, programmable in either direction
2. Plant exerciser, selectable – disabled or 7 day interval, 0-600 minutes load or no load
3. Retransfer mode – manual or automatic
4. Test pushbutton mode – disabled, load or no load.

H. The microprocessor-based controller shall contain the following input/output contacts:

1. Two (2) SPST contacts for generator start, rated 5A, 250V AC
2. Four (4) SPST contacts for position indication control functions, rated 10A, 250V AC
3. Three (3) SPDT contacts for source availability control functions, rated 10A, 250V AC

2.5 WIRING/TERMINATIONS

A. Terminal blocks shall conform to NEMA ICS 4. Terminal facilities shall be arranged for entrance of external conductors from the top or bottom of the enclosure. The automatic transfer switch terminals shall be suitable for the termination of conductors shown on the plans.

2.6 RATINGS

A. The automatic transfer switches shall have equal withstand, closing and interrupting ratings as noted below, 3 cycle “any breaker rating.” Series ratings are NOT acceptable. The automatic transfer switches shall be service rated for continuous duty. Unless shown otherwise on the plans and drawings, the minimum withstand rating shall be as follows:

100 - 400 amp	42,000 amps symmetrical
600 – 800 amp	65,000 amps symmetrical
1000 – 1200 amp	85,000 amps symmetrical

1600 – 4000 amp 100,000 amps symmetrical

B. The voltage rating of the automatic transfer switches shall be no less than the system voltage rating. The continuous current rating of the automatic transfer switches shall be no less than the maximum continuous current requirements of the system.

C. The automatic transfer switches shall be rated for continuous duty as shown on the drawings and shall conform to the applicable requirements of UL 1008 for emergency system total load.

D. The automatic transfer switches shall be fully rated to operate all types of loads, inductive and resistive, from loss of continuity of power, without derating, either open or enclosed.

2.7 ENCLOSURE

A. Enclosure: ICS 6, Type 1.

B. Finish: Manufacturer's standard gray enamel.

C. NEMA 1 unless shown otherwise on the project drawings.

PART 3 - EXECUTION

3.1 FACTORY TESTING

A. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of UL and NEMA standards.

B. Insulation check to ensure the integrity of insulation and continuity of the entire system.

C. Visual inspection to ensure that the switch matches the specification requirements and to verify that the fit and finish meet quality standards

D. Mechanical tests to verify that the switch's power sections are free of mechanical hindrances.

E. Electrical tests to verify the complete electrical operation of the switch and to set up time delays and voltage sensing settings of the logic

F. The manufacturer shall provide six (6) certified copies of factory test reports.

3.2 FIELD QUALITY CONTROL

A. Provide the services of a qualified factory-trained manufacturer's representative to assist the contractor in installation and start-up of the equipment specified under this section for a period of five (5) working days. The manufacturer's representative shall provide technical direction and

assistance to the contractor in general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained therein.

B. The contractor shall provide six (6) copies of the manufacturer's field start-up report.

3.3 MANUFACTURER'S CERTIFICATION

A. A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations.

B. The Contractor shall provide six (6) copies of the manufacturer's representative's certification.

3.4 EXAMINATION

A. Verify that surface is suitable for transfer switch installation.

B. Provide housekeeping pads for all floor mounted switches.

3.5 INSTALLATION

A. The transfer switch shall be installed as shown on the plans, in accordance with the manufacturer's recommendations and all applicable codes.

B. Provide and install automatic transfer switches with the number of poles and accessories noted on the drawings. Maintain required NEC safe working clearances.

C. All necessary hardware to secure the assembly in place shall be provided by the Contractor.

D. The equipment shall be installed and checked in accordance with the manufacturer's recommendations.

E. Provide engraved plastic nameplates under the provisions of Section 26 05 53.

F. Provide all associated control wiring to generator as required.

G. Provide and install all interface control wiring and conduit as required to provide required emergency operation of equipment on project as applicable.

H. Conduit or piping systems that contain water or liquid of any kind shall not be installed over the top of any electrical equipment, transformers, racks, cabinets, or enclosures without prior written approval from the Owner.

3.6 SITE TEST

A. An installation check and building load test shall be performed by the manufacturer's local representative. The OAR, designer, regular operators and the maintenance staff shall be notified of the time and date of the site test. The tests shall include automatic start-up by means

of simulated power outage to test remote-automatic starting, transfer of the load and automatic shutdown. Prior to this test, all transfer switch timers shall be adjusted and all necessary programming completed for proper system coordination.

3.7 DEMONSTRATION

A. Demonstrate operation of transfer switch in normal and emergency modes.

3.8 TRAINING

A. The contractor shall provide a training session for up to five (5) owner’s representatives for two (2) normal workdays at a jobsite location determined by the owner.

B. The training session shall be conducted by a manufacturer’s qualified representative. The training program shall consist of the instruction on the operation of the assembly, circuit breakers and major components within the assembly with "hands on" type training with a previously owner approved outline for the specific equipment.

3.9 FIELD SERVICE ORGANIZATION

A. The manufacturer of the ATS shall also have a national service organization that is available throughout the contiguous United States and is available on call 24 hours a day, 365 days a year.

3.10 SITE TEST

A. An installation check and building load test shall be performed by the manufacturer's local representative. The OAR, engineer, regular operators and the maintenance staff shall be notified of the time and date of the site test. The tests shall include automatic start-up by means of simulated power outage to test remote-automatic starting, transfer of the load and automatic shutdown. Prior to this test, all automatic transfer switch timers shall be adjusted for proper system coordination.

B. Test all equipment.

3.11 WARRANTY

A. The Automatic Transfer switch shall be warranty for a period of five (5) years from date of shipment. 100% of all parts and labor shall be covered to repair/replace faulty components or failures that occur during the five (5) year period.

END OF SECTION 26 36 23

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SECTION 26 41 13 - LIGHTNING PROTECTION SYSTEM

PART 1- GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification Sections, apply to this section.

1.2 SUMMARY

A. This section includes the requirements for provision and installation of a complete lightning protection system.

1.3 DESCRIPTION

A. A Lightning Protection System (LPS) shall be provided and installed on the structure as noted, and shall be complete even though all items may not be completely shown on drawings. The LPS shall be installed by an experienced Lightning Protection Institute (LPI) - Certified Installer, and in compliance with the provisions of the prevailing and enforced code(s) for LPS as adopted by the National Fire Protection Association (NFPA) and the Underwriters Laboratories (UL). Confirm the prevailing LPS code(s) prior to preparation of the bid and again prior to commencement of the construction. The LPS drawings are provided as a minimum standard, but where a higher standard exists and will be enforced by the Authority Having Jurisdiction (AHJ), the contractor will use the higher standard if unable to confirm acceptance of the lesser standard prior by the Authority Having Jurisdiction to the bid. All of the LPS equipment required for a completely operable and certified LPS, whether shown or not, shall be included.

B. Materials shall comply in weight, size and composition with the requirements of UL and the NFPA Code relating to this type of installation, and shall be UL Listed.

C. Where the LPS products and materials being used are available from a single (1) manufacturer, the LPS contractor shall use those materials in lieu of products and materials from multiple manufacturers.

D. System shall comply with the following:

1. The Lightning Protection Institute (LPI-175) – confirm edition and amendments with AHJ.

2. ANSI/NFPA 780; Class I or Class II as noted on the respective drawing set. The LPS contractor shall confirm the edition and amendments being enforced with AHJ prior to release of the bid.

3. UL 96A; Master Label for:

a) A new, single structure installation

1.4 REFERENCES

A. ANSI/NFPA 780 – Standard for the Installation of Lightning Protection System.

B. ANSI/UL 96 – Standard for Lightning Protection Components.

C. LPI-175 and LPI-177 – Lightning Protection Institute.

D. UL 96A - Installation Requirements for Lightning Protection Systems.

E. IEEE 81 – Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.

1.5 SUBMITTALS

A. The LPS design shown on these documents shall be used for the shop drawings and alternate means and methods will not be considered. The LPS contractor shall submit shop drawings showing the complete layout of all the LPS air terminals, all the LPS grounding electrodes, the respective in-ground box, the LPS bonding connections to the building metal structure(s) and the LPS connection to other metal objects located in the building and on the roof as shown. Provide a Symbol Legend to define the air terminals, the LPS grounding electrode, and the counterpoise ground loop size(s), the LPS down lead conductor size(s), and the LPS roof grid conductor size(s). Provide details, equal to those shown on these documents, which show the respective connection and termination types. Drawings shall include full layout of cabling and points, and connections.

B. Submit product data showing dimensions and materials of each component being provided for the LPS. Provide documentation showing compliance with the specific requirements of ANSI/UL 96 and a listing label. Provide documentation showing that coordination between the LPS contractor and the General/Roof/Paint/Finish contractors exists. The LPS contractor shall confirm all LPS connection types and materials with the respective contractor to be sure that adhesives or welds will not compromise the integrity of the material on which it is being installed. The LPS contractor will not void the warranty of any other contractor by using dissimilar metals or adhesives which are not approved by the other contractor/manufacturer.

C. Submit the LPS manufacturer's installation instructions for review and approval. Include submittal data for the adhesives to be used and welding types to be made.

D. Submittal shall include manufacturer’s installation instructions for the in-ground boxes as defined and shown on the LPS drawings.

1.6 PROJECT AS-BUILT DOCUMENTS

A. Record actual locations of air terminals, grounding electrodes, bonding connections, and routing of system conductors on red lined as-built documents. Maintain the red lined as-built documents and upon completion of the building prepare a REVIT model and drawings showing any changes to the bid documents.

B. Photograph and maintain digital pictures of all welding and bonding which will not be visible after completion of the construction. The photos shall use the column line Alpha-Numerical system established by the architect and as shown on the architectural drawings. Provide copies of the digital photographs to the Engineer of Record (EOR) within two (2) days of taking the photos. Use the correct Alpha-Numerical indicator and a typed list of the photos being submitted and a brief explanation of each photo.

1.7 QUALIFICATIONS

A. Manufacturer: A company which specializes in the manufacture of LPS equipment with a minimum of five (5) years documented experience. The company and their products shall be a certified member of the Lightning Protection Institute and the products shall bear the UL label as required.

B. Installer: An LPS company licensed in the State of Florida and the City of Orlando to provide and install the LPS shown on the drawings. The contractor shall be certified and authorized to install the LPS of each manufacturer being used, they shall have a minimum of five (5) years documented experience, and they shall be a certified member of the Lightning Protection Institute.

1.8 PRE-INSTALLATION CONFERENCE

A. Schedule and convene a pre-installation conference at least one (1) week prior to commencing any LPS work or excavation. Provide all attendees with at least a two (2) week notice prior to the meeting.

1.9 SEQUENCING AND SCHEDULING

A. The LPS contractor shall coordinate the work for this section with the roofing, structural steel, exterior and interior finish, HVAC, plumbing, fire protection and electrical contractors prior to any installations. Maintain concurrence with these disciplines throughout the project to avoid any conflict between the materials, and to avoid conflict during installation by means and methods.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Thompson Lightning Protection, Inc.: Premium Line.

B. Independent Protection Company, Inc.: Premium Line.

C. Heary Bros. Lightning Protection: Premium Lines.

2.2 MATERIALS

A. Components: In accordance with ANSI/UL 96 and LPI.

B. Air Terminals:

1. Air Terminals shall be solid (aluminum), one-half inch (1/2") diameter for Class I installations, five-eighths inch (5/8") for Class II installations, as required to match roof conductors, and shall have proper base support for surface on which they are attached. Mount and securely anchored to the surface on which they are to be attached. Provide a blunt tip type air terminal.

2. Terminal length: Twenty-four inches (24") or as otherwise noted on the drawings. Comply with the requirements of NFPA 780 for complete installation.

C. Conductors:

1. LPS Roof Conductor(s)- the LPS roof conductors shall consist of aluminum complying with the weight and construction requirements of the applicable NFPA 780 Code section or the LPI requirements, whichever is more stringent. The LPS roof conductor material shall match, and be compatible with, the roof and flashing materials. The LPS contractor shall use only gradual bends of eight inches (8") or more in radius when installing the conductor(s).

2. LPS Down Conductor(s) - the LPS down conductors shall be copper, and shall be provided where shown and installed in a minimum one-inch (1") PVC, schedule 40 conduit as noted in the drawing details. Conceal the conduit within the structure and take a digital photograph of any welds or bonds connected to the LPS. Identify each photo with the location of the weld or bond. The LPS contractor shall use only gradual bends of eight inches (8") or more in radius when installing the conductor(s) and the conduit. The down conductor shall be sized in accordance with NFPA 780, Table 4.1.1.1.1 for Class I Installations, and in accordance with NFPA 780, Table 4.1.1.1.2 for Class II Installations.

3. LPS Counterpoise – the LPS counterpoise (ground loop) conductor shall be a single (1) cable with thirty-two (32) strands of #17 AWG copper for Class I Installations, and a single (1) cable with twenty-eight (28) strands of #14 AWG copper for Class II

Installations. The counterpoise shall be buried in a trench at a depth of two feet (2'-0") minimum. The LPS contractor shall maintain the integrity of the counterpoise conductor by keeping it out of contact with the piping, conduits or underground utility cables of other trades. Where the pipe, conduit or another utility cable is within six inches (6") of the counterpoise conductor (above or below), the counterpoise conductor will be routed below the pipe, conduit or utility cable, and the LPS contractor shall maintain a minimum of twelve inches (12") of separation between the counterpoise conductor and any other utility pipe(s), cable(s) or conduit(s). Provide marking tape at six inches above the counterpoise conductor. Coordinate with all site trades to confirm their routing and depth prior to installation and connection of the counterpoise conductor. Do not connect the counterpoise conductor to the LPS ground rods until each rod has been tested and certified to be 5 Ohms or less in resistance. The LPS contractor shall only use gradual bends of eight inches (8") or more in radius when installing the counterpoise conductor. Plan and use "Sweep Type" radius when going under all other utility pipes, cables or conduits.

D. Fastener: Exposed LPS conductor fasteners shall be of the same material as the conductor, and shall have ample strength to support conductor. Exposed fasteners shall be installed using only an approved method and only with approved adhesives.

E. Couplings, Connectors and Splicers: The LPS ground rod couplings shall be threaded and self-tightening, DeMark type only. Provide Bronze or aluminum connectors as required to be compatible with conductor being connected.

F. Ground Rods: The LPS grounding rods shall consist of multiple sections of copper clad driven rods, three-quarter inch (3/4") diameter, a minimum of ten feet (10'-0") long for each section. The installation shall comply with the instructions listed in the LPS construction documents and any additional requirements of Section 26 05 26 Grounding and Bonding, but this section shall prevail if there is a conflict. The tests shall comply with the instructions listed in the LPS construction documents and any additional requirements of Section 26 08 13 Tests and Performance Verification, but this section shall prevail if there is a conflict. Each LPS ground rod shall have a unique and distinct identification, and all reports provided to the EOR will use the same identification when reporting tests. The LPS ground rods shall be driven to a minimum depth of forty feet (40'-0") and tested. If required, additional rod section(s) will be added and the assembly will be driven further down until a maximum of 5 Ohms resistance is achieved when measured using a clamp on, digital recorder. The 5 Ohm requirement will be achieved at the rod before connection of the copper counterpoise ground loop conductor.

PART 3 - EXECUTION

3.1 EXAMINATION

A. The LPS contractor shall verify that all surfaces are cleaned, prepared and ready to receive the work of this discipline.

B. The LPS contractor shall verify that the actual field measurements are the same as those shown on the LPS shop drawings.

C. The LPS contractor indicates acceptance of the existing conditions by beginning the work of the LPS construction.

3.2 PROTECTION OF SURROUNDING ELEMENTS

A. The LPS contractor shall provide protection of all LPS equipment and installations during the project. Coordinate with the general contractor if temporary shoring, barriers or enclosures are required to protect the work of this section from damage or disfiguration.

3.3 INSTALLATION

A. Install all LPS materials in accordance with manufacturer's written and published instructions.

B. Install all LPS materials in accordance with requirements of UL 96A, ANSI/NFPA 780, and LPI. The LPS contractor shall verify with the AHJ prior to shop drawing submission.

C. Install LPS ground rods as noted in the LPS Details and in accordance with Section 26 05 26 Grounding and Bonding. Where conflict exists between the requirements of Section 26 05 26 Grounding and Bonding and this section, the most stringent shall govern.

D. The LPS materials shall be installed in an inconspicuous manner where possible. The LPS conductors shall be routed concealed where possible. Down conductors shall be concealed within structure, and shall be run in a one-inch (1") PVC, Schedule 40 conduit.

E. Where the LPS fasteners are to be mounted in a masonry element, or in a structural element, the LPS contractor shall furnish the required fastener(s) to the Masonry or Structural contractor so they may be installed during construction of the project.

F. Provide the proper connections to the LPS from all the grounded media in and around the protected structure. All connections shall be in accordance with the requirements of NFPA 780 for Surge Protection and Potential Equalization. The LPS contractor shall coordinate with the specific low-voltage contractor to determine the appropriate connection type(s) required and the specific locations.

G. Provide the proper connections to the LPS from all grounding media in, on and around the structure to provide a common ground potential per NFPA 780 for Common Bonding of Grounded Systems, including the electrical service, the data, telephone and antenna system grounds, as well as underground metallic piping systems, underground metal conduits, etc.

H. Counterpoise Ground Loop: The LPS contractor shall bond the counterpoise ground loop to the Electrical Ground System. Refer to Section 26 05 26 Grounding and Bonding for additional information. Items required to be bonded/connected as noted in ‘F’ and ‘G’ above shall be bonded/connected via Electrical Ground System where available and applicable.

I. All exposed LPS conductors which are located within six feet (6’-0”) or less above finished floor, or the finished grade, shall be protected and shielded properly as well as other exposed locations where a conductor is subject to mechanical damage.

J. The LPS contractor shall coordinate with, and receive approval of, all penetrations of the roofing system and mounting to roofing system with LPS Designer and Roofing Contractor prior to submittal of shop drawings.

K. The LPS contractor shall coordinate with, and receive approval from, the Structural Engineer of Record for all connections to structural steel, rebar, and other structural elements prior to submittal of shop drawings.

L. Ground Terminals:

1. The LPS ground connections shall be made in accordance with requirements of all applicable codes and Section 26 05 26 Grounding and Bonding (including but not limited to requirements for testing, ground rods, materials, wells, etc.).

2. The LPS counterpoise ground rods shall be placed outside of the building at a minimum of two feet (2’-0”) away from the building foundation. Refer to the specific LPS Details for additional information.

3. The LPS counterpoise ground rod location shall consist of:

a) One (1) copper-clad steel (Copper-weld) driven ground rod which is three-quarter inch (3/4") in diameter and driven vertically to a minimum depth of forty feet (40'-0") into the ground. The rod will be tested, and if required, the contractor shall provide additional sections of rod to achieve a maximum of Five Ohms (5Ω) or less. The test of the ground rod shall only be performed a minimum of two (2) days after any substantial rain storm to avoid false readings.

b) Provide an in-ground box (ground well) enclosure at each ground rod location in accordance with LPS Details located on the LPS drawings.

3.4 FIELD QUALITY CONTROL

A. The LPS contractor shall test all ground rods, using a digital Ground Testing and Recording Meter and provide a Grounding Matrix in the form of an Excel spread sheet for review. Refer to IEEE Standard 81 for test methods and refer to the specific requirements of Section 26 08 13 Tests and Performance Verification for additional information. Each ground rod shall test positively for a maximum of Five Ohms (5Ω) resistance. The test on all ground rods shall only be performed a minimum of two (2) days after any rain to avoid false readings.

B. The LPS contractor shall obtain the service of Underwriters Laboratories, Inc. to provide inspection and certification of the lightning protection system under provisions of UL 96A. Submit certification and submit in O & M Manual.

C. The LPS contractor shall obtain, from the Underwriters Laboratories, Inc., a UL Master Label and attach it to the building at a location as directed by OAR. Submit copy of paperwork to EOR, OAR and submit in O & M Manual.

D. The LPS contractor shall include the required test results for each counterpoise ground rod location including final length of each ground rod at each ground rod location.

END OF SECTION 26 41 13

SECTION 26 43 00 - SURGE PROTECTIVE DEVICES (120VAC TO 480VAC)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification sections apply to this section.

1.2 SUMMARY

A. This section includes the requirements for provision and installation of surge suppression equipment for 120 volt AC to 480 volt AC circuits.

1.3 DESCRIPTION

A. Provide all materials, labor and auxiliaries required to furnish and install complete surge suppression for the protection of building electrical and electronics systems from the effects of line induced transient voltage surge and lightning discharge as specified for systems with voltages between 120VAC and 480VAC.

B. Provide surge suppression equipment for the following equipment:

1. Each existing and new main electrical service switchboard as called for on drawings.
2. Distribution and branch panels as called for on drawings.
3. All electronic communications equipment installed per all Division 27 sections including but not limited to: monitoring/metering equipment.
4. Point of use locations (receptacles, plug-in units) as required.

C. All surge protection to be connected via a 30A 3 pole circuit breaker (whether shown on Plans/Schedules or not.)

1.4 SUBMITTALS

A. Submit the following Product Data for each type of suppressor:

1. Dimensions
2. Means of mounting
3. Compliance with UL Standards referenced
4. Compliance with IEEE Standards referenced
5. Design type (Hybrid, MOV)
6. Internal fusing/Thermal Protection
7. Recommended overcurrent protection
8. Size of wire leads
9. Visual failure indicator
10. Warrantee
11. Performance data showing compliance with performance as specified herein
12. Non-Potted construction

1.5 PROJECT AS-BUILT DOCUMENTS

A. Record locations of surge protection units; indicate actual units used on red lined as-built documents.

1.6 OPERATION AND MAINTENANCE DATA

A. All approved shop drawings, product data, and cutsheets.

B. Installation, connection, and maintenance information on each type of surge suppression.

C. Procedure and time table for recommended periodic inspection of devices to determine usefulness and life expectancy.

1.7 QUALITY ASSURANCE

A. All surge suppression devices shall be manufactured by a company normally engaged in the design, development, and manufacture of such devices for electrical and electronics systems equipment.

B. The surge suppressor manufacturer shall offer technical assistance through support by a factory representative and local stocking distributor. Factory representatives are to approve installation prior to Substantial Completion.

1.8 REFERENCES AND REGULATORY REQUIREMENTS

A. Equipment Certification: Surge protective devices equipment shall be UL listed and labeled for intended use.

B. Surge protective devices shall be selected, installed and located in accordance with requirements of the following:

1. ANSI/NFPA 780 - Lightning Protection Code, latest edition.

2. ANSI/NFPA 70 - National Electrical Code, current adopted year.

3. U.L. 1449 – 3rd Edition, Standard for Safety for Surge Protective Devices.

4. 1363-1986 - Standard for Temporary Power Taps.

5. ANSI/IEEE C62.41-1991 (IEEE 587) - Guide for Surge Voltages in Low-Voltage AC Power Circuits.

6. ANSI/IEEE C62.33-1982 - Standard Test Specifications for Varistor Surge Protection Devices.

7. ANSI/IEEE C62.45-1987 - IEEE Guide for Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits.

1.9 COORDINATION/PROJECT CONDITIONS

A. Verify proper grounding is in place.

B. Verify if space and proper clearance for the surge suppressor installation is available.

C. Coordinate so that proper overcurrent device, as recommended by manufacturer, is installed to feed each surge suppression device.

1.10 WARRANTY

A. All surge suppression devices shall be warranted to be free from defects in materials and workmanship for a period of five (5) years.

B. Any suppressor which shows evidence of failure or incorrect operation during the warranty period shall be repaired or replaced at no cost to the owner.

PART 2 - PRODUCTS

2.1 GENERAL

A. Suppressors shall be designed for the specific type and voltage of electrical service and shall provide clamping action for both normal (L-N) and common (L-N-G) mode protection.

B. Suppressors shall be of a hybrid design, and include circuitry with tight, wave-tracking clamping characteristics.

C. Suppressors shall be designed to withstand a maximum continuous operating voltage of not less than 115% of nominal RMS line voltage.

D. Suppressors shall contain internal safety fusing to disconnect the suppressor from the electrical source if the suppressor fails, in order to prevent catastrophic failure modes.

E. Suppressors shall be fail safe, shall allow no follow-thru current, shall have repeated surge capability, shall be solid state, shall be self-restoring, and shall be fully automatic.

F. Suppressors shall be UL 1449 listed and shall be approved for the location in which they are installed.

2.2 SUPPRESSOR CRITERIA

A. Main Electrical Service Entrance Suppressors (First Level of Protection) shall meet or exceed the following:

1. General:

a) Suppressors shall be tested as per IEEE C62.41-1991 to determine clamping voltage using Cat. C3 test criteria.

b) Suppressors shall be sequential surge tested as per IEEE C62.45-1987, and shall withstand 1000 test cycles at 10kA, Cat. C3 test criteria.

c) Internal fusing for each phase connected.

d) Fail-safe with no hold over current.

e) Enclosure:

1. listed.

2. Fire retardant.

3. NEMA 1 as required for each location.

2. 400kA, remote monitoring.

a) Remote Monitoring. Provide complete with normally open and normally closed dry contacts for remote annunciation of unit status for interfacing with Power Xpert Monitoring System.

b) Maximum Surge Capacity: 400,000 Amps. per phase.

c) Clamping voltage:

1. Category B, UL 1449, Line to Neutral impulse (6KV - 1.2 x 50 µs, 3kA - 8 x 20 µs):

(a) 120/208V, 3Ø, 4W: 600V

(b) 277/480V, 3Ø, 4W: 920V

2. Category C3, Line to Neutral impulse (20KV - 1.2 x 50 µs, 10kA - 8 x 20 µs):

(a) 120/208V, 3Ø, 4W: 1160

(b) 277/480V, 3Ø, 4W: 1660

d) The unit suppressor shall be designed with redundant back-up surge protection in the event of a module failure.

1. Module status indicators shall be provided to indicate individual module status. When a module has failed, the module LED status indicator shall indicate said failure.

2. Unit status indicators shall be provided to indicate the status of the complete unit suppressor. The LED status indicators shall be located on the hinged front cover to redundantly indicate module or unit failure.

e) Basis of Design:

1. Advanced Protection Technologies, Inc. #XTE/*XLHP/CL/DC Series for applied voltage in enclosure or integral to switchgear as noted on Drawings.

2. Equal by Eaton, integral to equipment.

B. Branch Distribution and/or SubPanels (Second Level of Protection), suppressors shall meet or exceed the following:

1. General.

a) Suppressors shall be tested as per IEEE C62.41-1991 to determine clamping voltage using Cat. B3 test criteria.

b) Suppressors shall be sequential surge tested as per IEEE C62.45-1987, and shall withstand 1000 test cycles at 3kA, Cat. B3 test criteria.

c) Internal fusing for each phase connected.

d) Fail-safe with no hold over current.

e) Enclosure:

1. listed.

2. Fire retardant.

3. NEMA 1.

2. 160kA, remote monitoring.

a) Remote Monitoring. Provide complete with normally open and normally closed dry contacts for remote annunciation of unit status for interfacing with Power Xpert Monitoring System.

b) Replaceable module design.

c) Maximum Surge Capacity: 160,000 Amps. per phase.

d) Clamping voltage:

1. Category B, UL 1449, Line to Neutral impulse (6KV - 1.2 x 50µs, 3kA - 8 x 20µs):

(a) 120/208V, 3Ø, 4W: 530

(b) 277/480V, 3Ø, 4W: 920

e) The panel mounted unit suppressor shall be designed with redundant back-up surge protection in the event of a module failure.

1. Module status indicators shall be provided to indicate individual module status. When a module has failed, the module LED status indicator shall indicate said failure.

2. Unit status indicators shall be provided to indicate the status of the complete unit suppressor. The LED status indicators shall be located on the hinged front cover to redundantly indicate module or unit failure.

f) Basis of Design:

1. Advanced Protection Technologies #TE/*XT/160/DC Series for applied voltage in enclosure as required on drawings, as specified above, and/or as required by applicable codes.

3. 25kA Unit (Third Level of Protection)

a) Maximum Surge Capacity: 25,000 Amps.

b) Clamping Voltage at UL 1449, Line to Neutral Category B Impulse, (6kV – 1.2 x 50µs, 3kA, 8 x 20µs):

1. 120/208V, 3Ø, 4W: 500

2. 277/408V, 3Ø, 4W: 900

C. Point of Use Location (120 Volt), Hardwire.

1. 1449 Listed.

2. 20 Amp, 120V rated. All components must be 20 Amp rated.

3. Suppressors shall be tested per IEEE, C62.41-1991 for categories A and B.

4. Internal fusing.

5. Indicators for normal operation and failure indication.

6. Enclosure: Fire retardant high impact, phenolic or plastic housing or metal enclosure.

7. Clamping voltage UL 1449, Line to Neutral, Category B impulse at (3kA, 8 x 20 µs): 350V @ 120V.

8. Maximum Surge Capacity: 20,000 Amps.

9. Maximum continuous operating voltage: 115% of line voltage.

10. Provide hardwire connection or add 20 amp receptacle device to hardwired devices to match equipment being protected and maintain UL Listing.

D. Point of Use Location (120 Volt) Plug Strip

1. 20 amp, 120V rated.

2. Suppressors shall be tested per IEEE, C62.41-1991 for categories A and B.

3. Normal Mode (L - N), and common mode (L+N-G) protection.

4. Internal fusing.

5. 6 ft. line cord.

6. Protected outlets.

7. Indicators for normal operation and failure indication.

8. Re-settable circuit breaker.

9. On/off switch.

10. Extruded aluminum enclosure.

11. Clamping voltage UL 1449, line to neutral, Category B impulse at (3kA, 8 x 20 µs): 310V @ 120V.

12. Maximum Surge Capacity: 20,000 Amps.

13. Maximum continuous operating voltage: 135V.

PART 3- EXECUTION

3.1 GENERAL

A. Provide suppressor at first piece of electrical equipment (switchboard) that the electrical service encounters as it enters the facility.

B. Provide suppressor at each branch panel as noted on drawings.

C. Provide surge suppression at location where data, metering, or monitoring equipment is connected to line voltage (120V). Provide cords and receptacles as required to connect surge protective devices equipment to equipment being protected and maintain UL listing.

3.2 INSTALLATION OF SUPPRESSORS

A. Suppressors shall be installed as close as practical to the electric panel or electronic equipment to be protected, consistent with available space.

B. Suppressors shall be close nippled to the device being protected in a position near the neutral bus which will minimize lead length between suppressor and the buses or control breaker to which the suppressor connects. Suppressor leads shall not extend beyond the suppressor manufacturer's recommended maximum lead length without specific approval of the Designer.

C. Location shown on drawings is diagrammatic only.

D. Suppressors shall be installed in a neat, workmanlike manner. Lead dress shall be as short and as straight as possible and be consistent with recommended industry practices for the system on which these devices are installed.

E. Supplementary grounding and bonding connections required between the bonding bus or ground plane for each equipment cluster and other locations as indicated herein shall be accomplished using #6 AWG core copper conductor and approved connections unless otherwise noted. Referenced to a common earth ground.

F. Suppressors shall be installed in a manner that allows simple replacement within short periods of downtime.

G. Suppressors other then point of use type shall be installed with a means of disconnecting the suppressor at the panel. At the main service entrance location, provide a dedicated 30 amp, 3P-CB, 100,000 AIC for the surge protective device. At the distribution secondary and subpanel locations, provide dedicated 20 amp or 30 amp, 3P-CB’s, for the surge protective device. Label disconnect or CB "Surge Protector". Fused disconnects may be substituted for the CB, with the approval of the Designer. Change rating of CB's noted above as required to properly provide system as recommended by manufacturer.

H. All suppressors are to be monitored by Power Xpert Monitoring System. Provide/install all electrical as required to comply with this.

I. Suppressors at main switchgear are to be mounted integral to switchgear. Comply with all codes and UL labeling. Provide UL label for complete system. All status indicators are to be mounted to switchgear door, visible from exterior of switchgear without requiring operation of door, lid, etc.

J. Suppressors at distribution panels to be mounted external to panel cabinet in NEMA 1 enclosure.

END OF SECTION 26 43 00

SECTION 26 5010 - ARCHITECTURAL LIGHTING FIXTURES, LAMPS, BALLASTS FOR PUBLIC SPACES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide and install lighting fixtures as shown on drawings and as specified in this and all related Sections.

1.2 DEFINITIONS

A. The term Architect refers to the Architect, Interior Designer, Lighting Designer or Owner's Representative individually or collectively.

1.3 GENERAL REQUIREMENTS

A. Provide all lighting fixtures as shown complete with all lamps, completely wired, controlled and securely attached to supports.

B. Where a catalog number and a narrative or pictorial descriptions are provided, the written description shall take precedence and prevail.

C. General Contractor shall provide electrical subcontractor with entire lighting specification (including fixture illustrations and sketches); electrical subcontractor shall provide each specified manufacturer with complete information about the fixtures they will supply.

D. Type of fixtures shall be as indicated alphanumerically and as specified.

E. Fixture details shown may be modified by the manufacturer provided all of the following conditions have been met:

1. Fixture performance is equal or improved;
2. Structural, mechanical, electrical, safety, and maintenance characteristics are equal or improved;
3. Cost to the Owner is reduced or equal.
4. Modifications have been reviewed by the Architect and have been approved by the Architect in writing.

1.4 STANDARDS

A. The standards and regulating committees referred to in this specification and to which compliance with is required are:

1. UL Underwriters Laboratories
2. NRTL Nationally Recognized Testing Laboratory
3. NEC National Electric Code
4. ANSI American National Standards Institute
5. ASTM American Society of Testing and Materials
6. NEMA National Electrical Manufacturers Association
7. IEC International Electrotechnical Commission

B. All fixtures and assembled components shall be new, of good quality, and be approved by and bear the label of UL for the applicable location and conditions (wet, damp, dry, etc.) or other approved testing agencies, i.e. CSA, ETL, unless otherwise specified in writing.

C. All fixtures shall meet all required local, state and/or national building, electrical and energy codes and regulations.

1.5 BIDDING

A. Follow bidding procedures as described in Division 01 of this specification.

B. Provide unit and alternate prices as required in the Lighting Fixture Schedule at the end of this section.

1.6 SUBSTITUTIONS

A. Bidders' attention is called to the following procedure to be followed in submitting alternate fixture manufacturers than those specified:

1. Bidders wishing to obtain approval on brands other than those specified by name and/or catalog number in the Lighting Fixture Schedule at the end of this section, shall submit their requests not later than ten (10) business days before the bid opening. Approval will be in the form of an addendum to the specifications issued to all prospective bidders indicating that the additional brand or brands are approved as equal to those specified as far as the requirements of the project are concerned. If the bidders do not elect to obtain prior approval during the time so specified, the Owner has no obligation to review or consider any such article after the contract award.
2. If the bidder wishes to substitute fixtures from alternate manufacturers, his attention is called to Section 2.1, GENERAL MATERIAL REQUIREMENTS of PART 2 - PRODUCTS. In addition, he shall note that the dimensions of visible parts of many fixtures (for example, the aperture diameters of downlight fixtures)

are binding to the bidder and cannot be changed without prior approval by the Architect.

3. Contractor shall pay professional fees (at current standard hourly rates) and reimburse expenses directly to all designers (Architect, Engineer, Lighting Designer, et. al.) for time spent reviewing substitutions proposed by the Contractor. If payment by the Contractor is not made within 60 days of invoice date, the Owner shall deduct the amount due from subsequent payments to the Contractor in order to reimburse designers.
4. Request for approval shall be accompanied by working fixture samples (with an appropriate lamp, complete photometric, mechanical and electrical data, list of materials and finishes and unit cost to the Owner) of both the specified brand and the proposed substitutes as required to make complete comparison and evaluation. These samples shall be in addition to those required by Lighting Fixture Specification. The above data shall be delivered separately to the Architect and the Lighting Designer. The fixture samples shall be furnished and installed, at the bidder's expense, at the location selected by the Architect. In addition, the bidder shall furnish the Architect and the Lighting Designer with the name and location of at least one completed project where each proposed substitute has been in operation for a period of at least six (6) months, as well as the names and addresses of the Owner, the Lighting Designer and the Architect of record.

1.7 SUBMITTALS

A. For standard catalog items with no modifications, submit catalog cut sheets prepared by the manufacturer which clearly show all elements to be supplied and all corresponding product data (including lamping; ballast manufacturer and model number; voltage; accessories or options and any miscellaneous items detailed in the written description of the specification.) If cut sheet shows more than one (1) fixture type, all non-applicable information shall be crossed out.

B. For standard cataloged fixtures:

1. Submit one sample cone for each fixture type for review. Submit a certificate of compliance with Alzak finish requirements with all requests for approval.
2. When more than one louver panel occurs in a fixture, submit as a part of shop drawings the dimensioned layout of individual louver panels and supporting "tee" members.

C. For custom fixtures, modified fixtures or linear fixtures mounted in continuous rows, submit an engineered line drawing prepared by the manufacturer showing all details of construction, lengths of runs, lamping layout, pendant locations, power locations, finishes and list of materials. Drawings must be to scale. Contractor shall provide manufacturer with field dimensions where required. If scallop shields, wallwash reflectors or baffles are required, drawings shall indicate relative position to wall or adjacent vertical surface.

D. For all submittals under paragraphs A through C above, manufacturer shall provide submittals with fixture installation instruction sheets.

E. For all submittals under paragraphs A through C above, manufacturer shall provide submittals within two weeks of receipt of order. All submittals shall have project name and fixture type clearly shown.

F. Fixture cuts and shop drawings shall be submitted in quantities and format as described in the general conditions section the specification.

G. The Architect shall make the final determination as to whether or not the submittal contains sufficient information and reserves the right to request a shop drawing if the fixture cut is insufficient.

1.8 MOCK-UPs

A. It shall be the responsibility of the Contractor to provide a mock-up of the lighting fixture or lighting systems as indicated in the lighting fixture schedule. The mock-up shall be erected within a time period and in a location that is acceptable to the Architect.

B. The mock-up installation shall closely conform to the conditions of the actual installation as to: height, distance from ceiling, number and type of lamps, material, color and etc. The Contractor shall submit a written description of each proposed mock-up with drawings in order to obtain the Architect's approval prior to commencement of each mock-up.

C. The purpose of the mock-up will be to study the general appearance and performance of the intended lighting systems. At that time, certain minimal test variations may be requested as to lamp location, lamp type, reflector shape, color and etc. Final modifications, if any, shall be considered a part of these Specifications and shall be accomplished with no additional cost to the Owner.

1.9 SAMPLES

A. It shall be the responsibility of the Contractor to provide a sample(s) fixture as indicated in the Lighting Fixture Schedule at the end of this section. When samples are called for the manufacturer shall provide two working samples complete with lamp, ballast (rated for 120 Volt operation) and 6’ pig-tail with 3-prong Edison plug.

B. The sample(s) shall be shipped to a location that is determined by the Architect. Shipping and return shipping costs shall be provided as part of the contract.

C. The purpose of the sample is to review manufacturing techniques, detailing, lamping and scale. Sample fixtures must be approved prior to fabrication of fixtures for the project. Minor modifications, if any, shall be considered part of these Specifications and shall be accomplished with no additional cost to the Owner.

D. Sample fixtures may not be used on the project.

1.10 EXTRA STOCK

A. Furnish to the Owner and store at the site where directed, extra stock of each type of lighting fixture type and lamp type installed in the Project equaling 5% for each lighting fixture type as required by Owner, packaged in manufacturer's unopened cartons and identified as to contents by fixture type.

B. Furnish items above with appropriate quantity of each exposed trim, fastener, bracket and other items as required for a complete installation.

1.11 WARRANTIES

A. All fixtures and workmanship shall be guaranteed free of defects and fully operational for a minimum of one year after the acceptance of the project by the Owner. Any fixtures or workmanship found to be defective during the warranty period will be either fixed or replaced by the Contractor at no cost to the Owner.

PART 2 - PRODUCTS

2.1 GENERAL MATERIAL REQUIREMENTS

A. Ferrous mounting hardware and accessories shall be finished using either a galvanic or phosphate primer/baked paint process to prevent corrosion and discoloration of adjacent materials.

B. For weatherproof and vapor-tight installation, painted finishes of fixtures and accessories shall be weatherproof enamel using proper primers or hot dipped galvanized and bonderized epoxy, in accordance with manufacturer's requirements. Unless otherwise specified all painted surfaces shall have a life expectancy of not less than twenty years.

1. Hangers shall be conduit with chemically resistant, weatherproof, baked enamel finish.
2. Where dissimilar metal parts come in contact with each other, apply to both surfaces a coating material to prevent corrosion.
3. Colors shall be as specified in the Lighting Fixture Schedule at the end of this section.

C. Fasteners shall be manufactured of non-magnetic stainless steel or anodized aluminum, except in indoor applications where galvanized steel shall be acceptable.

D. Fixtures shall be free of light leaks and shall be designed to provide sufficient ventilation of lamps and ballasts including vent holes where required.

E. Outdoor fixtures shall have wire mesh corrosion resistant screens in the vent holes properly sized to prevent incursion of insects, small animals, and/or other small rodents.

F. All sheet metal work shall be free from tool marks and dents and shall have accurate angles bent as sharp as compatible with the gauges of the required metal. All intersections and joints shall be formed true and of adequate strength and structural rigidity to prevent any distortion after assembly. All sheet metal shall be free of light leaks. All edges shall be finished so there are no sharp edges exposed. All miters shall be in accurate alignment with abutting intersecting members. Piecing of plates in individual runs in single planes and the use of spliced pieces or filler material to cover defective workmanship shall not be acceptable. Sheet metal work shall be properly fabricated so that planes will not deform (i.e. become concave or convex, due to normal expected ambient and operating conditions).

G. Lampholders shall hold lamps securely against normal vibrations and maintenance handling. Provide solid nickel or nickel-and-silver-plated contacts in lampholders for the following types of lamps:

1. Lamps in outdoor fixtures.

H. Wiring channels and lampholder mountings shall be rigid and accurately made.

I. Reflector Cones:

1. Provide 45 degree lamp and lamp image cut-off unless otherwise specified. In fixtures where upper reflector is separate from cone, cut-off shall be 45 degrees unless otherwise specified.
2. Plastic materials shall not be used for reflector cones or aperture plates.
3. Fixtures in which reflector cones are riveted or welded to housing or where removal of cone requires pressure to be applied to finished surface of reflector shall not be acceptable.
4. Cone flange shall be formed as an integral part of the cone and shall have identical color and finish as the cone, except as shown. The flange major surface shall be perpendicular to the cone axis. The width of the flange shall adequately cover the ceiling opening without light leaks. No fixture parts (housing, mounting frame, etc.) shall be visible between the ceiling surface and the edge of the cone flange. The same requirement shall be applicable to fixtures where main reflector extends down to the bottom edge of the fixture without a separate cone. In such case, the flange shall be formed as an integral part of the main reflector.
5. Reflector cones shall be manufactured of uniform gauge, not less than 0.032-inch thick, high purity aluminum Alcoa 3002 alloy free of spin marks or other defects or blemishes caused during manufacturing.

6. The finish of the inner surface of the reflector shall be highly specular as produced under the Alzak process. The reflector shall have an anodic coating of not less than four mils thick. The reflector inner surface shall be free of water spotting and shall maintain a reflectivity ratio of not less than 85percent on clear specular finish. The reflector shall have a low iridescence finish free from multiple colors seen from normal viewing angles. Colors shall be derived from dyes supplied by Sandoz Chemical Company or approved equal.
7. The reflecting surface of the cone shall be tested for proper sealing. Test per ASTM B136-63T.
8. Fixtures with Alzak reflector cones, unless otherwise specified, must be furnished by the same manufacturer.
9. Reflector cone retention devices shall not deform cone in any manner whatsoever.
10. Submit a certificate of compliance with Alzak finish requirements with all requests for approval.

J. Lenses:

1. Fresnel:

   a. Lens shall have uniform brightness throughout the entire visible area at angles from 45 degrees to 90 degrees from vertical, without bright spots or striations.
   b. Lens shall have opaque risers; color shall be as specified in the Lighting Fixture Schedule at the end of this section.
   c. Finish of visible regress surface of door shall be matte baked enamel paint, special color as selected by Architect.
   d. All fixtures with fresnel lenses, unless otherwise specified, must be furnished by the same manufacturer.

2. Glass:

   a. Flat glass lenses shall be heat tempered borosilicate glass unless otherwise noted.
   b. Glass finishes, i.e. sandblasting, etching, polishing shall be performed as described in the fixture description.

3. Acrylic:

   a. Lenses shall be of injection molded crystal clear material 100% virgin acrylic (except as shown). For lenses with male pattern of pyramids or cones, specified minimum thickness refers to distance from flat surface to base of pyramids (cones), or thickness of undisturbed material. For lenses with female pattern, specified minimum thickness refers to overall thickness of material.
   b. Lenses shall fully eliminate lamp images when viewed from all directions within the 45 degrees to 90 degrees angle from vertical when the ratio of lamp spacing to the distance from lamp underside to top of lens does not

exceed 1.50. Within the viewing angle from 0 degrees to 45 degrees the ratio of maximum brightness (under a lamp) to minimum brightness (between lamps) shall not exceed 3 to 1.

c. Finishes, i.e. sandblasting, etching, polishing shall be performed as described in the fixture description.

K. Louvers:

1. Parabolic:

a. Louvers shall be continuously bound in channel formed frame, finish and color as specified or as selected.
b. Louver shall provide a minimum visual cut-off to the lamp of 45 degrees.
c. The finish of the inner surface of the reflector shall be highly specular as produced under the Alzak process. The reflector shall have an anodic coating of not less than four mils thick. The reflector inner surface shall be free of water spotting and shall maintain a reflectivity ratio of not less than 85 percent on clear specular finish. The reflector shall have a low iridescence finish free from multiple colors seen from normal viewing angles.

2. Flat Blade:

a. Provide flat blade louvers within formed frame, finish and color as specified.
b. Louvers to provide minimum of 45 degree cut-off from lamp image.
c. Blade thickness to minimum 0.125-inch flat steel.

L. In adjustable fixtures, aiming and positive locking devices shall be provided.

M. Fixtures with an adjustable lamp and using a lamp with an asymmetrical light pattern shall have an aiming stop which can be permanently set so that the lamp shall remain correctly positioned after service or relamping.

N. Solid State Lighting / Light Emitting Diode (LED) Lamps and Luminaires:

1. General:

a. Luminaire manufacturer shall have a minimum of five (5) years experience in the manufacture and design of LED products and systems and no less than one hundred (100) North American installations.
b. Unless otherwise specified, all LED luminaires and power/data supplies shall be provided by a single manufacturer to ensure compatibility.
c. All components, peripheral devices and control software are to be provided by and shall be the responsibility of a single entity. All components shall perform successfully as a complete system and shall operate as described in Lighting Designer’s Control Narrative documents and the Lighting Fixture Schedule at the end of this section.

d. Provide submittals as described in Part 1 above.
e. Include all components necessary for a complete installation. Provide all power supplies, synchronizers, data cables, and data terminators for a complete working system.
f. All LED sources used in the LED luminaire shall be of proven quality from established and reputable LED manufacturers and shall have been fabricated after 2007. Acceptable LED lamp manufacturers unless otherwise noted are:

1) Cree, Inc.
2) Philips Lighting
3) Nichia Corporation
4) Norlux
5) Opto Technology, Inc.
6) Osram Optronic Semiconductors

2. Replacement and Spares:

a. Manufacturer shall provide written guarantee of the following:

1) Manufacturer will keep record of original bin for each LED module and have replacement modules from the same bin available for three (3) years after date of installation.
2) Manufacturer will keep an inventory of replacement parts (source assembly, power and control components).
3) Manufacturer's LED system will not become obsolete for ten (10) years: Manufacturer will provide exact replacement parts, or provide upgraded parts that are designed to fit into the original luminaire and provide equivalent distribution and lumen output to the original, without any negative consequences.

b. All parts of system shall replaceable in field. Manufacturer shall provide written guarantee of the following:

1) Manufacturer has in place a written recycling and re-use program, and will accept returned product and/or components for recycling or re-use.
2) Manufacturer will properly dispose of non-recyclable components that are deemed harmful to the environment.

c. System shall carry a full warranty for five (5) years. Manufacturer shall be responsible for cost of labor not to exceed $50 per individual part, and cost of shipping, to replace any component of the system that fails within 2 years of installation.

3. Products and Components – Performance

a. LED luminaires and components shall be UL listed or UL classified.

b. LED luminaires and components shall be CE certified.
c. LED luminaires and components shall be PSE marked.
d. All LED luminaires shall be subjected to the following JEDEC Reliability Tests for Lead-free Semiconductors: HTOL, RTOL, LTOL, PTMCL, TMSK, Mechanical Shock, Variable Vibration Frequency, SHR, Autoclave.
e. To ensure luminaire quality, luminaire shall have been tested under accelerated life test conditions including an operating temperature span of 360 degrees Fahrenheit, and cyclic loading up to 60G.
f. All products included in system shall use Mil-Std 810F, Random Vibration 7.698g as a minimum standard. In installations subject to vibration, luminaire shall be installed with vibration isolation hardware to sufficiently dampen vibrations.
g. All LED components shall be mercury and lead-free.
h. All manufacturing processes and materials shall conform to the requirements of the European Union's Restriction on the Use of Hazardous Substances in Electrical and Electronics Equipment (RoHS) Directive, 2002/95/EC.
i. LEDs shall comply with ANSI/NEMA/ANSLG C78.377-2008 – Specifications for the Chromaticity of Solid State Lighting Products. Color shall remain stable throughout the life of the lamp. Color shall match approved sample.
j. LEDs shall comply with IESNA LM-80 – Standards for Lumen Maintenance of LED Lighting Products
k. White LEDs shall have a rated source life of 50,000 hours under normal operating conditions. RGB LEDs shall have a rated source life of 100,000 hours. LED “rated source life” is defined as the time when a minimum of 70 percent of initial lumen output remains. Refer to lighting fixture schedule for minimum rated life.
l. Luminaire assembly shall include a method of dissipating heat so as to not degrade life of source, electronic equipment, or lenses. LED luminaire housing shall be designed to transfer heat from the LED board to the outside environment. Luminaire housing shall have no negative impact on life of components.
m. Manufacturer shall supply in writing a range of permissible operating temperatures in which system will perform optimally.
n. High power LED luminaires shall be thermally protected using one or more of the following thermal management techniques: metal core board, gap pad, and/or internal monitoring firmware
o. LEDs shall be adequately protected from moisture or dust in interior applications.
p. For wet and damp use, LED-based luminaires itself shall be sealed, rated, and tested for appropriate environmental conditions, not accomplished by using an additional housing or enclosure. Such protection shall have no negative impact on rated life of source or components, or if so, such reductions shall be explicitly brought to the attention of the designer.
q. All hardwired connections to LED luminaires shall be reverse polarity protected and provide high voltage protection in the event connections are reversed or shorted during the installation process.

r. The LED luminaire shall be operated at constant and carefully regulated current levels. LEDs shall not be overdriven beyond their specified nominal voltage and current.
s. RGB LED luminaires shall utilize an equal combination of high brightness red, blue and green LEDs, unless otherwise noted, to provide up to 16.7 million additive RGB colors and shall be capable of at least 8-bit control.
t. Manufacturer shall be able to provide supporting documentation of the product meeting third party regulatory compliance.
u. Manufacturer shall ensure that products undergo and successfully meet appropriate design and manufacturability testing including Design FMEA, Process FMEA, Environmental Engineering Considerations and Laboratory Tests, IEC standards and UL/CE testing.
v. All LED luminaires (100 percent of each lot) shall undergo a minimum twenty-four (24) hour burn-in during manufacturing, prior to shipping.
w. Manufacturer shall provide Luminaire Efficacy (lm/W), total luminous flux (lumens), luminous intensity (candelas) chromaticity coordinates, CCT and CRI. optical performance, polar diagrams, and relevant luminance and illuminance photometric data. Provide data in IES file format in accordance with IES LM-79-2008, based on test results from an independent Nationally Recognized Testing Laboratory.
x. Power / data supply shall have the following:

1) Supply outputs shall have current limiting protection.
2) Supply shall provide miswiring protection.
3) Supply shall have power factor correction.
4) Supply shall provide connections that are conduit-ready or clamp-style connections in the case of low-voltage wiring.
5) Supply shall come with a housing that meets a minimum IP20 rating for dry location installation unless located in a damp or wet location.
6) Supply shall be UL listed for Class 1 or Class 2 wiring

y. Remote LED drivers shall be capable of being field-attached to allow for routing of low-voltage cable per architectural and electrical drawings.

4. LED Control and Communication – Performance

a. LED luminaires shall be network controllable via digital control. Refer to Section 26 09 24 for Architectural Lighting Controls requirements.
b. The LED system shall use integral and differential non-linear control.
c. Constant data transmission rates shall be employed, resulting in the output being independent of distance of cable between power supply and light source within the specified length.
d. LED system shall have a selectable means of external control via a data network.
e. Each LED luminaire and/or node shall have the capability to be set to a unique and individual address. Address shall be selectable through on board switches or by an external hardware or software method.

f. The LED system shall be scalable, with every LED luminaire/address in the system capable of being controlled by a single, centralized controller.

O. Wiring:

1. Voltage Rating

a. For voltages up to 120 volts fixture wiring shall be rated for 300 volts minimum.
b. For voltages above 120 volts fixture wiring shall be rated for 600 volts minimum.

2. Temperature Rating - Internal to Fixture

a. All wiring shall be code-approved for fixture wiring, and shall comply with the following temperature ratings unless fixture design or local codes require higher temperature wire.
b. High Intensity Discharge

1) minimum rating between lampholder(s) and separate junction box or connections with ballast components.
2) minimum rating between core and coil ballast components and separate junction box.
3) minimum rating between encased and potted ballast components and separate junction box.

3. Temperature Rating - External to Fixture

a. All flexible cord wiring between fixture components or to electrical receptacle and not in wireways shall have a minimum temperature rating of 105 degrees Celsius.
b. Cord type shall be suitable for application and shall be fitted with proper strain relief and watertight entries where required by application.

4. Splices

a. Splices internal to fixture shall be made within separate splice compartments and shall utilize nylon insulated crimped connections or insulated quick disconnects.
b. Splices to branch circuit wiring in separate junction boxes shall utilize flame retardant thermoplastic caps with fully seated helical metal spring and threaded entry.

5. No internal wiring shall be visible at normal viewing angles, i.e., above 45 degrees from vertical. Use additional wire clamps if necessary. Anticipate increased visibility if fixtures are mounted on or recessed within a sloping surface.

6. Any fixture fed from more than one panel, i.e., for normal and night or emergency operation, shall have separate neutrals to each panel.
7. Furnish code-approved wiring in ceiling cavities forming air plenums.

P. Air Handling Troffer Fixtures:

1. Refer to mechanical drawings and specifications for requirements, if any.
2. Air diffusers shall be supplied by others.

Q. Pole/Luminaire Assemblies:

1. Supply luminaires, davit arms, brackets, poles, handhole covers, base components, and all other accessories complete by specified manufacturer who will be responsible for proper fitting of all elements.
2. Manufacturer will supply assembly to withstand 100 mph winds with a 1.3 gust factor without permanent deflection.
3. Manufacturer shall be responsible for design of and structural integrity of complete base (i.e., concrete dimensions, rebar requirements, grounding and conduit requirements, drainage and ground compaction requirements).

PART 3 - EXECUTION

3.1 SHIPPING AND STORAGE

A. All fixtures received at the site shall be stored in clean and dry space until fixtures are installed.

B. Manufacturer shall clearly mark each box with fixture designation prior to shipping.

C. Reflector cones, baffles, louvers, aperture plates, and decorative elements of fixtures shall be packed by the manufacturer separate from the housing (body, stem, etc.) of the fixture.

3.2 LOCATION

A. Locations of fixtures are shown diagrammatically. Verify exact location and spacing with Reflected Ceiling Plans and other reference data before ordering of fixtures and during installation.

B. Notify Architect about field conditions at variance with Contract Documents before commencing installation.

C. Coordinate space conditions with other trades before ordering of fixtures.

D. Pendant mount, as approved, surface type fixtures where required to meet space conditions.

E. Coordinate length of continuous-run fixtures with adjacent walls, partitions, coffers and other architectural elements as required.

1. Continuous runs shall be defined as the optimal combination of 3’ and 4’ lamp length as necessary to complete runs with no more than 6” of free space at either end of the run as provided by the contractor.

3.3 INSTALLATION

A. Provide accessories as required for ceiling construction type indicated on Finish Schedule. Fixture catalog numbers do not necessarily denote specific mounting accessories for type of ceiling in which a fixture may be installed.

B. Provide adequate and sturdy support for each lighting fixture. Contractor shall be responsible for verifying weight and mounting method of all fixtures and furnish and install suitable supports. Fixture mounting assemblies shall comply with all local seismic codes and regulations.

C. Install rows of fixtures accurately on straight lines unless otherwise indicated on drawings. Coordinate with mechanical work.

D. Install fixtures with vent holes free of air blocking obstacles.

E. Where plaster ceilings occur, furnish plaster frames for setting under other applicable sections. Direct the setting and be responsible for correct location; make sure the bottom of frame is flush with finished ceiling, forming screed edge for finished plaster.

1. Fixtures shall be supported by plaster frames utilizing yokes or leveling lugs.

a. Fixtures and support elements shall not be mounted to or in contact with ducts or pipes.
b. Yoke shall have channel cross section of sufficient gauge, and shall support a fixture by means of not fewer than two (2) bolts each.

2. If air diffusers are located in common continuous rows with lighting fixtures in plaster ceilings, furnish plaster frames of proper length to accommodate diffusers.
3. Lighting fixtures recessed in ceilings which have a fire resistive rating of one hour or more shall be enclosed in a box which has a fire resistive rating equal to that of the ceiling.

F. Contractor shall be responsible for adjusting aperture rings on all ceiling recessed fixtures to accommodate various ceiling material thickness. Contractor shall responsible for coordinating the cut-out size in ceiling to ensure aperture covers cut-out entirely. The bottom of aperture rings shall be flush with finished ceiling or not more than 1/16" above. Under no circumstances will the aperture ring extend below the finished ceiling surface.

G. For fixtures with variable position lampholder assemblies Contractor shall confirm prior to installation proper lampholder (socket) position in field, and shall adjust, if necessary, after coordination with manufacturer.

H. Surface Mounted Fixtures: Support surface mounted fixtures from structural members other than ceiling tees.

I. Pendant Mounted Fixtures:

1. Pendant mounted fixtures shall be supported from structural framework of ceiling or from inserts cast into slab.
2. All pendants shall have swivel aligners located at the top ends; pendants shall be 1/2-inch rigid steel conduit unless specifically indicated otherwise on drawings or in specifications.
3. All pendant and surface mounted fixtures shall be supported with two (2) supports per four foot section or three (3) per eight foot section unless otherwise recommended by manufacturer.

J. Bracket Mounted Fixtures: For each bracket fixture, provide flanged metal stem attached to outlet box with threaded end suitable for supporting the fixture rigidly in design position. Flanged part of fixture stud shall be of broad base type, secured to outlet box at not fewer than three (3) points.

K. Top Relamping Fixtures: Top relamping fixtures shall have the necessary top-relamping screws loosened and moderately tightened, prior to installation, to assure ease of operation when relamping is required.

L. High Intensity Discharge Fixtures: Replace noisy ballasts as directed, at no cost to the Owner.

M. Solid State Lighting / Light Emitting Diode (LED) Fixtures:

1. Color Changing or Programming Support

a. Provide installation and commissioning support to the electrical contractor as required to achieve a complete and operational system that meets the intent of the Control Narrative.
b. In addition to the above, provide a factory representative for up to three (3) visits not to exceed 8 hours per visit for field calibration and programming in the presence of the Lighting Designer.

N. Mask the trims and bottoms of all lighting fixtures if necessary to protect the fixture during construction.

O. At the completion of construction clean the bottoms, the trim, the reflecting surfaces, lenses, baffles, louvers and reflector cones of all lighting fixtures so as to render them free of any material, substance or film foreign to the fixture. If the luminaires are deemed dirty by the Architect at the completion of the project, the Contractor shall

clean them at no additional cost to the Owner. Luminaire components whose finishes are damaged shall be replaced at no cost to the Owner. Refer to Division 01 for project cleaning requirements.

P. Ascertain and ensure that all lamps installed are exactly as specified for each fixture type.

Q. Replace all burned-out or inoperative lamps and inoperative ballasts before the building is accepted by the Owner so that all lighting fixtures will be in first-class operating condition.

R. Provide labor and materials for final aiming of all adjustable fixtures under the Architect's supervision. Aiming shall take place immediately before building is turned over to Owner, after regular working hours where required.

PART 4 - LIGHTING FIXTURE SCHEDULE AND CUTSHEETS

Type	Description	Mfr / Catalog No.	Alternates	Finish	Lamping	Electrical Data	Rated Life	Notes
F50	Elevator Header Lights Location: Public Elevators, ASC P1X	Dado Lighting C-LL15-2AML-35-1-W-R-S-(length)-S-(lip color)-(units)-(CL2Pxx as required) / R-X-DO10-UNV	Luminii "Kilo Recessed" Series	Custom finish per Architect	(1) 9.8 W/ft LED, 3500K, 571 lumens/ft, CRI 85+	Remote Dimming (0-10V to 10%)	L70: 50,000 hrs	1. For ASC P1X and GTF Reinstatement locations, Fixture to meet Buy American Act. Refer to 265010 for submittal requirements to be met. 2. Refer to architectural drawings for mounting details. Provide mounting accessories as required. 3. Provide all parts, accessories and components for a complete installation. Refer to manufacturer drawings for required accessories and components. 4. Provide finish per Architect. 5. Provide remote driver in an accessible, concealed and ventilated area approved by Architect and within Manufacturer's maximum remoting distance. Provide custom supply cable length as required.
F85	3" Aperture Recessed Linear LED Location: ASC P1X Circulation	Extant Lighting HTG-3R-LP-TD-(TRIM)-(LENGTH)-SLO-10-MEODF-835-(VOLTS)-DMX-(OPTIONS)	Prudential Lighting "BionicPro 4" Recessed" Nulite Lighting "Regolo 4"	Standard finish per Architect	(1) 3.8W/ft. LED, 3500K 395 delivered lumens/ft. CRI = 80+	Integral Dimming (DMX to 1%)	L90 > 60,000 hrs	1. Fixture to meet Buy American Act. Refer to 265010 for submittal requirements to be met. 2. Contractor to verify voltage and ceiling type. 3. Fixture to dim according to Zoning Intent. Contractor to verify compatibility of dimming driver with specified control system. 4. Finish to be verified by Architect. 5. Refer to architectural drawings/elevations for fixture length(s). 6. Provide continuous fixture length(s) per architectural drawings. Where individual fixtures are shown butted end-to-end on electrical drawings, provide joining sections and continuous lens such that overall fixture appears continuous. 7. Provide integral DMX dimming with per-fixture control.
F85a	3" Aperture Recessed Linear LED Location: ASC P1X Circulation	Extant Lighting HTG-3R-LP-TD-(TRIM)-(LENGTH)-DHL-MEODF-835-(VOLTS)-DMX-(OPTIONS)	Prudential Lighting "BionicPro 4" Recessed" Nulite Lighting "Regolo 4"	Standard finish per Architect	(1) 9.5W/ft. LED, 3500K 1,088 delivered lumens/ft. CRI = 80+	Integral Dimming (DMX to 1%)	L90 > 60,000 hrs	1. Fixture to meet Buy American Act. Refer to 265010 for submittal requirements to be met. 2. Contractor to verify voltage and ceiling type. 3. Fixture to dim according to Zoning Intent. Contractor to verify compatibility of dimming driver with specified control system. 4. Finish to be verified by Architect. 5. Refer to architectural drawings/elevations for fixture length(s). 6. Provide continuous fixture length(s) per architectural drawings. Where individual fixtures are shown butted end-to-end on electrical drawings, provide joining sections and continuous lens such that overall fixture appears continuous. 7. Provide integral DMX dimming with per-fixture control.
F86	4" aperture, recessed LED downlight with 50° beam spread Location: ASC P1X	Gotham Lighting ICO4-35/25-(REFLECTOR)-LSS-50D-(VOLTS)-EDXB-(OPTIONS)	Focal Point "ID+ 4.5" Adjustable Accent" USAI Lighting "B4RA Round"	Standard finish per Architect	(1) 26.5W LED, 3500K 2419 delivered lumens CRI = 80+ 50° Beam Angle	Integral Dimming (DMX to 0%)	L70: 60,000 hrs	1. Fixture to meet Buy American Act. Refer to 265010 for submittal requirements to be met. 2. Contractor to verify voltage and additional mounting accessories. 3. Fixture to dim according to Zoning Intent. Contractor to verify compatibility of dimming driver with specified control system. 4. Trim finish to be verified by Architect.
F86a	4" aperture, recessed LED downlight with 50° beam spread Location: ASC P1X	Gotham Lighting ICO4-35/10-(REFLECTOR)-LSS-50D-(VOLTS)-EDXB-(OPTIONS)	Focal Point "ID+ 4.5" Adjustable Accent" USAI Lighting "B4RA Round"	Standard finish per Architect	(1) 9.8W LED, 3500K 1,062 delivered lumens CRI = 80+ 50° Beam Angle	Integral Dimming (DMX to 0%)	L70: 60,000 hrs	1. Fixture to meet Buy American Act. Refer to 265010 for submittal requirements to be met. 2. Contractor to verify voltage and additional mounting accessories. 3. Fixture to dim according to Zoning Intent. Contractor to verify compatibility of dimming driver with specified control system. 4. Trim finish to be verified by Architect.

F87	110° Beam Angle Linear LED Cove Light within an Architectural Cove Location: ASC P1X Restrooms	Lumenpulse Lighting LCS2RO-(VOLTS)-(LENGTH)-35K-FR-(FINISH)-DMX/RDM-BUYAMERICA; CBX-DMX/RDM	Tempo Lighting "CLIP 5"	Standard finish per Architect	(1) 5W/ft. LED, 3500K CRI=80+ 511 delivered lumens/ft. 120° Beam Angle	Integral Dimming (DMX to 1%)	L70: 75,000 hrs	1. Fixture to meet Buy American Act. Refer to 265010 for submittal requirements to be met. 2. Provide continuous fixture length(s) per architectural drawings. Contractor shall field verify finished wall to wall distance for complete fixture length(s) prior to fixture ordering. 3. Contractor to coordinate mounting with architectural and field conditions. 4. Provide white fixture finish. Architect to confirm. 5. Contractor to provide necessary cables, connectors, feeds, etc. for a complete a functioning lighting system. 6. Refer to architectural drawings for mounting details.
F87a	110° Beam Angle Linear LED cove light within an Architectural Cove Location: ASC P1X Gate Entries	Lumenpulse Lighting LCS2HO-(VOLTS)-(LENGTH)-35K-FR-(FINISH)-DMX/RDM-BUYAMERICA; CBX-DMX/RDM	Tempo Lighting "CLIP 5"	Standard finish per Architect	(1) 12W/ft. LED, 3500K CRI=80+ 1,040 delivered lumens/ft. 120° Beam Angle	Integral Dimming (DMX to 1%)	L70: 75,000 hrs	1. Fixture to meet Buy American Act. Refer to 265010 for submittal requirements to be met. 2. Provide continuous fixture length(s) per architectural drawings. Contractor shall field verify finished wall to wall distance for complete fixture length(s) prior to fixture ordering. 3. Contractor to coordinate mounting with architectural and field conditions. 4. Provide white fixture finish. Architect to confirm. 5. Contractor to provide necessary cables, connectors, feeds, etc. for a complete a functioning lighting system. 6. Refer to architectural drawings for mounting details.
F88	Surface mounted 3.5" diameter x 10.5" tall LED downlight with DMX integral driver within architectural slot Location: ASC P1X Restrooms	USAI Lighting CMRD10-15X3-35KS-40-S-(FINISH)-SM-(VOLTAGE)-DMX-	Spectrum "pro-form" Series with Modified Driver	Standard finish per Architect	(1) 15 W LED, 3500K 1425 delivered lumens CRI=80+ 40° Reflector	Integral Dimming (DMX to 0%)	L70: >50,000 hrs	1. Fixture to meet Buy American Act. Refer to 265010 for submittal requirements to be met. 2. Contractor to verify voltage and additional mounting accessories. 3. Fixture to dim according to Zoning Intent. Contractor to verify compatibility of dimming driver with specified control system. 4. Fixture finish to be verified by Architect. 5. Provide 40° flood reflector option. 6. Note alternates may require adjustment to mounting details.
F88a	Surface mounted 3.5" diameter x 10.5" tall LED downlight with DMX integral driver within architectural slot Location: ASC P1X Gate Entries	USAI Lighting CMRD10-20X3-35KS-55-S-(FINISH)-SM-(VOLTAGE)-DMX-	Spectrum "pro-form" Series with Modified Driver	Standard finish per Architect	(1) 20 W LED, 3500K 1950 delivered lumens CRI=80+ 55° Beam Spread	Integral Dimming (DMX to 0%)	L80: >50,000 hrs	1. Fixture to meet Buy American Act. Refer to 265010 for submittal requirements to be met. 2. Contractor to verify voltage and additional mounting accessories. 3. Fixture to dim according to Zoning Intent. Contractor to verify compatibility of dimming driver with specified control system. 4. Fixture finish to be verified by Architect. 5. Provide 55° flood reflector option. 6. Note alternates may require adjustment to mounting details.
F89	4" Wet Listed Recessed LED Linear Location: ASC P1X Pet Relief Rooms	Mark Architectural Lighting SL4L-LOP-(LENGTH)-FLP-(CEILING)-80CRI-35K-600LMF-S80CRI-MIN1-(VOLTS)-(FINISH)-(OPTIONS)-ZT-BAA-WL	Selux Lighting "M125 LED"	Standard finish per Architect	(1) 6W/ft. LED, 3500K 544 delivered lumens/ft 80+ CRI	Integral Dimming (0-10V to 10%)	L80: 65,000 hrs	1. Fixture to meet Buy American Act. Refer to 265010 for submittal requirements to be met. 2. Provide continuous fixture length(s) per architectural drawings. Contractor shall field verify fixture length(s) prior to fixture ordering. 3. Contractor to coordinate mounting with architectural ceiling conditions. Provide mounting accessories as required. 4. Provide finish per Architect. 5. Fixture to be UL listed and labeled "suitable for wet locations."

F90	1.5" aperture, wall-recessed Linear LED Sconce Location: ASC P1X Restrooms	Extant Lighting HTG-1RW-LP-RD-(TRIM)-(LENGTH)-SLO-8-MEODF-935-(VOLTS)-DMX-(OPTIONS)	Axis Lighting "Beam2 Vertical" Series ALW "Lightplane 2" Series	Standard finish per Architect	(1) 3W/ft LED, 3500K 273 delivered lumens/ft 90+ CRI	Remote Dimming (DMX to 1%)	L90: 100,000+ hrs L70: 200,000+ hrs	1. Fixture to meet Buy American Act. Refer to 265010 for submittal requirements to be met. 2. Refer to architectural drawings for mounting information. Provide mounting accessories as required. 3. Refer to architectural drawings for fixture length. 4. Fixture to be UL listed and labeled "suitable for damp locations." 5. Provide finish per Architect. 6. Contractor to coordinate flange type and mounting with architectural and field conditions. Provide modified mounting and/or flange as required.
F91	Perimeter-mounted Linear LED Wall Grazer Location: ASC P1X Restroom entries at feature tile	Prudential P43-PSTD-REG3-LED35-MO-(length)-(trim)-AWW-D1G-WTW SC-(ceiling)-UNV-DM01	Coronet Lighting "Flawless - Wall Grazer" Nulite Lighting "RZ4"	Standard finish per Architect	(1) 7W/ft. LED, 3500K 550 lm/ft.	Integral Dimming (DMX to 1%)	L70: 150,000 hrs	1. Fixture to meet Buy American Act. Refer to 265010 for submittal requirements to be met. 2. Contractor to coordinate mounting with architectural and field conditions. 3. Provide fixture finish per architect. 4. Provide continuous length(s) per architectural drawings.
F91a	Perimeter-mounted Linear LED Wall Grazer Location: ASC P1X Restroom fixture walls	Prudential P43-PSTD-FLSH-LED35-MO-(length)-(trim)-AWW-D1G-WTW SC-(ceiling)-UNV-DM01	Coronet Lighting "Flawless - Wall Grazer" Nulite Lighting "RZ4"	Standard finish per Architect	(1) 7W/ft. LED, 3500K 550 lm/ft.	Integral Dimming (DMX to 1%)	L70: 150,000 hrs	1. Fixture to meet Buy American Act. Refer to 265010 for submittal requirements to be met. 2. Contractor to coordinate mounting with architectural and field conditions. 3. Provide fixture finish per architect. 4. Provide continuous length(s) per architectural drawings.
F92	8" diameter, ingrade LED uplight with narrow spot beam spread Location: ASC P1X East Windows	Vista Professional Lighting 1185-(FINISH)-NS-35-A-MV-AX-010-(CONDUIT ENTRY)-(ACCESSORIES)	BK Lighting* "CO2 LED Integral" Hydrel Lighting "M9400C" *Requires custom color temperature	Custom finish per Architect	(1) 16W LED, 3500K, 981 delivered lumens CRI = 83+ Narrow Spot optics	Integral Dimming (0-10V)	TBC	1. Fixture to meet Buy American Act. Refer to 265010 for submittal requirements to be met. 2. Provide finish per Architect. 3. Contractor to coordinate mounting with architectural field conditions. Provide mounting accessories as required. 4. Provide remote driver in an accessible and concealed location approved by Architect and within Manufacturer's maximum remoting distance. 5. Provide fixture with narrow spot optics
F93	2"-Wide Recessed LED Linear White Light Fixture with 2" "Dropped" Lens with Glowing End Caps Location: ASC P1X Concourse	Nulite Lighting RG2-06-L35-(VOLTS)-MOD(DMX)-1/1-STL2-(FINISH)-(LENGTH)-(OPTIONS)	Coronet Lighting "LSR3-RGBW" Picasso Lighting "Max 2.5 Drop Lens" Series	Standard finish per Architect	(1) 6.4W/FT LED, 3500K 505 delivered lumens/ft CRI=80+	Integral Dimming (0-10V to 1%)	L90: 100,000+ hrs	1. Fixture to meet Buy American Act. Refer to 265010 for submittal requirements to be met. 2. Provide fixture with custom 2" frosted drop lens with illuminated ends. 3. Provide continuous fixture length(s) per architectural drawings. Where individual fixtures are shown butted end-to-end on electrical drawings, provide joining sections and continuous lens such that overall fixture appears continuous. 4. Provide integral 0-10v to 1% dimming driver. Fixture to dim per zoning intent. 5. Provide trim finish per Architect.
F93a	2"-Wide Recessed LED Linear RGBW Fixture with 2" "Dropped" Lens with Glowing End Caps Location: ASC P1X Concourse	Nulite Lighting RG2-06-MOD(RGBW)-(VOLTS)-MOD(DMX)-1/1-STL2-(FINISH)-(LENGTH)-(OPTIONS)	Coronet Lighting "LSR3-RGBW" Picasso Lighting "Max 2.5 Drop Lens" Series	Standard finish per Architect	TBD W/ft (RGB+3500K White) CRI 80+ Allow up to 14W/ft	Integral Dimming (DMX to 0%, per-fixture resolution)	TBC	1. Fixture to meet Buy American Act. Refer to 265010 for submittal requirements to be met. 2. Provide continuous fixture length(s) per architectural drawings. Where individual fixtures are shown butted end-to-end on electrical drawings, provide joining sections and continuous lens such that overall fixture appears continuous. 3. Provide integral DMX dimming driver. Provide per-fixture dimming control. 4. Provide trim finish per Architect. 5. Provide custom 2" dropped lens with glowing end caps.

ARCHITECTURAL LIGHTING FIXTURES
Section 26 5010

Orlando International Airport
BP-S195: TERM C, PH 1X – AIRSIDE CONCOURSE

F94	4" Aperture, IP67 Rated, Surface Mounted Linear LED Downlight Location: ASC P1X RLC	Insight Lighting ME-MO-35K-100-FM-48-(VOLTAGE)-DMX-(FINISH)-CRF / CDS-RDM			Custom finish per Architect	982 delivered lumens per foot, CRI = 80+, 3500K Allow 9.0W/ft	Integral Dimming (DMX to 1%)	75,000 hrs	1. Provide fixture with IP66 Rating. 2. Provide fixture with integral DMX control, with per fixture control. 3. Provide fixture finish per architect. 4. Provide continuous fixture length(s) per architectural drawings. Contractor shall field verify fixture length(s) prior to fixture ordering. 5. Contractor to coordinate mounting with architectural and field conditions. 6. Provide manufacturer shop drawings showing all parts, systems, components and installation information for review and comment prior to release for production. 7. Fixture to meet Buy American Act. Refer to 265010 for submittal requirements to be met.
F95	Surface-mounted wet rated downlight Location: ASC P1X RLC	Gotham ICO4SC-35/20-(REFLECTOR COLOR)-(REFLECTOR FINISH)-60D-(VOLTAGE)-EDXB-(MOUNTING)-WL			Per Architect	(1) 21.5W LED, 3500K, 1977lm CRI = 80+ ~60° Beam Spread	Integral Dimming (DMX to 1%)	L70: >50,000 hrs	1. Refer to architectural drawings for mounting information. 2. Provide mounting accessories as required. 3. Provide finish per Architect. 4. Fixture to be wet rated. 5. Fixture to meet Buy American Act. Refer to 265010 for submittal requirements to be met.
F96	Wet Rated Wall Sconce Location: ASC P1X RLC	Lithonia Lighting ASW1 LED-42C-700-30K-SR4-(VOLTAGE)-(MOUNTING)-DMG-(OPTIONS)-(FINISH)			Per Architect	(1) 98W LED, 3000K, 8,476lm CRI = 70+	Integral Dimming (0-10V)	L85: >100,000 hrs	1. Refer to architectural drawings for mounting information. 2. Provide mounting accessories as required. 3. Provide finish per Architect. 4. Fixture to meet Buy American Act. Refer to 265010 for submittal requirements to be met.
F97	Wet Rated Pendant with a "hang-straight" swivel Location: ASC P1X RLC	Gotham Lighting ICO4CC-35/-10-(REFLECTOR COLOR)-(REFLECTOR FINISH)-60D-(VOLTAGE)-EDXB-JBX-CCAN45-C120-WL-			Per ARchitect	10W LED, 3500K, 1067 Delivered Lumens CRI= 80+	Integral Dimming (DMX)		1. Refer to architectural drawings for mounting information. 2. Provide mounting accessories as required. 3. Provide finish per Architect. 4. Fixture to be wet rated. 5. Fixture to meet Buy American Act. Refer to 265010 for submittal requirements to be met.
F98	Elevator Header Lights Location: Public Elevators, ASC P1X	Insight Lighting MER-MO-35K-100-SM-(FIXTURE LENGTH)-DMX-(FINISH)-WL / CDS-RDM			Custom finish per Architect	(1) 9 W/ft LED, 3500K, 687 Delivered lumens/ft, CRI 82+	Remote Dimming (DMX to 1%)	L70: 75,000 hrs	1. Fixture to meet Buy American Act. Refer to 265010 for submittal requirements to be met. 2. Refer to architectural drawings for mounting details. Provide mounting accessories as required. 3. Provide all parts, accessories and components for a complete installation. Refer to manufacturer drawings for required accessories and components. 4. Provide finish per Architect. 5. Provide remote driver in an accessible, concealed and ventilated area approved by Architect and within Manufacturer's maximum remoting distance. Provide custom supply cable length as required.

GENERAL NOTES:
1. Provide all lighting fixtures as shown complete with all lamps, completely wired, controlled and securely attached to supports.
2. Where both narrative and/or pictorial fixture descriptions are provided, the written description shall take precedence and prevail.
3. The lighting fixtures and workmanship must be in accordance with and meet the standards and regulations of the following: a.) Underwriters Laboratories b.) National Electric Code c.)Local Building and Life Safety Code Agencies.
4. All fixtures and workmanship shall be guaranteed free of defects and fully operational after the acceptance of the project by the Owner. Any fixtures or workmanship (excluding lamps) found to be defective during the warranty period will be either fixed or replaced by
5. Locations of fixtures are shown diagrammatically. Verify exact location and spacing with Plans and designer at the site during installation. Notify Owner about field conditions at variance with Contract Documents before commencing installation.
6. Provide adequate and sturdy support for each lighting fixture. Contractor shall be responsible for verifying weight and mounting method of all fixtures and furnish and install suitable supports. Fixture mounting assemblies shall comply with all local seismic codes and
7. At the completion of construction, clean lenses and reflectors of all lighting fixtures so as to render them free of any material, substance or film foreign to the fixture. Blemished, damaged, or unsatisfactory fixtures shall be replaced in a satisfactory manner. Refer to
8. Replace all burned-out or inoperative lamps, and inoperative ballasts/drivers/transformers in all fixtures before the building is accepted by the Owner so that all lighting fixtures will be in first class operating condition.
9. Contractor to review existing circuiting, verify new loads and panel capacity. Contractor shall notify Owner if a conflict between design documents and field conditions occur.
10. For all fixtures that are dimmed refer to electrical drawings for information on controls and dimming requirements. Provide appropriate dimming system based on load type. Contractor to provide all required components for a fully functioning system.
11. Contractor to provide line item pricing per fixture type with labor and installation shown as line items. Line item pricing to be provided at all official estimate sets and during final project bid along with any proposed alternate fixtures.
12. Refer to electrical drawings for Voltage information.
13. Per section 265010 Part III/U: For all adjustable fixtures provide labor and materials for final aiming and locking of all adjustable fixtures under the Architect's supervision. Aiming shall take place immediately before building is turned over to Owner, after regular

HNTB Corporation

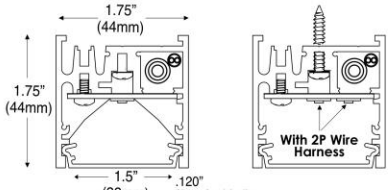
26 5010

dado Lighting

LiftLine LED 1.5 x 1-3/4"

Type:

- 1.5" wide continuous lines of light for elevators & thresholds
- General, emergency & indicator lighting for elevators and their thresholds
- Order in any length for precise fit
- Mounts within metal, stone or wood surfaces in head trimmer, door frame or elevator interior
- Provides minimum 5fc (50Lx) or 10fc (100lx) on threshold per ASME A17.1 2.11.10.2
- Can be connected to emergency lighting circuit
- Red, Green, Blue colors available for indicator lights



Ordering

Shipping	C	☐ Ship Complete Fixture
	H	☐ Ship Housing and Driver
	L	☐ Ship LED and Lens
Series	LL15	☐ LiftLine LED 1.5 inch width
Lamping	1AML	☐ Standard Output LED 4.9w/ft (16w/m)
	2AML	☐ High Output LED 9.8w/ft (32w/m)
Color	27	☐ 2700K, 85+ CRI R ☐ Red
	30	☐ 3000K, 85+ CRI G ☐ Green
	35	☐ 3500K, 85+ CRI B ☐ Blue
Wire Harness	1	☐ Single
	2 or 3	☐ Separate harnesses for multiple color sections in same housing
	2P	☐ Two harnesses with two colors parallel entire length
Lens	W	☐ White
Driver	R	☐ Remote
Start End	S	☐ Straight End
	D	☐ Internal Divider (Use to separate colored sections within the same housing)
Length	xx	☐ xx is distance in inch or mm
	xxFC	☐ Allows for housing to be field cut for exact fit (must use H shipping option)
Transition (Only if lens changes direction)	LTxx	☐ Left Turn same plane (degrees 90° to 179°)
	RTxx	☐ Right Turn same plane (degrees 90° to 179°)
	ICxx	☐ Inside Corner (degrees 90° to 179°)
		(Add Lengths & Transitions to form pattern)
Finish End	S	☐ Straight End
	D	☐ Internal Divider (Use to separate colored sections)
Lip Color	NA	☐ Natural anondiozed BK ☐ Black
	BZ	☐ Bronze __ ☐ Other
		(Add E if entire fixture needs color)
Units	mm	☐ mm
	in	☐ inches
Options	CL2Pxx	☐ Longer length CL2P supply cable (std is 15ft) to reach remote power supply.
Driver*	R	☐ Remote
Drive Qty Per Power Supply	-	☐ Blank for MLV type
	X	☐ Factory determined with N100 or D010 type
Type	MLV	☐ Mag low voltage, 100W max.
	N100	☐ Electronic, 100W max.
	DO10	☐ Dimming via 0-10Vdc
Voltage	UNV	☐ Universal 120-277V for N100 or D010 type
	-	120, 220 or 277 for MLV type

* See Power Supplies spec sheet for additional versions and details

1002 05152014

Environmental Data

For Standard Output lamping at 3000k:
W: 4.9W/ft (16W/m)
LLD: 50,000hrs @ 70%lm
20ft (6M) on one 100w driver
12ft (3.7m) on one 60w driver

For High Output lamping at 3000k:
W: 9.8W/ft (32W/m)
LLD: 50,000hrs @ 70%lm
10ft (3M) on one 100w driver

Temp range: 0° ~ 90°F (-20 ~ 30°C)
No Mercury, No UV, No Flicker
Warranty: 5 years

Specifications and dimensions subject to change without notice. Protected under U.S. Pat. 8109659 and other patents pending. info@dadolighting.com v/f 877.323.6584

Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F50

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

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dado Lighting LiftLineLED 1.5 x 1-3/4"

Housing
Extruded aluminum housing mounts via screws to framing.
Surface material* (metal, tile, stone, etc.) can abut housing sides.
* If wood on 3 sides, drill 3/4" holes behind fixture every 6" to ensure adequate venting.
Anodized for superior thermal performance.
Housings ship with 15ft CL2P cable attached to back, to reach remote power supply. Longer lengths optional.
One-piece extrusions up to 12ft (3.66m). Multiple extrusions couple together with brass barrel connector & bolt assembly plus alignment pins for secure fit and straight alignment.
End caps attach via single screw connecting to brass barrel nut plus alignment pins.
Inside corner sections overlap for even illumination without direct view of LEDs. Tab aligns housing sections at corner.
ETL listed, IC rated, damp location.

Modifications
Runs can be provided to the nearest 1/16" or 1mm.
"FC" field cutting option reduces lead time for perfect architectural fit. Housings may be cut on site up to 6" parallel to straight or factory mitered end. Then LED panels are made at factory to fit installed length.
For unique custom work, such as corners and patterns, consult factory for shop drawings.

Options
"CP" Chicago Plenum rated housing with 6ft whip of FMT attached.

Ends
"S" Machined aluminum end to start or stop a section.

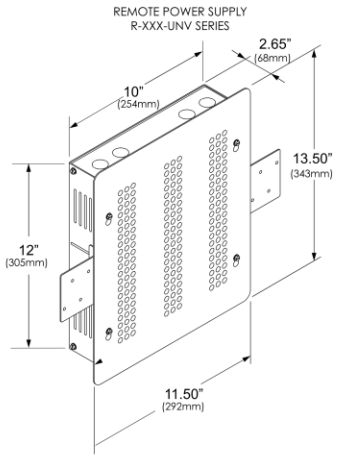
Transitions
When lens changes directions (Minimum length 3.875" or 98mm per side).
"LT" Left Turn same plane (degrees 90° to 179°); pre-assembled at factory.
"RT" Right Turn same plane (degrees 90° to 179°); pre-assembled at factory.
"IC" inside corner between two planes. Housings overlap and tab together for alignment.
"OC" outside corner around two planes; pre-assembled at factory. 90° standard, consult factory for other angles.

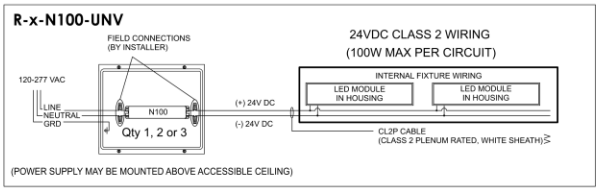
LED
Low wattage white light LED produces even distribution with no shadows.
Binned within 3 MacAdam ellipses.
Blending and overlap keep color and light output uniform.
May select Low or High output versions when ordering.

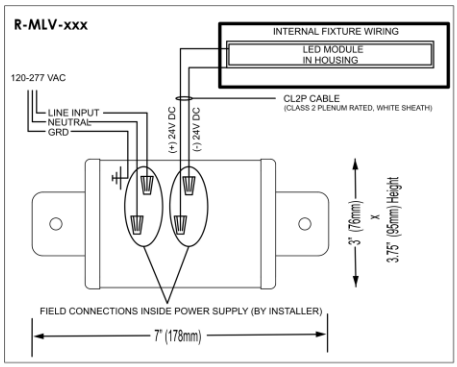
Optics
Light guide panel diffuses multiple LED sources.
Panel plugs into housing via DC barrel connects & is secured with screws for quick & easy replacement.
Snap-in high transmission acrylic lens, up to 24ft per section, provides a matte white finish & even distribution.
Lens fits flush with finished bottom of housing.
One-piece, extruded housing ensures constant lens retention along length.
"CP" Chicago Plenum rated housing with 6ft of FMT attached.

R-MLV Driver
Economical magnetic remote mounted power supply with 24Vdc Constant Voltage output for simple class 2 installation.
120V or 240V or 277V input, 50/60Hz.
Short circuit and overload protected.
Non-IC installations.
Listed for 90 C conductors with 1/2" trade size knock outs.
Housing is 304SS matte stainless steel.
See Power Supplies spec sheet for additional information.

R-x-N100 Driver
Electronic remote power supply with up to 3 100w drivers with 24Vdc Constant Voltage output for simple class 2 installation.
120V thru 277V input, 50/60 Hz.
Short circuit and overload protected.
Non-IC installations standard. Consult factory for IC installations.
Listed for 90 C conductors with 1/2" trade size knock outs.
Housing is die-formed 16ga CRS with white painted after fabrication finish.
May be surfaced or recessed mounted in 2x4 walls or above accessible ceilings..
See Power Supplies spec sheet for additional information







Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F50

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

dado Lighting

LiftLineLED 1.5 x 1-3/4"

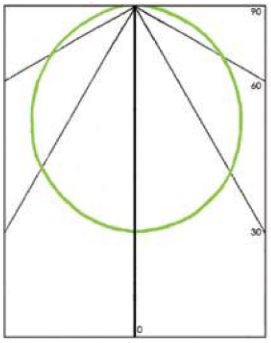
Photometric Data

BALLabs
Independent LM-79
Test No. 17943.0

Cat No.: LL15-2AML-35-1-W-R-S-24-S-in *
Meanwell Driver No.: LPV-20-24 operating at 120v
Total Lumens: 1142
* Multiply all data by .50 for 1ML lamping
Multiply all data by .60 if 2P wire harness is used

This is an absolute test per LM-79-08
Luminous Length: 24"
Width: 2.5"

Candlepower Distribution (cd)



Angle	Along	45°	Across
0°	410	410	410
5°	415	411	407
10°	407	400	399
15°	399	394	389
20°	385	378	372
25°	367	359	355
30°	348	338	334
35°	324	313	310
40°	300	291	287
45°	272	267	260
50°	243	234	229
55°	209	201	197
60°	178	172	165
65°	149	141	137
70°	111	106	105
75°	81	78	77
80°	48	48	45
85°	23	22	24
90°	0	0	0

Zonal Lumen Summary

Zone	Lumen	% Luminaire
0-30°	315	27.7%
0-40°	512	45.1%
0-60°	894	78.7%
60-90°	242	21.3%
90-180°	0	0%
0-180°	1,136.00	100%

Luminance Data (cd/m2)

Angle	Along	45°	Across
45°	16411	16065	15660
55°	15530	14960	14604
65°	14986	14213	13826
75°	13262	12788	12630
85°	11252	10783	11721

Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F50

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

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dado Lighting **LiftLineLED 1.5 x 1-3/4"**

FC levels for typical elevator threshold using 2ML fixture as shown in header. (0/50/0 reflectance values)

⊕ Denotes the start & power feed point of each run. Can be at either end; whichever is closest to remote power supply. Longer runs or multiple colors may require additional feed points

Ex. Cat #s (xx denotes lengths)

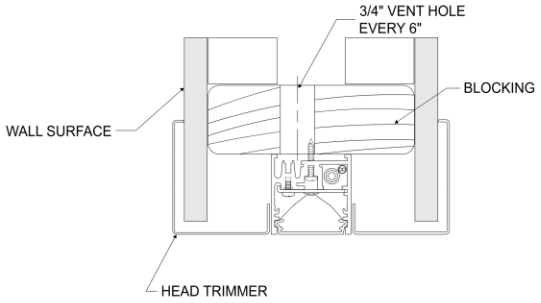
(1) White light in head trimmer over door threshold
C-LL15-2AML-1-W-R-S-xx-S-NA-in

(2) White light with red & green indicator ends in head trimmer over door threshold
C-LL15-2AML-3-R-30-G-W-R-S-xx-D-xx-D-xx-S-NA-in

(3) Square pattern in ceiling of cab
C-LL15-2AML-1-30-W-R-LT90-xx-LT90-xx-LT90-xx-LT90-xx-mm

(4) White light in head trimmer and red & green indicator lights in door jamb
C-LL15-2AML-3-30-G-R-W-R-S-xx-IC90-xx-D-xx-S-NA-in

Notes:
• Consult factory for help with applications not shown or assistance with specifying & ordering.
• Shop drawings will be prepared for all patterns and straight runs upon request.



Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F50

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

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EXTANT | ARCHITECTURAL LIGHTING

HTG-3R-LP | SPEC SHEET
RECESSED - LoPro

HUNTINGTON 3 - RECESSED CEILING

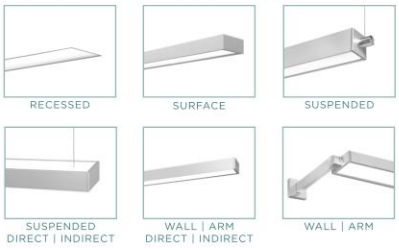
LoPro

Brilliant by Design™, the Huntington 3 Recessed LoPro is sure to level up your space. Our patent pending Microstructure EdgeTech Optics™ (MEO) technology delivers unparalleled optic control, low glare visual comfort, exceptional performance, seamless illumination, and uniformity in unprecedented low-profile behind ceiling depths. Lens gaps, pixelation and hot spots are a thing of the past with our innovative Dual Lens Edge-lit MEO™ technology.

FEATURES

- Low profile depth behind ceiling for use in any plenum installation:
  - 1.5" - 1.75" Depth (Remote Driver)
  - 2.14" - 2.45" Depth (Integral Driver)
- Design without compromise: Specify Batwing, Glare Control, Diffused (Lambertian) or Wall Wash Optics
- Specified Lumen Outputs (SLO) available: 224 lm/ft – 1754 lm/ft
- Sleek 3" Aperture
- Individual fixture lengths and seamless continuous runs with no lens breaks up to 500 feet
- Achieve up to 16 feet on center spacing with 35fc on work surface
- Drivers, wiring and serviceability completely accessible from below ceiling with our patent pending toolless "Push to Eject" System
- Toolless Latch System and Quick-Click 5 Wire system allows for simple, quick, and seamless installation
- Trim Flange, Spackle Flange, 15/16" or 9/16" Grid Lay-in 15/16" or 9/16" Grid Tegular, Bolt Slot or Armstrong Interlude/USG Identitee
- 4" TechZone™ compatitble for seamless integration
- Proudly crafted in Huntington Beach, CA - USA

HUNTINGTON 3 LINEUP



PERFORMANCE OVERVIEW

4' Huntington 3 Direct - 3500K 80CRI - MEODF

Lumen Output	LL (Low)	ML (Medium)	HL (High)	SLO* (Specified)
Delivered Lumens	896	2208	4352	896-6852
Consumed Wattage	7	18	38	7.3 - 65.6
Efficacy (lm/W)	122	121	115	105-122
SDCM	3	3	3	3

*Specified Lumen Output (SLO) available in customizable lumen configurations (896 lm - 6852 lm). See SLO Configurator at ExtantLighting.com

MADE IN USA MEO™ cULus PATENT PENDING JA8 CCEA APPROVED

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011921 HTG-3R-LP | |

Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F85 Series

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

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HTG-3R-LP | SPEC SHEET
RECESSED - LoPro

Ordering Information

PROJECT _____ TYPE _____
PRODUCT _____ QTY _____

Product Family

HTG-3R-LP Huntington Series 3" Aperture (Recessed - LoPro)

Driver Location

- ☐ **TD** Integral Driver
- ☐ **RD** Remote Driver

Trim

TRIM FLANGE

- ☐ **TFSA** Trim Flange - Silver Anodized
- ☐ **TFWP** Trim Flange - Matte White
- ☐ **TFBP** Trim Flange - Matte Black
- ☐ **TFCC** Trim Flange - Custom Color

TRIMLESS

- ☐ **SF** Spackle Flange (Mud-in)

T-GRID

- ☐ **L1*** 15/16" Grid Lay-in
- ☐ **L9*** 9/16" Grid Lay-in
- ☐ **T1*** 15/16" Grid Tegular
- ☐ **T9*** 9/16" Grid Tegular
- ☐ **SB*** Bolt Slot Grid
- ☐ **AI*** Armstrong Interlude/ USG Identitee

*White finish is standard on all T-Grid (Suspended Ceiling) trim options (L1, L9, T1, T9, SB and AI)

Length

- ☐ ____* Specify length in 1 foot increments
- ☐ **R__x__** Rectangle
- ☐ **L__x__** L Pattern
- ☐ **U__x__x__** U Pattern
- ☐ **C__W__** Ceiling to Wall Transition Example: C14'W12'
- ☐ **CP** Custom Pattern

*Minimum Integral Driver length is 2'. Minimum Remote Driver lengths can be shorter, consult factory. Custom length fixtures can be ordered in 3" increments. Any length over 8' requires multiple fixture segments.

Lumen Output

- ☐ **DLL** Low (224 l/ft @ 1.84 W)*
- ☐ **DML** Medium (552 l/ft @ 4.55 W)*
- ☐ **DHL** High (1088 l/ft @ 9.46 W)*
- ☐ **SLO-xx** *Specified Lumen Output available. (224 lm/ft - 1754 lm/ft)

*Delivered lumen output & consumed wattage based on "MEODF 835" (80 CRI - 3500K). See SLO Configurator for alternate outputs.

Optics

MEO*

- ☐ **MEODF** Diffusing
- ☐ **MEOBW** Batwing
- ☐ **MEOGC** Glare Control
- ☐ **MEOWW** Wall Wash
- ☐ **MEORF** Room Fill

*See page 5 for Optic Detail

Color Temp

80+ CRI

- ☐ **830** 3000K
- ☐ **835** 3500K
- ☐ **840** 4000K

90+ CRI

- ☐ **927** 2700K
- ☐ **930** 3000K
- ☐ **935** 3500K
- ☐ **940** 4000K
- ☐ **XX** Optional Color Temp & CRI Available

Voltage

- ☐ **VU** 120V-277V
- ☐ **V3** 347V

Driver

- ☐ **D*** 1% 0-10V
- ☐ **DN** NON DIM
- ☐ **DL1** Lutron Hi-Lume 1% EcoSystem
- ☐ **DE*** .1% 0-10V
- ☐ **DD1** 1% DALI
- ☐ **DDE** .1% DALI
- ☐ **DMX** .1% DMX/RDM
- ☐ **DELV** 1% Electronic Low Voltage Dimming (Reverse Phase)
- ☐ **DTRIAC** 1% Electronic Low Voltage Dimming (Forward Phase)
- ☐ **XX** Other (Please Specify)

*Dim to Off available. Please Specify "-OFF" next to driver option if required.

Options

- ☐ **EMB_*** Emergency Battery Pack(s)
- ☐ **EMC_*** Emergency Circuit(s)
- ☐ **SOC *** Occupancy Sensor
- ☐ **SDL*** Daylight Sensor
- ☐ **2C** 2 Circuit (Direct Light and Indirect Light Controlled Independently)
- ☐ **BCS*** Brilliant Communications Solutions (wired/wireless)
- ☐ **CP** Chicago Plenum Approved
- ☐ **JA8** JA8 Approved
- ☐ **QAF** Extant Express 9-Day Quick Ship

EMB: Specify quantity of battery packs. Minimum 4' unit.
Note: Remote Driver (RD) fixtures will have remote battery packs.

EMC: Specify quantity of emergency circuits.

SOC & SDL: Specify spacing/location of sensors(s).

BCS: includes wired and wireless integration from our partners at nLight™, Enlighted, Legrand, Crestron, Osram, Lutron and many more. Contact Extant for details.

EXTANT ARCHITECTURAL LIGHTING™
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011921 HTG-3R-LP | 2

Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F85 Series

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

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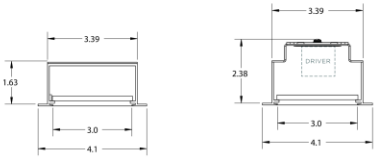
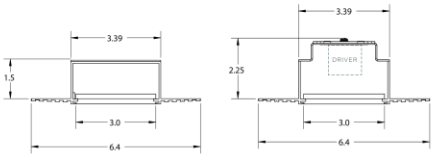
HTG-3R-LP | SPEC SHEET
RECESSED - LoPro

Dimensions

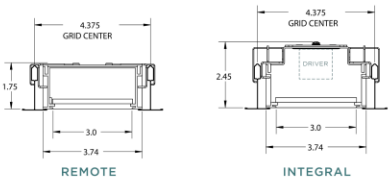
TF - TRIM FLANGE



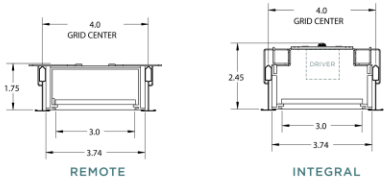
SF - SPACKLE FLANGE



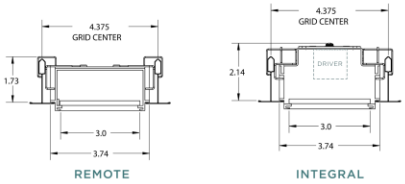
L1 - 15/16" GRID LAY-IN



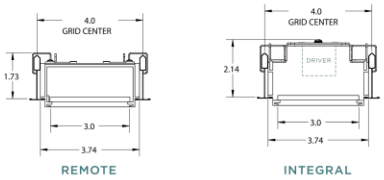
L9 - 9/16" GRID LAY-IN



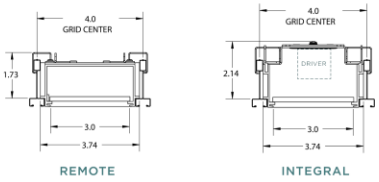
T1 - 15/16" GRID TEGULAR



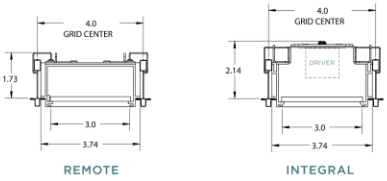
T9 - 9/16" GRID TEGULAR



SB - BOLT SLOT GRID



AI - ARMSTRONG INTERLUDE/ USG IDENTITEE



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Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F85 Series

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

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EXTANT | ARCHITECTURAL LIGHTING

HTG-3R-LP | SPEC SHEET
RECESSED - LoPro

Specifications

Construction Heavy gauge 6063 extruded aluminum housing.

Optics Microstructure EdgeTech Optics (MEO)™ utilizes high efficiency Microstructure Lenses and Light Guide Plates for high optical extraction and precise light management. Specify Batwing, Glare Control, Diffused (Lambertian) or Wall Wash Optics.

Light Output (3) Standard lumen packages are available: Low (DLL), Medium (DML) and High (DHL). Specified Lumen Output (SLO)packages available. Please see the (SLO) configurator at Extantlighting.com.

LEDS Latest generation of premium Nichia 3-step MacAdam Ellipse LED's available in (90+ CRI) 2700K, 3000K, 3500K, 4000K or (80+ CRI) 3000K, 3500K or 4000K. LED modules are easily accessible and replaceable.

Voltage Universal 120/277V (VU) and 347V (V3) available. Consult factory for driver options when 347V is specified.

Emergency Battery Factory provided low profile 10W emergency battery for UL924 required 90-minute run time (optional).

Finish Standard finishes include silver anodized, powder coated white or powder coated black. White powder coat finish standard on all T-Grid trim options. Custom colors available.

Continuous Rows Innovative Toolless Latch System and Quick-Click 5-Wire System ensures simple installation. Seamless continuous rows with no lens breaks, pixelation or hot spots up to 500 feet.

Patterns Standard Rectangle Pattern (R), U Pattern (U), and L Pattern (L) available. Custom patterns available.

Mounting Trim Flange, Spackle Flange, 15/16" or 9/16" Grid Lay-in, 15/16" or 9/16" Grid Tegular, Bolt Slot or Armstrong Interlude/USG Identitee.

Approvals UL and cUL Listed. Approved for Dry/Damp locations. IC Rated. Made in the USA. Chicago Plenum Approved. JA8 Approved.

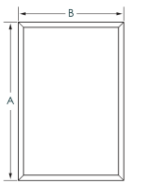
Lumen Maintenance (L70) 70% of initial light output = Reported > 60,000 hours | Calculated > 200,000 hours (L90) 90% of initial light output = Reported > 60,000 hours | Calculated > 200,000 hours.

Warranty HTG 3 offered with a 5-year limited warranty. 5-year limited warranty covers LED, driver and fixture. For further details, refer to General Warranty and Obligations at ExtantLighting.com.

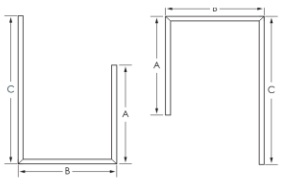
Patents Extant Lighting's intellectual property is protected under Patent Pending Status by the U.S. Patent Office.

* Due to our culture of always striving for product enhancement, specifications and information within this document are subject to change without notice. 2020 Extant Lighting, Inc. All rights reserved.

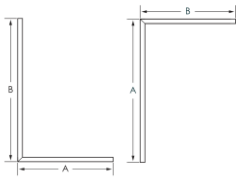
Patterns



R__X__
Rectangle
Provide AxB
Example: R6'x4'



U__X__X__
U-Shape
Provide AxBxC
Example: U6'x4'x4'



L__X__
L-Shape
Provide AxB
Example: L6'x4'

Note: All miters/patterns shown and ordered in Plan View.

Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

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Submittal: ASC P1X

Type: F85 Series

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EXTANT™ | ARCHITECTURAL LIGHTING

HTG-3R-LP | SPEC SHEET
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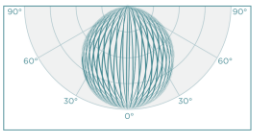
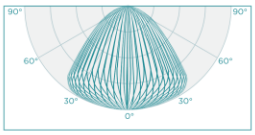
Microstructure EdgeTech Optics (MEO)™

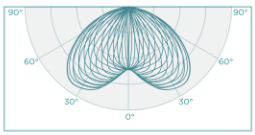
Our innovative MEO™ design utilizes high efficiency Microstructure Lenses and Light Guide Plates for high optical extraction and precise light management. MEO™ delivers exceptional light quality with seamless illumination and uniformity with no pixelation, hot spots or lens breaks up to 500' continuous rows.



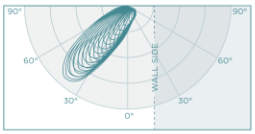
MEODF
LAMBERTIAN



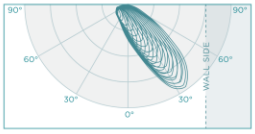
MEOGC
GLARE CONTROL



MEOBW
BATWING



MEORF
ROOM FILL



MEOWW
WALL WASH

EXTANT ARCHITECTURAL LIGHTING™
15572 Commerce Lane, Huntington Beach, CA 92649 | O 714-362-8099 | ExtantLighting.com
011921 HTG-3R-LP | 5

Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F85 Series

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

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EXTANT™ | ARCHITECTURAL LIGHTING

HTG-3R-LP | SPEC SHEET
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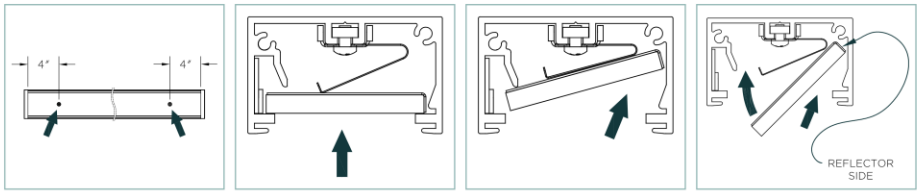
Thoughtful Engineering...

Thoughtful engineering is at the core of all of our fixture designs. All of our products are thoughtfully engineered and include innovative features that create a sophisticated fixture that is also contracator friendly and easy to install and service.

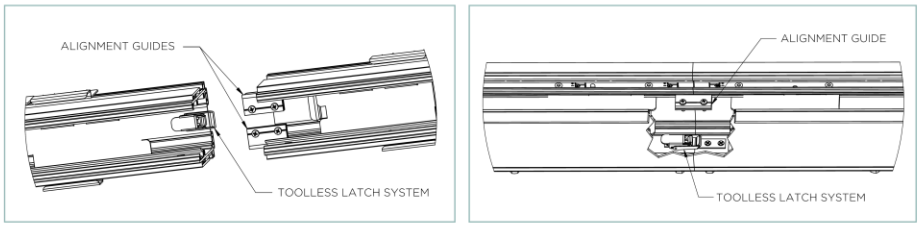
PUSH AND EJECT SYSTEM

Innovative "Push and Eject" System allows for toolless removal and installation of the Light Guide Plate. This thoughtful engineering creates easy access into the housing for simple installation and servicebility.



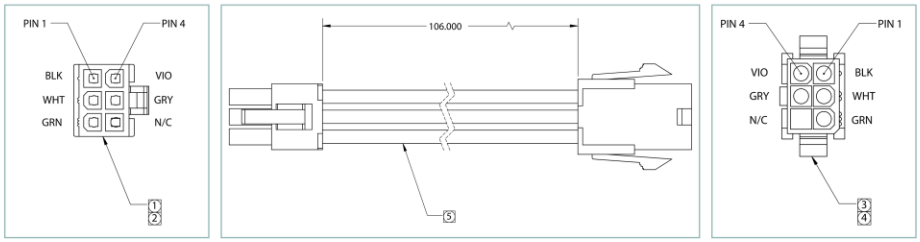
TOOLLESS LATCH SYSTEM

Our Toolless Latch System is designed to securely connect the extrusions of the continuous runs without the use of any tools, screws or external parts. Our innovative design allows the contractor to perfectly align the extrusion with the built-in alignment pins and cinch up the extrusion with the Toolless Latch System for a tight fit. The Toolless Latch System eliminates gaps and ensures perfect alignment.



QUICK-CLICK 5-WIRE SYSTEM

Our Quick-Click 5-Wire System connects all continuous run through wiring with a simple push and click connection. The Quick-Click System is contractor friendly and decreases installation time and cost and ensures proper wiring.



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011921 HTG-3R-LP | 6

Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

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Type: F85 Series

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Multiple Layers of Light

Luminaire Type:
Catalog Number:

Buy American

High Center Beam Round Downlight — 4"

OVERVIEW

Feature Set

- Eleven optimized distribution patterns allow designers to achieve tailored objectives
- Bounding Ray™ optical design
- 45° Cutoff to source and source image
- Field interchangeable optic
- Driver and LED light engine fully serviceable from below ceiling
- 70% lumen maintenance at 60,000 hours
- 2.5 SDCM; 85 CRI typical, 90+ CRI optional
- Fixtures are wet location, covered ceiling
- ENERGY STAR® Certified product

Distribution

Superior Perfomance

Nominal Lumens	500	750	1000	1500	2000	2500	3000	3500	4000	4500	5000
Delivered	703	807	1062	1545	1977	2419	2920	3548	3982	4419	4848
Wattage	6.7	7.5	9.8	15.1	21.5	26.5	34.1	33.8	39.5	46.2	53.2
Efficacy	104	108	108	102	92	91	86	105	101	96	91

*Based on 3500K 80CRI 35D AR LSS

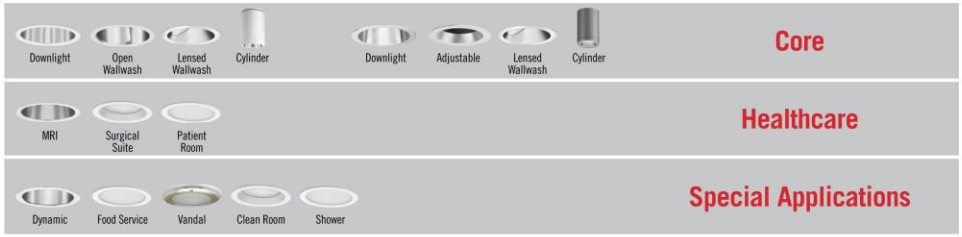
COMPLIMENTARY PRODUCTS

Coordinated Apertures | Multiple Layers of Light

General Illumination Layer | EVO

High Center Beam Layer | Incito

EVO + Incito — Multiple Layers of Light



IC04
page 1 of 8

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Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F86 Series

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4" **High Center Beam Round Downlight**

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: 50 units.

Luminaire Type:

Catalog Number:

EXAMPLE: IC04 35/15 AR LSS 35D 277 EZ1

Series		Color Temperature		Lumens		Reflector Color		Flange Type		Reflector Finish		Beam	
IC04	Incito 4in Round Downlight	27/	2700 K	05	500 lumens	AR	Clear	(blank)	Self-flanged	LSS	Semi-specular	10D[2]	10° beam angle
		30/	3000 K	07	750 lumens	PR	Pewter	FL	Flangeless	LD	Matte diffuse	15D	15° beam angle
		35/	3500 K	10	1000 lumens	WTR	Wheat					20D	20° beam angle
		40/	4000 K	15	1500 lumens	GR	Gold					25D	25° beam angle
		50/	5000 K	20	2000 lumens	WR[1]	White painted					30D	30° beam angle
				25	2500 lumens	BR[1]	Black					35D	35° beam angle
				30	3000 lumens	BZR[1]	Dark Bronze painted					40D	40° beam angle
				35	3500 lumens	WRAMF[1]	White Anti-microbial					45D	45° beam angle
				40	4000 lumens							50D	50° beam angle
				45	4500 lumens							60D	60° beam angle
				50	5000 lumens							65D	65° beam angle

Voltage		Driver		Control Interface		Options	
120	120V	GZ10	0-10V driver dims to 10%	(blank)		SF	Single fuse.
277	277V	GZ1	0-10V driver dims to 1%	NLT[7]	nLight® dimming pack.	90CRI	High CRI (90+)
347[3,4]	347V	EZ10	eldoLED 0-10V ECOdrive. Linear dimming to 10% min.	NLTER[7,8]	nLight® dimming pack for fixtures on emergency circuit	TRW[9]	White Painted Flange
		EZ1	eldoLED 0-10V ECOdrive. Linear dimming to 1% min.	NLTAIR2	nLight® AIR dimming pack.	TRBL[10]	Black Painted Flange
		EZB	eldoLED 0-10V SOLOdrive. Logarithmic dimming to <1%.	NLTAIRER2[8]	nLight® AIR dimming pack for fixtures on emergency circuit	ELR[11]	Batterypack with remote test switch
		EDAB[5]	eldoLED SOLOdrive DALI. Logarithmic dimming to <1%.	NLTAIREM2	nLight® AIR dimming pack for fixtures on emergency circuit	CP[12]	Chicago Plenum
		EDXB[5,6]	eldoLED POWERdrive DMX with RDM (remote device management). Square Law dimming to <1%. MIN:1000 MAX:4000			N80	nLight Lumen Compensation
		ECOS2[6]	Lutron® Hi-Lume® 2-wire forward-phase driver. 120V Only. Minimum dimming level 1%. Min: 1000LM; Max: 4000LM.			RRL___	RELOC® Ready Luminaire connectors enable a simple and consistent factory installed option across all ABL luminaire brands. Available only with RRLA, RRLB, RRLAE, and RRLC12S. Refer to RRL spec sheet on www.acuitybrands.com for RELOC® product specifications. Above ceiling access required.
		ECOD[6]	Lutron® EcoSystem® digital Hi-Lume 1% soft-on, fade to black. Min: 500LM; Max: 750LM.				

ACCESSORIES — order as separate catalog numbers (shipped separately)

OPTC4 XXD	Additional optics for field installation. Replace "XX" with beam angle.

ORDERING NOTES

1. Not Available with Finishes.
2. Only available 1500lm and below.
3. Not available with ELR emergency option.
4. Supplied with factory installed step down transformer.
5. Includes terminator resistor.
6. Not Available with Control Interfaces.
7. Must specify 120 or 277.
8. For use with generator supply EM power. Will require an emergency hot feed and normal hot feed.
9. For use with different reflector finish only (i.e. AR, PR, WTR, GR options). Not available with WR (White Reflector). Not available with FL.
10. For use with different reflector finish only (i.e. AR, PR, WTR, GR options). Not available with BR (Black Reflector). Not available with FL.
11. Must specify 120 or 277. Not available with 347. Require 13 1/2" above ceiling access for use with ELR option.
12. Only available up to 4500 lumens. Specify 120 or 277.

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Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F86 Series

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

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gotham | INCITO™

4" **High Center Beam Round Downlight**

SPECIFICATIONS

Optical and Trim Assembly
Fully serviceable and upgradeable lensed LED light engine suitable for field maintenance or service from above or below the ceiling.
Optical design is a Bounding Ray™ design with 45° cutoff to source and source image. Top down flash characteristic for superior glare control.
Flangeless trim option includes proprietary Gotham mud ring enabling seamless integration into drywall applications. Mud ring ships separately.

Electrical
The luminaire shall operate from a 50 or 60 Hz ±3 Hz AC line over a voltage ranging from 120 VAC to 277 VAC. Support 347V via fixture-mounted stepdown transformer. The fluctuations of line voltage shall have no visible effect on the luminous output.
The luminaire shall have a power factor of 90% or greater at all standard operating voltages and full luminaire output.
Sound Rated A+. Driver shall be >80% efficient at full load across all input voltages.
Input wires shall be 18AWG, 300V minimum solid copper.

Controls
Luminaire shall be equipped with interface for nLight wired or nLight AIR networks with integral power supply as per specification.

Emergency
Luminaires supplied with a battery pack comply with NFPA 101 (Life Safety code) and deliver constant light output throughout the 90 minutes of code required emergency operation period when there is a normal AC power loss with remote test switch available.

Dimming
The luminaire shall be capable of continuous dimming without perceivable stroboscopic flicker as measured by flicker index (ANSI/IES RP-16-10) 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%.
eldoLED LED drivers shall conform to IEEE P1789 standards. Alternatively, manufacturers must demonstrate conformance with product literature and testing which demonstrates this performance. Systems that do not meet IEEE P1789 will not be considered.
Driver is inaudible in 24dB environment, and stable when input voltage conditions fluctuate over what is typically experienced in a commercial environment.

Construction
Light engine and driver are accessible from above or below ceiling.
16-gauge black painted steel mounting frame with mounting bars included.
Post-installation adjustment possible from above or below ceiling.
Galvanized steel junction box with hinged access covers and spring latch. Three combination 1/2"-3/4" and one 1/2" knockout for straight-through conduit runs.
Capacity: 8 (4 in, 4 out) No. 12 AWG conductors rated for 90°C.
Accommodates up to 1½"-thick ceilings.

Listings
Fixtures are CSA Certified to meet US and Canadian Standards: All fixtures manufactured in strict accordance with the appropriate and current requirements of the "Standards for Safety" to UL, wet location covered ceiling.
Luminaire configurations are Energy Star certified through testing in EPA–recognized laboratories, with the results reviewed by an independent, accredited certification organization. Visit www.energystar.gov for specific configurations listed.
IC-rated up to 1000 lumens.

Photometrics
LEDs tested to LM-80 standards. Measured by IESNA Standard LM-79-08 in an accredited lab. Lumen output shall not decrease by more than 30% over the minimum operational life of 60,000 hours.
Color appearance from luminaire to luminaire of the same type and in all configurations, shall be consistent both initially and at 6,000 hours and operate within a tolerance of <2.5 MacAdam ellipse as defined by the center of the quadrangles defined in ANSI C78.377-2015.

Buy American
This product is assembled in the USA and meets the Buy America(n) government procurement requirements under FAR, DFARS and DOT.
Please refer to www.acuitybrands.com/buy-american for additional information.

Warranty
5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. 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.

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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South Terminal C - Phase 1X
HLB Project #: 160045

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Submittal: ASC P1X

Type: F86 Series

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4" High Center Beam Round Downlight

Tables of Use

ICO - eldoLED Driver Default Dimming Curve			
Nomenclature	Min Dimming	Driver Dim Curve	Control Dim Curve
EZ10	10%	Linear	Linear/Logarithmic
EZ1	1%	Linear	Linear/Logarithmic
EZB	<1%	Logarithmic	Linear
EDAB	<1%	Logarithmic*	Linear
EDXB	<1%	Square	Linear

*Changable thorugh DALI controller

Lumen Output Multiplier		
CRI	CCT	Multplier
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	
Reflector Finish	Multiplier
LS - Specular	1
LSS - Semi Specular	0.956
WR - White	0.87
LD - Matte Diffuse	0.85
BR - Black	0.73
BZR - Bronze	0.73

Driver		Control Provided				
Nomenclature	Description	NLT	NLTER	NLTAIR2	NLTAIREM2	NLTAIRER2
GZ10	0-10V driver dims to 10%	nPP16 D EFP	nPP16 D ER EFP	RPP20 D 24V G2	RPP20 D 24V EM G2	RPP20 D 24V ER G2
GZ1	0-10V driver dims to 1%	nPP16 D EFP	nPP16 D ER EFP	RPP20 D 24V G2	RPP20 D 24V EM G2	RPP20 D 24V ER G2
EZ10	eldoLED 0-10V ECOdrive	nPS 80 EZ	nPS 80 EZ ER	RPP20 D 24V G2	RPP20 D 24V EM G2	RPP20 D 24V ER G2
EZ1	eldoLED 0-10V ECOdrive	nPS 80 EZ	nPS 80 EZ ER	RPP20 D 24V G2	RPP20 D 24V EM G2	RPP20 D 24V ER G2
EZB	eldoLED 0-10V SOLOdrive	nPS 80 EZ	nPS 80 EZ ER	RPP20 D 24V G2	RPP20 D 24V EM G2	RPP20 D 24V ER G2

Marked Spacing in Inches 25°C Ambient			
Lumen Package	Fixed Center to Center MIN	Fixture Center to Building Member MIN	Space Above Fixture
5000	24	12	0.5
3500-4500 (GZ1/GZ10 Only)	24	12	0.5
4000-4500 w/CP (EZ1/EZ10 Only)	24	12	0.5
3500-4500 w/CP (GZ1/GZ10 Only)	24	12	0.5

ELR Availability/Compatability – Initial Lumens			
LED			Initial Lumens
Product	Lumens	Watts	ELR
ICO4	500-5000	6-53	630

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Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F86 Series

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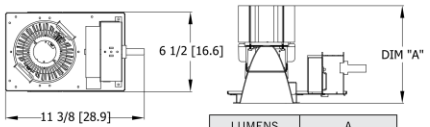
4" **High Center Beam Round Downlight**

DIMENSIONAL DATA

*Dimensions in inches [centimeters]

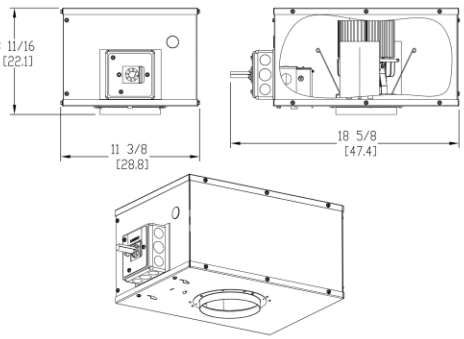
Aperture: 4-5/16 [11]	Ceiling Opening: 5-1/8 [13] self-flanged
Overlap Trim: 5-7/16 [13.8]	4-5/8 [11.7] flangeless

Standard



LUMENS	A
Up to 1000	6 [15.2]
Up to 2000	7 [17.8]
Above 2000	8 [20.3]

Chicago Plenum



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Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F86 Series

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

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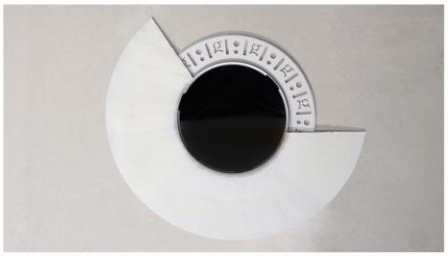
4" **High Center Beam Round Downlight**

Flangeless

Partially finished mud ring, showing cross-section detail.



An ICO downlight requires only approximately 3" of plaster to finish.

ICO with flangeless trim

Flangeless Installation

Gotham's flangeless option utilizes a micro-thin polymer mud ring that minimizes the amount of drywall compound required to finish the ceiling. The end result is a virtually undetectable flangeless downlight installation.

The polymer mud ring is installed independent of the of the recessed frame, therefore floating with the ceiling. This innovation minimizes any surface cracks during reflector installation, ceiling movement and any future service to the recessed frame, wiring, electronics, etc.

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Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F86 Series

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

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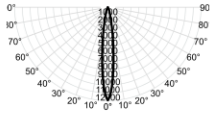
4" **High Center Beam Round Downlight**

Photometry

CONSULT WWW.GOTHAMLIGHTING.COM FOR ADDITIONAL PHOTOMETRY

ICO4 35/15 AR LSS 15D Input Watts: 15.1, Delivered Lumens: 1504, LPW: 99.6, S/MH: 0.24, Test No: ISF 192654P563



CP Summary 0°	Zonal Lumen Summary Zone	Lumens	% Fixture
0°	11,964	0° - 30°	1,449	96%
5°	8,038	0° - 40°	1,479	98%
15°	1,254	0° - 60°	1,501	100%
25°	280	0° - 90°	1,503	100%
35°	41	90° - 180°	1	0%
45°	19	0° - 180°	1,504	100%
55°	5			
65°	1			
75°	0			
85°	0			
90°	0			

Coefficients of Utilization

pf / pc	80% pw	50%	30%	10%	70% 50%	30%	10%	50% 50%	30%	10%
0	122	122	122	119	119	119	114	114	114
1	116	115	113	114	113	111	110	109	108
2	112	109	107	110	107	105	107	105	103
3	108	104	102	106	103	101	104	101	99
4	104	100	98	103	100	97	101	98	96
5	101	97	94	100	97	94	98	95	93
6	98	94	92	97	94	91	96	93	91
7	96	92	89	95	91	89	94	91	89
8	93	90	87	93	89	87	92	89	87
9	91	88	85	91	87	85	90	87	85
10	89	86	83	89	86	83	88	85	83

Cone of Light

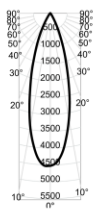
Mounting Height	Initial FC Center Beam	Beam Diameter
6.0	332.3	1.5
8.0	186.9	2.0
10.0	119.6	2.4
12.0	83.1	2.9
14.0	61.0	3.4

Beam Angle: 13.9°
Field Angle: 30.8°

Luminance (cd/sq.m)

	Average Luminance
0°	1,505,657
45°	3,408
55°	1,106
65°	300
75°	0
85°	0

ICO4 35/15 AR LSS 30D Input Watts: 15.1, Delivered Lumens: 1411, LPW: 93.4, S/MH: 0.47, Test No: ISF 192657P563



CP Summary 0°	Zonal Lumen Summary Zone	Lumens	% Fixture
0°	4,525	0° - 30°	1,295	92%
5°	4,140	0° - 40°	1,376	97%
15°	2,088	0° - 60°	1,407	100%
25°	590	0° - 90°	1,410	100%
35°	95	90° - 180°	1	0%
45°	26	0° - 180°	1,411	100%
55°	6			
65°	1			
75°	0			
85°	0			
90°	0			

Coefficients of Utilization

pf / pc	80% pw	50%	30%	10%	70% 50%	30%	10%	50% 50%	30%	10%
0	119	119	119	116	116	116	111	111	111
1	112	110	108	110	108	107	106	105	103
2	106	103	100	105	102	99	102	99	97
3	101	97	94	100	96	93	97	94	92
4	97	92	89	96	92	88	94	90	87
5	92	88	85	92	87	84	90	86	84
6	89	84	81	88	84	81	87	83	80
7	85	81	77	85	80	77	84	80	77
8	82	77	74	82	77	74	81	77	74
9	79	75	72	79	74	71	78	74	71
10	76	72	69	76	72	69	75	71	69

Cone of Light

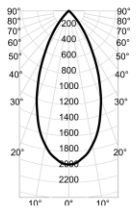
Mounting Height	Initial FC Center Beam	Beam Diameter
6.0	125.7	3.1
8.0	70.7	4.2
10.0	45.3	5.2
12.0	31.4	6.3
14.0	23.1	7.3

Beam Angle: 29.3°
Field Angle: 58.8°

Luminance (cd/sq.m)

	Average Luminance
0°	569,489
45°	4,664
55°	1,327
65°	300
75°	0
85°	0

ICO4 35/15 AR LSS 45D Input Watts: 15.1, Delivered Lumens: 1437, LPW: 95.2, S/MH: 0.73, Test No: ISF 192660P563



CP Summary 0°	Zonal Lumen Summary Zone	Lumens	% Fixture
0°	1,968	0° - 30°	1,060	74%
5°	1,901	0° - 40°	1,329	92%
15°	1,504	0° - 60°	1,432	100%
25°	894	0° - 90°	1,437	100%
35°	378	90° - 180°	1	0%
45°	78	0° - 180°	1,437	100%
55°	10			
65°	3			
75°	1			
85°	0			
90°	0			

Coefficients of Utilization

pf / pc	80% pw	50%	30%	10%	70% 50%	30%	10%	50% 50%	30%	10%
0	120	120	120	117	117	117	112	112	112
1	111	109	107	109	107	105	105	104	102
2	104	100	97	102	99	96	99	96	94
3	97	92	89	96	91	88	93	90	86
4	91	86	82	90	85	81	88	84	80
5	86	80	76	85	79	75	83	78	75
6	81	75	71	80	74	70	78	74	70
7	76	70	66	75	70	66	74	69	66
8	72	66	62	71	66	62	70	65	62
9	68	62	59	68	62	58	67	62	58
10	65	59	55	64	59	55	63	58	55

Cone of Light

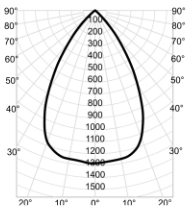
Mounting Height	Initial FC Center Beam	Beam Diameter
6.0	54.7	5.2
8.0	30.8	6.9
10.0	19.7	8.7
12.0	13.7	10.4
14.0	10.0	12.1

Beam Angle: 46.9°
Field Angle: 80.5°

Luminance (cd/sq.m)

	Average Luminance
0°	247,708
45°	13,812
55°	2,211
65°	900
75°	490
85°	0

ICO4 35/15 AR LSS 65D Input Watts: 15.1, Delivered Lumens: 1382, LPW: 91.5, S/MH: 0.98, Test No: ISF 192663P563



CP Summary 0°	Zonal Lumen Summary Zone	Lumens	% Fixture
0°	1,280	0° - 30°	913	66%
5°	1,270	0° - 40°	1,238	90%
15°	1,231	0° - 60°	1,376	100%
25°	946	0° - 90°	1,382	100%
35°	471	90° - 180°	1	0%
45°	114	0° - 180°	1,382	100%
55°	12			
65°	3			
75°	1			
85°	0			
90°	0			

Coefficients of Utilization

pf / pc	80% pw	50%	30%	10%	70% 50%	30%	10%	50% 50%	30%	10%
0	119	119	119	116	116	116	111	111	111
1	110	108	106	108	106	104	104	102	101
2	102	98	95	101	97	94	97	94	92
3	95	90	86	94	89	85	91	87	84
4	88	83	78	87	82	78	85	81	77
5	82	76	72	82	76	72	80	75	71
6	77	71	66	76	70	66	75	70	66
7	72	66	61	71	66	61	70	65	61
8	68	61	57	67	61	57	66	61	57
9	64	57	53	63	57	53	62	57	53
10	60	54	50	59	54	50	59	53	50

Cone of Light

Mounting Height	Initial FC Center Beam	Beam Diameter
6.0	35.6	7.5
8.0	20.0	10.0
10.0	12.8	12.5
12.0	8.9	15.0
14.0	6.5	17.5

Beam Angle: 64.1°
Field Angle: 96.1°

Luminance (cd/sq.m)

	Average Luminance
0°	161,080
45°	20,269
55°	2,654
65°	900
75°	490
85°	0

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Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F86 Series

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

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4" **High Center Beam Round Downlight**

NLIGHT AIR

nLight® AIR is the ideal solution for retrofit or new construction spaces where adding communication wiring is cost prohibitive. The integrated nLight AIR rPP20 Power Pack is part of each EVO Luminaire ordered with the NLTAIR option. These individually addressable controls offer the ultimate in flexibility during initial setup and for space repurposing.

nLight® AIR Control Accessories
Order as separate catalog number. Visit nLight AIR.

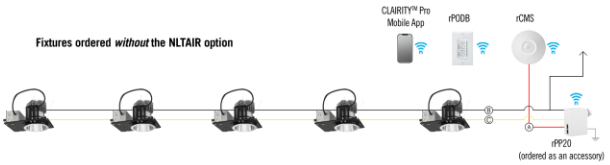
Wall Switches	Model Number
On/Off single pole	rPODB (color) G2
On/Off two pole	rPODB 2P (color) G2
On/Off & raise/lower single pole	rPODB DX (color) G2
On/Off & raise/lower two pole	rPODB 2P DX (color) G2

nLight® AIR Control Accessories *(cont.)*

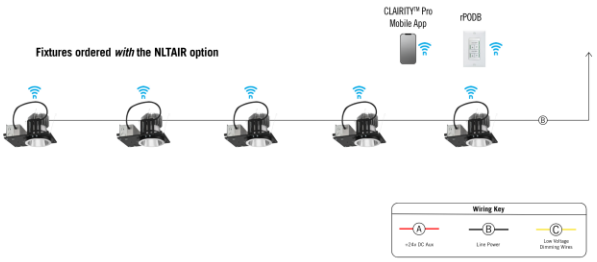
Occupancy Sensors (PIR/dual tech)	Model Number
Small motion 360°, ceiling	rCMS 9 / rCMS PDT 9
Large motion 360°, ceiling	rCMS 10 / rCMS PDT 10

Possibilites for nLight® AIR

Fixtures ordered *without* the NLTAIR option



Fixtures ordered *with* the NLTAIR option



NLIGHT

nLight® Wired The nLight® solution is a digital networked lighting control system that provides both energy savings and increased user configurability by cost effectively integrating time-based, daylight-based, sensor-based and manual lighting control schemes.

nLight® Wired Control Accessories
Order as separate catalog number. Visit nLight.

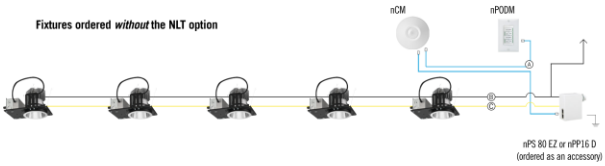
Wall Switches	Model Number
On/Off single pole	nPODM (XX)
On/Off two pole	nPODM 2P (XX)
On/Off & raise/lower single pole	nPOD DX (XX)
On/Off & raise/lower two pole	nPODM 2P DX (XX)
Graphic touchscreen	nPOD GFX (XX)
Photocell Controls	
Dimming	nCM ADCX

nLight® Wired Control Accessories *(cont.)*

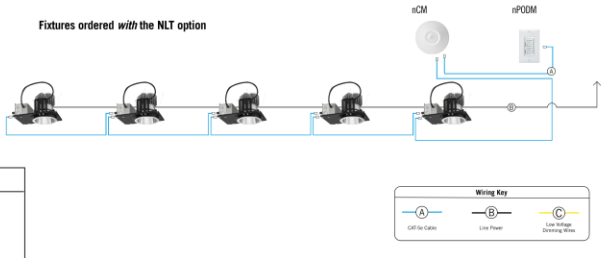
Occupancy Sensors (PIR/dual tech)	Model Number
Small motion 360°, ceiling	nCM 9 / nCM PDT 9
Large motion 360°, ceiling	nCM 10 / nCM PDT 10
Wide View	nWV 16 / nWV PDT 16
Wall switch with raise/lower	nWSX LV DX / nWSX PDT LV DX
Cat-5 Cables (plenum rated)	
10', CAT5	CAT5 10FT J1
15', CAT5	CAT5 15FT J1

Possibilites for nLight® wired

Fixtures ordered *without* the NLT option



Fixtures ordered *with* the NLT option



ICO4
page 8 of 8

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Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F86 Series

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

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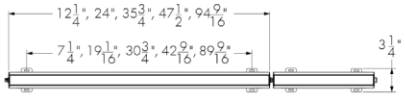
Specification Sheet

lumencove
Lumencove 2.0
LCS2

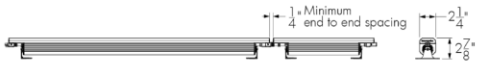
WHITE AND STATIC COLORS

Project Name _____ **Qty** _____

Type _____ **Catalog / Part Number** _____



Top view



Front and side views

Photometric Summary

RO - Regular output

CCT	Delivered Output [lm]	Power [W]	Efficacy [lm/W]
2200K [3]	1346	19	71
2700K [3]	1912	19	101
3000K [3]	1957	19	103
3500K [3]	2045	19	108
4000K	2174	19	114

HO - High output

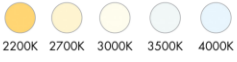
CCT	Delivered Output [lm]	Power [W]	Efficacy [lm/W]
2200K [3]	2745	39	70
2700K [3]	3896	39	100
3000K [3]	3984	39	102
3500K [3]	4161	39	107
4000K	4427	39	114

Photometric performance is measured in compliance with IESNA LM-79-08.
[1] Use 0.25 multiplier for each 12in [305mm] section.
[2] Frosted lens option ratio = x0.85.
[3] Estimated. Consult website for the latest photometric files.

Optic

110°x110°

Colors and Color Temperatures



2200K 2700K 3000K 3500K 4000K

Red Green Blue

Description

Optimized for size, Lumencove 2.0 offers excellent performance and a complete toolbox of options for interior indirect general lighting and cove lighting applications. The system is available in 12 in, 24 in, 36 in, 48 in and 96 in sections enabling both curved and linear layouts. The longer 96 in sections help decrease installation costs by reducing the number of connections. Options include a choice of ouputs, with regular (RO 5 W/ft) and high-output (HO 12 W/ft) versions.

Features

Color and Color Temperature	2200K, 2700K, 3000K, 3500K, 4000K, Red, Green, Blue
Length (nominal)	12 in, 24 in, 36 in, 48 in, 96 in
Optics	110° x 110°
Power Consumption	5 W/ft (RO version), 12 W/ft (HO version)
Adjustability	+/- 90° tilt angle
Warranty	5-year limited warranty

Performance

Maximum Delivered Output	4427 lm (HO 4000K, 48 in fixture, clear lens)
Color Consistency	2 SDCM
Color Rendering	Minimum CRI 80
Lumen Maintenance	L70 126,000 hrs (Ta 25 °C and Ta 40 °C), L95 19,000 hrs (Ta 25 °C and Ta 40 °C)

Physical

Housing Material	Low copper content extruded aluminum
Lens Material	Extruded polycarbonate, clear or frosted
Finish	White
Surface Finish	Electrostatically applied polyester powder coat

lumenpulse™
1220 Marie-Victorin Blvd., Longueuil, QC J4G 2H9 CA
info@lumenpulse.com www.lumenpulse.com
T United States 617.307.5700 | Canada 1.877.937.3003 | 514.937.3003 F 514.937.6289
www.lumenpulse.com/products/2237

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EM - R18

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Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F87 Series

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

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Specification Sheet

lumencove
Lumencove 2.0
LCS2

WHITE AND STATIC COLORS

Controls

ON/OFF | 0-10V | DALI
DMXrdm | EcoSystem Enabled | lumentalk

Rating

IP20

Certifications

cULus | CE | RoHS | 5 YEARS

Weight	12 in: 1.25 lbs, 24 in: 2.5 lbs, 36 in: 3.75 lbs, 48 in: 5 lbs, 96 in: 10 lbs

Electrical and control

Voltage	120-277V
Fixture Cable	Power and data in one cable
Leader Cable Conductor	5C #16-5
Connector Type	Thumb latch connectors, breakable under load
Fixture Cable and Connector Color	White
Maximum Cable and Fixture Run Length	Up to 350 ft (On/Off, DALI, DMX/RDM, 277V, RO version)
Control	On/Off control, Lumentalk, 0-10V dimming, DALI dimming, Lutron® EcoSystem® Enabled dimming, DMX/RDM enabled
Resolution (DMX/RDM)	Per foot or per fixture (configured with LumenID V3 software), 8-bit or 16-bit

Environmental

Storage Temperature	-40 °F to 122 °F (device must reach start-up temperature value before operating)
Start-up Temperature	-13 °F to 122 °F
Operating Temperature	-13 °F to 122 °F
Environment	Indoor applications only
Ingress Protection Rating	IP20

Accessories (order separately)

Cables	Leader Cable, Jumper Cable
Control Boxes	DMX/RDM enabled (daisy chain or star configuration), Ethernet enabled (daisy chain or star configuration), Lumentalk Data Bridge
Control Systems	Lumentone™ 2, Pharos® kit
Diagnostic and Addressing Tools	LumenID, LumentalkID

lumenpulse™ 1220 Marie-Victorin Blvd., Longueuil, QC J4G 2H9 CA info@lumenpulse.com www.lumenpulse.com
T United States 617.307.5700 | Canada 1.877.937.3003 | 514.937.3003 F 514.937.6289
www.lumenpulse.com/products/2237

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Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022
Submittal: ASC P1X

Type: F87 Series

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

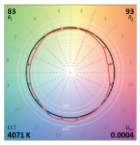
Specification Sheet

lumencove
Lumencove 2.0
LCS2
WHITE AND STATIC COLORS

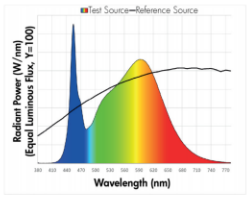
Chromaticity Data

TM-30 - 4000K

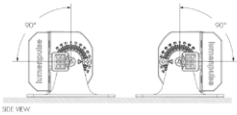
CCT	CIE		TM-30	
4000K	R_a	83	83	R_f
	R_9	4	93	R_g



Spectral Power Distribution

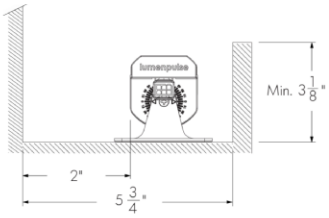


Maximum pivot limits



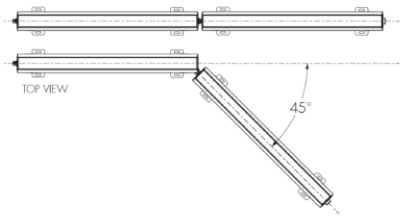
Mounting details

Suggested cove dimensions



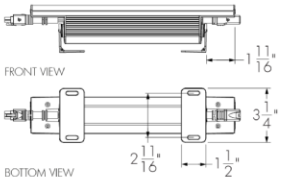
Minimum cove height depends on sight line.

Maximum angle adjustment



A jumper cable is required for angles greater than 45°.

Mounting bracket dimensions



12 in fixture shown.

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Specification Sheet

lumencove
Lumencove 2.0
LCS2

WHITE AND STATIC COLORS

Cables (order separately)

LCS2LC - Leader cable for Lumencove 2.0

LCS2LC-**CERTIFICATION**-**CONTROL**-**LENGTH**-WH
Please specify:
CERTIFICATION: UL or CE; **CONTROL:** NO, DATA or DMX/RDM; **LENGTH:** 10 ft or 25 ft.

- For NO and LT fixture control options: specify the NO control option for the leader cable.
- For DIM, DIM/DTW, DALI and ES fixture control options: specify the DATA control option for the leader cable.
- For DMX/RDM and DMX/RDM1 fixture control options: specify the DMX/RDM control option for the leader cable.
- DMX terminator is mandatory for any unused connector. One (1) included with every DMX/RDM leader cable.
- Consult Lumencove 2.0 leader cable specification sheet for details.

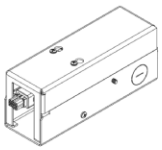
LCS2JC - Jumper cable for Lumencove 2.0

LCS2JC-**CERTIFICATION**-**CONTROL**-**LENGTH**-WH
Please specify:
CERTIFICATION: UL or CE; **CONTROL:** NO or DATA; **LENGTH**: 2 ft or 4 ft.

- For NO and LT fixture control options: specify the NO control option for the jumper cable.
- For DIM, DIM/DTW, DALI, ES, DMX/RDM and DMX/RDM1 fixture control options: specify the DATA control option for the jumper cable.
- Consult Lumencove 2.0 jumper cable specification sheet for details.

Wiring compartment (order separately)

WC-120/277-LCS2-WH - Wiring compartment



The Wiring Compartment is pre-wired with a leader cable, allowing the quick connection of conduits. Consult WC specification sheet for details.

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EM - R18

Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F87 Series

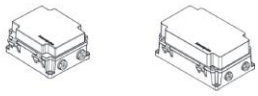
APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

Specification Sheet

lumencove
Lumencove 2.0
LCS2
WHITE AND STATIC COLORS

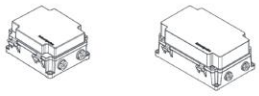
Control boxes (order separately)

CBX-DMX/RDM - DMX/RDM enabled (daisy chain or star configuration)



DMX/RDM control box. Up to six power and data outputs to fixtures or fixture runs. Consult CBX specification sheet and installation instructions for details. Lumenterminators provided with CBX (2x for daisy chain configuration, 6x for star configuration), consult factory to order spares.

CBX-ENET - Ethernet enabled (daisy chain or star configuration)



Ethernet control box. Up to four power and data outputs to fixture or fixture runs. Consult Ethernet CBX specification sheet and installation instructions for details.

LDB - Lumentalk Data Bridge

The Lumentalk Data Bridge is a digital interface that connects non-Lumentalk luminaires to the Lumentalk network, 0-10V or DMX output. Consult LDB specification sheet for details.

Control systems (order separately)

LTN2 - Lumentone™ 2

Lumentone 2 is a simple pre-programmed DMX 512 controller with a push button rotary dial and live feedback.

PHAROS - Pharos® kit

The Pharos kit, available for 1 or 2 DMX universes, allows for complete control of large lighting installations. 2 DMX universes kit shown.

Diagnostic and addressing tools (order separately)

LID - LumenID

LumenID is a diagnostic and addressing DMX/RDM tool. It must be specified on all DMX applications. Consult LID specification sheet for details.

LID-LT - LumentalkID

LumentalkID is a diagnostic and addressing tool. It must be specified for all Lumentalk (LT) applications. Consult LID-LT specification sheet for details.

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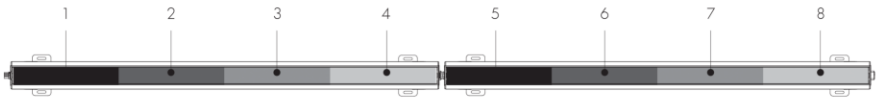
Specification Sheet

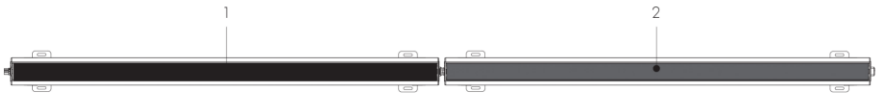
lumencove
Lumencove 2.0
LCS2
WHITE AND STATIC COLORS

Resolution details

DMX/RDM control, resolution per foot: each 12 in section is addressed independently
DMX addresses:



DMX/RDM control, resolution per fixture: each fixture is addressed independently
DMX addresses:



- 48 in fixtures shown.
- Applicable for DMX/RDM control option only. Fixture resolution can be configured on-site within the LumenID V3 software. A DMX/RDM enabled CBX is required.

Typical wiring diagrams

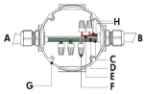
Wiring color code

UL Color Code	USE
Green	Ground
Black	Line
White	Line/Neutral
Red or Purple	0-10V / Data +
Orange	0-10V / Data -

On/Off Control (NO)

A - Power input (120-277V, wiring by others)
B - Junction box (by others)
C - Leader cable (LCS2LC)
D - Lumencove 2.0
E - Jumper cable (LCS2JC) (optional)

On/Off Control (NO) - wiring detail



A - Power input
B - To fixture
C - Line
D - Ground
E - Line/Neutral
F - Wire-nuts (by others)
G - Junction box (by others)
H - Not required

- Consult factory for specific applications and maximum fixture count cable length recommendations.
- Regular Output version : 5 W/ft, High Output version : 12 W/ft.

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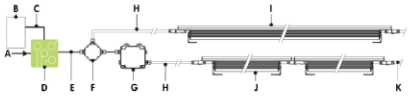
Specification Sheet

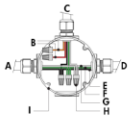
lumencove
Lumencove 2.0
LCS2
WHITE AND STATIC COLORS

Lumentalk (LT)



A - Power input (100-277V AC, wiring by others)
B - Dimmer/controller (order separately from lumenpulse, or by others)
C - Data wiring (by others)
D - Lumentranslator 2 (LTL2-010, -DMX, -TRIAC, -DALI)
E - Power wiring (by others)
F - Junction box (by others)
G - Lumentalk Data Bridge (LDB-DIM or LDB-DMX)
H - Leader cable (LCS2LC)
I - Lumencove 2.0 (24 in, 36 in, 48 in or 96 in fixture lengths)
J - Lumencove 2.0 (12 in)
K - Jumper cable (LCS2JC) (optional)

Lumentalk (LT) - wiring detail



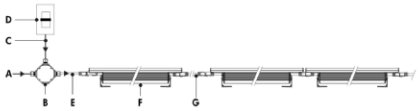
A - Power input (control over power line via Lumentalk system)
B - Not required
C - To fixture
D - To Lumentalk Data Bridge (for run lengths with 12 in fixtures)
E - Line
F - Ground
G - Line/Neutral
H - Wire-nuts (by others)
I - Junction box (by others)

- Consult factory for specific applications and maximum fixture count/cable length recommendations.
- Lumentalk Data Bridge required for 12 in fixture lengths, see LDB installation instructions for details.

- For applications with all fixtures controlled as 1 zone : fixtures and Lumentalk Data Bridge must be specified as DIM. Maximum of 10 fixtures per LDB-DIM, consult factory for applications that require additional capabilities.
- For applications with fixtures controlled individually : fixtures and Lumentalk Data Bridge must be specified as DMX, 2-step commissioning process: 1 - DMX/RDM system using LumenID software and a LID, 2 - Lumentalk system using LumentalkID software and a LID-LT. Maximum of 32 fixtures per LDB-DMX. Consult factory for details.

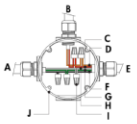
- For DMX applications: 1 DMX controller per Lumentalk network, maximum of 48 DMX channels per Lumentalk network (minimum step transition update rate is 1 second, minimum fade time between two colors is 1 minute). Consult factory for applications that require additional capabilities.
- Maximum of 1 transmitter (Lumentranslator or Lumenlink) per system.
- No third party fixtures allowed on the same circuit.
- Consult factory for DALI Lumentalk applications.
- 1% minimum dimming value.
- Regular Output version : 5 W/ft, High Output version : 12 W/ft.

0-10V dimming (DIM)



A - Power input (120-277V, wiring by others)
B - Junction box (by others)
C - Data wiring (by others)
D - Dimmer (by others)
E - Leader cable (LCS2LC)
F - Lumencove 2.0
G - Jumper cable (LCS2JC) (optional)

0-10V dimming (DIM) - wiring detail



A - Power input
B - From dimmer (by others)
C - 0-10V +
D - 0-10V -
E - To fixture
F - Line
G - Ground
H - Neutral
I - Wire-nuts (by others)
J - Junction box (by others)

- Consult factory for specific applications and maximum fixture count/cable length recommendations.
- Run length cannot exceed 8A per linear run **OR** maximum amperage capacity of the specified dimmer.
- 0-10V mA ratings : passive dimmer (Current Sink) : 3mA per fixture, active dimmer (Current Source): 0.5mA per fixture.
- 1% minimum dimming value.
- Regular Output version : 5 W/ft, High Output version : 12 W/ft.

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Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022
Submittal: ASC P1X

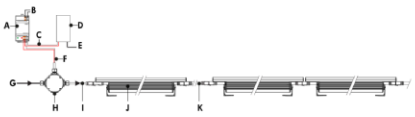
Type: F87 Series

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

Specification Sheet

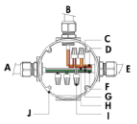
lumencove
Lumencove 2.0
LCS2
WHITE AND STATIC COLORS

DALI dimming (DALI)



A - DALI bus power supply (by others)
B - Power input for DALI bus power supply (wiring by others)
C - Data output to DALI controller (by others)
D - DALI controller (by others)
E - Power input for DALI controller (wiring by others)
F - Data output to fixture (wiring by others)
G - Power input (120-277V, wiring by others)
H - Junction box (by others)
I - Leader cable (LCS2LC)
J - Lumencove 2.0
K - Jumper cable (LCS2JC) (optional)

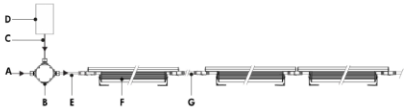
DALI dimming (DALI) - wiring detail



A - Power input
B - From DALI controller (by others)
C - DA +
D - DA -
E - To fixture
F - Line
G - Ground
H - Neutral
I - Wire-nuts (by others)
J - Junction box (by others)

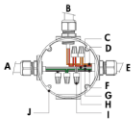
- Consult factory for specific applications and maximum fixture count/cable length recommendations.
- Maximum of 64 DALI fixtures per DALI loop.
- 1% minimum dimming value.
- Regular Output version : 5 W/ft, High Output version : 12 W/ft.
- Commissioning may be required based on the selection of 3rd party DALI controller. Controller and commissioning provided by others.

Lutron® EcoSystem® Enabled dimming (ES)



A - Power input (120-277V, wiring by others)
B - Junction box (by others)
C - Data wiring (by others)
D - Lutron® EcoSystem® controller (by others)
E - Leader cable (LCS2LC)
F - Lumencove 2.0 (24 in, 36 in, 48 in or 96 in fixture lengths)
G - Jumper cable (LCS2JC) (optional)

Lutron® EcoSystem® Enabled dimming (ES) - wiring detail



A - Power input
B - From Lutron® EcoSystem® controller (by others)
C - Data +
D - Data -
E - To fixture
F - Line
G - Ground
H - Neutral
I - Wire-nuts (by others)
J - Junction box (by others)

- Consult factory for specific applications and maximum fixture count/cable length recommendations.
- Each Lutron® EcoSystem® enabled fixture has its own address ; for the example shown, there are a total of 3 EcoSystem® addresses.
- 1% minimum dimming value.
- Regular Output version : 5 W/ft, High Output version : 12 W/ft.

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Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022
Submittal: ASC P1X

Type: F87 Series

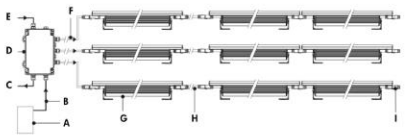
APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

Specification Sheet

lumencove
Lumencove 2.0
LCS2

WHITE AND STATIC COLORS

Star Layout (DMX/RDM)



A - DMX/RDM controller (order separately from Lumenpulse, or by others)
B - Data input (Belden 9841 or equivalent, by others)
C - Data output to next CBX (optional, not isolated/not boosted)
D - CBX-ST
E - Power input (120-277V, wiring by others)
F - Leader cable (LCS2LC)
G - Lumencove 2.0
H - Jumper cable (LCS2JC) (optional)
I - DMX Terminator (last fixture in DMX/RDM run only)

Daisy Chain Layout (DMX/RDM)

A - DMX/RDM controller (order separately from Lumenpulse, or by others)
B - Data input (Belden 9841 or equivalent, by others)
C - Data output to next CBX (optional, not isolated/not boosted)
D - CBX-DS
E - Power input (120-277V, wiring by others)
F - Leader cable (LCS2LC)
G - Lumencove 2.0
H - Jumper cable (LCS2JC) (optional)
I - DMX Terminator (last fixture in DMX/RDM run only)

Maximum Run of Fixtures, Lumencove® 2.0 White & Static Colors RO 5W/ft

Voltage	120V	240V	277V
Maximum Run of Fixtures*		128ft	

Maximum Run of Fixtures, Lumencove® 2.0 White & Static Colors HO 12W/ft

Voltage	120V	240V	277V
Maximum Run of Fixtures*	71ft	128ft	128ft

Based on 8A maximum, 50ft leader cable.
*Example: 120V = 128ft maximum run of end to end fixtures (32 fixtures maximum for 4ft LCS2 RO).

- Refer to CBX installation instructions for additional wiring details.
- Consult factory for specific applications and maximum fixture count/cable length recommendations. Maximum run length calculations are typically based on 48 in fixtures.
- The DMX/RDM protocol states a maximum of 32 DMX/RDM enabled fixtures on any single run.
- Maximum of 4 DMX/RDM repeaters/CBX cascading in line.
- Maximum of 6 outputs per CBX-ST, maximum of 1output per CBX-DS.
- DMX terminator is required at the end of each run to maintain data integrity. One (1x) DMX terminator included with each leader cable. See installation instructions for details.
- Each fixture requires 1 DMX address.
- 1% minimum dimming value.
- Regular Output version : 5 W/ft, High Output version : 12 W/ft.

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Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F87 Series

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

Specification Sheet

lumencove
Lumencove 2.0
LCS2

WHITE AND STATIC COLORS

How to order

Housing	Voltage	Length	Color and Color Temperature [2]	Lens	Finish	Control
LCS2 RO Lumencove® 2.0 Regular Output 5 W/ft **LCS2 HO** Lumencove® 2.0 High Output 12 W/ft	**120** 120 volts **208** 208 volts **220** 220 volts **240** 240 volts **277** 277 volts	**12** 12 1/4 in (1.25 lbs) [1] **24** 24 in (2.5 lbs) **36** 35 3/4 in (3.75 lbs) **48** 47 1/2 in (5 lbs) **96** 94 9/16 in (10 lbs)	**22K** 2200K **27K** 2700K **30K** 3000K **35K** 3500K **40K** 4000K **RD** Red [3] [4] **GR** Green [4] **BL** Blue [4]	**CL** Clear lens **FR** Frosted lens	**WH** Smooth white **CC** Custom color and finish (please specify RAL color) [5] [6] [7]	**NO** On/Off control **LT** Lumentalk [1] [8] **DIM** 0-10V dimming **DALI** DALI dimming **ES** Lutron® EcoSystem® Enabled dimming [9] **DMX/RDM** DMX/RDM enabled [10]

Notes:

1. To connect 12 in fixture lengths to the Lumentalk system, DIM or DMX/RDM must be specified as the control option, and a Lumentalk Data Bridge (LDB) is required. See the typical wiring diagrams in the specification sheet for details.
2. Consult factory for availability of static Royal Blue, 6500K and 90+ CRI.
3. Consult factory for HO static red configuration.
4. Static colors made to order 8-10 weeks.
5. Lumenpulse offers a wide selection of RAL CLASSIC (K7) colors with a smooth texture and high-gloss finish. Please consult factory for a list of available K7 colors, other RAL textures and glosses, or to match alternate color charts. Final color matching results may vary.
6. Setup charges apply for RAL colors. Consult factory for details.
7. Longer lead times can be expected for custom RAL color finishes.
8. A Lumentranslator 2 (LTL2) and LumentalkID (LIDLT) must be specified for Lumentalk applications. Consult Lumentranslator 2 and Lumentalk pages and specification sheets for details.
9. Available for 24 in, 36 in, 48 in and 96 in fixture lengths only.
10. A control box (CBX) and LumenID (LID) must be specified.

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Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

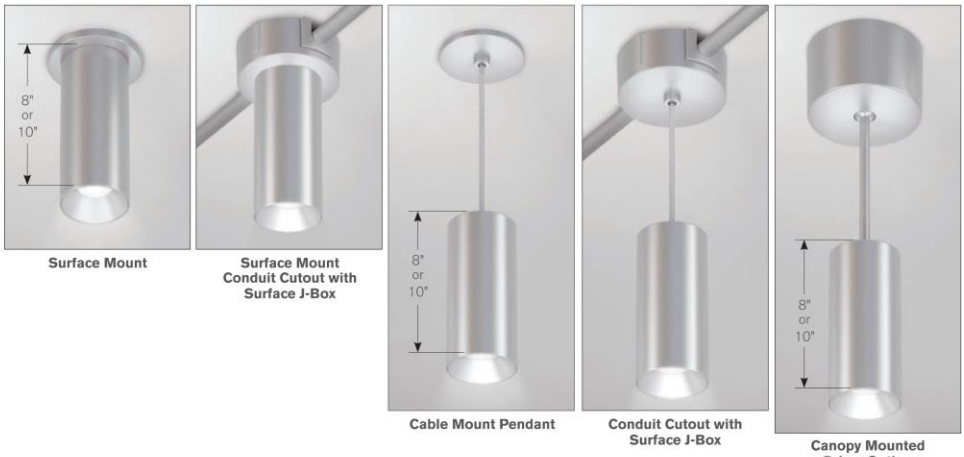
Submittal: ASC P1X

Type: F87 Series

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

BeveLED Mini® Cylinder - CMRD
Round Downlight

USAI Lighting



Surface Mount | Surface Mount Conduit Cutout with Surface J-Box | Cable Mount Pendant | Conduit Cutout with Surface J-Box | Canopy Mounted Driver Option

ROUND DOWNLIGHT CYLINDER PERFORMANCE DATA

LED COLOR CHOICES

DELIVERED* PERFORMANCE:	Classic White			Warm Glow Dimming		Color Select	
	9W	15W	20W	15W	20W	12W	18W
Source Lumens:	1175	1825	2475	1350	1800	925	1200
Lumens Per Watt:	102	102	97	68	66	65	57
Delivered Lumens:	925	1425	1950	1025	1375	775	1050

*Based on 3000K, 80+ CR. Performance varies for each specific beamspread and color temperature. See IES files for exact values at usailighting.

CORRELATED COLOR TEMPERATURE MULTIPLIER	Classic White											
	2700K			3000K			3500K			4000K		
Color Rendering Index:	80+	90+	95+	80+	90+	95+	80+	90+	95+	80+	90+	95+
Multiplier for Lumen	0.96	0.81	0.70	1.00	0.86	0.74	1.03	0.88	0.79	1.06	0.81	0.81

	Warm Glow Dimming				Color Select						
	2700K		3000K		2200K	2700K	3000K	3500K	4000K	5000K	6000K
Color Rendering Index:	80+	90+	80+	90+	80+	80+	80+	80+	80+	80+	80+
Multiplier for Lumen	1.00	0.78	1.00	0.83	0.92	0.97	1.00	1.03	1.05	1.10	1.13

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Revised 05/11/2022

Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F88 Series

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

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HOW TO SPECIFY

BeveLED Mini® Cylinder - CMRD
Round Downlight with Integral Driver

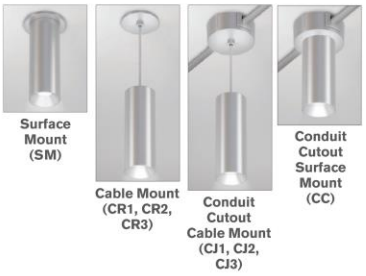
USAI Lighting

1. Specify fixture part number. (All boxes must be filled in to correctly order)

CMRD_ [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ]

Fixture Size	Wattage Options	LED Color Options	Beam Options	Lens Options	Finish	Mounting Options	Voltage Options *Select one*	Dimming Driver Options
CMRD8 8" Length Round Downlight Cylinder (1, 2) **CMRD10** 10" Length Round Downlight Cylinder	**Classic White Light**			**S** Solite (provided standard) **SF** Solite Frosted **BF** Borosilicate Frosted	**WH** White **SC** Conduit Silver **GR** Grey **BL** Black **BZ** Bronze **RAL** Custom Color Specify RAL #	**SM** Surface Mount to recessed junction box **CC** Conduit Cutout for surface mounted 4" octagonal junction box **Rigid Stem Mount + Conduit Cutout Canopy Style (Field Cuttable)** **PJ1A** 2' Nominal Length **PJ2A** 4' Nominal Length **PJ3A** 8' Nominal Length **Rigid Stem Mount + Recessed JBox Canopy Style (Field Cuttable)** **PR1A** 2' Nominal Length **PR2A** 4' Nominal Length **PR3A** 5' Nominal Length **Cable Mount + Conduit Cutout Canopy Style (Field Cuttable)** **CJ1** 2' Nominal Length (2) **CJ2** 4' Nominal Length (2) **CJ3** 8' Nominal Length (2) **Cable Mount + Recessed JBox Canopy Style (Field Cuttable)** **CR1** 2' Nominal Length (2) **CR2** 4' Nominal Length (2) **CR3** 8' Nominal Length (2)	**UNV** 120V-277V	***For use with Universal Voltage 120V - 277V*** *No Additional Charge* **D6E** EldoLED 0-10V, 1% (4) **D6F** EldoLED 0-10V, 1% (4) **D22** ERP 0-10V, 1% (2) **D4H** Lutron H ECO, 1% Fade (1, 2, 4) **D4** Lutron ECO/3-wire, 1% (3,4) **D6A** EldoLED 0-10V, 0.1% (4) **D6B** EldoLED 0-10V, 0.1% (4) **D7** EldoLED DALI, 0.1% (4)
							120V	***For use with 120V only*** *No Additional Charge* **D19** Hatch Phase 2-wire, 1% (1, 2, 4) **D22** ERP Phase 2-wire, 1% (2) **D3** Lutron 2-wire, 1% (4)
	09X3 9W LED **15X3** 15W LED **20X3** 20W LED	**27KS** 2700K, 80+ CRI **27KH** 2700K, 90+ CRI **27KU** 2700K, 95+ CRI **30KS** 3000K, 80+ CRI **30KH** 3000K, 90+ CRI **30KU** 3000K, 95+ CRI **35KS** 3500K, 80+ CRI **35KH** 3500K, 90+ CRI **35KU** 3500K, 95+ CRI **40KS** 4000K, 80+ CRI **40KH** 4000K, 90+ CRI **40KU** 4000K, 95+ CRI	**25** 25° beam **40** 40° beam **55** 55° beam **65** 65° beam					
	Warm Glow Dimming							
	15WG3 15W LED (4) **20WG3** 20W LED (4)	**2722KS** 2700K-2200K, 80+ CRI **2722KH** 2700K-2200K, 90+ CRI **3022KS** 3000K-2200K, 80+ CRI **3022KH** 3000K-2200K, 90+ CRI	**30** 30° beam **45** 45° beam **55** 55° beam **65** 65° beam					
	Color Select Tunable White							
	12CS1 12W LED (4, 5) **18CS1** 18W LED (4, 5)	**6022KS** 6000K-2200K, Tunable White Light 80+ CRI	**30** 30° beam **45** 45° beam **55** 55° beam **65** 65° beam					
	Note: Color Select option requires additional 0-10V dimming wires; see wiring diagrams for details							

Notes:
1 Not available for Warm Glow
2 Not available for Color Select
3 Not available with Classic White. For use with Warm Glow and Color Select only
4 Not available with 8" length CMRD8
5 Not available with cable mount



Surface Mount (SM) | Cable Mount (CR1, CR2, CR3) | Conduit Cutout Cable Mount (CJ1, CJ2, CJ3) | Conduit Cutout Surface Mount (CC)

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Revised 05/11/2022

Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F88 Series

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

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HOW TO SPECIFY

BeveLED Mini® Cylinder - CMRD
Round Downlight with Canopy Mounted Driver

USAI Lighting

1. Specify fixture part number. (All boxes must be filled in to correctly order)

CMRD_						PD_		
Fixture Size	**Wattage Options**	**LED Color Options**	**Beam Options**	**Lens Options**	**Finish**	**Mounting Options**	**Voltage Options** *Select one*	**Dimming Driver Options**
CMRD8 8" Length Round Downlight Cylinder **CMRD10** 10" Length Round Downlight Cylinder	**Classic White Light**			**S** Solite (provided standard) **SF** Solite Frosted **BF** Borosilicate Frosted	**WH** White **SC** Conduit Silver **GR** Grey **BL** Black **BZ** Bronze **RAL** Custom Color Specify RAL #	**Rigid Stem Mount + Canopy Mounted Driver Style (Field Cuttable)** **PD1A** 2' Nominal Length **PD2A** 4' Nominal Length **PD3A** 8' Nominal Length	**UNV** 120V-277V	***For use with Universal Voltage 120V - 277V*** *No Additional Charge* **D6E** EldoLED 0-10V, 1% **D6F** EldoLED 0-10V, 1% **D22** ERP 0-10V, 1% (2) **D4H** Lutron H ECO, 1% Fade (1, 2) **D4** Lutron ECO/3-wire, 1% (3) **D6A** EldoLED 0-10V, 0.1% **D6B** EldoLED 0-10V, 0.1% **D7** EldoLED DALI, 0.1% **D28** EldoLED DMX, 0.1%
	09X3 9W LED **15X3** 15W LED **20X3** 20W LED	**27KS** 2700K, 80+ CRI **27KH** 2700K, 90+ CRI **27KU** 2700K, 95+ CRI **30KS** 3000K, 80+ CRI **30KH** 3000K, 90+ CRI **30KU** 3000K, 95+ CRI **35KS** 3500K, 80+ CRI **35KH** 3500K, 90+ CRI **35KU** 3500K, 95+ CRI **40KS** 4000K, 80+ CRI **40KH** 4000K, 90+ CRI **40KU** 4000K, 95+ CRI	**25** 25° beam **40** 40° beam **55** 55° beam **65** 65° beam			**Canopy Mounted Driver (PD1A, PD2A, PD3A)**	**120V**	***For use with 120V only*** *No Additional Charge* **D19** Hatch Phase 2-wire, 1% (1, 2) **D22** ERP Phase 2-wire, 1% (2) **D3** Lutron 2-wire, 1%
	Warm Glow Dimming							
	15WG3 15W LED **20WG3** 20W LED	**2722KS** 2700K-2200K, 80+ CRI **2722KH** 2700K-2200K, 90+ CRI **3022KS** 3000K-2200K, 80+ CRI **3022KH** 3000K-2200K, 90+ CRI	**30** 30° beam **45** 45° beam **55** 55° beam **65** 65° beam					
	Color Select Tunable White							
	12CS1 12W LED **18CS1** 18W LED	**6022KS** 6000K-2200K, Tunable White Light 80+ CRI	**30** 30° beam **45** 45° beam **55** 55° beam **65** 65° beam					
	Note: Color Select option requires additional 0-10V dimming wires; see wiring diagrams for details							

Notes:
1 Not available for Warm Glow
2 Not available for Color Select
3 Not available with Classic White. For use with Warm Glow and Color Select only

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Revised 05/11/2022

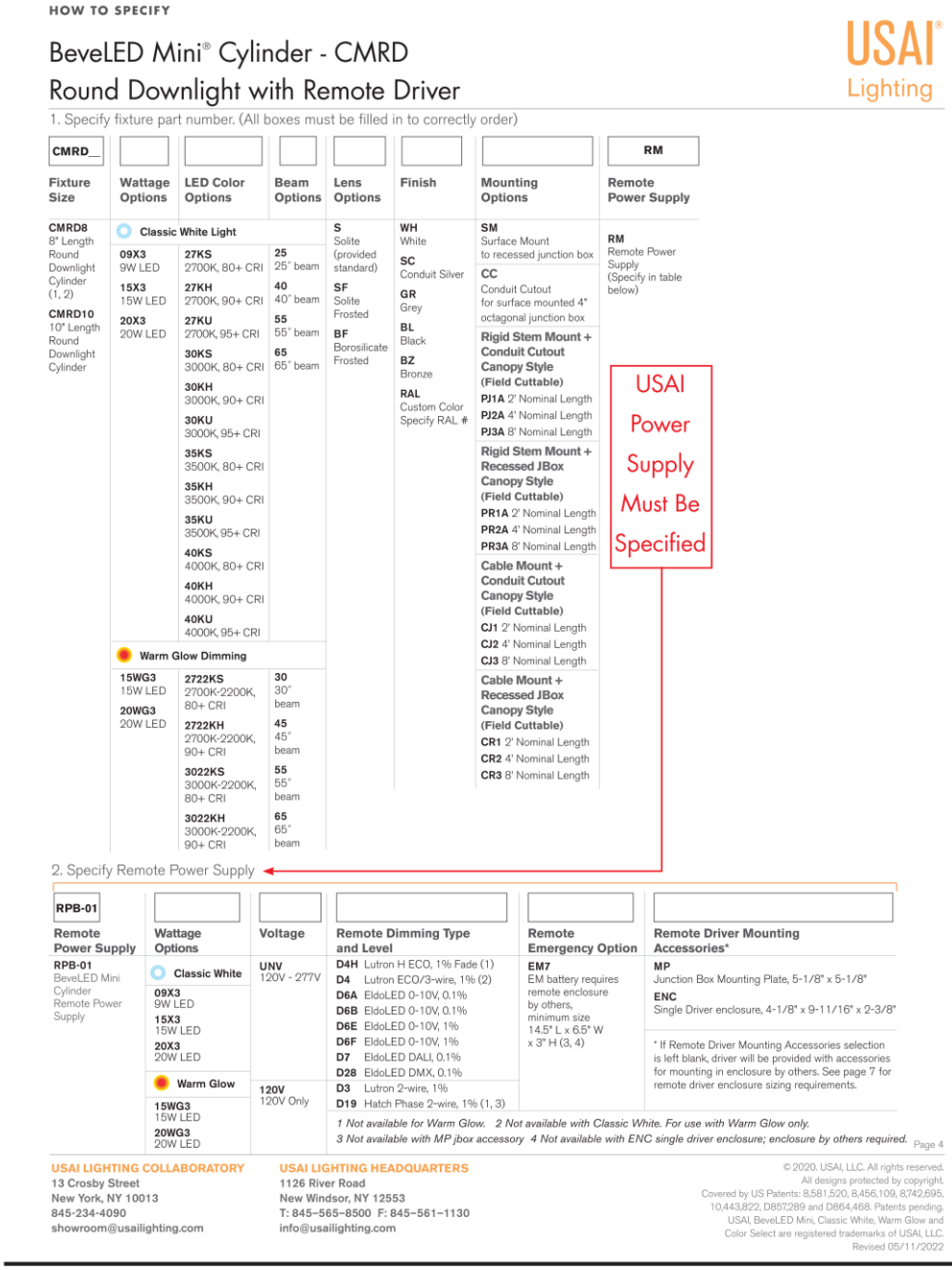
Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F88 Series

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.



HOW TO SPECIFY

BeveLED Mini® Cylinder - CMRD
Round Downlight with Remote Driver

USAI Lighting

1. Specify fixture part number. (All boxes must be filled in to correctly order)

CMRD_							RM
Fixture Size	**Wattage Options**	**LED Color Options**	**Beam Options**	**Lens Options**	**Finish**	**Mounting Options**	**Remote Power Supply**
CMRD8 8" Length Round Downlight Cylinder (1, 2) **CMRD10** 10" Length Round Downlight Cylinder	**Classic White Light**			**S** Solite (provided standard) **SF** Solite Frosted **BF** Borosilicate Frosted	**WH** White **SC** Conduit Silver **GR** Grey **BL** Black **BZ** Bronze **RAL** Custom Color Specify RAL #	**SM** Surface Mount to recessed junction box **CC** Conduit Cutout for surface mounted 4" octagonal junction box **Rigid Stem Mount + Conduit Cutout Canopy Style (Field Cuttable)** **PJ1A** 2' Nominal Length **PJ2A** 4' Nominal Length **PJ3A** 8' Nominal Length **Rigid Stem Mount + Recessed JBox Canopy Style (Field Cuttable)** **PR1A** 2' Nominal Length **PR2A** 4' Nominal Length **PR3A** 8' Nominal Length **Cable Mount + Conduit Cutout Canopy Style (Field Cuttable)** **CJ1** 2' Nominal Length **CJ2** 4' Nominal Length **CJ3** 8' Nominal Length **Cable Mount + Recessed JBox Canopy Style (Field Cuttable)** **CR1** 2' Nominal Length **CR2** 4' Nominal Length **CR3** 8' Nominal Length	**RM** Remote Power Supply (Specify in table below)
	09X3 9W LED **15X3** 15W LED **20X3** 20W LED	**27KS** 2700K, 80+ CRI **27KH** 2700K, 90+ CRI **27KU** 2700K, 95+ CRI **30KS** 3000K, 80+ CRI **30KH** 3000K, 90+ CRI **30KU** 3000K, 95+ CRI **35KS** 3500K, 80+ CRI **35KH** 3500K, 90+ CRI **35KU** 3500K, 95+ CRI **40KS** 4000K, 80+ CRI **40KH** 4000K, 90+ CRI **40KU** 4000K, 95+ CRI	**25** 25° beam **40** 40° beam **55** 55° beam **65** 65° beam				
	Warm Glow Dimming						
	15WG3 15W LED **20WG3** 20W LED	**2722KS** 2700K-2200K, 80+ CRI **2722KH** 2700K-2200K, 90+ CRI **3022KS** 3000K-2200K, 80+ CRI **3022KH** 3000K-2200K, 90+ CRI	**30** 30° beam **45** 45° beam **55** 55° beam **65** 65° beam				

USAI Power Supply Must Be Specified

2. Specify Remote Power Supply

RPB-01					
Remote Power Supply	**Wattage Options**	**Voltage**	**Remote Dimming Type and Level**	**Remote Emergency Option**	**Remote Driver Mounting Accessories***
RPB-01 BeveLED Mini Cylinder Remote Power Supply	**Classic White** **09X3** 9W LED **15X3** 15W LED **20X3** 20W LED **Warm Glow** **15WG3** 15W LED **20WG3** 20W LED	**UNV** 120V - 277V **120V** 120V Only	**D4H** Lutron H ECO, 1% Fade (1) **D4** Lutron ECO/3-wire, 1% (2) **D6A** EldoLED 0-10V, 0.1% **D6B** EldoLED 0-10V, 0.1% **D6E** EldoLED 0-10V, 1% **D6F** EldoLED 0-10V, 1% **D7** EldoLED DALI, 0.1% **D28** EldoLED DMX, 0.1% **D3** Lutron 2-wire, 1% **D19** Hatch Phase 2-wire, 1% (1, 3)	**EM7** EM battery requires remote enclosure by others, minimum size 14.5" L x 6.5" W x 3" H (3, 4)	**MP** Junction Box Mounting Plate, 5-1/8" x 5-1/8" **ENC** Single Driver enclosure, 4-1/8" x 9-11/16" x 2-3/8" * If Remote Driver Mounting Accessories selection is left blank, driver will be provided with accessories for mounting in enclosure by others. See page 7 for remote driver enclosure sizing requirements.

1 Not available for Warm Glow. 2 Not available with Classic White. For use with Warm Glow only.
3 Not available with MP jbox accessory 4 Not available with ENC single driver enclosure; enclosure by others required. Page 4

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Revised 05/11/2022

Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F88 Series

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

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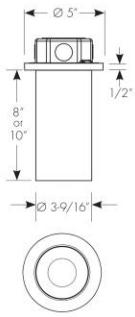
BeveLED Mini® Cylinder - CMRD
Round Downlight

USAI Lighting

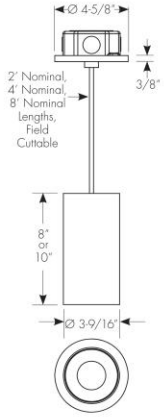
CYLINDER DIMENSIONS

FOR USE WITH RECESSED MOUNTED J-BOXES

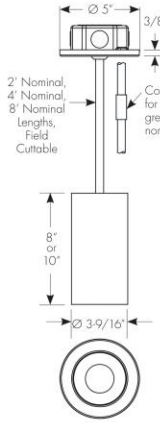
Surface Mount SM



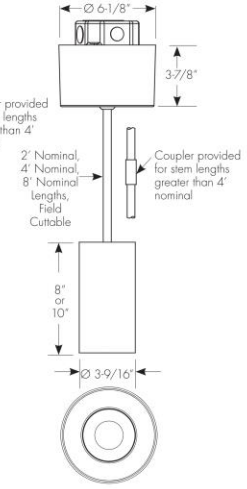
Cable Mount CR1, CR2, CR3



Stem Mount PR1A, PR2A, PR3A

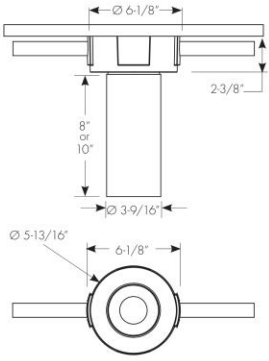


Canopy Mounted Driver Stem Mount PD1A, PD2A, PD3A

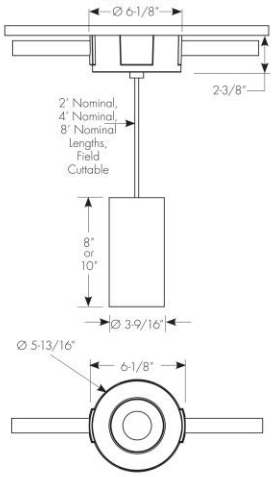


FOR USE WITH SURFACE MOUNTED J-BOXES

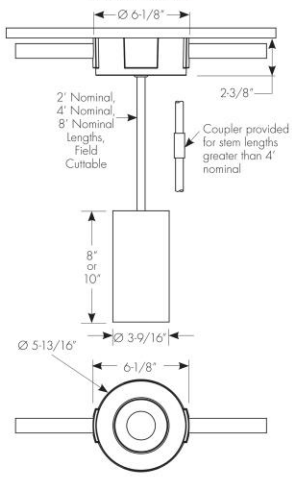
Conduit Cutout Surface Mount CC



Conduit Cutout Canopy Cable Mount CJ1, CJ2, CJ3



Conduit Cutout Canopy Stem Mount PJ1A, PJ2A, PJ3A



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Revised 05/11/2022

Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F88 Series

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BeveLED Mini® Cylinder - CMRD
Round Downlight

USAI Lighting

SPECIFICATIONS

FIELD REPLACEABLE LED LIGHT ENGINE
Light engine is serviceable without tools. All USAI Lighting light engines feature industry-leading color consistency.

FIELD REPLACEABLE OPTICS
Cylinder beamspreads are interchangeable. USAI's proprietary tooled optical reflectors can be easily swapped out in the field without tools. See ordering table for exact beamspread options available with each light engine.

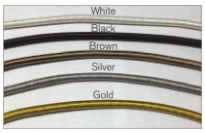
BODY
3-9/16"Ø extruded aluminum body available in 8" or 10" length. Cylinder body and canopy are available in a variety of powder coated paint finishes. Custom colors also available (provide RAL #).

MOUNTING
Hardware included for mounting to 4" octagonal junction box.

SURFACE MOUNT
If the Surface Mount option (SM) is specified, BeveLED Mini Cylinder fixture is provided with a 5"Ø x 1/2" deep round canopy in body finish specified. The installation is completed with no visible hardware.

PENDANT STEM MOUNT WITH INTEGRAL OR REMOTE DRIVER
1/2" Ø (1/4" IPS) steel stem is provided with 30° hang straight in length specified (2' nominal, 4' nominal, or 8' nominal) and is field cuttable to a minimum length of 6". Rigid steel stem is provided in finish as specified in pendant stem ordering table.

CABLE MOUNT WITH INTEGRAL OR REMOTE DRIVER
7/16" Ø braided cable is field cuttable and is provided in length specified (2' Nominal, 4' Nominal or 8' Nominal). Installers must cut the cable in the field to desired length. Cable is provided in finish matching standard cylinder body finish specified. If a different cable color is desired, please contact factory. For custom color RAL body finish, cable color options are white, black, brown, silver, or gold. Color Select tunable white is not available with cable mount option.



RECESSED JBOX PENDANT CANOPY
If recessed J-box canopy style is specified (PR1A, PR2A, PR3A or CR1, CR2, CR3 options) a 5" Ø or 4-5/8" Ø round x 3/8" deep canopy is provided for mounting to recessed mounted junction box. Recessed jbox canopy is provided in finish matching cylinder body finish specified. If a different canopy color is desired, please contact factory.

PENDANT STEM MOUNT WITH CANOPY MOUNTED DRIVER
If canopy mounted driver option is specified (PD1A, PD2A or PD3A) a 6-7/8" Ø round x 3-7/8" deep canopy is provided in finish matching body finish specified for mounting to recessed mounted junction box. Please contact factory if a different canopy color is desired. Dimming driver is mounted inside canopy assembly. 1/2"Ø (1/4" IPS) steel stem is provided with 30° hang straight in length specified (2' nominal, 4' nominal, or 8' nominal) and is field cuttable to a minimum length of 6". Installers must cut the stem in the field to desired length. Rigid steel stem is provided in finish as specified in pendant stem ordering table.

CONDUIT CUTOUT SURFACE MOUNT
Conduit cutout fixtures are designed to mount to surface-mounted 4"octagonal junction boxes with surface-mounted conduit connections. If the conduit cutout surface mount option (CC) is specified, BeveLED Mini Cylinder is provided with a 5-13/16" Ø x 2-1/2" deep conduit cutout canopy base in body finish specified. CC bases have 4 keyslots, one in each side, and ship with one conduit cutout key and three solid cover keys installed. 2 additional conduit cutout keys are shipped with the fixture, and the different key types are interchangeable in the field. Please see installation instructions for drawings and more details.

CONDUIT CUTOUT PENDANT CANOPY
If Conduit Cutout Canopy is specified (PJ1A, PJ2A, PJ3A or CJ1, CJ2, CJ3 options) a 5-13/16" Ø round x 2-3/8" deep canopy is provided for mounting to standard 4" octagonal surface mounted junction box. Conduit cutout canopy has 4 keyslots, one in each side, and ships with three conduit cutout keys and three solid cover keys which are field interchangeable and can be configured to accommodate any ceiling layout using ½" or ¾" conduit. Conduit cutout canopy is provided in finish, matching cylinder body finish specified. If a different canopy color is desired, please contact factory.

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Revised 05/11/2022Revised 05/11/2022

Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F88 Series

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

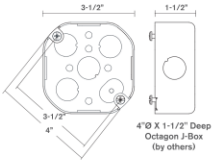
BeveLED Mini® Cylinder - CMRD Round Downlight

USAI Lighting

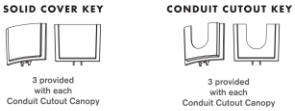
SPECIFICATIONS

CONDUIT CUTOUT MOUNTING EXAMPLE

4"OCTAGONAL JUNCTION BOX



KEY COVER DETAIL



FIELD REPLACEABLE INTEGRAL OR CANOPY MOUNTED DRIVER

100%-1% solid state electronic constant current dimming driver with a high power factor is provided standard. All integral dimming drivers are located within the cylinder body and are serviceable from below the ceiling. All canopy mounted drivers are located within the oversized canopy and are also servicable from below the ceiling. Some on-time delay may be experienced depending on control system used. All dimming drivers comply with IEEE C62.41 surge protection.
NOTE: Color Select tunable white requires additional 0-10V dimming wires; see wiring diagrams for details.

REMOTE LOCATION DRIVER

BeveLED Mini Cylinder is available for use with remotely located driver. Driver is provided separately for remote location on site, enclosure to be provided by others. Remote dimming driver power supply option must be clearly specified in the "RP" table. Remote power supplies require enclosures by others that meet local codes and must be located in an accessible service panel within 100ft of the light fixture; see remote driver table below for coordination of enclosure sizes and wire gauges required. All dimming drivers comply with IEEE C62.41 surge protection.

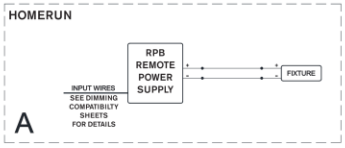
Remote Power Supply Requirements and Wiring Diagram
enclosure sizes and wire gauge with **1 fixture** per power supply.

Remote Power Supply Dimming Option			Wire Gauge Required*	Minimum Enclosure Size Required (by others) RP Only	RP with EM Option**
	UNV-D4H	Lutron H ECO, 1% fade (1)	14/12		
	UNV-D4	Lutron ECO/3-wire, 1% (2)			
	UNV-D6A	EldoLED 0-10V, 1%	18/16	6.25" W x 4" L x 2" H	14.5" W x 6.5" L x 3" H
RPB-01-09X3	**UNV-D6B**	EldoLED 0-10V, 1%			
RPB-01-15X3	**UNV-D6E**	EldoLED 0-10V, 1%			
RPB-01-20X3	**UNV-D6F**	EldoLED 0-10V, 1%			
RPB-01-15WG3	**UNV-D7**	EldoLED DALI, 0.1%			
RPB-01-20WG3	**UNV-D28**	EldoLED DMX, 0.1%			
	120V-D3	Lutron 2-wire phase, 1%	14/12		
	120V-D19	Hatch 2-wire phase, 1% (1)	14/12	5.75" W X 2.625" L x 2" H	

1 Not available for Warm Glow 2 Not available with Classic White. For use with Warm Glow only

Not all dimming options are availbale with all LED light engine options. See RP ordering table for details.
* Wire gauge 14/12 = Maximum distance from light fixture to remote power supply is 100' using 12 gauge wire, 50' using 14 gauge wire.
* Wire gauge 18/16 = Maximum distance from light fixture to remote power supply is 100' using 16 gauge wire, 50' using 18 gauge wire.
** Emergency battery remote power supplies cannot be located any more than 50 feet from light fixture.

Note: All light fixtures must be wired in homeruns per wiring diagram here:



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Revised 05/11/2022

Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F88 Series

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

BeveLED Mini® Cylinder - CMRD Round Downlight

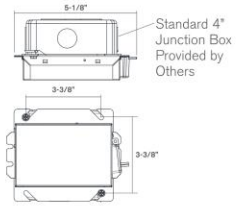
USAI Lighting

SPECIFICATIONS

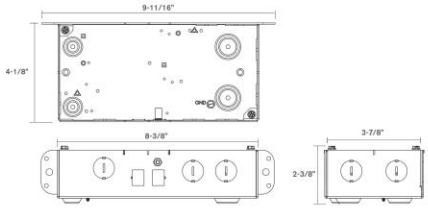
ENCLOSURES FOR REMOTE DRIVERS

Remote drivers require enclosures per local code. Enclosures can be provided by others, or for convenience, USAI can provide them to you. The choices available depend on the dimming driver specified. In the case of the metal encased drivers, USAI can offer a metal mounting plate sized 5-1/8" x 5-1/8" which attaches to the back of each dimming driver and can be installed directly inside a standard 4" square junction box. For the other dimming drivers we offer, USAI can provide an enclosure sized 4-1/8" wide x 9-11/16" long x 2-3/8" deep to accommodate one dimming driver each. Please refer to remote dimming driver ordering tables for clarification on which driver installation accessories, mounting plate or enclosure, are available for each remote dimming driver option. When choosing to use USAI remote dimming driver mounting accessories, whether enclosures or mounting plates, specify the accessory in the accessories column of the remote dimming driver ordering table to indicate selection. Field wiring should be according to NEC code; per article 411.7. EC is responsible for adherence to all local codes. Refer to remote dimming driver tables for maximum distances, locations, and wire gauges required, which varies by driver type.

MP JUNCTION BOX MOUNTING PLATE



ENC SINGLE DRIVER ENCLOSURE



FIXTURE WEIGHT

Cylinder weighs 3 lbs (not including rigid pendant stem accessory).

WARRANTY

Based on IESNA LM80-2008, BeveLED Mini Cylinder has a 50,000 hour rated life at 70% lumen maintenance (L70). USAI Lighting Warranty covers replacement parts for 5 years from date of shipment. Warranty is void if USAI Cylinder is used with any power supply other than that which is provided by USAI.

LISTINGS

Dry/Damp. NRTL/CSA-US tested to UL standards. IBEW union made.

NOTES

- Ambient temperatures at fixture location should not exceed 40°C during normal operation.
- For interior use only

PHOTOMETRICS

Consult factory or website for IES files. Tested in accordance with IESNA LM79-2008.

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Revised 05/11/2022Revised 05/11/2022

Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
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Date: 17 June 2022

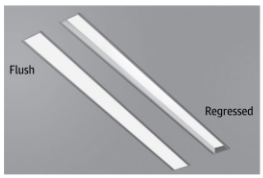
Submittal: ASC P1X

Type: F88 Series

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

MARK ARCHITECTURAL LIGHTING™

Slot 4 LED
Recessed Linear



Slot 4 LED takes both form and function a step further with increased efficacy and integral controls creating a digitally addressable luminaire that is perfect where visually harmonious illumination and energy efficiency are desired.

Slot 4 LED is the ideal choice for spaces that emphasize lines and clean contemporary design. It is a perfect fit for Armstrong TechZone™ ceiling systems. A regressed lens option provides added dimension to the sleek, slender design and the flush lens now has a Wet Label option.

Type:

Project:

Catalog Number:
DO NOT TYPE HERE. Autopopulated field.

Specification Features

Housing
Nominal 4" x 2', 3', 4', 5', 6', 7', 8' and continuous rows in 1" increments as standard, upper housing fabricated from cold-rolled steel with extruded aluminum ceiling trim.

Finish
Polyester powder coat painted finish.

Reflector
Precision-formed steel; high reflectance matte white powder coat; 93% reflectivity.

Shielding
Flush Lens: Snap-in 90% transmissive satin acrylic lens.

Regressed Lens: Lay-in 90% transmissive satin acrylic lens.

Mounting
Recessed. Available for sheetrock, 9/16" slot grid or 15/16" inverted tee ceilings, or 9/16" inverted tee.

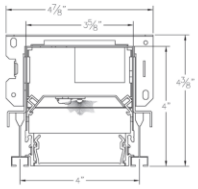
Certification
CSA tested to UL 1598 standards. Optional Damp or Wet location listings available, see ordering tree. This product is IC rated.

Listings
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.

Warranty
5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/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.*

Technical Drawing



Flush - (FLP)

eldoLED nLIGHT Declare.

Fixture Performance - SL4L*

Lumens Output	400 LMF		600 LMF**		800 LMF**		1000LMF	
Fixture Style	RLP	FLP	RLP	FLP	RLP	FLP	RLP	FLP
Delivered Lumens/FT	316	314	544	541	737	734	928	924
Input Watts/FT	4	4	6	6	8	8	10	10
Lumen/Watt	91	91	95	95	93	93	90	89

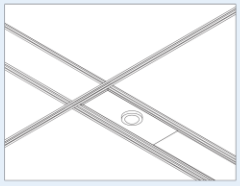
*CCT (35K)
* Consult factory for customized lumen output and wattage
** Based on calculated values

LED Components
Linear: Nichia® - 757 Series LED chips (available in 80 or 90 CRI)

LED Life
Rated 65,000 hours (L80) at 25 °C ambient temperature.

Color Consistency
The Acuity Brands circuit boards for the linear LED components use a precise binning algorithm which creates a consistent color temperature from board to board. Color variation is no greater than a 2.5 Step MacAdam (2.5SDCM) along the black body locus from board to board.

Driver
eldoLED constant current driver options delivers ultra-smooth dimming resolution from 100% to 0.1%, while assuring flicker free, low current inrush, 89% efficiency and low EMI.


Occupancy Sensor (PDT) and/or Photocell (ADC)

Integrated Controls
Optional nLight® embedded controls make luminaire addressable- allowing it to digitally communicate with other nLight enabled controls such as dimmers, switches, occupancy sensors and photocontrols. Simply connect all the nLight enabled control devices using standard CAT5 Cabling. (Input option: NLIGHT)

Photometry
For photometric information refer to www.marklighting.com.

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Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F89

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

MARK ARCHITECTURAL LIGHTING™

Slot 4 LED
Recessed Linear

A+ Capable options indicated by this color background.

Ordering

Example: SL4L LOP 4FT FLP TG 90CRI 35K 400LMF MIN1 277V NLIGHT

Series	Linear Length Plan	Total Run Length	Fixture Style	Ceiling Trim	Direct Light Source Color Rendering	Direct LED Color Temp
SL4L Slot 4 LED Linear Recessed	**LOP** Linear Optimized Plan	**2FT** 2' **3FT** 3' **4FT** 4' **5FT** 5' **6FT** 6' **7FT** 7' **8FT** 8' **_FT_** *Specify continuous linear feet in 1" increments (7FT6 = 7FT 6IN)	**RLP**[2,3] Regressed Lens **FLP**[3] Flush Lens	**FL**[4] 5/8" Flange(sheetrock) **TG** 9/16" or 15/16" Flat or Inverted Tee **GB**[4] Trimless (sheetrock) **WFL** Perimeter Mount, 5/8" Flange (Sheetrock) **WTG** 9/16" Flat or Inverted Tee, Perimeter Mount *For metal pan, hard wood or other ceiling types consult factory.	**80CRI** 80 CRI **90CRI** 90 CRI	**27K*** 2700K **30K** 3000K **35K** 3500K **40K** 4000K **50K*** 5000K

Direct LED Light Output	Direct Distribution	Downlight[11]	Downlight Color Rendering	Downlight Color Temp	Minimum Dimming Level	Voltage
400LMF 400 Lumens per FT **600LMF** 600 Lumens per FT **800LMF** 800 Lumens per FT **1000LMF** 1000 Lumens per FT **_LMF*** [5] ## Lumens per FT (Limited to 300LMF to 1000LMF in 50LMF increments)	**(blank)** Standard Distribution **WW**[5] Wall Wash	**2DL**[3,6] LED Downlight Standard **_DL**[3,6] LED downlights per Run (3DL, 4DL, ect.)	**S80CRI** 80 CRI **S90CRI** 90 CRI	**S27K** 2700K **S30K** 3000K **S35K** 3500K **S40K** 4000K	**NODIM** Non - Dim **MIN1** Constant current, dimming to 1% **DARK** Constant current, dimming to 0.1% **MIN5**[7] Constant current, dimming to 5% **MIN10**[18] Constant current, dimming to 10%	**120** 120V **277** 277V **347*** [8] 347V

Finish	Emergency Options	Control Input	Primary Sensor[13]	Secondary Sensor[13]
(blank) White (satin) **xxx/BLKT** Black (satin) **xxx/SLVT** Silver (satin) **xxx/RALTBD** RAL paint finish xxx = fill in with the appropriate ceiling trim. Only trims are painted RALTBD is for pricing only. Replace with applicable RAL number and texture when placing order	**(blank)** No Emergency **_E10WLCP**[9] Number of 4ft Emergency Section(s) with battery pack **_EC**[10] # of Emergency Circuits	**(blank)** Non-dim[12] **ZT** 0 10V **NLIGHT** nLight enabled **NLTAIR2**[19] nLight Air (wireless enabled) **ECOD*** [17] Lutron Hi-Lume digital driver **ECOD2*** [4,17] Lutron Hi-Lume 2-wire (1% dimming) **ECOD5*** [7] Lutron 5-series digital driver (5% dimming) **DALI**[20] DALI compatible	**(blank)** Single Zone, No Sensor **NS** Multi-zone, No Sensor Main Zone **PDT**[14] Dual Technology Occupancy Sensor, PIR and Microphonics Sensor **ADC**[14] Daylight Dimming Sensor **API**[15] Passive Infrared Occupancy Sensor and Daylight Dimming Sensor **APD**[15] Dual Technology Occupancy Sensor and Daylight Dimming Sensor	**(blank)** No additional zones/sensors **SNS** Multi-zone, with no sensor in secondary zone **SPDT**[14] Dual Technology Occupancy Sensor, PIR and Microphonics Sensor **SADC**[14] Dual Technology Occupancy Sensor, PIR and Microphonics Sensor **SAPI**[15] Passive Infrared Occupancy Sensor and Daylight Dimming Sensor **SAPD**[15] Dual Technology Occupancy Sensor and Daylight Dimming Sensor

Tertiary Zone	Options	
(blank) No additional zones/sensors **TNS** Multi-zone, with no sensor in tertiary zone	**(blank)** No Options **CP**[21] Chicago Plenum **BAA** Buy America(n) Compliant	**WL**[3,11] Wet Location Listing **DPL** Damp Location Listing **PWS** 6' Pre-Wire, 3/8" Diameter, 18 Gauge

* Requires longer lead time.

Notes

1. Supplied with lift and shift lay-in lens.
2. Supplied with snap-in lens.
3. Wet Location label not available with downlights, regressed lens, or with sensor options, or PWS. Cannot be installed on vertical surfaces.
4. Not intended for post sheetrock installation.
5. Wall Wash not available with downlights, RLP lens and all sensor options.
6. See notes on page 3, downlights only available with DARK dimming level.
7. MIN5 requires ECOD5 Control Input. ECOD5 only available with MIN5 dimming.
8. Not available with 2' sections, E10WLCP or sensors. Only available with NODIM or MIN1 with ZT.
9. Default battery pack is integral, battery pack will be remote on 2' & 3' (RE10WLCP). Integral battery not available with RLP, WW, sensors or downlights. Only 1 integral battery pack per unit. CP listing must have an integral battery. Remote batteries are not wet location listed, they may be used with a wet location fixture is the battery itself is mounted in a dry location.
10. Standard 4' EC section, defaults to end of run. 2ft, 3ft and 5ft powers entire fixture, 6ft powers 3ft EC section.
11. Not available with ECOD, ECOD2, ECOD5.
12. Only available with NODIM option.
13. Sensors not available with WW, NODIM driver, WL, RLP, downlights or 2' & 3' units. Not available with 347 & NLIGHT together. Default location for sensor is the left side of the fixture. For runs the first fixture will include the sensor.
14. Requires ZT or NLIGHT Control Input.
15. Requires ZT, NLIGHT or NLTAIR2 Control Input.
16. Must use 120 volt.
17. Must select MIN1 options.
18. MIN10 not available with 347, sensors, NLIGHT or NLTAIR2, requires ZT.
19. Must select MIN1 or DARK. Not available with RLP, WW, PDT, ADC or 347, DPL or WL. If with EC, cannot be on individual units, and on runs, the EC cannot be on the same section as NLTAIR2.
20. DALI is only available with DARK or MIN1. It is not available with sensors or downlights.
21. CP not available with NLTAIR2.

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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South Terminal C - Phase 1X
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Type: F89

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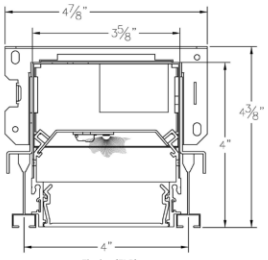
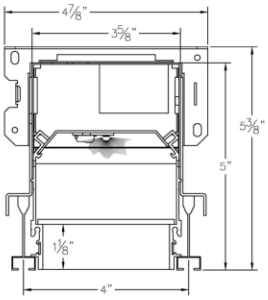
MARK ARCHITECTURAL LIGHTING™

Slot 4 LED
Recessed Linear

Technical Drawing

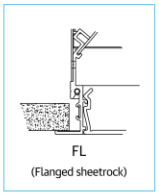


Flush - (FLP)

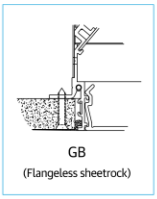


Regressed - (RLP)

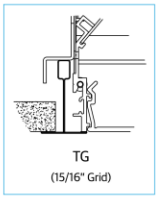
Ceiling Trim



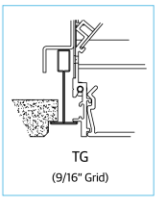
FL
(Flanged sheetrock)



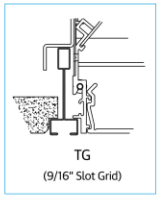
GB
(Flangeless sheetrock)



TG
(15/16" Grid)



TG
(9/16" Grid)

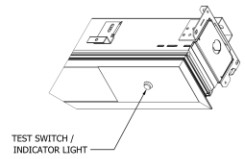


TG
(9/16" Slot Grid)

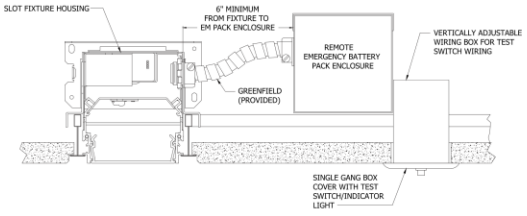
TG ceiling trim is suitable to mounted to a 4" techzone ceiling type.

Emergency Battery

Internally Mounted (E10WLCP)



Remote Mounted (RE10WLCP)



Notes
- Delivers 700 lumens per 4FT length. Default location is the right side of fixture and end of run.
- Provided with 4FT of flexible conduit. Maximum of 25FT remote distance if extended. Extension provided by others.
- See ordering tree notes for remote battery pack scenarios.

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Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F89

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

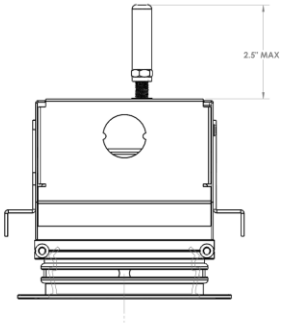
MARK ARCHITECTURAL LIGHTING™

Slot 4 LED
Recessed Linear

nLight Air Wireless

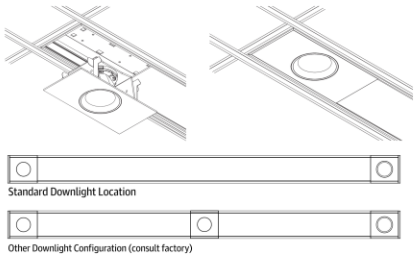
nLight Air

The default location of the antenna will be at the left end of an individual unit. On a run, it will be placed at the beginning or left end of the first section. Please consult factory for other placement options.



Downlights

Optional downlights powered by Xicato Spot Modules are available with any linear length and no less than 2' on center spacing. Each downlight module is 6W with 700 lumens delivered (28 degree beam spread). Downlights are supplied with a dedicated feed-point and will be controlled separately.



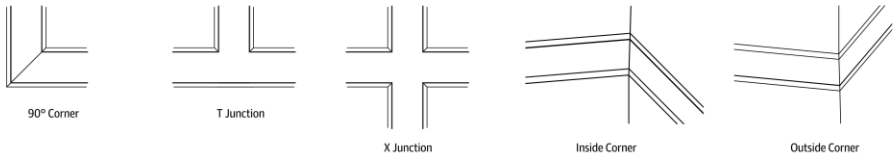
Notes
- 2DL - Downlights are supplied at each end of an individual unit
- _DL - Multiple downlights will be supplied with one at each end and the remainder will be centered over the length of the run.
- Downlights are not adjustable and are provided with solite lens

Continuous Runs

Slot 4 LED continuous rows can be configured in 1" increments.

Run Patterns, Corners and Junction

Slot 4 LED patterns be configured in 1' increments with illuminated 90° inside and outside corners, T junctions, and X junctions with standard 2' corner and junction lengths. For custom angles, corner or junction lengths, consult factory.



Layout Sketch

Please draw and configure your linear run below.

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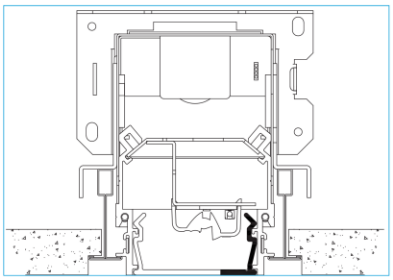
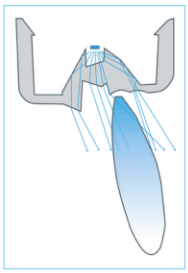
MARK ARCHITECTURAL LIGHTING™

Slot 4 LED
Recessed Linear

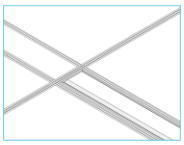
OPTICS

Slot LED's patent-pending, precision lumen DIRECTIR optics condition and refract light to deliver accurately controlled, striation-free, and uniform white light. All lumen DIRECTIR optics are injection-molded, optical grade, UV-resistant acrylic with selective finishing/polishing treatment.

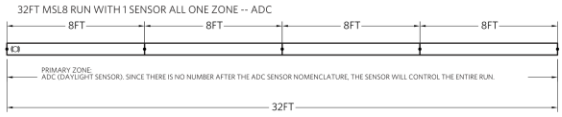




Wall Wash (WW)



INTEGRATED SENSOR LAYOUT



Notes:
- Only one sensor per zone

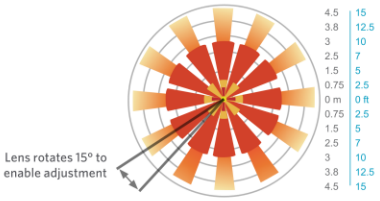
OCCUPANCY DETECTION COVERAGE

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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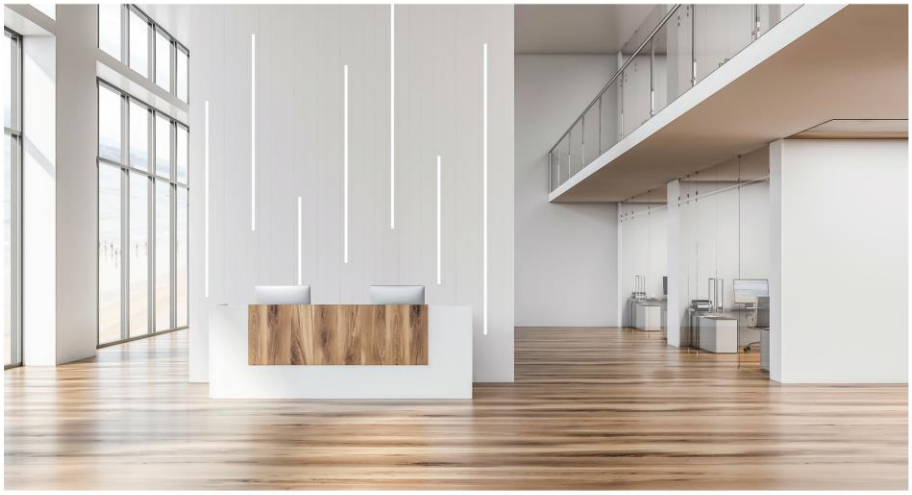
HTG-1RW | SPEC SHEET
RECESSED LOPRO - WALL



HUNTINGTON 1 - RECESSED WALL

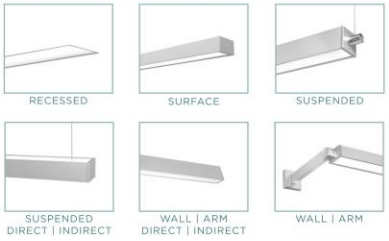
LoPro

Brilliant by Design™, the Huntington 1 Recessed LoPro Wall is sure to level up your space. Our patent pending Microstructure EdgeTech Optics™ (MEO) technology delivers unparalleled optic control, low glare visual comfort, exceptional performance, seamless illumination, and uniformity in unprecedented low-profile behind wall depths. Lens gaps, pixelation and hot spots are a thing of the past with our innovative Dual Lens Edge-lit MEO™ technology.

FEATURES

- Low profile depth behind ceiling for use in any plenum installation:
  - 1.5" - 1.75" Depth (Remote Driver)
  - 2.14" - 2.45" Depth (Integral Driver)
- Design without compromise: Specify Batwing, Glare Control, Diffused (Lambertian) or Wall Wash Optics
- Specified Lumen Outputs (SLO) available: 193 lm/ft – 1480 lm/ft
- Minimalistic 1.5" Aperture
- Individual fixture lengths and seamless continuous runs with no lens breaks up to 500 feet
- Achieve up to 16 feet on center spacing with 35fc on work surface
- Drivers, wiring and serviceability completely accessible from below ceiling with our patent pending toolless "Push to Eject" system
- Toolless Latch System and Quick-Click 5 Wire system allows for simple, quick, and seamless installation
- Trim Flange, Spackle Flange and Ceiling to Wall transitions available.
- Proudly crafted in Huntington Beach, CA - USA

HUNTINGTON 1 LINEUP



PERFORMANCE OVERVIEW

4' Huntington 1 Direct - 3500K 80CRI

Lumen Output	LL (Low)	ML (Medium)	HL (High)	SLO* (Specified)
Delivered Lumens	772	1908	3760	772-5920
Consumed Wattage	7	18	38	7.3 - 65.6
Efficacy (lm/W)	105	105	99	90-105
SDCM	3	3	3	3

*Specified Lumen Output (SLO) available in customizable lumen configurations (896 lm - 6852 lm). See SLO Configurator at ExtantLighting.com

MADE IN USA MEO cULus JA8

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02032021 HTG-1RW-LP | 1

Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F90

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

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HTG-1RW | SPEC SHEET
RECESSED LOPRO - WALL

Ordering Information

PROJECT _____ TYPE _____
PRODUCT _____ QTY _____

Product Family

HTG-1RW-LP Huntington Series 1.5" Aperture (Recessed - LoPro - Wall)

Driver Location

- ☐ **TD** Integral Driver
- ☐ **RD** Remote Driver

Trim

TRIM FLANGE

- ☐ **TFSA** Trim Flange - Silver Anodized
- ☐ **TFWP** Trim Flange - Matte White
- ☐ **TFBP** Trim Flange - Matte Black
- ☐ **TFCC** Trim Flange - Custom Color

TRIMLESS

- ☐ **SF** Spackle Flange (Mud-in)

Length

- ☐ **____*** Specify length in 1 foot increments
- ☐ **R__x__** Rectangle
- ☐ **L__x__** L Pattern
- ☐ **U__x__x__** U Pattern
- ☐ **C__W__** Ceiling to Wall Transition Example: C14'W12'
- ☐ **CP** Custom Pattern

*Minimum Integral Driver length is 2'. Minimum Remote Driver lengths can be shorter, consult factory. Custom length fixtures can be ordered in 3" increments. Any length over 8' requires multiple fixture segments.

Lumen Output

- ☐ **DLL** Low (193 lm/ft @ 1.84 W)*
- ☐ **DML** Medium (477 lm/ft @ 4.55 W)*
- ☐ **DHL** High (940 lm/ft @ 9.46 W)*
- ☐ **SLO-xx** *Specified Lumen Output available. (193 lm/ft - 1480 lm/ft)

*Delivered lumen output & consumed wattage based on "MEODF 835" (80 CRI - 3500K). See SLO Configurator for alternate outputs.

Optics

MEO

- ☐ **MEODF** Diffusing
- ☐ **MEOBW** Batwing
- ☐ **MEOGC** Glare Control

Color Temp

80+ CRI

- ☐ **830** 3000K
- ☐ **835** 3500K
- ☐ **840** 4000K
- ☐ **8TW*** Tunable White (2700K-6500K)

80+ CRI

- ☐ **927** 2700K
- ☐ **930** 3000K
- ☐ **935** 3500K
- ☐ **940** 4000K
- ☐ **XX** Optional Color Temp & CRI Available

Voltage

- ☐ **VU** 120V-277V
- ☐ **V3** 347V

Driver

- ☐ **D'__** 1% 0-10V
- ☐ **DN** NON DIM
- ☐ **DL5** Lutron 5-Series EcoSystem
- ☐ **DL1** Lutron Hi-Lume 1% EcoSystem
- ☐ **DL2** Lutron Hi-Lume 1% 2-wire (120V only)
- ☐ **DE*** .1% 0-10V
- ☐ **DD1** 1% DALI
- ☐ **DDE** .1% DALI
- ☐ **XX** Other (Please Specify)

*Dim to Off available. Please Specify "-OFF" next to driver option if required.

*1% minimum dimming level and other custom dimming levels and settings available. Consult factory.

Options

- ☐ **EMB_*** Emergency Battery Pack(s)
- ☐ **EMC_*** Emergency Circuit(s)
- ☐ **SOC *** Occupancy Sensor
- ☐ **SDL*** Daylight Sensor
- ☐ **BCS*** Brilliant Communications Solutions (wired/wireless)
- ☐ **CP** Chicago Plenum Approved
- ☐ **JA8** JA8 Approved
- ☐ **QAF*** Extant Express 9-Day Quick Ship

EMB: Specify quantity of battery packs. Minimum 4' unit.
Note: Remote Driver (RD) fixtures will have remote battery packs. Integral Driver (TD) fixtures will require a deeper housing. (See Page 7 for details)
EMC: Specify quantity of emergency circuits.
SOC & SDL: Specify spacing/location of sensors(s).
BCS: Includes wired and wireless integration from our partners at nLight™, Enlighted, Legrand, Crestron, Osram, Lutron and many more. Contact Extant for details.
QAF: For more details, visit ExtantLighting.com.

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02032021 HTG-1RW-LP | 2

Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F90

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

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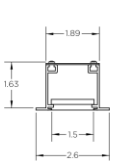
EXTANT™ | ARCHITECTURAL LIGHTING

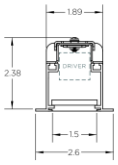
HTG-1RW | SPEC SHEET
RECESSED LOPRO - WALL

Dimensions

TF - TRIM FLANGE

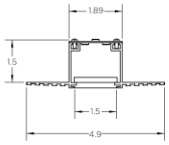


REMOTE

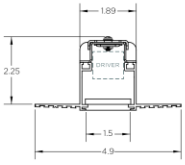


INTEGRAL

SF - SPACKLE FLANGE



REMOTE



INTEGRAL

Specifications

Construction One-piece heavy gauge 6063 extruded aluminum housing. Precision-machined aluminum end caps.

Optics Microstructure EdgeTech Optics (MEO)™ utilizes high efficiency Microstructure Lenses and Light Guide Plates for high optical extraction and precise light management. Specify Batwing, Glare Control, Diffused (Lambertian) or Wall Wash Optics.

Light Output (3) Standard lumen packages are available: Low (DLL), Medium (DML) and High (DHL). Specified Lumen Output (SLO) packages available. Please see the (SLO) configurator at Extantlighting.com.

LEDS Latest generation of premium Nichia 3-step MacAdam Ellipse LED's available in (90+ CRI) 2700K, 3000K, 3500K, 4000K or (80+ CRI) 3000K, 3500K or 4000K. LED modules are easily accessible and replaceable.

Voltage Universal 120/277V (VU) and 347V (V3) available. Consult factory for driver options when 347V is specified.

Emergency Battery Factory provided low profile 10W emergency battery for UL924 required 90-minute run time (optional).

Finish Standard finishes include silver anodized, powder coated white or powder coated black. Custom anodized and powder coated finishes available (RAL number matched).

Continuous Rows Innovative Toolless Latch System ensures simple installation. Seamless continuous rows with no lens breaks, pixelation or hotspots up to 500 feet (MEODF, MEOGC) or 250 feet (MEOBW).

Patterns Standard Rectangle Pattern (R), U Pattern (U), and L Pattern (L) available. Custom patterns available.

Mounting Trim Flange or Spackle Flange.

Approvals UL and cUL Listed. Approved for Dry/Damp locations. IC Rated. Made in the USA. JA8 Approved.

Lumen Maintenance (L70) 70% of initial light output = Reported > 60,000 hours | Calculated > 200,000 hours (L90) 90% of initial light output = Reported > 60,000 hours | Calculated > 200,000 hours.

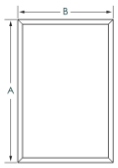
Warranty HTG 1 offered with a 5-year limited warranty. 5-year limited warranty covers LED, driver and fixture. For further details, refer to General Warranty and Obligations at ExtantLighting.com.

Patents Extant Lighting's intellectual property is protected under Patent Pending Status by the U.S. Patent Office.

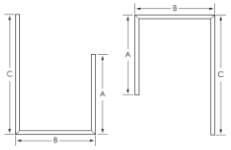
* Due to our culture of always striving for product enhancement, specifications and information within this document are subject to change without notice. 2020 Extant Lighting, Inc. All rights reserved.

Patterns

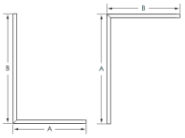
Note: All miters/patterns shown and ordered in Plan View.



R__X__
Rectangle
Provide AxB
Example: R6'x4'



U__X__X__
U-Shape
Provide AxBxC
Example:
U6'x4'x4'



L__X__
L-Shape
Provide AxB
Example: L6'x4'

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02032021 HTG-1RW-LP | 3

Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F90

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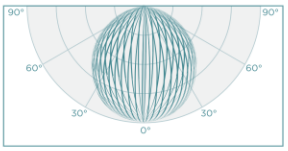
EXTANT™ | ARCHITECTURAL LIGHTING

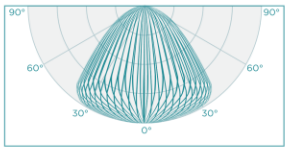
HTG-1RW | SPEC SHEET
RECESSED LOPRO - WALL

Microstructure EdgeTech Optics (MEO)™

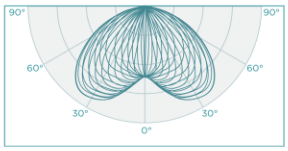
Our innovative MEOTM design utilizes high efficiency Microstructure Lenses and Light Guide Plates for high optical extraction and precise light management. MEOTM delivers exceptional light quality with seamless illumination and uniformity with no pixelation, hot spots or lens breaks up to 500' (MEODF, MEOGC) or 250' (MEOBW).



MEODF
LAMBERTIAN



MEOGC
GLARE CONTROL

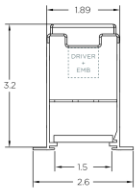


MEOBW
BATWING

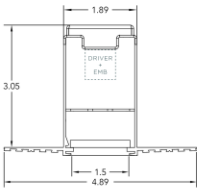
Dimensions - EMB Fixtures

The dimensions shown below are only for recessed fixtures that contain an Emergency Battery Pack. Dimensions for all fixtures without an EMB(s) can be found on page 3.

TF - TRIM FLANGE



SF - SPACKLE FLANGE



Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F90

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

EXTANT™ | ARCHITECTURAL LIGHTING

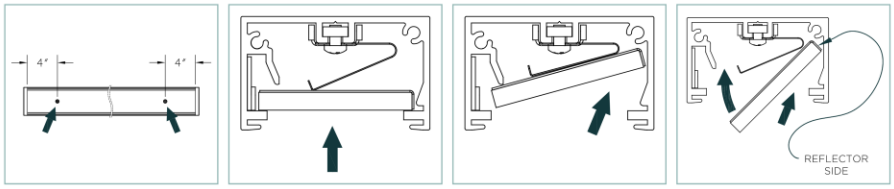
HTG-1RW | SPEC SHEET
RECESSED LOPRO - WALL

Thoughtful Engineering...

Thoughtful engineering is at the core of all of our fixture designs. All of our products are thoughtfully engineered and include innovative features that create a sophisticated fixture that is also contracator friendly and easy to install and service.

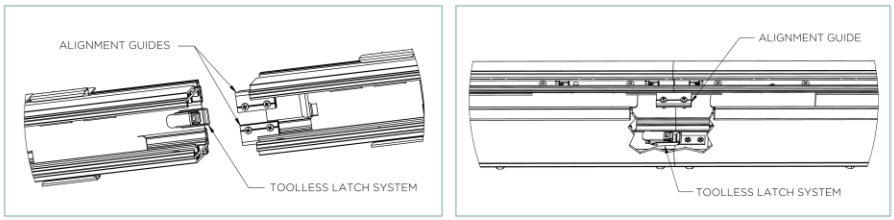
PUSH AND EJECT SYSTEM

Innovative "Push and Eject" System allows for toolless removal and installation of the Light Guide Plate. This thoughtful engineering creates easy access into the housing for simple installation and servicebility.



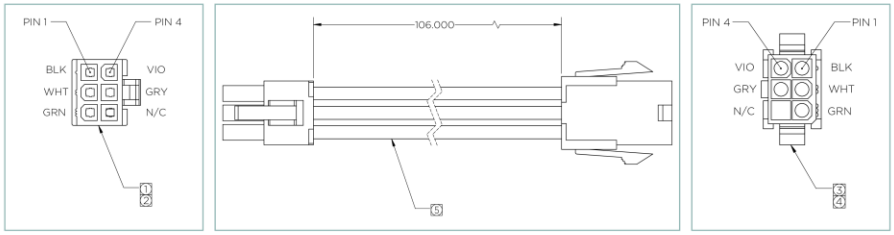
TOOLLESS LATCH SYSTEM

Our Toolless Latch System is designed to securely connect the extrusions of the continuous runs without the use of any tools, screws or external parts. Our innovative design allows the contractor to perfectly align the extrusion with the built-in alignment pins and cinch up the extrusion with the Toolless Latch System for a tight fit. The Toolless Latch System eliminates gaps and ensures perfect alignment.



QUICK-CLICK 5-WIRE SYSTEM

Our Quick-Click 5-Wire System connects all continuous run through wiring with a simple push and click connection. The Quick-Click System is contractor friendly and decreases installation time and cost and ensures proper wiring.



EXTANT ARCHITECTURAL LIGHTING™
15572 Commerce Lane, Huntington Beach, CA 92649 | O 714-362-8099 | ExtantLighting.com
02032021 HTG-1RW-LP | 5

Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F90

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

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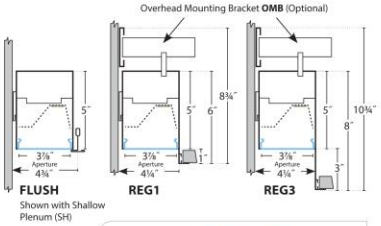
P43 | Cove & Perimeter
4˝ Perimeter

PRUDENTIAL LTG.
PRULITE.COM 213.746.0360



High performance wall grazer.

Optics: Glow, Wall Graze or wash a corridor in light (D1R).
Series: P43 recessed linear and Wall Wash for visual continuity.

Bionic Perimeter System contains same great optics with extruded aluminum housing to accommodate more ceiling systems.

LOW OUTPUT:
P43-PSTD-FLSH-LED4-LO-AWW-D1G
1620 Delivered Lumens
16 Watts
101 Lm/W
4000 CCT

UP TO 101 LPW (CLICK HERE)

		LO	MO	SO	HO
FLUSH:					
SAL-D1	Lm/Ft	400	600	800	900
AWW-D1G	Lm/Ft	400	600	800	900
AWL-D1R	Lm/Ft	400	600	800	900
REGRESS 3:					
REG3-SAL	Lm/Ft	350	500	700	800
REG3-D1G	Lm/Ft	350	500	700	800
	W/Ft	4.6	6.5	9.5	11

Declare. 5 IC RATED PROGRESS PROFESSIONAL LED Details Made in the USA

Lumen output may vary +/- 5%
4000K used for lm/ft estimates above 3500K –2% IIf, 3000K –4%, 2700K –6% -10% LLF for 90 CRI (4K, 3500K and 3K)
See LED Details PDF for more info

SERIES	LENS POSITION	LED COLOR	OUTPUT	NOMINAL LENGTH	TRIM COLOR	SHIELDING	DISTRIBUTION	MOUNTING	CIRCUITING	CEILING SYSTEMS	VOLTAGE	DRIVERS	OPTIONS, SENSORS & CORNERS
P43-PSTD									SC				
Perimeter Standard	FLSH Flush Lens REG1 1˝ Regress Lens REG3 3˝ Regress Lens	LED27 2700K (90CRI) LED3 3000K LED35 3500K LED4 4000K LED3-90 90CRI LED35-90 90CRI LED4-90 90CRI	LO Low MO Medium SO Standard HO High PROG Programmable Light Output (Specify desired lm/ft or w/ft)	2˝ 3˝ 4˝ 6˝ 7˝ 8˝ R___ (Row length) Any row length is achievable with field trimable filler kit **NOTE:** Individual not intended for row mounting	TMW Textured Matte White (Standard) YGW Gloss White Y___ Premium Color CC Custom Color	SAL Satin Acrylic Lens (D1 only) AWW Acrylic Wall Grazer Lens (D1G only) AWL Perimeter Fill Lens (D1R only) SAL-D1 AWL-D1R	D1 Direct (SAL only) D1G Wall Grazer (AWW only) D1R Perimeter Fill (AWL only, NA - REG3) AWW-D1G	WTW Wall to Wall (Any row length) LP Light Pocket (Typically 1˝ increments, fixture stops before wall)	SC Single Circuit	X1 T-Bar 15/16˝ Exposed X1M T-Bar 9/16˝ Exposed X2 Interlude T-Bar X6 Slot Grid X3B Hard Ceiling (Overlapping flange) X7 Hard Ceiling (Trimless mud-over concealed flange)	UNV (120-277) 347 (Emergency battery requires a Step Down transformer)	ND Non-Dimming DM01 0-10v, 1% Dimming (Standard) LDE1 Lutron Hi-lume 1% EcoSystem LED (Soft fade on, fade-to-black dimming, NA - HO) ECO 1% 0-10v, EldoLED (Logarithmic dimming std) ECDA 1% DALI, EldoLED (Logarithmic dimming std) SOLO 0.1% 0-10v, EldoLED (Dim-to-dark, Logarithmic dimming std) SODA 0.1% DALI, EldoLED (Dim-to-dark, Logarithmic dimming std)	EMHE CA T20 Emergency Battery (D1, D1R–1000, D1G–750 delivered lumens, CA Title 20 compliant, 4˝ or longer [remote for < 4˝]) PRUBIN Meticulous Binning and Labeling every LED Board within a 2-Step MacAdams Ellipse SENSORS: 205-ON/OFF WattStopper PIR Occupancy 205-STEP: Dim to 50% 205-DM: Dim to 1% LUX Phillips DLH ENL Enlighted 2-Wire DLH & Environmental CORNERS: C2I Lit 90˚ 2-Way Inside C2O Lit 90˚ 2-Way Outside C2X Special Angled Connector (Consult factory)

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Cove & Perimeter 1
04-12-2022

Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F91 Series

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

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P43 | Cove & Perimeter
4˝ Perimeter

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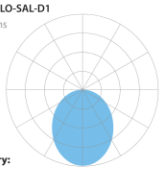
DIRECT

LOW OUTPUT:
P43-PSTD-FLSH-LED4-LO-SAL-D1
1934 Delivered Lumens
19 Watts
101 Lm/W
4000 CCT



Zonal Lumen Summary:
0-90 = 100%
878

Vertical Angle	0°	25°	45°	65°	90°
0°	885	885	885	885	885
5°	876	878	878	885	884
15°	828	825	815	803	797
25°	739	727	704	681	670
35°	619	601	569	540	525
45°	421	403	373	349	337
55°	484	463	429	402	388
65°	229	216	196	181	174
75°	115	107	97	90	86
85°	28	26	24	23	23
90°	0	0	0	0	0

Luminance Chart:

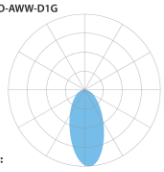
Angle	0°	45°	90°
45°	5823	5168	4058
55°	5173	4484	3997
65°	4618	3950	3500
75°	3768	3189	2841
85°	2711	2362	2243

UPTO 101 LM/W

FLUSH:	LO	MO	SO	HO
Lm/Ft	400	600	800	900
W/Ft	4	6	8.3	10

WALL GRAZER

LOW OUTPUT:
P43-PSTD-FLSH-LED4-LO-AWW-D1G
1620 Delivered Lumens
16 Watts
101 Lm/W
4000 CCT



Zonal Lumen Summary:
0-90 = 100%
1327

Vertical Angle	0°	25°	45°	65°	90°
0°	1317	1317	1317	1317	1317
5°	1271	1285	1311	1327	1296
15°	814	861	981	1159	1258
25°	521	549	638	861	1042
35°	386	393	429	580	828
45°	290	297	309	384	578
55°	205	208	217	253	346
65°	141	145	147	160	187
75°	48	77	84	81	79
85°	24	24	24	23	17
90°	0	0	0	0	0

Luminance Chart:

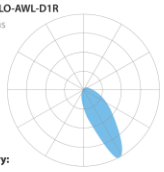
Angle	0°	45°	90°
45°	3390	3618	6847
55°	2952	3134	4958
65°	2768	2881	3646
75°	1543	2683	2572
85°	2292	2292	1746

UPTO 101 LM/W

FLUSH:	LO	MO	SO	HO
Lm/ft	400	600	800	900
W/Ft	4	6	8.3	10

PERIMETER FILL

LOW OUTPUT:
P43-PSTD-FLSH-LED3-LO-AWL-D1R
1594 Delivered Lumens
16 Watts
100 Lm/W
3000 CCT



Zonal Lumen Summary:
0-90 = 100%
1217

Vertical Angle	0°	22.5°	45°	67.5°	90°
0°	461	461	461	461	461
5°	552	545	525	494	460
15°	903	842	698	558	448
25°	1217	1212	1006	634	422
35°	899	944	1064	700	382
45°	614	635	730	705	325
55°	392	402	442	538	250
65°	225	230	244	301	159
75°	98	101	106	123	73
85°	15	16	17	29	12
90°	0	0	0	0	0

Luminance Chart:

Angle	0°	45°	90°
45°	7071	8411	3744
55°	5568	6274	3547
65°	4336	4704	3056
75°	3074	3344	2287
85°	1355	1598	1150

UPTO 100 LM/W

FLUSH:	LO	MO	SO	HO
Lm/Ft	400	600	800	900
W/Ft	4	6	8.3	10

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Cove & Perimeter 2
04-12-2022

Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F91 Series

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

Horton Lees Brogden Lighting Design | 3575 Ringsby Court Suite 402 Denver CO 80216 | P: 303 317 5006 | www.HLBlighting.com

LED **P43** | Cove & Perimeter
4˝ Perimeter

PRUDENTIAL LTG.
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LUMEN MAINTENANCE
Designed to last with cool running mid-power LEDs projected to maintain 90% (L90) of their initial output for 100,000 hours (at HO), and L70 exceeding 150,000 hours.

LED SYSTEM
LED modules and drivers are field replaceable.

PROG (OPTIONAL)
Programmable light output. Specify desired lumens or watts per linear foot. Min: 2½ w/ft, consult factory for requests above 12 w/ft.

BINNING
Standard binning (all Prudential LED boards) includes testing at the chip level and board integration to provide consistent color temperature within a 3-step MacAdams ellipse, with +/- 5% lumen output range and +/- .004 Duv.

PRUBIN™ (OPTIONAL)
Prudential Ltg's exclusive 'job binning' method that ensures color temperature consistency across all luminaires on a project. Meticulously testing and labeling **EVERY LED BOARD** to +/- 25 lumens, +/- 50k CCT and +/- .004 Duv — while also separating positive from negative — allows us to match color, hue and intensity throughout a project and provides a consistent color temperature within a 2-step MacAdams ellipse.

LABELS
CSA and ETL damp labeled and I.B.E.W. manufactured.

ELECTRICAL
Must specify LED dimming controls. LED fixtures have constant current driver(s) with less than 20% THD when loaded to a minimum of 60%. Drivers sink a maximum of 6mA per driver. DM01 LED drivers are 0-10V dimmable and are compatible with most 0-10V wall slide dimmers and direct 0-10V analog signal dimmers. Max driver size 1¼˝ w x 1˝ h.

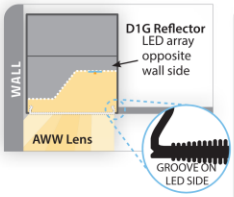
CONSTRUCTION

Housing	20-gauge steel, >20% PC recycled, 100% recyclable.
Lens	Acrylic, 100% recyclable.
X1, X2, X6 Trim	Steel.
X3, X7 Trim	Extruded aluminum.
Weight	**FLUSH** 4 lbs / ft.
	3˝ REGRESS 5 lbs / ft.

MOUNTING
Recessed into drywall or T-bar ceilings.

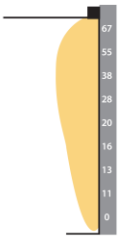
WARRANTY
Single-source, 5 year limited warranty covers standard components and construction.

WALL GRAZER ORIENTATION



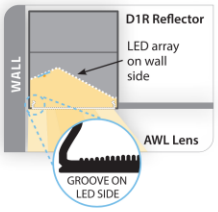
Smooth Wall Grazing.

A tight, focused beam grazes wall textures evenly, accenting and highlighting details to elevate the visual drama.



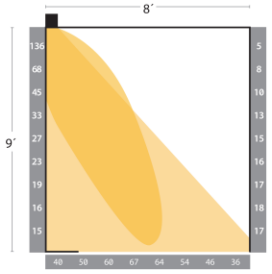
	Watts/Ft.	Ceiling Height	Average Illuminance	Max	Min	Max/Min Ratio
Standard Output - 750 lm/ft	10	9′	40fc	76fc	16fc	4.75

PERIMETER FILL ORIENTATION



Perimeter Fill.

Fill a Corridor with Light — from the Perimeter.
It's a perimeter optic that washes corridors in light, offering outstanding light distribution, far more energy efficient than typical soft glow solutions and significantly reduces installation cost. Ideal for corridors where budget and energy efficiency conflict with strict IES requirements for high footcandles.
Suspended, surface mounted or recessed, perimeter lighting system.



	Watts/Sq. Ft.	Ceiling Height	Average Illuminance	Max/Min	Max/Min Ratio
Standard Output - 875 lm/ft	1.25	9′	57fc	79/32	2.5:1

Footcandles along the floor Reflectances 80: 50: 20

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Cove & Perimeter 3
04-12-2022

Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F91 Series

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

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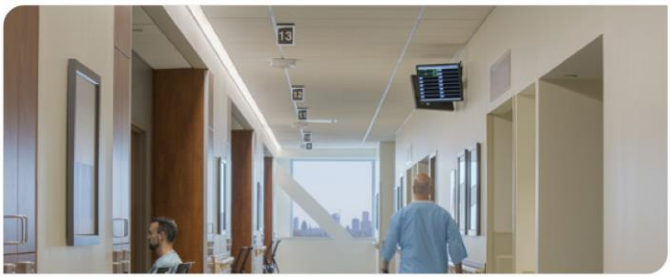
LED **P43** | Cove & Perimeter
4″ Perimeter

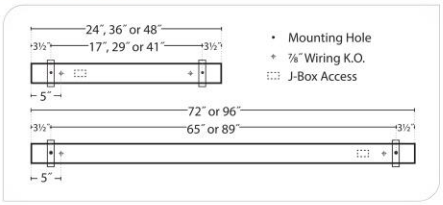
PRUDENTIAL LTG.
PRULITE.COM 213.746.0360

Choose from one of our Premium Colors with no set-up fee.

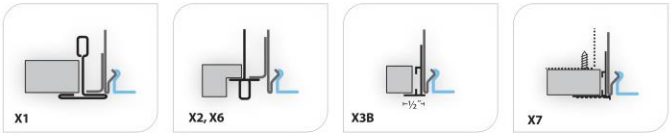
For paint chip samples, please email: **info@prulite.com**



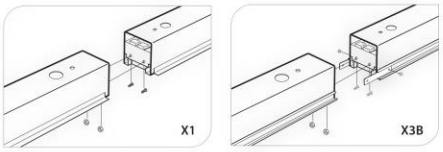
MOUNTING LOCATIONS

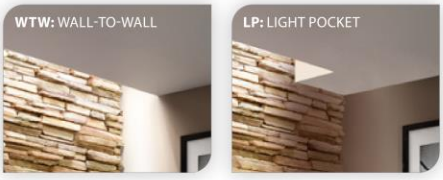


CEILING SYSTEMS



ADJOINING DETAILS





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Cove & Perimeter 4
04-12-2022

Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F91 Series

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

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P43 | Cove & Perimeter
4″ Perimeter

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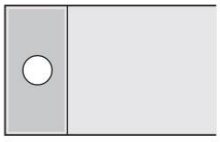
CONTROL SENSORS

205 WattStopper PIR Occupancy

LUX Phillips LuxSense Daylight Harvesting, used with Phillips HFR Driver

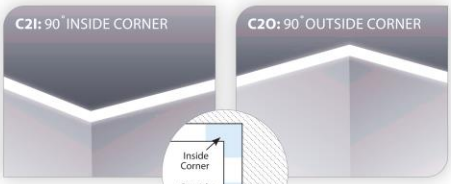
ENL Enlighted 2-Wire PIR Daylight, Motion & Environmental Sensor

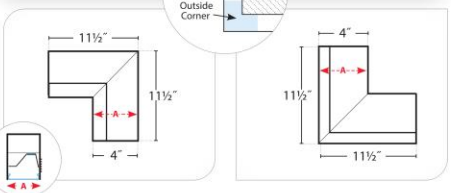


NOTE: Sensor plate will match fixture color finish

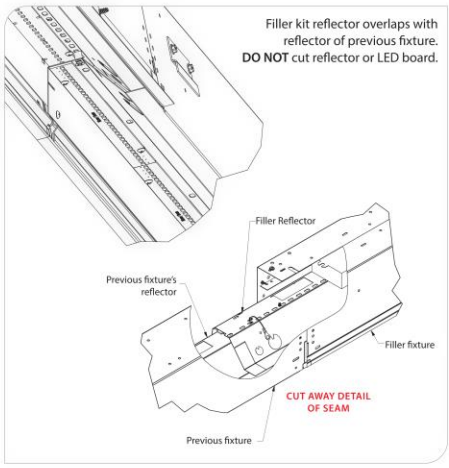
Consult factory for other sensors, please email: **info@prulite.com**

CORNERS

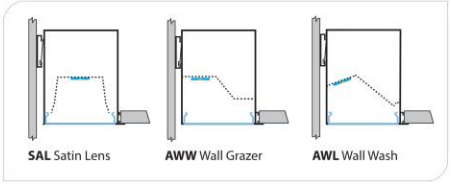




FIELD TRIMMABLE FILLER KIT



DISTRIBUTION CROSS SECTIONS



SAL Satin Lens **AWW** Wall Grazer **AWL** Wall Wash

Prudential Ltg. reserves the right to change design specifications or materials without notice. Please visit prulite.com for most current data.
© 2014 All rights reserved – All products manufactured at: Prudential Ltg. 1774 E. 21st Street, Los Angeles, CA 90058

Cove & Perimeter 5
04-12-2022

Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F91 Series

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

Horton Lees Brogden Lighting Design | 3575 Ringsby Court Suite 402 Denver CO 80216 | P: 303 317 5006 | www.HLBlighting.com

PROFESSIONAL OUTDOOR LIGHTING

Type:

Model:

Project:

SPECIFICATION SHEET

MODEL 1185 Architectural Series • Inground & Well Lights

FIXTURE SPECIFICATIONS:

DOOR:
Die-cast, low copper content, A360 aluminum. Post anodized Type III (hard anodized) and powder coated for maximum corrosion protection. Captive stainless steel fasteners affixed to a ventilated door. Inner vents allow hot air to escape from around optic housing while outer vents allow cool air to enter fixture housing.

FIXTURE HOUSING:
Compression-molded, glass-reinforced polymer for strength and high UV stability. Molded with integral junction box. Unibody construction allows for superior door and optic housing support. J-box comes standard with two ¾" NPT bottom **B34** tapped holes. ¾" NPT front **F34**, ¾" NPT side **S34** and ¾" NPT all **A34** conduit entry holes optional (Consult Factory).

OPTIC HOUSING:
Die-cast A360 aluminum. Finned for maximum heat disapation. Type III hard anodized and Henderlubed for maximum corrosion protection. Optic and driver compartment separately sealed while being electrically connected.

DRIVER COMPARTMENT:
Injection molded PPS for maximum corrosion protection. Driver compartment houses electronic LED driver and thermostat which cuts power to fixture in abnormal ambient temperature conditions. Driver compartment is completely epoxy potted to protect electronics from moisture.

DOOR FINISH:
Durable powder coat finish available in Black, Architectural Bronze, Dark Bronze, Granite, White, Architectural Brick, Light Bronze, Special Bronze, Glossy Gray, Rust, Hunter Green, Weathered Bronze, Weathered Iron, Graphite Metallic, Verde, Pewter, Mocha and Olde Finish. Custom Powder coat finishes available on request.

LED:
Cree® CXA 1830 COB driven at 350mA, 500mA, or 620mA.

CRI:
The CRI range is 83 - 85.

COLOR TEMPERATURE:
LED's are offered in 2700°K, 3000°K, 3500°K, 4000°K, or 5000°K CCT ANSI white 4 step Cree® East White™ bins

LIGHT DISTRIBUTION:
Very Narrow Spot **VNS** (NEMA 2x2), Narrow Spot **NS** (NEMA 2x2), Medium Flood **MF** (NEMA 4x4), and Wide Flood **WF** (NEMA 6x6).

REFLECTOR:
Specular or semi-specular optics designed for maximum performance and uniformity. Very Narrow Spot **VNS** optic incorporates an internal source shield to eliminate unwanted glare outside the beam pattern.

LENS/SEAL:
¼" thick tempered pressed clear glass sealed with a solid molded silicone gasket.

WIRING:
3' 18/3 outdoor-rated hard usage cable standard for non-dimming **ND** and Phase Cut TRIAC (120V only) dimming **PCT** fixtures. 3' 18/5 outdoor-rated hard usage cable standard for 0-10V dimming **010** fixtures. Cable exits fixture housing through a liquid tight cable fitting.

DRIVER:
Integral CUL listed LED driver, either non-dimmable **ND** or dimmable. Dimming: 0-10VDC **010** and Phase Cut TRIAC (120V only) **PCT** options available. Multi-Volt **MV** 120V-277V driver input standard.

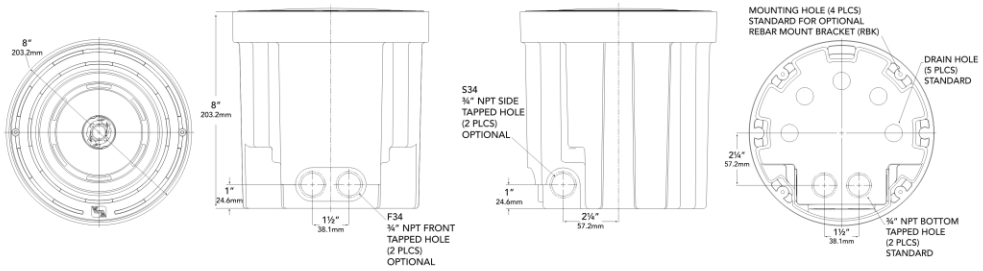
ACCESSORIES:
TO5 - Tilt Optic 5°, **TO10** - Tilt Optic 10°, **TO15** - Tilt Optic 15°, **TO25** - Tilt Optic 25°, **DF** - Diffuse Filter, **LSF** - Linear Spread Filter, **RBK** - Rebar Bracket Kit, **STR** Stainless Trim Ring, and **HS** - Half Glare Shield.
Dichroic Lenses: **YL** - Yellow, **RL** - Red, **BL** - Blue, **GL** - Green.

MOUNTING:
Fixture suitable for direct burial in earth or poured concrete applications.

CERTIFICATION:
C ETL US wet location listed. *IP68*

All Vista Architectural luminaires are MADE IN THE U.S.A.

DIMENSIONS:



TOP VIEW | FRONT VIEW | SIDE VIEW | BOTTOM VIEW

Vista Professional Outdoor Lighting reserves the right to modify the design and/or construction of the fixture shown without further notification.

1625 Surveyor Avenue • Simi Valley, CA 93063 • (805) 527-0987 • (800) 766-VISTA (8478)
FAX: (888) 670-VISTA (8478) • email@vistapro.com • www.vistapro.com

Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F92

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

PROFESSIONAL
OUTDOOR LIGHTING

SPECIFICATION SHEET

MODEL 1185 Architectural Series • Inground & Well Lights

LAMP SPECIFICATIONS

LED:
- High lumen output LED powered for high efficacy
- Cree® CXA 1830 COB driven at 350mA, 500mA, or 620mA
- 2700°K, 3000°K, 3500°K, 4000°K, or 5000°K CCT ANSI white 4 step Cree® Easy White™ bins.
- 800-2000 Delivered Lumens
- 15-25 Watts

OPTICS/AIMING:
- Specular or semi-specular optics designed for maximum performance and uniformity.
- Very Narrow Spot **VNS** (NEMA 2x2), Narrow Spot **NS** (NEMA 2x2), Medium Flood **MF** (NEMA 4x4), and Wide Flood **WF** (NEMA 6x6).
- Fixture aiming achieved via a series of tilt optic lenses and patent pending magnetic aiming system.

ELECTRICAL:
- Constant current 350mA, 500mA, or 620mA output driver.
- Multi-Volt **MV** 120V-277V universal input.
- 3' 18/3 outdoor-rated hard usage cable standard for non-dimming fixtures and Phase Cut TRIAC PCT dimming fixtures.
- 3' 18/5 outdoor-rated hard usage cable standard for 0-10V dimming fixtures.

1185 SERIES-LOAD RATING:
- Peak compressive force of **2,000 lbs.** This represents 94% of max load to load failure on average. Independent tests performed by SGS US Testing Company, Inc., an ISO 17025 accredited National Testing Laboratory.

FIXTURE ORDERING INFORMATION

TO ORDER FIXTURE: Select appropriate choice from each column as in the following example.

EXAMPLE: 1185-GG-NS-30-A-MV-CX-ND-F34-TO5

MODEL	DOOR FINISH	DISTRIBUTION	COLOR TEMPERATURE	DELIVERED LUMENS
1185	Standard **B** - Black **Z** - Architectural Bronze **DZ** - Dark Bronze **GT** - Granite **W** - White Premium **BR** - Architectural Brick **LZ** - Light Bronze **SB** - Special Bronze **GG** - Glossy Gray **R** - Rust **HG** - Hunter Green **WB** - Weathered Bronze **WI** - Weathered Iron **GM** - Graphite Metallic Hand Finished **G** - Verde **P** - Pewter **M** - Mocha **OF** - Olde Finish	**VNS** - Very Narrow Spot **NS** - Narrow Spot **MF** - Medium Flood **WF** - Wide Flood	**27** - 2700°K **30** - 3000°K **35** - 3500°K **40** - 4000°K **50** - 5000°K	**A** - 800-1200 **B** - 1200-1600 **C** - 1600-2000 1185-VNS not available with B & C lumen packages.

VOLTAGE	LENS	DIMMING	CONDUIT ENTRIES	ACCESSORIES	
MV - Multi-Volt (120V-277V)	**CX** - Crowned Clear **AX** - Anti Slip Clear	**ND** - No Dimming **010** - 0-10V **PCT** - Phase Cut TRIAC (120V only)	**B34** - Bottom ¾ " (standard) **F34** - Front ¾" **S34** - Sides ¾" **A34** - All ¾" (available as an option) (Consult Factory)	**TO5** - Tilt Optic 5° **TO10** - Tilt Optic 10° **TO15** - Tilt Optic 15° **TO25** - Tilt Optic 25° **DF** - Diffuse Filter **LSF** - Linear Spread Filter	**RBK** - Rebar Bracket Kit **STR** - Stainless Trim Ring **HS** - Half Glare Shield **YL** - Yellow Lens **RL** - Red Lens **BL** - Blue Lens **GL** - Green Lens *Colored Lenses not available with B & C Lumen packages.

Vista Professional Outdoor Lighting reserves the right to modify the design and/or construction of the fixture shown without further notification.

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Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
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APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

PROFESSIONAL
OUTDOOR LIGHTING

SPECIFICATION SHEET

MODEL 1185 Architectural Series • Inground & Well Lights

LUMEN OUTPUT PACKAGES Watts / Lumens

Beam Spread	A	B	C
VNS	25.5 Watts / 1141 Lumens		
NS	15.9 Watts / 981 Lumens	22.9 Watts / 1407 Lumens	25.7 Watts / 1738 Lumens
MF	16.1 Watts / 997Lumens	23.1 Watts / 1431 Lumens	25.9 Watts / 1766 Lumens
WF	16.1 Watts / 917 Lumens	23.1 Watts / 1317 Lumens	25.9 Watts / 1625 Lumens

Vista Professional Outdoor Lighting reserves the right to modify the design and/or construction of the fixture shown without further notification.

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1185 3.20.20

Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F92

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

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NULITE

DATE: PROJECT:

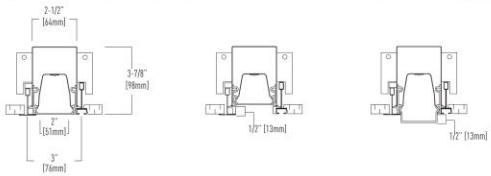
CATALOG #: TYPE: QTY:

RG2

Recessed / Grid

The Regolo RG2 series is a narrow recessed, nominal 2" wide profile, slot unit designed for grid ceiling systems. The slender design is ideal for corridors, open and private offices, classrooms, lobbies and general purpose rooms.

Construction: The housing consists of visible white powder coat extruded aluminum trim rails, with formed 20 gauge galvanized steel back channel and heavy gauge end caps. Steel alignment tabs and white snap-in joiner clips are used for continuous row applications.
Reflector / Driver: Reflector / driver cover is finished with high reflectant white paint. Drivers are standard constant current electronic driver with 0-10V dimming input with dimming range from 100% down to 1% and Universal (UNV) voltage from 120 - 277V, 50/60 Hz.
Shielding: Extruded frosted or satin white acrylic snap-in lens with DR.
LED Module: Distributed LED array in a variety of lumen output packages. LED color is available in 3000K, 3500K, 4000K or 5000K and in 80CRI or 90CRI. Module is replaceable. L90 ≥ 100,000 hrs.
Mounting: Compatible with 9/16" and 1" T-Bar and Slotted Grid ceilings. IC rated. Individual mount or continuous rows.
Labels: ETL Listed, conforms to UL Standard 1598/8750, CSA Standard C22.2 and Damp Location.
Warranty: 5-Year Warranty Standard
Quick Ship: 10 Day lead time for options highlighted in orange. Available in 4' nominal increments; includes 4' & 8' standalone fixtures and continuous rows.



RG2 / Flush Lens **RG2 /** Regressed Lens **RG2 /** Drop Lens

ORDERING INFORMATION / Example: QS-RG2-05-L35-U-D-11-FRF-WH-4

RG2

SERIES	LUMEN PACKAGE[2]	CRI/ CCT	VOLTAGE	DRIVER
RG2[1] - Recessed Linear LED Luminaire Designed for Grid Ceilings, Nominal 2" Aperture Width **QS-RG2**[1] - Quick Ship 10 Day Lead Time	**03** - 393 lm/ft (3.28W/ft) **05** - 573 lm/ft (4.85W/ft) **06** - 732 lm/ft (6.38W/ft) **09** - 886 lm/ft (7.79W/ft)	**L30** - 80 CRI, 3000K **L35** - 80 CRI, 3500K **L40** - 80 CRI, 4000K **L50** - 80 CRI, 5000K **H30**[3] - 90 CRI, 3000K **H35**[3] - 90 CRI, 3500K **H40**[3] - 90 CRI, 4000K **TW** - Tunable White 90 CRI, 2700-6000K	**U** – Universal **1** – 120V **2** – 277V	**Dimming 0-10V** **D** - Dim to 1% (Standard) **D0**[4] - Dim to 1%, Fade to Off **D02** - Eldoled Solodrive, Dim to 0% **TW10** - Tunable White **LUTRON** - See Page 2 **DALI Dimming** **ELE** - Eldoled Ecodrive, Dim to 1% **ELS** - Eldoled Solodrive, Dim to 0% **TWDA** - DALI Tunable White

CIRCUITING[5] / EMERGENCY OPTIONS[6]			SHIELDING	FINISH	LENGTH[9]	OPTIONS
Qty of Power Circuits **1** - 1 circuit **2** - 2 circuits	**Qty of Control Circuits** **1** - 1 circuit **2** - 2 circuits	**Options** **B5**[7] - 5 Watt Battery Pack **B7**[7] - 7 Watt Battery Pack **B12**[7] - 12 Watt Battery Pack **CEC**[7] - CEC Compliant (10 Watt Battery Pack) **EM** - Dedicated Emergency Circuit **GTD** - Generator Transfer Device	**FRF** - Frosted Flush Lens **FRD** - Frosted Drop Lens (Opaque Ends) **FRL** - Frosted Drop Lens (Luminous Ends) **FRR**[8] - Frosted Regressed Lens **STF** - Satin White Flush Lens **STD** - Satin White Drop Lens (Opaque Ends) **STL** - Satin White Drop Lens (Luminous Ends) **STR**[8] - Satin White Regressed Lens	**WH** - White Painted Finish **BK** - Black Painted Finish **SV** - Silver Painted Finish	**2** - 24" **3** - 36" **4** - 48" **5** - 60" **6** - 72" **7** - 84" **8** - 96" **XX** - Specify run lengths in 6" increments (US 4' increments). Consult factory for custom lengths.	**CP** - Chicago Plenum **DSOS** - Combined Daylight and Occupancy Sensor **FLEX** - 6' of Flexible Conduit **GLR** - Fusing **PMT** - Perimeter Mount

Notes:
1. Some products are DesignLights Consortium™ Qualified, refer to www.designlights.org Qualified Products List.
2. Nominal lumen output per foot for frosted lens and 3500K.
3. Significant efficacy reduction with 90CRI, consult factory for data
4. Consult factory for specifications and manufacturer.
5. Multiple power circuits and control circuits can be accommodated. In Direct fixtures, the power and control circuits will be left to right within a fixture and/or row. Consult factory if the sum of the two numerals exceeds 4 (i.e. "32"). Unable to accommodate left-right zoning in fixtures 5' or less.

Notes (Continued):
6. The EM Option will illuminate the direct light of a 4' section in fixtures 6' or greater.
7. Battery Pack not available in fixtures 3' or less.
8. The Satin White lens is recommended with the Regressed shielding.
9. Fixtures can be provided in custom run lengths down to the nearest (+/- 1/8").

Specifications and dimensions are subject to change without notification.

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Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F93 Series

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

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NULITE

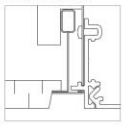
RG2

Ceiling Grid Details

1" Grid Detail

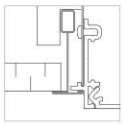
Standard Tile

9/16" Grid Detail



Tegular Tile

Standard Tile - 1-1/2" "T" height & supported by grid hook extension

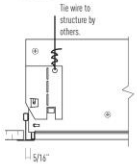


Standard Tile - Drop-down Luminaire

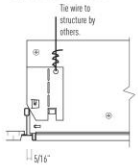
Screw Slot Detail

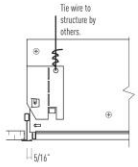
Tegular Tile

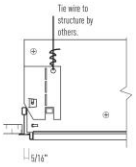
1" End Detail



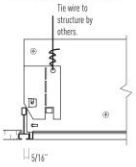
9/16" End Details







Screw Slot End Detail



Conventional, Techzone, and Logix ceilings are acceptable.

Lens Options

Shielding

Frosted Lens
This diffuser is designed for a balance between efficiency and lens uniformity. (Transmission ~ 89%)

Satin White Lens
This diffuser is designed for visible lens uniformity. It's recommended for regressed lens configuration in our shallow housing. (Transmission ~ 69%)

Lutron Driver Ordering Codes

Nulite Code	Lutron Prefix	Lutron Series	Dim Level	Quantity of Wires	Dim to Dark (Smooth)
L11*	PEQ	Hi-Lume™ Premiere	0.1%	2	X
L12	LTEA	Hi-Lume™ 2-Wire 120V forward phase	1%	No Control Wires - Uses Hot	
L15	LDE1	Hi-Lume™ H-Series	1%	2	X
L16	LDE5	Hi-Lume™ 5-Series	5%	2	

*Maximum lumen package with L11 is 05

Position:

Regressed Lens - "R"

1/2" Regressed Lens (Satin White lens is

Drop Lens - "L"

1/2" Drop Lens with Luminous Acrylic Ends

DSOS Sensor Option:

Integral Daylight and Occupancy Sensor
The Regolo series is available with a combination PIR occupancy and daylight sensor for daylight harvesting. Consult factory for more details on sensor operation and commissioning.

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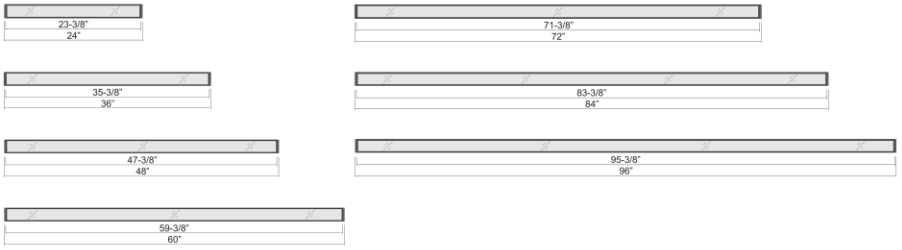
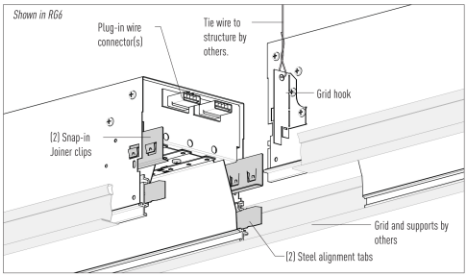
NULITE

RG2

Individual Lengths



Continuous Row Joiner Detail



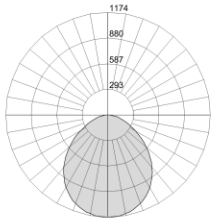
Continuous Run Lengths

Run Length

Number of Housings	2'	3'	4'	5'	6'	7'	8'	9'	10'	11'	12'	13'	14'	15'	16'	17'	18'	19'	20'	21'	22'	23'	24'	25'	26'	27'	28'	29'	30'	31'	32'	33'	34'	35'	36'	37'	38'	39'	40'	41'	42'	43'	44'
2'	1																																										
3'		1																																									
4'			1					1	1	1	1					1	1	1	1					1	1	1	1					1	1	1	1					1	1	1	1
5'				1				1				1				1				1				1				1				1				1				1			
6'					1				1				1				1				1				1				1				1				1				1		
7'						1				1				1				1				1				1				1				1				1				1	
8'							1				1	1	1	1	2	1	1	1	2	2	2	2	3	2	2	2	3	3	3	3	4	3	3	3	4	4	4	4	5	4	4	4	5

Photometric Curves

Cat. # RG2-05L35-...-FRF-...-4'
Frosted Flush Lens
Wattage/Ft - 4.85
Lumens/Watt - 118



Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F93 Series

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

insight lighting

MEDLEY EXTERIOR (ME)

PERFORMANCE LINEAR | WHITE LIGHT + STATIC COLORS

PROJECT: TYPE: CATALOG #: ME-

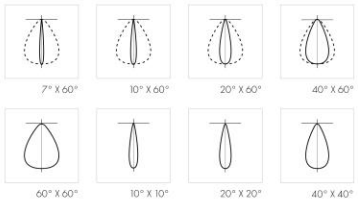
PROFILE

OUTPUT	LO (3.5W/FT), MO (9.0 W/FT), HO (15.0 W/FT)
OPTICS	7° X 60°, 10° X 10°, 10° X 60°, 10° X 90°, 20° X 20°, 20° X 60°, 40° X 40°, 40° X 60°, 40° X 90°, 60° X 60°, 90° X 90° 80° X 80°, ASY
CRI	82 (OPTIONAL 90+)
CCT	27K, 30K, 35K, 40K, RED, GREEN, BLUE, AMBER
PERFORMANCE	UP TO 117530 PEAK CANDELA
VOLTAGE	UNIVERSAL 110-208V, 277V
POWER	INTEGRAL POWER SUPPLY
CONTROL	0-10V, DMX, LUTRON HI-LUME
DIMENSIONS	2.60" X 2.00"
WEIGHT	2.75 LB (1.25 KG) PER FOOT
HOUSING	PRECISION EXTRUDED ALUMINUM
LENS	HIGH DENSITY TEMPERED GLASS
FINISH	HIGH DURABILITY POWDER COATING
OPERATING TEMP	-20° C TO 50° C
WARRANTY	5-YEAR LIMITED
LUMEN MAINTENANCE	75,000 HOURS
CERTIFICATION	ETL AND cETL FOR IP67, IK07, 5G/3G OPTIONS

IP67 IK07 3G 5G

STANDARD FINISHES

OPTICS



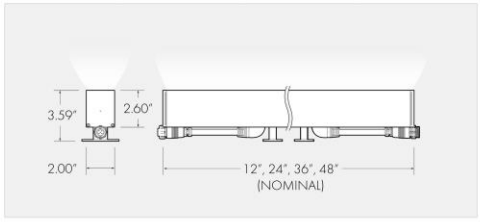
PERFORMANCE SAMPLE

Go to Performance Data >

40K, HO, 48.00"	10° X 10°	10° X 60°	20° X 20°	80° X 80°	100°
LUMENS	6316	5417	6475	6161	6459
CANDELA	117530	19943	52385	3960	2739
EFFICACY	91.2 LM/W	77.3 LM/W	93.3 LM/W	88.8 LM/W	94.4 LM/W

PROFILE

Go to Fixture Dimensions >



OPTIONS

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HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F94

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

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insight lighting

MEDLEY EXTERIOR (ME)

PERFORMANCE LINEAR | WHITE LIGHT + STATIC COLORS

PROJECT: TYPE: CATALOG #: ME- - - - - - - - - -

SPECIFICATION

Separate options with dashes

ME | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10

1 FIXTURE

MEDLEY EXTERIOR	ME

2 WATTAGE

LOW OUTPUT 3.5 W/FT	LO
MEDIUM OUTPUT 9.0 W/FT	MO
HIGH OUTPUT 15.0 W/FT	HO

3 CCT

2700K	27K
3000K	30K
3500K	35K
4000K	40K
RED	R
GREEN	G
BLUE	B
AMBER	A

4 OPTIC

7° X 60°	760
10° X 10°	1010
10° X 60°	1060
10° X 90°	1090
20° X 20°	2020
20° X 60°	2060
20° X 90°	2090
40° X 40°	4040
40° X 60°	4060
40° X 90°	4090
60° X 60°	6060
60° X 90°	6090
80° X 80°	8080
100° X 100°	100
ASYMMETRIC DIRECT Direct = down-light	AD
ASYMMETRIC INDIRECT Indirect = up-light	AI

5 MOUNTING

SURFACE MOUNT 5G Ansi C136.31 rated	SM
GROUND MOUNT	GM
EXTENDED ARM X = extended arm length specify 6", 12" or 18" 6.00" arm is 3G Ansi C136.3 rated	EA-X
EXTENDED ARM, BACK X = extended arm length specify 6", 12" or 18"	EAB-X
SURFACE BACK MOUNT	SMB
FIXED MOUNT Not intended for continuous run applications	FM
END MOUNT Not intended for continuous run applications	EM
STAKE MOUNT	STM

6 FIXTURE LENGTH

12"	12
24"	24
36"	36
48"	48

Nominal lengths

7 VOLTAGE

120V	120
277V	277

8 CONTROL OPTIONS

0-10V DIMMING (1%) Not available with 12.00" **HO** fixtures	DIM
LUTRON HI-LUME Hi-lume 1% EcoSystem Available with 36.00" and 48.00" fixtures in **LO** and **MO** outputs only	L3DA
DMX DIMMING Not available with 12.00" **HO** fixtures DMX control system must be ordered seperately **DMX Programming Kit** required - see below	DMX

9 FINISH

TEXTURED WHITE	TW
TEXTURED BLACK	TB
TEXTURED BRONZE	TBR
TEXTURED LIGHT BRONZE	TLB
TEXTURED GRAY	TG
TEXTURED SANDSTONE	TS
ANODIZED ALUMINUM Includes **CRF** finish	AA
CUSTOM COLOR Contact factory for custom color - additional charges will apply	CC

10 OPTIONS

HIGH CRI, 90+	HCRI
LOUVER Field installable snooted louver LLF of 10% - 15% depending on color	LV
VISOR Field installable visored louver LLF of 10% - 15% depending on color	VS
INTEGRAL HEX LOUVER Not available with Asymmetric (AD & AI) optics	IHL
DIRECT VIEW DOME LENS Field installable	DVD
WHITE LENS LLF OF 30% Only available with 100° X 100°	WL
CONCEALED WIRING Not available with 12" fixture	CW
WHITE CABLING White cabling is standard with textured white finish	WC
CORROSION RES. FINISH Corrosion Resistance Finish Complies with ASTM B 117 standard CRF is recommended for coastal or extreme exterior environments	CRF

CONTROL & WIRING ORDER OPTIONS

Go to DMX Guide >

DMX DISTRIBUTION & PROGRAMMING KIT - REQUIRED FOR DMX DIMMING

DMX/RDM DISTRIBUTION KIT (4 OUTPUTS) - IP67	CDS-RDM

DMX/RDM Distribution Kit consists of four output
Each output is limited to (1) run per output - up to 32 fixtures max
Four terminators are included for end of line termination

Go to Cable Guide >

EXTERIOR LEADER CABLE - REQUIRED

5.0 FT LEADER CABLE	LC-5

A leader cable is required for each single fixture and for each fixture run for connection from the first fixture to the j-box
Black cables are standard unless White Cabling (**WC**) option or Textured White (**TW**) fixture finish is selected

EXTERIOR JUMPER CABLES

1.0 FT JUMPER CABLE	JC-1
2.0 FT JUMPER CABLE	JC-2
5.0 FT JUMPER CABLE	JC-5
10.0 FT JUMPER CABLE	JC-10
25.0 FT JUMPER CABLE	JC-25

Required if fixtures are not mounted in an end-to-end continuous manner and for line voltage only
Black cables are standard unless White Cabling (**WC**) option or Textured White (**TW**) fixture finish is selected

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insight lighting

MEDLEY EXTERIOR (ME)

PERFORMANCE LINEAR | WHITE LIGHT + STATIC COLORS

PROJECT: TYPE: CATALOG #: ME-

PERFORMANCE

CCT AND LENGTH	OPTIC	LOW OUTPUT (3.5 W/FT)			MEDIUM OUTPUT (9.0 W/FT)			HIGH OUTPUT (15.0 W/FT)		
		DELIVERED LUMENS	LUMINAIRE EFFICACY	PEAK CANDELA	DELIVERED LUMENS	LUMINAIRE EFFICACY	PEAK CANDELA	DELIVERED LUMENS	LUMINAIRE EFFICACY	PEAK CANDELA
4000K 24.00"	7° X 60°	998 LM	107.0 LM/W	3662	1685 LM	110.0 LM/W	6189	3366 LM	98.0 LM/W	12363
	10° X 10°	932 LM	100.5 LM/W	17011	1566 LM	103.0 LM/W	28686	3158 LM	91.2 LM/W	58765
	10° X 60°	804 LM	86.6 LM/W	2905	1348 LM	88.4 LM/W	4871	2709 LM	77.3 LM/W	9972
	20° X 20°	948 LM	102.1 LM/W	7658	1601 LM	102.4 LM/W	12983	3238 LM	93.3 LM/W	26193
	20° X 60°	862 LM	92.8 LM/W	1893	1451 LM	96.2 LM/W	3207	2914 LM	84.6 LM/W	6379
	40° X 40°	1001 LM	108.0 LM/W	1395	1688 LM	111.0 LM/W	2338	3392 LM	98.8 LM/W	4733
	40° X 60°	896 LM	96.7 LM/W	724	1497 LM	98.6 LM/W	1211	3039 LM	88.1 LM/W	2470
	60° X 60°	993 LM	107.1 LM/W	882	1666 LM	109.3 LM/W	1485	3354 LM	97.7 LM/W	2999
	80° X 80°	912 LM	98.2 LM/W	585	1525 LM	100.1 LM/W	976	3081 LM	88.8 LM/W	1980
	100° X 100°	620 LM	86.8 LM/W	263	1964 LM	93.3 LM/W	829	3230 LM	94.4 LM/W	1370
	ASY	888 LM	96.3 LM/W	3134	1473 LM	97.8 LM/W	5199	2890 LM	88.2 LM/W	9369
4000K 36.00"	7° X 60°	1496 LM	107.0 LM/W	5492	2527 LM	110.0 LM/W	9283	5048 LM	98.0 LM/W	18544
	10° X 10°	1398 LM	100.5 LM/W	25516	2349 LM	103.0 LM/W	43029	4737 LM	91.2 LM/W	88148
	10° X 60°	1205 LM	86.6 LM/W	4357	2022 LM	88.4 LM/W	7306	4063 LM	77.3 LM/W	14957
	20° X 20°	1421 LM	102.1 LM/W	11486	2402 LM	102.4 LM/W	19474	4856 LM	93.3 LM/W	39289
	20° X 60°	1292 LM	92.8 LM/W	2840	2177 LM	96.2 LM/W	4810	4371 LM	84.6 LM/W	9569
	40° X 40°	1502 LM	108.0 LM/W	2093	2531 LM	111.0 LM/W	3506	5088 LM	98.8 LM/W	7100
	40° X 60°	1344 LM	96.7 LM/W	1086	2245 LM	98.6 LM/W	1817	4559 LM	88.1 LM/W	3704
	60° X 60°	1489 LM	107.1 LM/W	1322	2499 LM	109.3 LM/W	2228	5031 LM	97.7 LM/W	4499
	80° X 80°	1368 LM	98.2 LM/W	877	2287 LM	100.1 LM/W	1464	4621 LM	88.8 LM/W	2970
	100° X 100°	929 LM	86.8 LM/W	394	2946 LM	93.3 LM/W	1244	4844 LM	94.4 LM/W	2054
	ASY	1332 LM	96.3 LM/W	4700	2209 LM	97.8 LM/W	7798	4335LM	88.2 LM/W	14053
4000K 48.00"	7° X 60°	1995 LM	107.0 LM/W	7323	3369 LM	110.0 LM/W	12377	6731 LM	98.0 LM/W	24725
	10° X 10°	1864 LM	100.5 LM/W	34021	3132 LM	103.0 LM/W	57372	6316 LM	91.2 LM/W	117530
	10° X 60°	1607 LM	86.6 LM/W	5809	2696 LM	88.4 LM/W	9741	5417 LM	77.3 LM/W	19943
	20° X 20°	1895 LM	102.1 LM/W	15315	3202 LM	102.4 LM/W	25965	6475 LM	93.3 LM/W	52385
	20° X 60°	1723 LM	92.8 LM/W	3786	2902 LM	96.2 LM/W	6413	5828 LM	84.6 LM/W	12758
	40° X 40°	2002 LM	108.0 LM/W	2790	3375 LM	110.7 LM/W	4675	6784 LM	98.8 LM/W	9466
	40° X 60°	1792LM	96.7 LM/W	1448	2993 LM	98.6 LM/W	2422	6078 LM	88.1 LM/W	4939
	60° X 60°	1985 LM	107.1 LM/W	1763	3332 LM	109.3 LM/W	2970	6708 LM	97.7 LM/W	5998
	80° X 80°	1824 LM	98.2 LM/W	1169	3049 LM	100.1 LM/W	1952	6161 LM	88.8 LM/W	3960
	100° X 100°	1239 LM	86.8 LM/W	525	3928 LM	93.3 LM/W	1658	6459 LM	94.4 LM/W	2739
	ASY	1776 LM	96.3 LM/W	6267	2945 LM	97.8 LM/W	10397	5780 LM	88.2 LM/W	18787

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Type: F94

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insight lighting

MEDLEY EXTERIOR (ME)

PERFORMANCE LINEAR | WHITE LIGHT + STATIC COLORS

PROJECT: TYPE: CATALOG #: ME-

WIRING

MAXIMUM FIXTURES PER CIRCUIT (CIRCUITS MAY NOT BE LOADED OVER 10 AMPS)

	LOW OUTPUT (3.5 W/FT)		MEDIUM OUTPUT (9.0 W/FT)		HIGH OUTPUT (15 .0 W/FT)	
FIXTURE	120V	277V	120V	277V	120V	277V
12.00"	343	791	133	308	71	163
24.00"	171	396	67	154	35	81
36.00"	114	264	44	103	24	54
48.00"	86	198	33	77	18	41

insight lighting

MEDLEY EXTERIOR (ME)

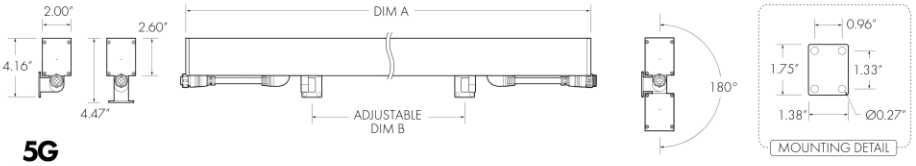
PERFORMANCE LINEAR | WHITE LIGHT + STATIC COLORS

PROJECT: TYPE: CATALOG #: ME- - - - - - - - - - -

DIMENSIONS

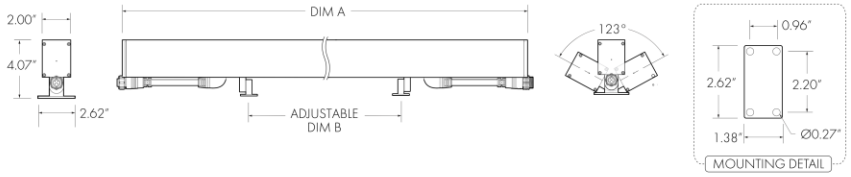
	12.00"	24.00"	36.00"	48.00"
DIM A	12.10"	23.85"	35.60"	47.35"
DIM B	9.28"	4.00" MIN | 6.00" MAX	12.00" MIN | 18.00" MAX	18.00" MIN | 30.00" MAX

SURFACE MOUNT (SM)

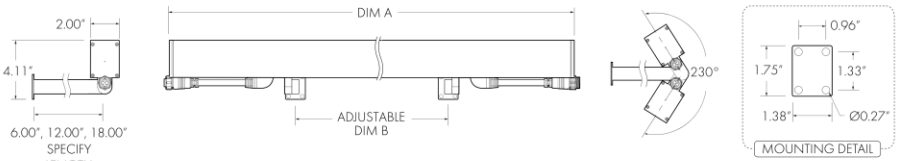


5G
ANSI C136.31

GROUND MOUNT (GM)



EXTENDED ARM (EA-X)



3G
ANSI C136.3

3G rated with 6.00" arm

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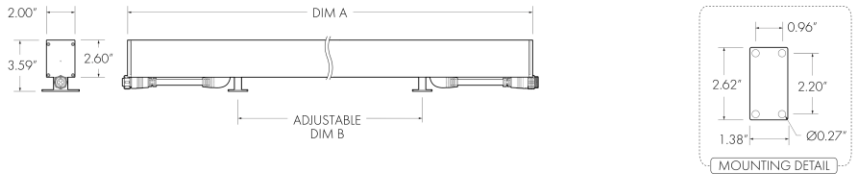
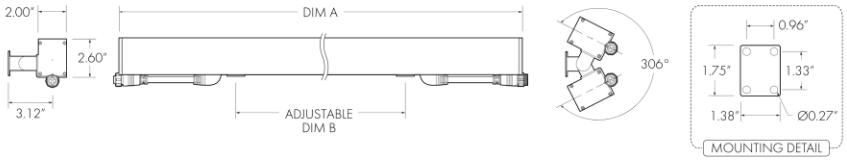
DIMENSIONS

	12.00"	24.00"	36.00"	48.00"
DIM A	12.10"	23.85"	35.60"	47.35"
DIM B	9.28"	4.00" MIN | 6.00" MAX	12.00" MIN | 18.00" MAX	18.00" MIN | 30.00" MAX

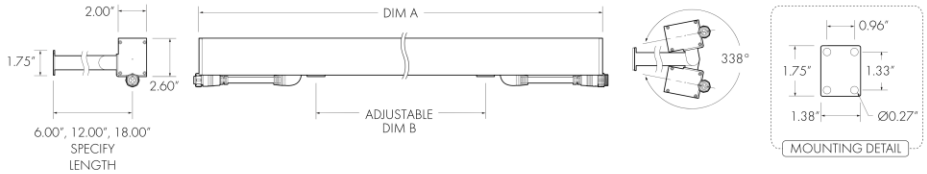
FIXED MOUNT (FM)



SURFACE, BACK MOUNT (SMB)



EXTENDED ARM, BACK MOUNT (EAB-X)



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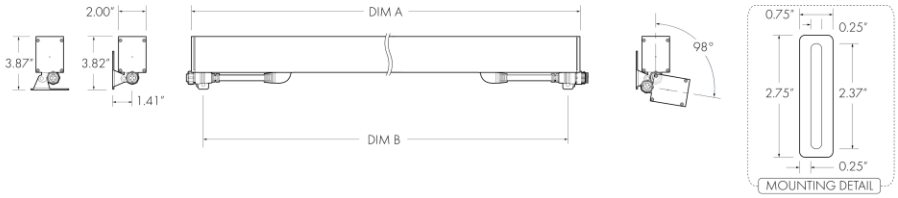
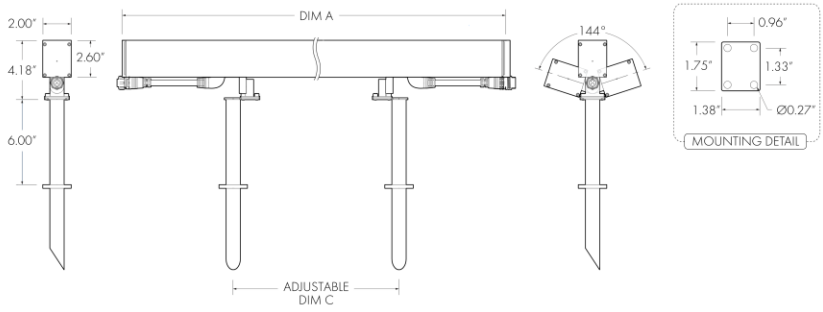
DIMENSIONS

	12.00"	24.00"	36.00"	48.00"
DIM A	12.10"	23.85"	35.60"	47.35"
DIM B	11.65	22.31"	34.06"	45.81"
DIM C	10.56"	4.00" MIN | 6.00" MAX	12.00" MIN | 18.00" MAX	18.00" MIN | 30.00" MAX

END MOUNT (EM)



STAKE MOUNT



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MEDLEY EXTERIOR (ME)

PERFORMANCE LINEAR | WHITE LIGHT + STATIC COLORS

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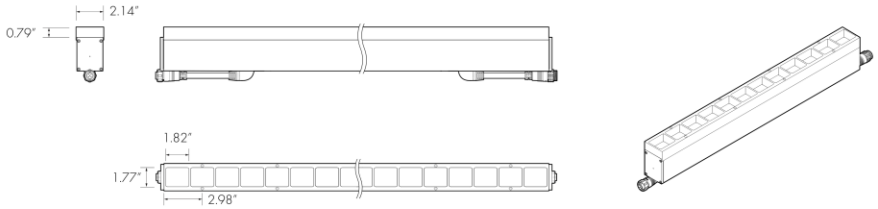
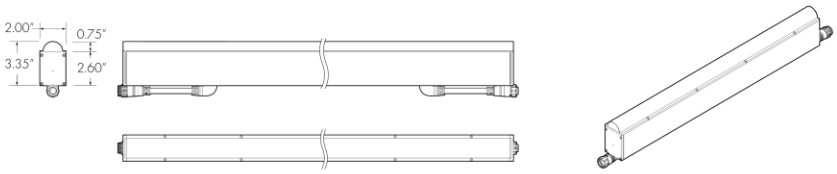
ACCESSORIES

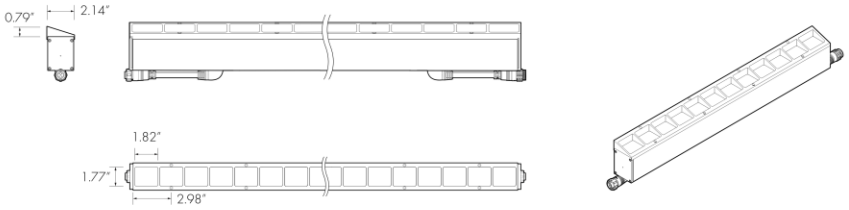
LOUVER (LV)



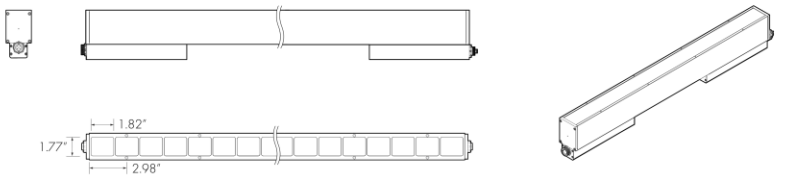
DIRECT VIEW LENS (DV)



VISOR (VS)



CONCEALED WIRING (CW)



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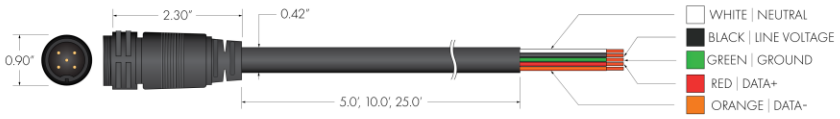
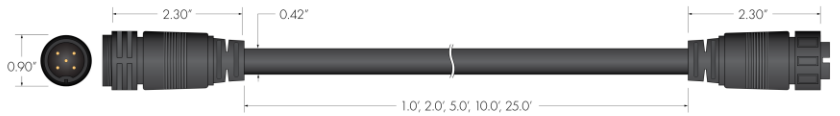
CABLES

AC LEADER (LC-X) WHITE/BLACK | 5 X 16 AWG | 105°C | 300V | IP67

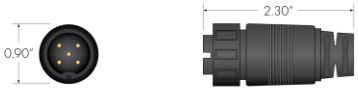


AC JUMPER (JC-X) WHITE/BLACK | 5 X 16 AWG | 105°C | 300V | IP67



AC CAP (EL11447) WHITE/BLACK | 105°C | 300V | IP67

AC TERMINATOR (EL11586) WH/BL | 105°C | 300V



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Type: F94

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Multiple Layers of Light

Luminaire Type:
Catalog Number:

Buy American | 66 IP RATED | ENERGY STAR

High Center Beam Surface Ceiling Cylinder 4"

OVERVIEW

Feature Set

- Eleven optimized distribution patterns allow designers to achieve tailored objectives
- Bounding Ray™ optical design
- 45° Cutoff to source and source image
- Fully serviceable lensed LED light engine
- 70% lumen maintenance at 60,000 hours
- 2.5 SDCM; 85 CRI typical, 90+ CRI optional
- Fixtures are damp location standard; wet location option (WL), covered ceiling, IP66 option available, covered ceiling not required.
- 20 standard colors in textured and gloss finish; custom or RAL colors also available
- Multiple recessed or surface j-box mounting configurations available
- Field configurable surface junction box conduit covers available
- ENERGY STAR® Certified product

Distribution

Superior Perfomance

Nominal Lumens	500	750	1000	1500	2000	2500	3000	3500	4000	4500	5000
Delivered	703	807	1062	1545	1977	2419	2920	3548	3982	4419	4848
Wattage	6.7	7.5	9.8	15.1	21.5	26.5	34.1	33.8	39.5	46.2	53.2
Efficacy	104	108	108	102	92	91	86	105	101	96	91

COMPLEMENTARY PRODUCTS

Coordinated Apertures | Multiple Layers of Light

General Illumination Layer | EVO

High Center Beam Layer | Incito

EVO + Incito — Multiple Layers of Light

Core: Downlight | Adjustable | Open Wallwash | Lensed Wallwash | Cylinder | Pinhole | Bevel | Hyperbolic

Healthcare: MRI | Surgical Suite | Patient Room

Special Applications: Dynamic | Food Service | Vandal/Tamper | Clean Room | Shower | Steam Room

ICO4SC
page 1 of 10

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Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F95

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4" **High Center Beam Surface Ceiling Cylinder**

ORDERING INFORMATION

A+ Capable options indicated by this color background.

Luminaire Type:

Catalog Number:

EXAMPLE: ICO4SC 35/15 AR LSS 35D MVOLT EZ1 JBXCC DWHG

Series		Color Temperature		Lumens		Reflector Color		Reflector Finish		Beam		Voltage	
ICO4SC	Incito 4in Surface Ceiling Round Cylinder Open Downlight	27/	2700 K	05	500 lumens	AR	Clear	LSS	Semi-specular	10D[2]	10° beam angle	MVOLT	120V - 277V
		30/	3000 K	07	750 lumens	PR	Pewter	LD	Matte diffuse	15D	15° beam angle	120	120V
		35/	3500 K	10	1000 lumens	WTR	Wheat	LS	Specular	20D	20° beam angle	277	277V
		40/	4000 K	15	1500 lumens	GR	Gold			25D	25° beam angle	347[3]	347V
		50/	5000 K	20	2000 lumens	WR[1]	White painted			30D	30° beam angle		
				25	2500 lumens	BR[1]	Black			35D	35° beam angle		
				30	3000 lumens	BZR[1]	Dark Bronze painted			40D	40° beam angle		
				35	3500 lumens	WRAMF[1]	White Anti-microbial			45D	45° beam angle		
				40	4000 lumens					50D	50° beam angle		
				45	4500 lumens					60D	60° beam angle		
				50	5000 lumens					65D	65° beam angle		

Driver[4]		Mounting		Control Interface[7,8,10]	
GZ10	0-10V driver dims to 10%	JBX	Integral driver, Recessed or Surface J-box	(blank)	No controls
GZ1	0-10V driver dims to 1%	JBXCC	Integral driver, Surface J-box with Conduit Covers	NLT	nLight® dimming pack.
EZ10	eldoLED 0-10V ECOdrive. Linear dimming to 10% min.	RGH	Recessed Gear Housing	NLTER[8,9]	nLight® dimming pack for fixtures on emergency circuit
EZ1	eldoLED 0-10V ECOdrive. Linear dimming to 1% min.			NLTAIR2	nLight® AIR dimming pack.
EZB	eldoLED 0-10V SOLOdrive. Logarithmic dimming to <1%.			NLTAIRER2[8,9]	nLight® AIR dimming pack for fixtures on emergency circuit
EDAB[5]	eldoLED SOLOdrive DALI. Logarithmic dimming to <1%.				
EDXB[5,6]	eldoLED POWERdrive DMX with RDM (remote device management). Square Law dimming to <1%. Min: 1000LM; Max: 4000LM.				
ECOS2[5]	Lutron® Hi-Lume® 2-wire forward-phase driver. 120V Only. Minimum dimming level 1%. Min: 1000LM; Max: 2000LM.				
ECOD[5]	Lutron® EcoSystem® digital Hi-Lume 1% soft-on, fade to black. Max: 4000LM.				
ELV[5]	Electronic line voltage/Forward phase/Triac dimming. 120V only.				

Options		Architectural Colors - Powder Paint[11]			
SF	Single fuse. Specify 120V or 277V.	DDB	Gloss Dark Bronze	DDBT	Textured Dark Bronze
90CRI	High CRI (90+)	DBL	Matte Black	DBLB	Textured Black
N80	nLight Lumen Compensation	DWH	Gloss White	DWHG	Textured White
HAO[9]	HAO High Ambient Option (40°C)	DMB	Matte Medium Bronze	DBNH	Textured Bronze
WL[10]	Wet Location	DNA	Gloss Natural Aluminum	DNAT	Textured Natural Aluminum
IP66[10]	Lensed, IP66 rated	DSS	Gloss Sandstone	DSST	Textured Sandstone
E10WCPR	Emergency battery pack, 10W Constant Power, CA Title 20 compliant with remote test switch (requires RGH)	DGC	Gloss Charcoal Grey	DSPD	Textured Dark Grey
		DTG	Gloss Tennis Green	DSPE	Textured Green
CP[12]	Chicago Plenum. Specify 120V or 277V (requires RGH)	DBR	Gloss Bright Red	DSPH	Textured Light Red
GTD	IOTA Generator Transfer Device. Specify 120V or 277V (requires RGH)	DSB	Gloss Steel Blue	DWHAMF	Gloss White with Anti-microbial finish

ACCESSORIES — order as separate catalog numbers (shipped separately)

GCOLORS KIT	Architectural colors chip kit, consisting of powder-coat and plated finishes
OPTC4 XXD	Additional optics for field installation. Replace "XX" with beam angle.
CYLJBOXADPT 4SQ2OCT __	4in Square J-box to 4in Octagonal J-box adaptor. Replace __ with Architectural Color or PRM for primed ready for field painting

ORDERING NOTES

1. Not Available with Finishes.
2. Only available 1500lm and below.
3. Factory supplied step down transformer must be remote mounted. Access required to location of remote mounted device.
4. Refer to Tech 240 for compatible dimmers.
5. Not Available with Control Interfaces.
6. Includes terminator resistor.
7. Factory installed with RGH option otherwise field installed. Access required to location of remote mounted device.
8. ER for use as UL924 Emergency Operation via power sense lead. Will require an emergency hot feed and normal hot feed. EM for use as UL924 Emergency Operation via power interrupt detection.
9. Only available up to 2500 lumens. Not available with WL or ECOS2.
10. Not available with JBXCC. Max: 3000LM.
11. For details on RAL and Custom colors please see Architectural colors
12. CP not available with NLTAIR2, NLTAIRER2 or E10WCPR options.

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Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F95

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4" **High Center Beam Surface Ceiling Cylinder**

SPECIFICATIONS

Optical Assembly
Fully serviceable and upgradeable lensed LED light engine suitable for field maintenance or service from below the ceiling.
Optical design is a Bounding Ray™ design with 45° cutoff to source and source image. Top down flash characteristic for superior glare control.

Electrical
The luminaire shall operate from a 50 or 60 Hz ±3 Hz AC line over a voltage ranging from 120 VAC to 277 VAC. Support 347V via remote-mounted stepdown transformer. The fluctuations of line voltage shall have no visible effect on the luminous output.
The luminaire shall have a power factor of 90% or greater at all standard operating voltages and full luminaire output.
Sound Rated A+. Driver shall be >80% efficient at full load across all input voltages.
Input wires shall be 18AWG, 300V minimum solid copper.

Controls
Luminaire shall be equipped with interface for nLight wired or nLight AIR networks with integral power supply as per specification.

Emergency
Luminaires supplied with a battery pack comply with NFPA 101 (Life Safety code) and deliver constant light output throughout the 90 minutes of code required emergency operation period when there is a normal AC power loss.
Luminaires equipped with a generator transfer device work in conjunction with an auxiliary generator or a central inverter system to power fixtures for safe egress lighting.

Dimming
The luminaire shall be capable of continuous dimming without perceivable stroboscopic flicker as measured by flicker index (ANSI/IES RP-16-10) 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%.
eldoLED LED drivers shall conform to IEEE P1789 standards. Alternatively, manufacturers must demonstrate conformance with product literature and testing which demonstrates this performance. Systems that do not meet IEEE P1789 will not be considered.
Driver is inaudible in 24dB environment, and stable when input voltage conditions fluctuate over what is typically experienced in a commercial environment.

Construction
Heaving-gauge aluminum construction.
Extruded body with flangeless reflector allows flow-through passive thermal management.
Surface ceiling mount for direct installation to 4" recessed or surface octagonal or square junction box.
Optional field configurable conduit covers available. Conduit covers match cylinder in finish and diameter.
Recessed gear box available for driver above ceiling, nLight, battery pack, CP, and GTD options.

Listings
Fixtures are CSA Certified to meet US and Canadian Standards: All fixtures manufactured in strict accordance with the appropriate and current requirements of the "Standards for Safety" to UL, damp location standard; wet location covered ceiling optional (WL); IP66 rating optional (IP66).
Luminaire configurations are Energy Star certified through testing in EPA–recognized laboratories, with the results reviewed by an independent, accredited certification organization. Visit www.energystar.gov for specific configurations listed.

Photometrics
LEDs tested to LM-80 standards. Measured by IESNA Standard LM-79-08 in an accredited lab. Lumen output shall not decrease by more than 30% over the minimum operational life of 60,000 hours.
Color appearance from luminaire to luminaire of the same type and in all configurations, shall be consistent both initially and at 6,000 hours and operate within a tolerance of <2.5 MacAdam ellipse as defined by the center of the quadrangles defined in ANSI C78.377-2015.

Buy American
This product is assembled in the USA and meets the Buy America(n) government procurement requirements under FAR, DFARS and DOT.
Please refer to www.acuitybrands.com/buy-american for additional information.

Warranty
5-year limited warranty. Complete warranty terms located at: www.acuitybrands.com/support/warranty/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.

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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Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F95

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

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4" **High Center Beam Surface Ceiling Cylinder**

Tables of Use

ICO - eldoLED Driver Default Dimming Curve			
Nomenclature	Min Dimming	Driver Dim Curve	Control Dim Curve
EZ10	10%	Linear	Linear/Logarithmic
EZ1	1%	Linear	Linear/Logarithmic
EZB	<1%	Logarithmic	Linear
EDAB	<1%	Logarithmic*	Linear
EDXB	<1%	Square	Linear

*Changable thorugh DALI controller

Lumen Output Multiplier		
CRI	CCT	Multplier
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	
Reflector Finish	Multiplier
LS - Specular	1
LSS - Semi Specular	0.956
WR - White	0.87
LD - Matte Diffuse	0.85
BR - Black	0.73
BZR - Bronze	0.73

Driver		Control Provided (note: 347V/UVOLT versions provided with 347 option selected)			
Nomenclature	Description	NLT	NLTER	NLTAIR2	NLTAIRER2
GZ10	0-10V driver dims to 10%	nPP16 D EFP	nPP16 D ER EFP	RPP20 D 24V G2	RPP20 D 24V ER G2
GZ1	0-10V driver dims to 1%	nPP16 D EFP	nPP16 D ER EFP	RPP20 D 24V G2	RPP20 D 24V ER G2
EZ10	eldoLED 0-10V ECOdrive	nPS 80 EZ	nPS 80 EZ ER	RPP20 D 24V G2	RPP20 D 24V ER G2
EZ1	eldoLED 0-10V ECOdrive	nPS 80 EZ	nPS 80 EZ ER	RPP20 D 24V G2	RPP20 D 24V ER G2
EZB	eldoLED 0-10V SOLOdrive	nPS 80 EZ	nPS 80 EZ ER	RPP20 D 24V G2	RPP20 D 24V ER G2

J-box Compatibility Matrix		Cylinder Configurations		
		JBX	JBX w/EDXB Driver	JBXCC
Recommended J-box (by others)	4" Octagonal 4x4x1.5 deep*	✓	×	✓
	4" Octagonal 4x4x2.125 deep	✓	✓	×
	4" Square 4x4x1.5 deep	✓ *with adaptor plate accessory	×	×

Standard Architectural Color Options for Cylinder Bodies

NOTE: These colors were carefully reproduced to give as true a depiction as possible of finished product color. Some colors, however, may vary slightly from actual appearance due to display/printing variations and limitations. Please always contact a Gotham representative for an accurate paint chip sample.

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Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

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Submittal: ASC P1X

Type: F95

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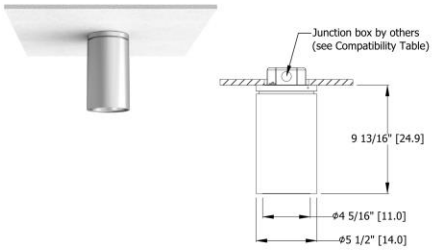
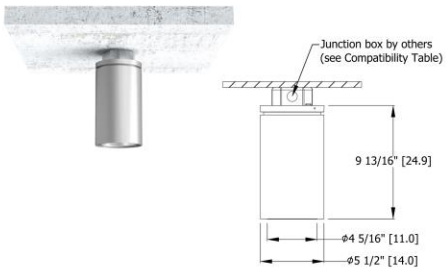
4" **High Center Beam Surface Ceiling Cylinder**

DIMENSIONAL DATA

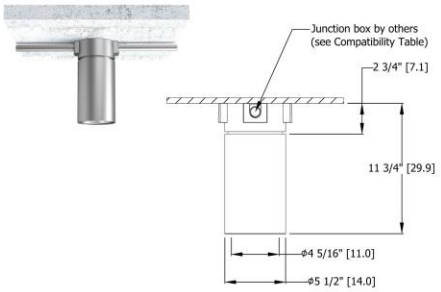
JBX Recessed J-Box



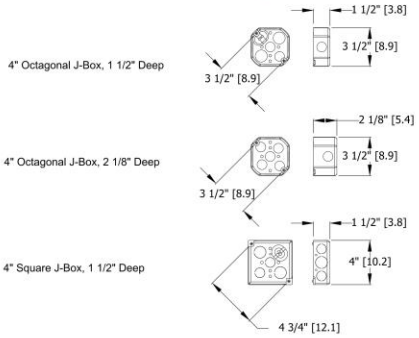
JBX Surface J-Box



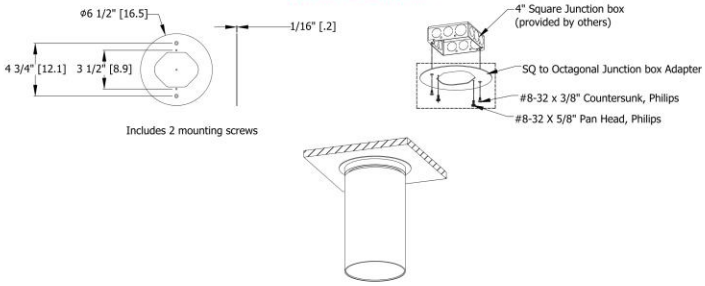
JBXCC Surface J-Box with Conduit Covers



Junction Box Dimensions (by others)



Cylinder Adapter Plate



*Dimensions in inches [centimeters]

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Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
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Submittal: ASC P1X

Type: F95

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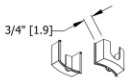
4" **High Center Beam Surface Ceiling Cylinder**

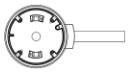
DIMENSIONAL DATA

Conduit Feed Examples and Keys

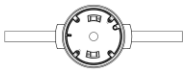


Conduit Key
(4) provided with each,
for use with 1/2" or 3/4" conduit

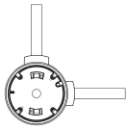
Blank Key
(4) provided with each



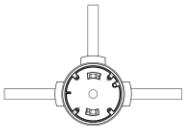
Single Conduit Feed



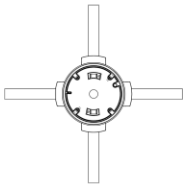
Double 180° conduit



Double 90°conduit



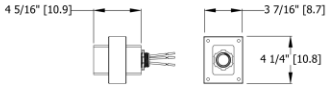
Triple 0°, 90° & 180° conduit



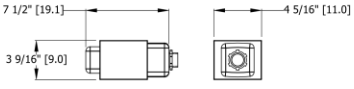
Quad 0°, 90°, 180°, & 270° conduit

Top conduit feed

347V Stepdown Transformer



347 Transformer:
Up to 6000LM
Install to accessible
junction box by others



347 Transformer:
8000LM and up
Install to accessible
junction box by others

*Dimensions in inches [centimeters]

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HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F95

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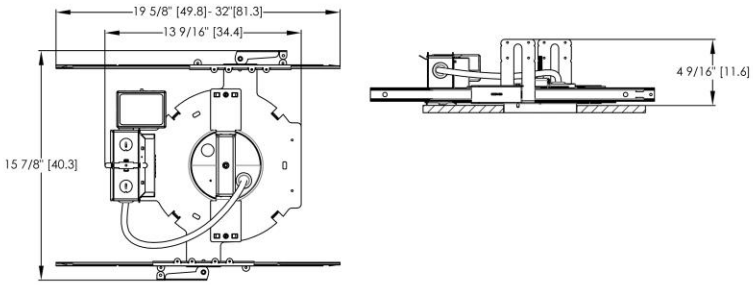
4" **High Center Beam Surface Ceiling Cylinder**

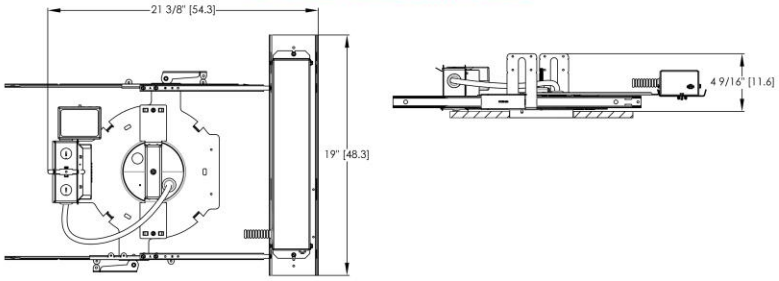
DIMENSIONAL DATA

RGH Standard



Ceiling thickness range: 1/2"[1.3] to 3"[7.6]
Ceiling cutout: 5 1/16"[12.9]

RGH with Battery Backup (E10WCPR) Standard



With Emergency Battery or GTD option
Minimum plenum height for emergency batteries in non-accessible ceilings: 12 1/2"[31.8]
Ceiling thickness range: 1/2"[1.3] to 3"[7.6]
Ceiling cutout: 5 1/16"[12.9]

*Dimensions in inches [centimeters]

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Submittal: ASC P1X

Type: F95

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

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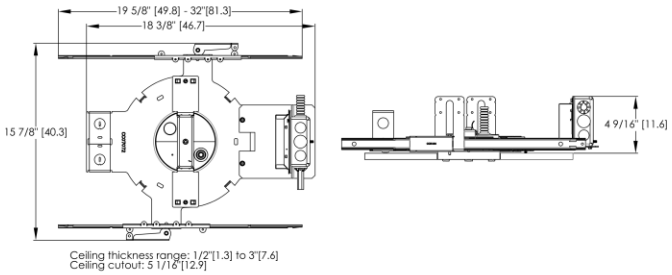
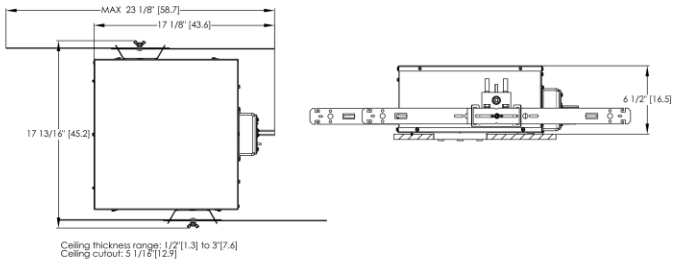
4" **High Center Beam Surface Ceiling Cylinder**

DIMENSIONAL DATA

RGH CP Standard



RGH with Chicago Plenum (CP) for use with nLight Enclosed



*Dimensions in inches [centimeters]

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Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F95

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

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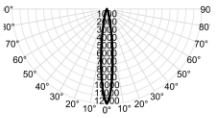
4" **High Center Beam Surface Ceiling Cylinder**

Photometry

CONSULT WWW.GOTHAMLIGHTING.COM FOR ADDITIONAL PHOTOMETRY.

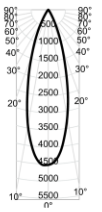
ICO4SC 35/15 AR LSS 15D Input Watts: 15.1, Delivered Lumens: 1504, LPW: 99.6, S/MH: 0.24, Test No: ISF 192654P1964



CP Summary		Zonal Lumen Summary			
	0°	Zone	Lumens	% Fixture	
0°	11,964	0° - 30°	1,449	96%	
5°	8,038	0° - 40°	1,479	98%	
15°	1,254	0° - 60°	1,501	100%	
25°	280	0° - 90°	1,503	100%	
35°	41	90° - 180°	1	0%	
45°	19	0° - 180°	1,504	100%	
55°	5				
65°	1				
75°	0				
85°	0				
90°	0				

Coefficients of Utilization											Cone of Light			Luminance (cd/sq.m)	
pf		80%			20%			50%			Mounting Height	Initial FC Center Beam	Beam Diameter		
pc					70%										Average Luminance
pw	50%	30%	10%	50%	30%	10%	50%	30%	10%						
0	122	122	122	119	119	119	114	114	114		6.0	332.3	1.5	0°	1,505,657
1	116	115	113	114	113	111	110	109	108		8.0	186.9	2.0	45°	3,408
2	112	109	107	110	107	105	107	105	103		10.0	119.6	2.4	55°	1,106
3	108	104	102	106	103	101	104	101	99		12.0	83.1	2.9	65°	300
4	104	100	98	103	100	97	101	98	96		14.0	61.0	3.4	75°	0
5	101	97	94	100	97	94	98	95	93					85°	0
6	98	94	92	97	94	91	96	93	91		Beam Angle: 13.9°				
7	96	92	89	95	91	89	94	91	89		Field Angle: 30.8°				
8	93	90	87	93	89	87	92	89	87						
9	91	88	85	91	87	85	90	87	85						
10	89	86	83	89	86	83	88	85	83						

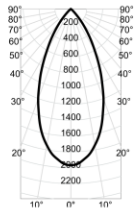
ICO4SC 35/15 AR LSS 30D Input Watts: 15.1, Delivered Lumens: 1411, LPW: 93.4, S/MH: 0.47, Test No: ISF 192657P1964



CP Summary		Zonal Lumen Summary			
	0°	Zone	Lumens	% Fixture	
0°	4,525	0° - 30°	1,295	92%	
5°	4,140	0° - 40°	1,376	97%	
15°	2,088	0° - 60°	1,407	100%	
25°	590	0° - 90°	1,410	100%	
35°	95	90° - 180°	1	0%	
45°	26	0° - 180°	1,411	100%	
55°	6				
65°	1				
75°	0				
85°	0				
90°	0				

Coefficients of Utilization											Cone of Light			Luminance (cd/sq.m)	
pf		80%			20%			50%			Mounting Height	Initial FC Center Beam	Beam Diameter		
pc					70%										Average Luminance
pw	50%	30%	10%	50%	30%	10%	50%	30%	10%						
0	119	119	119	116	116	116	111	111	111		6.0	125.7	3.1	0°	569,489
1	112	110	108	110	108	107	106	105	103		8.0	70.7	4.2	45°	4,664
2	106	103	100	105	102	99	102	99	97		10.0	45.3	5.2	55°	1,327
3	101	97	94	100	96	93	97	94	92		12.0	31.4	6.3	65°	300
4	97	92	89	96	92	88	94	90	87		14.0	23.1	7.3	75°	0
5	92	88	85	92	87	84	90	86	84					85°	0
6	89	84	81	88	84	81	87	83	80		Beam Angle: 29.3°				
7	85	81	77	85	80	77	84	80	77		Field Angle: 58.8°				
8	82	77	74	82	77	74	81	77	74						
9	79	75	72	79	74	71	78	74	71						
10	76	72	69	76	72	69	75	71	69						

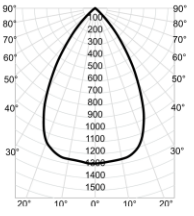
ICO4SC 35/15 AR LSS 45D Input Watts: 15.1, Delivered Lumens: 1437, LPW: 95.2, S/MH: 0.73, Test No: ISF 192660P1964



CP Summary		Zonal Lumen Summary			
	0°	Zone	Lumens	% Fixture	
0°	1,968	0° - 30°	1,060	74%	
5°	1,901	0° - 40°	1,329	92%	
15°	1,504	0° - 60°	1,432	100%	
25°	894	0° - 90°	1,437	100%	
35°	378	90° - 180°	1	0%	
45°	78	0° - 180°	1,437	100%	
55°	10				
65°	3				
75°	1				
85°	0				
90°	0				

Coefficients of Utilization											Cone of Light			Luminance (cd/sq.m)	
pf		80%			20%			50%			Mounting Height	Initial FC Center Beam	Beam Diameter		
pc					70%										Average Luminance
pw	50%	30%	10%	50%	30%	10%	50%	30%	10%						
0	120	120	120	117	117	117	112	112	112		6.0	54.7	5.2	0°	247,708
1	111	109	107	109	107	105	105	104	102		8.0	30.8	6.9	45°	13,812
2	104	100	97	102	99	96	99	96	94		10.0	19.7	8.7	55°	2,211
3	97	92	89	96	91	88	93	90	86		12.0	13.7	10.4	65°	900
4	91	86	82	90	85	81	88	84	80		14.0	10.0	12.1	75°	490
5	86	80	76	85	79	75	83	78	75					85°	0
6	81	75	71	80	74	70	78	74	70		Beam Angle: 46.9°				
7	76	70	66	75	70	66	74	69	66		Field Angle: 80.5°				
8	72	66	62	71	66	62	70	65	62						
9	68	62	59	68	62	58	67	62	58						
10	65	59	55	64	59	55	63	58	55						

ICO4SC 35/15 AR LSS 65D Input Watts: 15.1, Delivered Lumens: 1382, LPW: 91.5, S/MH: 0.98, Test No: ISF 192663P1964



CP Summary		Zonal Lumen Summary			
	0°	Zone	Lumens	% Fixture	
0°	1,280	0° - 30°	913	66%	
5°	1,270	0° - 40°	1,238	90%	
15°	1,231	0° - 60°	1,376	100%	
25°	946	0° - 90°	1,382	100%	
35°	471	90° - 180°	1	0%	
45°	114	0° - 180°	1,382	100%	
55°	12				
65°	3				
75°	1				
85°	0				
90°	0				

Coefficients of Utilization											Cone of Light			Luminance (cd/sq.m)	
pf		80%			20%			50%			Mounting Height	Initial FC Center Beam	Beam Diameter		
pc					70%										Average Luminance
pw	50%	30%	10%	50%	30%	10%	50%	30%	10%						
0	119	119	119	116	116	116	111	111	111		6.0	35.6	7.5	0°	161,080
1	110	108	106	108	106	104	104	102	101		8.0	20.0	10.0	45°	20,269
2	102	98	95	101	97	94	97	94	92		10.0	12.8	12.5	55°	2,654
3	95	90	86	94	89	85	91	87	84		12.0	8.9	15.0	65°	900
4	88	83	78	87	82	78	85	81	77		14.0	6.5	17.5	75°	490
5	82	76	72	82	76	72	80	75	71					85°	0
6	77	71	66	76	70	66	75	70	66		Beam Angle: 64.1°				
7	72	66	61	71	66	61	70	65	61		Field Angle: 96.1°				
8	68	61	57	67	61	57	66	61	57						
9	64	57	53	63	57	53	62	57	53						
10	60	54	50	59	54	50	59	53	50						

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Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F95

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

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4" **High Center Beam Surface Ceiling Cylinder**

NLIGHT AIR

nLight® AIR is the ideal solution for retrofit or new construction spaces where adding communication wiring is cost prohibitive. The integrated nLight AIR rPP20 Power Pack is part of each EVO Luminaire ordered with the NLTAIR option. These individually addressable controls offer the ultimate in flexibility during initial setup and for space repurposing.

nLight® AIR Control Accessories
Order as separate catalog number. Visit nLight AIR.

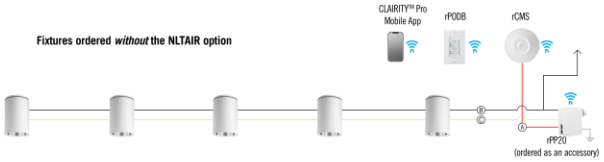
Wall Switches	Model Number
On/Off single pole	rPODB (color) G2
On/Off two pole	rPODB 2P (color) G2
On/Off & raise/lower single pole	rPODB DX (color) G2
On/Off & raise/lower two pole	rPODB 2P DX (color) G2

nLight® AIR Control Accessories *(cont.)*

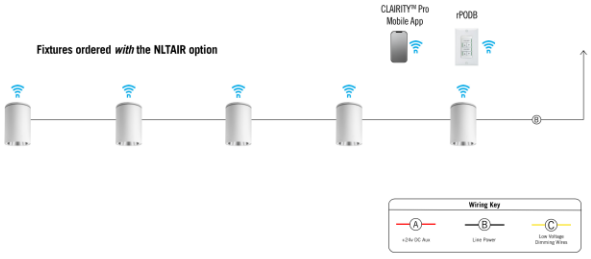
Occupancy Sensors (PIR/dual tech)	Model Number
Small motion 360°, ceiling	rCMS 9 / rCMS PDT 9
Large motion 360°, ceiling	rCMS 10 / rCMS PDT 10

Possibilites for nLight® AIR

Fixtures ordered *without* the NLTAIR option



Fixtures ordered *with* the NLTAIR option



NLIGHT

nLight® Wired The nLight® solution is a digital networked lighting control system that provides both energy savings and increased user configurability by cost effectively integrating time-based, daylight-based, sensor-based and manual lighting control schemes.

nLight® Wired Control Accessories
Order as separate catalog number. Visit nLight.

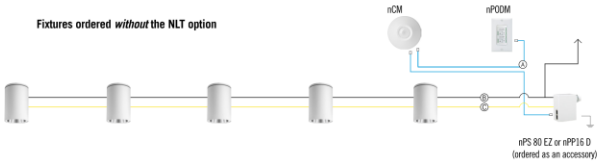
Wall Switches	Model Number
On/Off single pole	nPODM (XX)
On/Off two pole	nPODM 2P (XX)
On/Off & raise/lower single pole	nPOD DX (XX)
On/Off & raise/lower two pole	nPODM 2P DX (XX)
Graphic touchscreen	nPOD GFX (XX)
Photocell Controls	
Dimming	nCM ADCX

nLight® Wired Control Accessories *(cont.)*

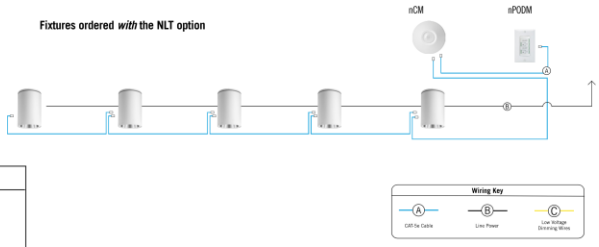
Occupancy Sensors (PIR/dual tech)	Model Number
Small motion 360°, ceiling	nCM 9 / nCM PDT 9
Large motion 360°, ceiling	nCM 10 / nCM PDT 10
Wide View	nWV 16 / nWV PDT 16
Wall switch with raise/lower	nWSX LV DX / nWSX PDT LV DX
Cat-5 Cables (plenum rated)	
10', CAT5	CAT5 10FT J1
15', CAT5	CAT5 15FT J1

Possibilites for nLight® wired

Fixtures ordered *without* the NLT option



Fixtures ordered *with* the NLT option



IC04SC
page 10 of 10

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Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F95

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

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ASW1 LED
LED Wall Luminaire

Buy American

AERIS

Catalog Number

Notes

Type

Hit the Tab key or mouse over the page to see all interactive elements.

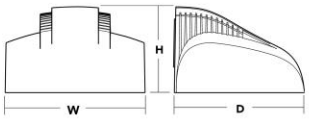
Introduction

The Aeris™ family combines sleek, fluid forms and crisp edges into a striking architectural aesthetic that can be echoed throughout entire sites.

The ASW1 LED integrates the latest LED technology with the designer aesthetic of the Aeris™ family for stylish, high-performance illumination that lasts. The ASW1 LED is ideal for replacing 100-400W metal halide in area lighting applications with typical energy savings of 65% and expected service life of over 100,000 hours.

Specifications

Width:	15" (38.1 cm)
Depth:	13-3/4" (34.9 cm)
Height:	9-1/4" (25.5 cm)
Weight (max):	34 lbs (15.4 kg)



Ordering Information

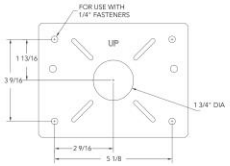
EXAMPLE: ASW1 LED 42C 700 40K SR4 MVOLT DDBTXD

ASW1 LED

Series	LEDs	Drive Current	Color temperature	Distribution	Voltage	Mounting
ASW1 LED	42C 42 LEDs (one engine)	350 350mA 530 530mA 700 700mA	30K 3000 K 40K 4000 K 50K 5000 K	SR2 Type II SR3 Type III SR4 Type IV	MVOLT [1] 277 [1] 120 [1] 347 208 [1] 480 240 [1]	**Shipped included** (blank) Surface mount **Shipped separately** BBW Surface-mounted back box (for conduit entry) [2]

Control Options				Other Options	Finish *(required)*	
Shipped installed				**Shipped installed**	DDBXD	Dark bronze
PE	Photoelectric cell, button type [3]	PNMT5D3	Part night, dim 5 hrs [3]	SF Single fuse (120, 277, 347V) [1]	DBLXD	Black
BL30	Bi-level switched dimming, 30% [4,5]	PNMT6D3	Part night, dim 6 hrs [3]	DF Double fuse (208, 240, 480V) [1]	DNAXD	Natural aluminum
BL50	Bi-level switched dimming, 50% [4,5]	PNMT7D3	Part night, dim 7 hrs [3]	DFL Diffusing lens	DWHXD	White
PNMTDD3	Part night, dim till dawn [3]	DMG	0-10v dimming wires pulled outside fixture (for use with an external control, ordered separately) [6]	**Shipped separately** [2]	DDBTXD	Textured dark bronze
				VG Vandal guard	DBLBXD	Textured black
				WG Wire guard	DNATXD	Textured natural aluminum
					DWHGXD	Textured white

Drilling



Accessories

Ordered and shipped separately.

ASW1BBW DDBXD U	Back box accessory (specify finish)
ASW1WG U	Wire guard accessory
ASW1VG U	Vandal guard accessory

NOTES
1. MVOLT driver operates on any line voltage from 120-277V (50/60 Hz). Single fuse (SF) requires 120 or 277 voltage option. Double fuse (DF) requires 208 or 240 voltage option.
2. Also available as a separate accessory; see Accessories information at left.
3. Photocontrol (PE) requires 120, 208, 240, 277 or 347 voltage option. Must be ordered with fixture; cannot be field installed.
4. Requires an additional switched line.
5. Dimming driver standard. Not available with 347V or 480V.
6. Not available with 347V, 480V, BL30, BL50 or PNMT options.

LITHONIA LIGHTING

One Lithonia Way • Conyers, Georgia 30012 • Phone: 800.279.8041 • www.lithonia.com

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Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F96

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

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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. Contact factory for performance data on any configurations not shown here.

Light Engines	Drive Current (mA)	System Watts	Dist. Type	40 K (4000 K, 70 CRI)				
				Nominal Lumens	B	U	G	LPW
42C (42 LEDs)	350	49W	SR2	4,013	1	0	1	82
			SR3	3,998	1	0	1	82
			SR4	3,971	1	0	1	81
	530	75W	SR2	7,140	2	0	2	95
			SR3	7,114	1	0	2	95
			SR4	7,066	1	0	1	94
	700	98W	SR2	8,564	2	0	2	87
			SR3	8,533	2	0	2	87
			SR4	8,476	2	0	2	86

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	1.06
10°C	50°F	1.04
20°C	68°F	1.01
25°C	**77°F**	**1.00**
30°C	86°F	0.99
40°C	104°F	0.96

Projected LED Lumen Maintenance

Data references the extrapolated performance projections for the **ASW1 LED 42C 700** 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).

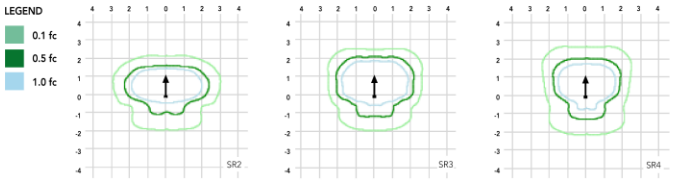
To calculate LLF, use the lumen maintenance factor that corresponds to the desired number of operating hours below. For other lumen maintenance values, contact factory.

Operating Hours	0	25,000	50,000	100,000
Lumen Maintenance Factor	1.0	0.96	0.92	0.85

Photometric Diagrams

To see complete photometric reports or download .ies files for this product, visit Lithonia Lighting's ASW1 LED homepage.

Isofootcandle plots are considered to be representative of available optical distributions.



FEATURES & SPECIFICATIONS

INTENDED USE
The ASW1 LED is a high performance, high efficacy, long life luminaire that is ideally suited for lighting building entries, walk ways and surrounding areas adjacent to commercial exteriors.

CONSTRUCTION
Single-piece, die-cast aluminum housing. Die-cast doorframe has impact-resistant, tempered glass lens. Doorframe is fully sealed with a closed-cell silicone gasket.

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
Precision-molded refractive acrylic lenses housed behind the door frame lens are available in three distributions. Light engines are available in standard 4000 K or optional 3000 K or 5000 K (70 CRI) configurations.

ELECTRICAL
Light engine consists of 42 high-efficacy LEDs mounted to a metal-core circuit board and aluminum heat sink, ensuring optimal thermal management and long life. Class 1 electronic driver has a power factor >90%, THD <20%, and has an expected life of 100,000 hours with <1% failure rate. Easily-serviceable surge protection device meets a minimum Category C Low (per ANSI/IEEE C62.41.2).

INSTALLATION
Universal mounting plate with integral mounting bolts supports the fixture for easy, one-person installation. Suitable for downward orientation only.

LISTINGS
CSA certified to U.S. and Canadian standards. Luminaire is IP65 rated. **US. Patent No. D500,569. Canada Patent No. 107561**.

BUY AMERICAN
This product is assembled in the USA and meets the Buy America(n) government procurement requirements under FARS, DFARS and DOT. Please refer to www.acuitybrands.com/resources/buy-american for additional information.

WARRANTY
Five year limited warranty. Full 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..

LITHONIA LIGHTING

One Lithonia Way • Conyers, Georgia 30012 • Phone: 800.279.8041 • www.lithonia.com

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ASW1-LED
Rev. 03/12/21

Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F96

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

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Multiple Layers of Light

Luminaire Type:
Catalog Number:

Buy American

High Center Beam Pendant Cord Cylinder 4"

OVERVIEW

Feature Set

- Eleven optimized distribution patterns allow designers to achieve tailored objectives
- Bounding Ray™ optical design
- 45° cutoff to source and source image
- Fully serviceable lensed LED light engine
- Fixtures are damp location standard; wet location option (WL)
- ENERGY STAR® Certified product
- Have the cleanest of installations with a 0.29" diameter color coordinated cord. Multi-conductor ultra-pliable cord with embedded aircraft cable ensures no chance of kinks, crooked mounting, or need to tether power cord to suspension cable (patent pending).
- Multiple recessed or surface j-box mounting configurations available with cords
- 20 standard colors in textured and gloss finish; custom or RAL colors also available

Distribution

Superior Perfomance

Nominal Lumens	500	700	1000	1200	1500	2000	2500	3000	3500	4000	4500	5000
Delivered	703	807	1062	1326	1545	1977	2419	2920	3548	3982	4419	4848
Wattage	6.7	7.5	9.8	12.2	15.1	21.5	26.5	34.1	33.8	39.5	46.2	53.2
Efficacy	104	108	108	108	102	92	91	86	105	101	96	91

COMPLEMENTARY PRODUCTS

Coordinated Apertures | Multiple Layers of Light

General Illumination Layer | EVO

High Center Beam Layer | Incito

EVO + Incito — Multiple Layers of Light

Core

Healthcare

Special Applications

ICO4CC
page 1 of 13

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Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F97

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

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4" **High Center Beam Pendant Cord Cylinder**

ORDERING INFORMATION

A+ Capable options indicated by this color background.

Luminaire Type:

Catalog Number:

EXAMPLE: IC04CC 35/15 AR LSS 35D MVOLT EZ1 JBXCC CCAN C120 DWHG

Series		Color Temperature		Lumens		Reflector Color		Reflector Finish		Beam		Voltage	
IC04CC	Incito 4in Pendant Cord Round Cylinder Open Downlight	27/	2700 K	05	500 lumens	AR	Clear	LSS	Semi-specular	10D[2]	10° beam angle	MVOLT	120V - 277V
		30/	3000 K	07	750 lumens	PR	Pewter	LD	Matte diffuse	15D	15° beam angle	120	120V
		35/	3500 K	10	1000 lumens	WTR	Wheat	LS	Specular	20D	20° beam angle	277	277V
		40/	4000 K	15	1500 lumens	GR	Gold			25D	25° beam angle	347[3]	347V
		50/	5000 K	20	2000 lumens	WR[1]	White painted			30D	30° beam angle		
				25	2500 lumens	BR[1]	Black			35D	35° beam angle		
				30	3000 lumens	WRAMF[1]	White Anti-microbial			40D	40° beam angle		
				35	3500 lumens					45D	45° beam angle		
				40	4000 lumens	BZR[1]	Dark Bronze painted			50D	50° beam angle		
				45	4500 lumens					60D	60° beam angle		
				50	5000 lumens					65D	65° beam angle		

Driver[4]		Mounting		Canopy Type		Cord Length[10,18]	
GZ10	0-10V driver dims to 10%	JBX	Integral driver, Recessed or Surface J-box	CCAN	5° Cord canopy with "hang straight" swivel	C120	10' Mounting Cord
GZ1	0-10V driver dims to 1%	JBXCC	Integral driver, Surface J-box with Conduit Covers	CCAN45[9]	45° Cord canopy with "hang straight" swivel	C180	15' Mounting Cord
EZ10	eldoLED 0-10V ECOdrive. Linear dimming to 10% min.	SGB[6]	Surface gear box (for driver at ceiling), Recessed or surface J-box (not wall or surface ceiling)			C240	20' Mounting Cord
EZ1	eldoLED 0-10V ECOdrive. Linear dimming to 1% min.	SGBCC[6]	Surface gear box (for driver at ceiling), surface J-box with Conduit Covers (not wall or surface ceiling)				
EZB	eldoLED 0-10V SOLOdrive. Logarithmic dimming to <1%.	RGH	Recessed Gear Housing				
EDAB[5]	eldoLED SOLOdrive DALI. Logarithmic dimming to <1%.						
EDXB[5,6,7]	eldoLED POWERdrive DMX with RDM (remote device management). Square Law dimming to <1%. Min: 1000LM; Max: 4000LM						
ECOS2[5]	Lutron® Hi-Lume® 2-wire forward-phase driver. 120V Only. Minimum dimming level 1%. Min: 1000LM; Max: 2000LM.						
ECOD[5]	Lutron® EcoSystem® digital Hi-Lume 1% soft-on, fade to black. Max: 4000LM.						
ELV[5]	Electronic line voltage/Forward phase/Triac dimming. 120V only.						

Control Interface[11]		Options		Architectural Colors - Powder Paint[15]			
(blank)	No controls	SF	Single fuse. Specify 120V or 277V.	DWHAMF	Gloss White with Anti-microbial finish	DDBT	Textured Dark Bronze
NLT	nLight® dimming pack. Specify 120V or 277V	90CRI	High CRI (90+)	DDB	Gloss Dark Bronze	DBLB	Textured Black
NLTER[12]	nLight® dimming pack for fixtures on emergency circuit. Specify 120V or 277V	N80	nLight Lumen Compensation	DBL	Matte Black	DWHG	Textured White
NLTAIR2	nLight® AIR dimming pack. Specify 120V or 277V	HAO[13]	High Ambient Option (40°C)	DWH	Gloss White	DBNH	Textured Bronze
NLTAIRER2[12]	nLight® AIR dimming pack for fixtures on emergency circuit. Specify 120V or 277V	WL[14]	Wet Location	DMB	Matte Medium Bronze	DNAT	Textured Natural Aluminum
		E10WCPR	Emergency battery pack, 10W Constant Power, CA Title 20 compliant with remote test switch (requires RGH)	DNA	Gloss Natural Aluminum	DSST	Textured Sandstone
				DSS	Gloss Sandstone	DSPD	Textured Dark Grey
		CP[17]	Chicago Plenum. Specify 120V or 277V (requires RGH)	DGC	Gloss Charcoal Grey	DSPE	Textured Green
		GTD	IOTA Generator Transfer Device. Specify 120V or 277V (requires RGH)	DTG	Gloss Tennis Green	DSPH	Textured Light Red
				DBR	Gloss Bright Red		
				DSB	Gloss Steel Blue		

ACCESSORIES — order as separate catalog numbers (shipped separately)

GCOLORS KIT	Architectural colors chip kit, consisting of powder-coat and plated finishes
OPTC4 XXD	Additional optics for field installation. Replace "XX" with beam angle.
CYLJBOXADPT 4SQ2OCT __	4in Square J-box to 4in Octagonal J-box adaptor. Replace __ with Architectural Color or PRM for primed ready for field painting

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Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F97

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4" **High Center Beam Pendant Cord Cylinder**

ORDERING INFORMATION

ORDERING NOTES

1. Not Available with Finishes.
2. Only available 1500lm and below.
3. Factory supplied step down transformer must be remote mounted. Access required to location of remote mounted device.
4. Refer to Tech 240 for compatible dimmers.
5. Not Available with Control Interfaces.
6. Requires SGB or SGBCC mounting option.
7. Includes terminator resistor.
8. Only available with DMX driver (EDXB).
9. Not available with SGB or SGBCC: those mountings require a flat ceiling.
10. Cord can be cut in field to achieve non-uniform lengths (i.e. for a field cut 8' length, order 10' cord). Cord length is nominal: actual length is about 2" shorter.
11. Factory installed with RGH option otherwise field installed. Access required to location of remote mounted device.
12. ER for use as UL924 Emergency Operation via power sense lead. Will require an emergency hot feed and normal hot feed. EM for use as UL924 Emergency Operation via power interrupt detection.
13. Only available up to 2500 lumens; not available with wet location.
14. Not available with JBXCC, SGB, or SGBCC. Max: 2500LM.
15. For details on RAL and Custom colors please see Architectural colors.
16. Cord color is determined by cylinder color: DWHG, DWH, and DWHAMF will have white cord; DBL and DBLB will have black cord; all others will have gray cord.
17. CP not available with NLTAIR2, NLTAIRER2 or E10WCPR options.

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Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F97

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4" **High Center Beam Pendant Cord Cylinder**

SPECIFICATIONS

Optical Assembly
Fully serviceable and upgradeable lensed LED light engine suitable for field maintenance or service from below the ceiling.
Optical design is a Bounding Ray™ design with 45° cutoff to source and source image. Top down flash characteristic for superior glare control.

Electrical
The luminaire shall operate from a 50 or 60 Hz ±3 Hz AC line over a voltage ranging from 120 VAC to 277 VAC. Support 347V via remote-mounted stepdown transformer. The fluctuations of line voltage shall have no visible effect on the luminous output.
The luminaire shall have a power factor of 90% or greater at all standard operating voltages and full luminaire output.
Sound Rated A+. Driver shall be >80% efficient at full load across all input voltages.
Input wires shall be 18AWG, 300V minimum solid copper.

Controls
Luminaire shall be equipped with interface for nLight wired or nLight AIR networks with integral power supply as per specification.

Emergency
Luminaires supplied with a battery pack comply with NFPA 101 (Life Safety code) and deliver constant light output throughout the 90 minutes of code required emergency operation period when there is a normal AC power loss.
Luminaires equipped with a generator transfer device work in conjunction with an auxiliary generator or a central inverter system to power fixtures for safe egress lighting.

Dimming
The luminaire shall be capable of continuous dimming without perceivable stroboscopic flicker as measured by flicker index (ANSI/IES RP-16-10) 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%.
eldoLED LED drivers shall conform to IEEE P1789 standards. Alternatively, manufacturers must demonstrate conformance with product literature and testing which demonstrates this performance. Systems that do not meet IEEE P1789 will not be considered.
Driver is inaudible in 24dB environment, and stable when input voltage conditions fluctuate over what is typically experienced in a commercial environment.

Construction
Heaving-gauge aluminum construction. Extruded cylinder body with flangeless reflector allows flow-through passive thermal management. Canopy matches cylinder in finish and diameter.
Pendant cord mount for installation to 4" recessed or surface octagonal junction box with integral driver.
Recessed gear box available for driver above ceiling, nLight, battery pack, CP, and GTD options.
Surface gear box available for driver at ceiling installation.
Optional field configurable conduit covers available. Conduit covers match cylinder in finish and diameter.

Listings
Fixtures are CSA Certified to meet US and Canadian Standards: All fixtures manufactured in strict accordance with the appropriate and current requirements of the "Standards for Safety" to UL, damp location standard; wet location covered ceiling optional (WL).
Luminaire configurations are Energy Star certified through testing in EPA–recognized laboratories, with the results reviewed by an independent, accredited certification organization. Visit www.energystar.gov for specific configurations listed.

Photometrics
LEDs tested to LM-80 standards. Measured by IESNA Standard LM-79-08 in an accredited lab. Lumen output shall not decrease by more than 30% over the minimum operational life of 60,000 hours.
Color appearance from luminaire to luminaire of the same type and in all configurations, shall be consistent both initially and at 6,000 hours and operate within a tolerance of <2.5 MacAdam ellipse as defined by the center of the quadrangles defined in ANSI C78.377-2015.

Buy American
This product is assembled in the USA and meets the Buy America(n) government procurement requirements under FAR, DFARS and DOT.
Please refer to www.acuitybrands.com/buy-american for additional information.

Warranty
5-year limited warranty. Complete warranty terms located at: www.acuitybrands.com/support/warranty/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.

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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Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F97

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

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4" **High Center Beam Pendant Cord Cylinder**

Tables of Use

ICO - eldoLED Driver Default Dimming Curve			
Nomenclature	Min Dimming	Driver Dim Curve	Control Dim Curve
EZ10	10%	Linear	Linear/Logarithmic
EZ1	1%	Linear	Linear/Logarithmic
EZB	<1%	Logarithmic	Linear
EDAB	<1%	Logarithmic*	Linear
EDXB	<1%	Square	Linear

*Changable thorugh DALI controller

Lumen Output Multiplier		
CRI	CCT	Multplier
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	
Reflector Finish	Multiplier
LS - Specular	1
LSS - Semi Specular	0.956
WR - White	0.87
LD - Matte Diffuse	0.85
BR - Black	0.73
BZR - Bronze	0.73

Driver		Control Provided (note: 347V/UVOLT versions provided with 347 option selected)			
Nomenclature	Description	NLT	NLTER	NLTAIR2	NLTAIRER2
GZ10	0-10V driver dims to 10%	nPP16 D EFP	nPP16 D ER EFP	RPP20 D 24V G2	RPP20 D 24V ER G2
GZ1	0-10V driver dims to 1%	nPP16 D EFP	nPP16 D ER EFP	RPP20 D 24V G2	RPP20 D 24V ER G2
EZ10	eldoLED 0-10V ECOdrive	nPS 80 EZ	nPS 80 EZ ER	RPP20 D 24V G2	RPP20 D 24V ER G2
EZ1	eldoLED 0-10V ECOdrive	nPS 80 EZ	nPS 80 EZ ER	RPP20 D 24V G2	RPP20 D 24V ER G2
EZB	eldoLED 0-10V SOLOdrive	nPS 80 EZ	nPS 80 EZ ER	RPP20 D 24V G2	RPP20 D 24V ER G2

J-box Compatibility Matrix		Cylinder Configurations					
		JBX	SGB	SGBCC	SGB w/EDXB Driver	SGBCC w/EDXB Driver	JBXCC
Recommended J-box (by others)	4" Octagonal 4x4x1.5 deep*	✓	✓	✓	✓	✓	✓
	4" Octagonal 4x4x2.125 deep	✓	✓	×	✓	×	×
	4" Square 4x4x1.5 deep	✓ *with adaptor plate accessory	✓ *with adaptor plate accessory	×	✓ *with adaptor plate accessory	×	×

Standard Architectural Color Options for Cylinder Bodies

NOTE: These colors were carefully reproduced to give as true a depiction as possible of finished product color. Some colors, however, may vary slightly from actual appearance due to display/printing variations and limitations. Please always contact a Gotham representative for an accurate paint chip sample.

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South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F97

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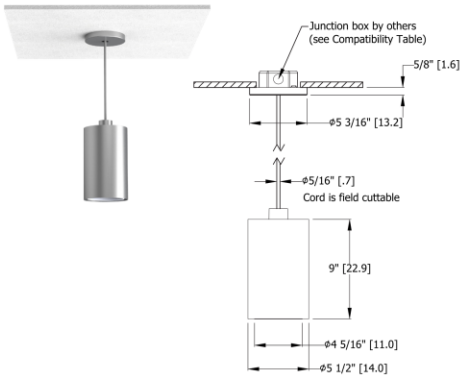
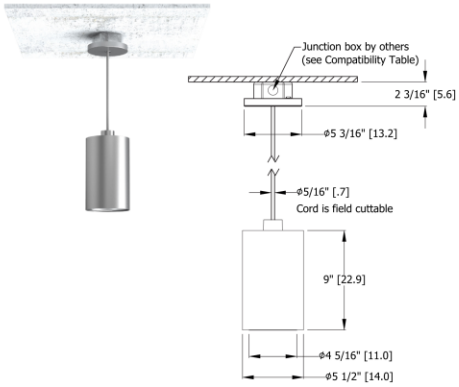
4" **High Center Beam Pendant Cord Cylinder**

DIMENSIONAL DATA

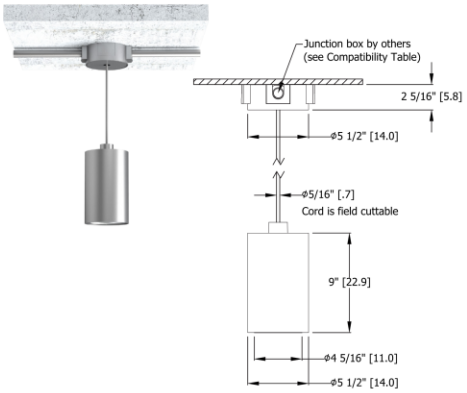
JBX Recessed J-Box



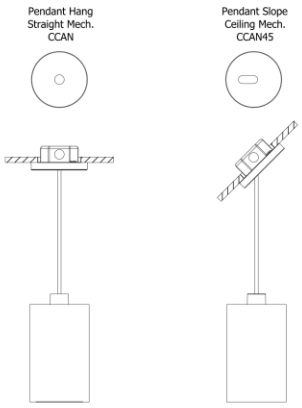
JBX Surface J-Box



JBXCC Surface J-Box with Conduit Covers



Canopy Covers for Flat or Sloped Ceilings



*Dimensions in inches [centimeters]

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Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

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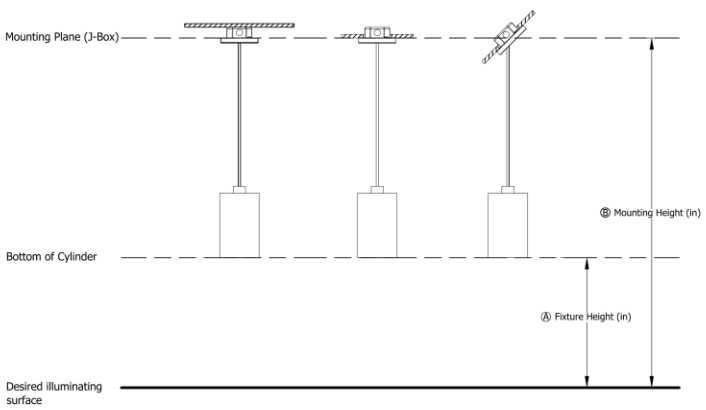
4" **High Center Beam Pendant Cord Cylinder**

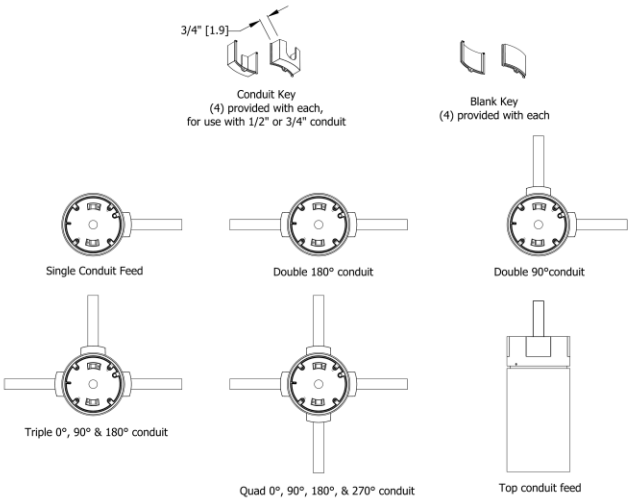
DIMENSIONAL DATA

Stem Cutting Formulas for JBX



Cord Length=Ⓑ-Ⓐ- 4"

Conduit Feed Examples and Keys



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Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F97

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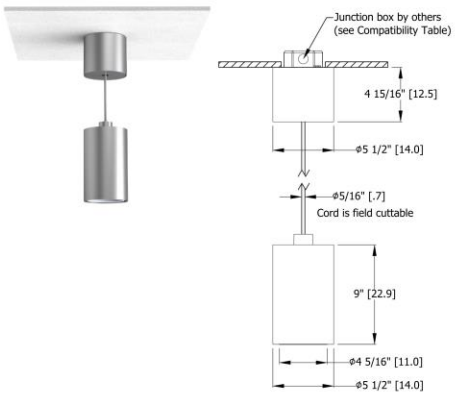
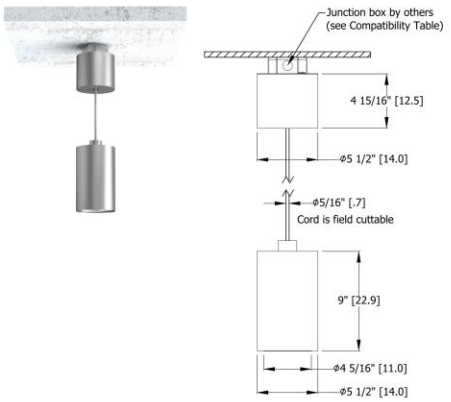
4" **High Center Beam Pendant Cord Cylinder**

DIMENSIONAL DATA

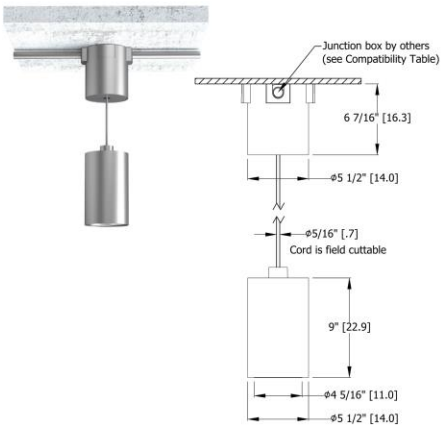
SGB Surface Gear Box for EDXB_Recessed J-Box



JBX Surface J-Box



SGBCC Surface Gear Box for EDXB with Conduit Covers



*Dimensions in inches [centimeters]

ICO4CC
page 8 of 13

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Date: 17 June 2022

Submittal: ASC P1X

Type: F97

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

Horton Lees Brogden Lighting Design | 3575 Ringsby Court Suite 402 Denver CO 80216 | P: 303 317 5006 | www.HLBlighting.com

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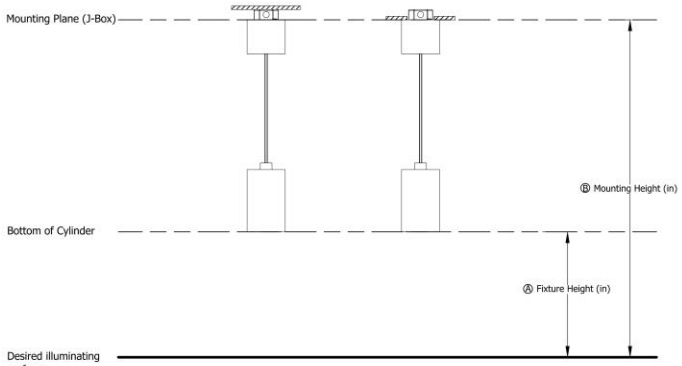
4" **High Center Beam Pendant Cord Cylinder**

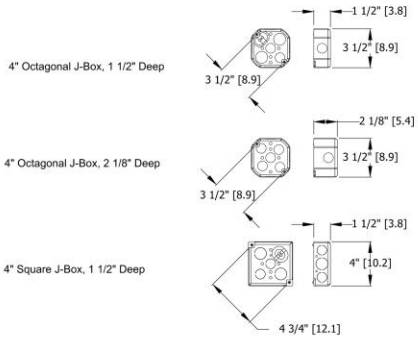
DIMENSIONAL DATA

Cutting Formulas for SGB



Cord Length=Ⓑ-Ⓐ- 8"

Junction Box Dimensions (by others)



*Dimensions in inches [centimeters]

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Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F97

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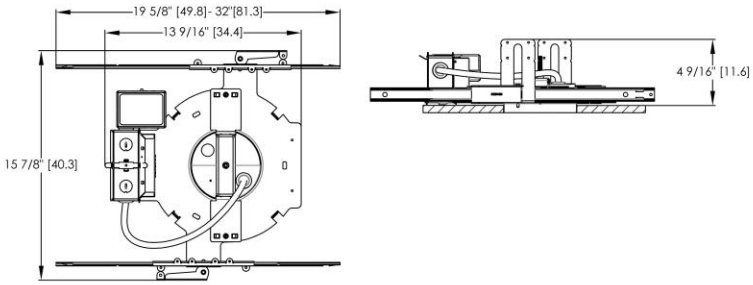
4" **High Center Beam Pendant Cord Cylinder**

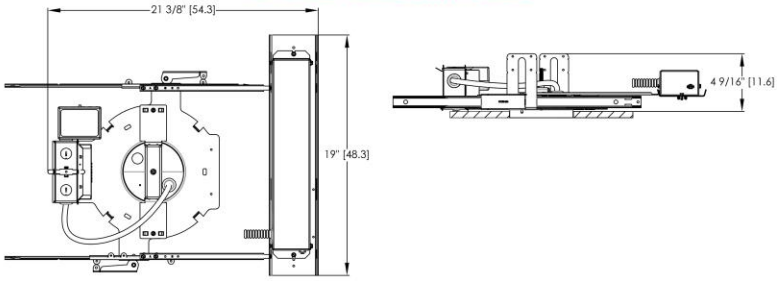
DIMENSIONAL DATA

RGH Standard



Ceiling thickness range: 1/2"[1.3] to 3"[7.6]
Ceiling cutout: 5 1/16"[12.9]

RGH with Battery Backup (E10WCPR) Standard



With Emergency Battery or GTD option
Minimum plenum height for emergency batteries in non-accessible ceilings: 12 1/2"[31.8]
Ceiling thickness range: 1/2"[1.3] to 3"[7.6]
Ceiling cutout: 5 1/16"[12.9]

*Dimensions in inches [centimeters]

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Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F97

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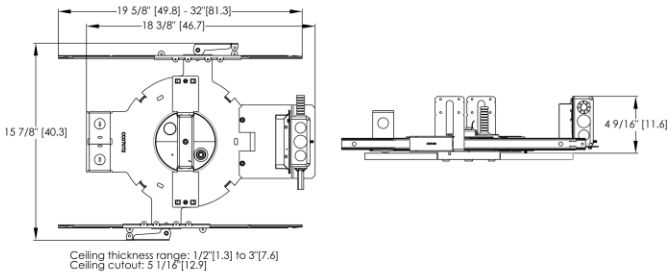
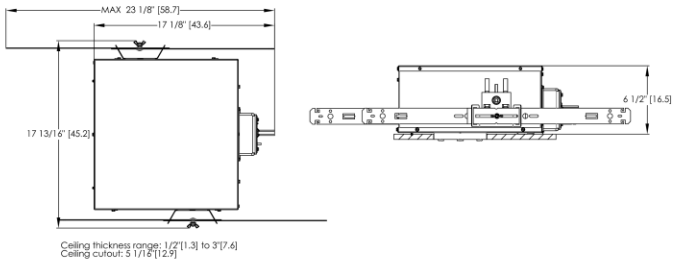
4" **High Center Beam Pendant Cord Cylinder**

DIMENSIONAL DATA

RGH CP Standard



RGH with Chicago Plenum (CP) for use with nLight Enclosed



*Dimensions in inches [centimeters]

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Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F97

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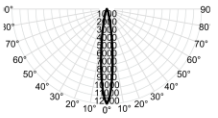
4" **High Center Beam Pendant Cord Cylinder**

Photometry

CONSULT WWW.GOTHAMLIGHTING.COM FOR ADDITIONAL PHOTOMETRY.

ICO4CC 35/15 AR LSS 15D Input Watts: 15.1, Delivered Lumens: 1504, LPW: 99.6, S/MH: 0.24, Test No: ISF 192654P4364



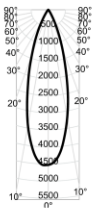
CP Summary		Zonal Lumen Summary			
	0°	Zone	Lumens	% Fixture	
0°	11,964	0° - 30°	1,449	96%	
5°	8,038	0° - 40°	1,479	98%	
15°	1,254	0° - 60°	1,501	100%	
25°	280	0° - 90°	1,503	100%	
35°	41	90° - 180°	1	0%	
45°	19	0° - 180°	1,504	100%	
55°	5				
65°	1				
75°	0				
85°	0				
90°	0				

Coefficients of Utilization											
pf		80%			20%			50%			
pc					70%						
pw	50%	30%	10%	50%	30%	10%	50%	30%	10%		
0	122	122	122	119	119	119	114	114	114		
1	116	115	113	114	113	111	110	109	108		
2	112	109	107	110	107	105	107	105	103		
3	108	104	102	106	103	101	104	101	99		
4	104	100	98	103	100	97	101	98	96		
5	101	97	94	100	97	94	98	95	93		
6	98	94	92	97	94	91	96	93	91		
7	96	92	89	95	91	89	94	91	89		
8	93	90	87	93	89	87	92	89	87		
9	91	88	85	91	87	85	90	87	85		
10	89	86	83	89	86	83	88	85	83		

Cone of Light			
Mounting Height	Initial FC Center Beam	Beam Diameter	
6.0	332.3	1.5	
8.0	186.9	2.0	
10.0	119.6	2.4	
12.0	83.1	2.9	
14.0	61.0	3.4	
Beam Angle: 13.9°			
Field Angle: 30.8°			

Luminance (cd/sq.m)	
	Average Luminance
0°	1,505,657
45°	3,408
55°	1,106
65°	300
75°	0
85°	0

ICO4CC 35/15 AR LSS 30D Input Watts: 15.1, Delivered Lumens: 1411, LPW: 93.4, S/MH: 0.47, Test No: ISF 192657P4364



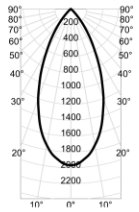
CP Summary		Zonal Lumen Summary			
	0°	Zone	Lumens	% Fixture	
0°	4,525	0° - 30°	1,295	92%	
5°	4,140	0° - 40°	1,376	97%	
15°	2,088	0° - 60°	1,407	100%	
25°	590	0° - 90°	1,410	100%	
35°	95	90° - 180°	1	0%	
45°	26	0° - 180°	1,411	100%	
55°	6				
65°	1				
75°	0				
85°	0				
90°	0				

Coefficients of Utilization											
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	112	110	108	110	108	107	106	105	103		
2	106	103	100	105	102	99	102	99	97		
3	101	97	94	100	96	93	97	94	92		
4	97	92	89	96	92	88	94	90	87		
5	92	88	85	92	87	84	90	86	84		
6	89	84	81	88	84	81	87	83	80		
7	85	81	77	85	80	77	84	80	77		
8	82	77	74	82	77	74	81	77	74		
9	79	75	72	79	74	71	78	74	71		
10	76	72	69	76	72	69	75	71	69		

Cone of Light			
Mounting Height	Initial FC Center Beam	Beam Diameter	
6.0	125.7	3.1	
8.0	70.7	4.2	
10.0	45.3	5.2	
12.0	31.4	6.3	
14.0	23.1	7.3	
Beam Angle: 29.3°			
Field Angle: 58.8°			

Luminance (cd/sq.m)	
	Average Luminance
0°	569,489
45°	4,664
55°	1,327
65°	300
75°	0
85°	0

ICO4CC 35/15 AR LSS 45D Input Watts: 15.1, Delivered Lumens: 1437, LPW: 95.2, S/MH: 0.73, Test No: ISF 192660P4364



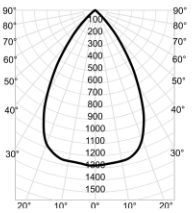
CP Summary		Zonal Lumen Summary			
	0°	Zone	Lumens	% Fixture	
0°	1,968	0° - 30°	1,060	74%	
5°	1,901	0° - 40°	1,329	92%	
15°	1,504	0° - 60°	1,432	100%	
25°	894	0° - 90°	1,437	100%	
35°	378	90° - 180°	1	0%	
45°	78	0° - 180°	1,437	100%	
55°	10				
65°	3				
75°	1				
85°	0				
90°	0				

Coefficients of Utilization											
pf		80%			20%			50%			
pc					70%						
pw	50%	30%	10%	50%	30%	10%	50%	30%	10%		
0	120	120	120	117	117	117	112	112	112		
1	111	109	107	109	107	105	105	104	102		
2	104	100	97	102	99	96	99	96	94		
3	97	92	89	96	91	88	93	90	86		
4	91	86	82	90	85	81	88	84	80		
5	86	80	76	85	79	75	83	78	75		
6	81	75	71	80	74	70	78	74	70		
7	76	70	66	75	70	66	74	69	66		
8	72	66	62	71	66	62	70	65	62		
9	68	62	59	68	62	58	67	62	58		
10	65	59	55	64	59	55	63	58	55		

Cone of Light			
Mounting Height	Initial FC Center Beam	Beam Diameter	
6.0	54.7	5.2	
8.0	30.8	6.9	
10.0	19.7	8.7	
12.0	13.7	10.4	
14.0	10.0	12.1	
Beam Angle: 46.9°			
Field Angle: 80.5°			

Luminance (cd/sq.m)	
	Average Luminance
0°	247,708
45°	13,812
55°	2,211
65°	900
75°	490
85°	0

ICO4CC 35/15 AR LSS 65D Input Watts: 15.1, Delivered Lumens: 1382, LPW: 91.5, S/MH: 0.98, Test No: ISF 192663P4364



CP Summary		Zonal Lumen Summary			
	0°	Zone	Lumens	% Fixture	
0°	1,280	0° - 30°	913	66%	
5°	1,270	0° - 40°	1,238	90%	
15°	1,231	0° - 60°	1,376	100%	
25°	946	0° - 90°	1,382	100%	
35°	471	90° - 180°	1	0%	
45°	114	0° - 180°	1,382	100%	
55°	12				
65°	3				
75°	1				
85°	0				
90°	0				

Coefficients of Utilization											
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	110	108	106	108	106	104	104	102	101		
2	102	98	95	101	97	94	97	94	92		
3	95	90	86	94	89	85	91	87	84		
4	88	83	78	87	82	78	85	81	77		
5	82	76	72	82	76	72	80	75	71		
6	77	71	66	76	70	66	75	70	66		
7	72	66	61	71	66	61	70	65	61		
8	68	61	57	67	61	57	66	61	57		
9	64	57	53	63	57	53	62	57	53		
10	60	54	50	59	54	50	59	53	50		

Cone of Light			
Mounting Height	Initial FC Center Beam	Beam Diameter	
6.0	35.6	7.5	
8.0	20.0	10.0	
10.0	12.8	12.5	
12.0	8.9	15.0	
14.0	6.5	17.5	
Beam Angle: 64.1°			
Field Angle: 96.1°			

Luminance (cd/sq.m)	
	Average Luminance
0°	161,080
45°	20,269
55°	2,654
65°	900
75°	490
85°	0

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Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F97

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4" **High Center Beam Pendant Cord Cylinder**

NLIGHT AIR

nLight® AIR is the ideal solution for retrofit or new construction spaces where adding communication wiring is cost prohibitive. The integrated nLight AIR rPP20 Power Pack is part of each EVO Luminaire ordered with the NLTAIR option. These individually addressable controls offer the ultimate in flexibility during initial setup and for space repurposing.

nLight® AIR Control Accessories
Order as separate catalog number. Visit nLight AIR.

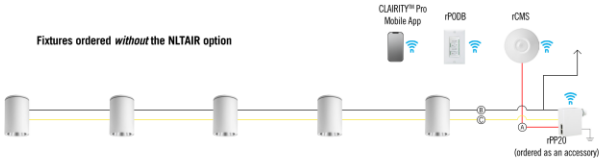
Wall Switches	Model Number
On/Off single pole	rPODB (color) G2
On/Off two pole	rPODB 2P (color) G2
On/Off & raise/lower single pole	rPODB DX (color) G2
On/Off & raise/lower two pole	rPODB 2P DX (color) G2

nLight® AIR Control Accessories *(cont.)*

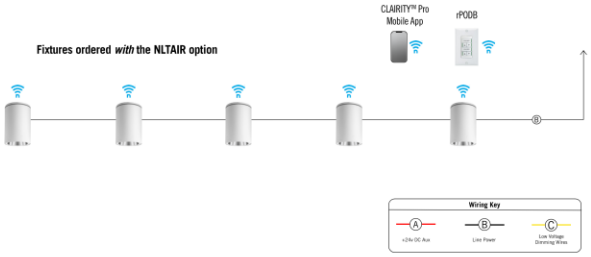
Occupancy Sensors (PIR/dual tech)	Model Number
Small motion 360°, ceiling	rCMS 9 / rCMS PDT 9
Large motion 360°, ceiling	rCMS 10 / rCMS PDT 10

Possibilites for nLight® AIR

Fixtures ordered *without* the NLTAIR option



Fixtures ordered *with* the NLTAIR option



NLIGHT

nLight® Wired The nLight® solution is a digital networked lighting control system that provides both energy savings and increased user configurability by cost effectively integrating time-based, daylight-based, sensor-based and manual lighting control schemes.

nLight® Wired Control Accessories
Order as separate catalog number. Visit nLight.

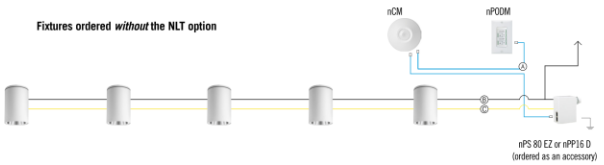
Wall Switches	Model Number
On/Off single pole	nPODM (XX)
On/Off two pole	nPODM 2P (XX)
On/Off & raise/lower single pole	nPOD DX (XX)
On/Off & raise/lower two pole	nPODM 2P DX (XX)
Graphic touchscreen	nPOD GFX (XX)
Photocell Controls	
Dimming	nCM ADCX

nLight® Wired Control Accessories *(cont.)*

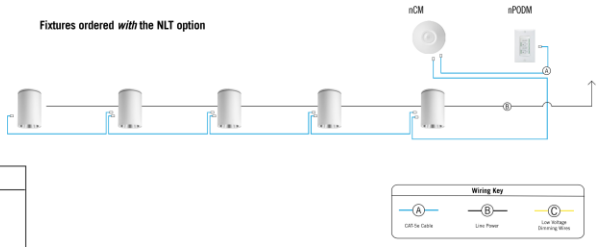
Occupancy Sensors (PIR/dual tech)	Model Number
Small motion 360°, ceiling	nCM 9 / nCM PDT 9
Large motion 360°, ceiling	nCM 10 / nCM PDT 10
Wide View	nWV 16 / nWV PDT 16
Wall switch with raise/lower	nWSX LV DX / nWSX PDT LV DX
Cat-5 Cables (plenum rated)	
10', CAT5	CAT5 10FT J1
15', CAT5	CAT5 15FT J1

Possibilites for nLight® wired

Fixtures ordered *without* the NLT option



Fixtures ordered *with* the NLT option



IC04CC
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South Terminal C - Phase 1X
HLB Project #: 160045

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insight lighting

MEDLEY EXTERIOR REMOTE (MER)

PERFORMANCE LINEAR | WHITE LIGHT & STATIC COLOR SPECIFICATION

PROJECT: TYPE: CATALOG #: MER-

PROFILE

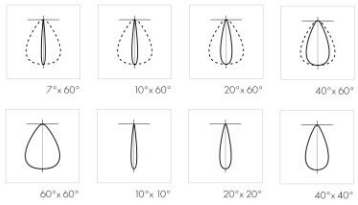
LIGHT SOURCE	3.5 W/FT, 9.0 W/FT, 15.0 W/FT
OPTICS	7° X 60°, 10° X 10°, 10° X 60°, 10° X 90°, 20° X 20°, 20° X 60°, 40° X 40°, 40° X 60°, 40° X 90°, 60° X 60°, 90° X 90° 80° X 80°, ASY
CCT	27K, 30K, 35K, 40K, RED, GREEN, BLUE, AMBER
CRI	82 (OPTIONAL 90+)
PERFORMANCE	UP TO 117530 PEAK CANDELA
VOLTAGE	UNIVERSAL 120-277 V
POWER	REMOTE POWER SUPPLY
CONTROL	0-10V, DMX, LUTRON HI-LUME
DIMENSIONS	1.85" X 2.00"
HOUSING	PRECISION EXTRUDED ALUMINUM
LENS	HIGH DENSITY TEMPERED GLASS
FINISH	HIGH DURABILITY POWDER COATING
OPERATING TEMP	-20° C TO 50° C
WARRANTY	5-YEAR LIMITED
LUMEN MAINTENANCE	75,000 HOURS
CERTIFICATION	ETL AND cETL FOR IP67, IK07, 5G/3G OPTIONS

IP67 IK07 3G 5G

STANDARD FINISHES

OPTICS

Not all available optics shown



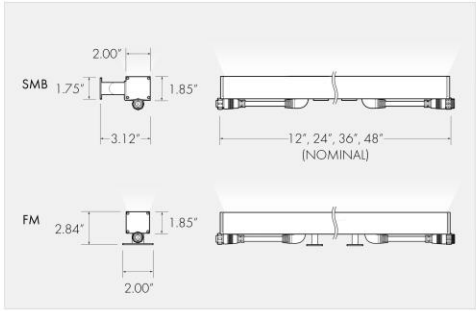
PERFORMANCE SAMPLE

Go to Performance Data >

40K, HO, 48.00"	10°X 10°	10°X 60°	20°X 20°	80°X 80°	100°
LUMENS	6316	5417	6475	6161	6459
CANDELA	117530	19943	52385	3960	2739
EFFICACY	91.2 LM/W	77.3 LM/W	93.3 LM/W	88.8 LM/W	94.4 LM/W

PROFILE

Go to Fixture Dimensions >



OPTIONS

*Shown with white diffusing lense

Revised 05/5/2022
Specifications subject to change without notice

1/9

insight lighting
4341 Fulcrum Way NE, Rio Rancho New Mexico 87144
P: 505.345.0888 | insightlighting.com

Project: Greater Orlando Aviation Authority
South Terminal C - Phase 1X
HLB Project #: 160045

Date: 17 June 2022

Submittal: ASC P1X

Type: F98

APPENDIX: LUMINAIRE CATALOGUE CUTS Note: This document is for information only. Refer to specifications for all catalog numbers, etc.

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insight lighting

MEDLEY EXTERIOR REMOTE (MER)

PERFORMANCE LINEAR | WHITE LIGHT & STATIC COLOR SPECIFICATION

PROJECT: TYPE: CATALOG #: MER- - - - - - - - -

SPECIFICATION

Separate options with dashes

MER | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9

1 FIXTURE

MEDLEY EXTERIOR REMOTE	MER

2 WATTAGE

LOW OUTPUT 3.5 W/FT	LO
MEDIUM OUTPUT 9.0 W/FT	MO
HIGH OUTPUT 15.0 W/FT	HO

3 CCT

2700K	27K
3000K	30K
3500K	35K
4000K	40K
RED	R
GREEN	G
BLUE	B
AMBER	A

4 OPTIC

7° X 60°	760
10° X 10° 10° X 10° optic is intended for a 6.00° fixture setback from the surface	1010
10° X 60°	1060
10° X 90°	1090
20° X 20°	2020
20° X 60°	2060
20° X 90°	2090
40° X 40°	4040
40° X 60°	4060
40° X 90°	4090
60° X 60°	6060
60° X 90°	6090
80° X 80°	8080
100° X 100°	100
ASYMMETRIC DIRECT Direct = down-light Asymmetric distribution is intended for a wall height of 10.0 FT to 12.0 FT with the fixture setback 18.00" from the wall	AD
ASYMMETRIC INDIRECT Indirect = up-light Asymmetric distribution is intended for a wall height of 10.0 FT to 12.0 FT with the fixture setback 18.00" from the wall	AI

5 MOUNTING

SURFACE MOUNT 5G Ansi C136.31 rated	SM
GROUND MOUNT	GM
EXTENDED ARM X = extended arm length specify 6", 12" or 18" 6.00" arm is 3G Ansi C 136.3 rated	EA-X
EXTENDED ARM, BACK X = extended arm length specify 6", 12" or 18"	EAB-X
SURFACE BACK MOUNT	SMB
FIXED MOUNT Not intended for continuous run applications	FM
END MOUNT Not intended for continuous run applications	EM
STAKE MOUNT	STM

6 FIXTURE LENGTH

12"	12
24"	24
36"	36
48" Nominal lengths	48

7 CONTROL OPTIONS

NO DIMMING	NO
0-10V DIMMING (1%)	DIM
DMX DIMMING DMX controls are required and must be ordered seperately **DMX Programming Kit** required - see below	DMX
LUTRON L3D0E - Hi-lume Premier 0.1% EcoSystem 24V constant voltage LED driver with Soft-on, Fade to Black dimming technology All power supplies must be ordered - see below	L3DOE

8 FINISH

TEXTURED WHITE	TW
TEXTURED BLACK	TB
TEXTURED BRONZE	TBR
TEXTURED LIGHT BRONZE	TLB
TEXTURED GRAY	TG
TEXTURED SANDSTONE	TS
ANODIZED ALUMINUM Includes CRF Finish	AA
CUSTOM COLOR Contact factory for custom color - additional charges will apply	CC

9 OPTIONS

HIGH CRI, 90+	HCRI
LOUVER Field installable snooted louver LLF of 10% -15% depending on color	LV
VISOR Field installable visored louver LLF of 10% -15% depending on color	VS
DIRECT VIEW DOME LENS Field installable Only available with 100° X 100°	DVD
WHITE LENS LLF OF 30% Only available with 100° X 100°	WL
CONCEALED WIRING Not available with 12" fixtures	CW
WHITE CABLING White cabling is standard with textured white finish	WC
CORROSION RES. FINISH Recommended for coastal or extreme exterior environments	CRF

POWER SUPPLY & CONTROL ORDER OPTIONS

Go to DMX Guide >

REMOTE POWER SUPPLY OPTIONS - WET LOCATION - REQUIRED

CONTRA EXTERIOR LOW POWER, 96W OUTPUT (120V-277V)	CEL
CONTRA EXTERIOR STANDARD POWER, 240W OUTPUT (120V-277V)	CES
CONTRA EXTERIOR HIGH POWER, (2)-240W OUTPUT (120V-277V)	CEH

Above wattage is based on 75% of the Power Supply's total wattage capacity
See page 3 for maximum fixture per power supply.
For specific and case by case requirements, please contact factory for assistance

DMX DISTRIBUTION & PROGRAMMING KIT - REQUIRED

DMX/RDM DISTRIBUTION KIT (4 OUTPUTS) - IP67	CDS-RDM

DMX/RDM **Distribution Kit** consists of four outputs
Each output is limited to (1) run per output - up to 32 fixtures max
Four terminators are included for end of line termination

Go to Cable Guide >

EXTERIOR LEADER CABLE - REQUIRED

5.0 FT LEADER CABLE	LC-5

A leader cable is required for each single fixture and for each fixture run for connection from the first fixture to the j-box
Black cables are standard unless White Cabling (**WC**) option or Textured White (**TW**) Fixture finish is selected

EXTERIOR JUMPER CABLES

1.0 FT JUMPER CABLE	JC-1
2.0 FT JUMPER CABLE	JC-2
5.0 FT JUMPER CABLE	JC-5
10.0 FT JUMPER CABLE	JC-10
25.0 FT JUMPER CABLE	JC-25

Required if fixtures are not mounted in an end-to-end continuous manner and for line voltage only
Black cables are standard unless White Cabling (**WC**) option or Textured White (**TW**) Fixture finish is selected

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MEDLEY EXTERIOR REMOTE (MER)

PERFORMANCE LINEAR | WHITE LIGHT & STATIC COLOR SPECIFICATION

PROJECT: TYPE: CATALOG #: MER- - - - - - - - -

PERFORMANCE

Nominal lengths

CCT AND LENGTH	OPTIC	LOW OUTPUT (3.5 W/FT) DELIVERED LUMENS	LOW OUTPUT (3.5 W/FT) LUMINARE EFFICACY	LOW OUTPUT (3.5 W/FT) PEAK CANDELA	MEDIUM OUTPUT (9.0 W/FT) DELIVERED LUMENS	MEDIUM OUTPUT (9.0 W/FT) LUMINARE EFFICACY	MEDIUM OUTPUT (9.0 W/FT) PEAK CANDELA	HIGH OUTPUT (15.0 W/FT) DELIVERED LUMENS	HIGH OUTPUT (15.0 W/FT) LUMINARE EFFICACY	HIGH OUTPUT (15.0 W/FT) PEAK CANDELA
4000K 24"	7° X 60°	998 LM	107.0 LM/W	3662	1685 LM	110.0 LM/W	6189	3366 LM	98.0 LM/W	12363
	10° X 10°	932 LM	100.5 LM/W	17011	1566 LM	103.0 LM/W	28686	3158 LM	91.2 LM/W	58765
	10° X 60°	804 LM	86.6 LM/W	2905	1348 LM	88.4 LM/W	4871	2709 LM	77.3 LM/W	9972
	20° X 20°	948 LM	102.1 LM/W	7658	1601 LM	102.4 LM/W	12983	3238 LM	93.3 LM/W	26193
	20° X 60°	862 LM	92.8 LM/W	1893	1451 LM	96.2 LM/W	3207	2914 LM	84.6 LM/W	6379
	40° X 40°	1001 LM	108.0 LM/W	1395	1688 LM	111.0 LM/W	2338	3392 LM	98.8 LM/W	4733
	40° X 60°	896 LM	96.7 LM/W	724	1497 LM	98.6 LM/W	1211	3039 LM	88.1 LM/W	2470
	60° X 60°	993 LM	107.1 LM/W	882	1666 LM	109.3 LM/W	1485	3354 LM	97.7 LM/W	2999
	80° X 80°	912 LM	98.2 LM/W	585	1525 LM	100.1 LM/W	976	3081 LM	88.8 LM/W	1980
	100° X 100°	620 LM	86.8 LM/W	263	1964 LM	93.3 LM/W	829	3230 LM	94.4 LM/W	1370
	ASY	888 LM	96.3 LM/W	3134	1473 LM	97.8 LM/W	5199	2890 LM	88.2 LM/W	9369
4000K 36"	7° X 60°	1496 LM	107.0 LM/W	5492	2527 LM	110.0 LM/W	9283	5048 LM	98.0 LM/W	18544
	10° X 10°	1398 LM	100.5 LM/W	25516	2349 LM	103.0 LM/W	43029	4737 LM	91.2 LM/W	88148
	10° X 60°	1205 LM	86.6 LM/W	4357	2022 LM	88.4 LM/W	7306	4063 LM	77.3 LM/W	14957
	20° X 20°	1421 LM	102.1 LM/W	11486	2402 LM	102.4 LM/W	19474	4856 LM	93.3 LM/W	39289
	20° X 60°	1292 LM	92.8 LM/W	2840	2177 LM	96.2 LM/W	4810	4371 LM	84.6 LM/W	9569
	40° X 40°	1502 LM	108.0 LM/W	2093	2531 LM	111.0 LM/W	3506	5088 LM	98.8 LM/W	7100
	40° X 60°	1344 LM	96.7 LM/W	1086	2245 LM	98.6 LM/W	1817	4559 LM	88.1 LM/W	3704
	60° X 60°	1489 LM	107.1 LM/W	1322	2499 LM	109.3 LM/W	2228	5031 LM	97.7 LM/W	4499
	80° X 80°	1368 LM	98.2 LM/W	877	2287 LM	100.1 LM/W	1464	4621 LM	88.8 LM/W	2970
	100° X 100°	929 LM	86.8 LM/W	394	2946 LM	93.3 LM/W	1244	4844 LM	94.4 LM/W	2054
	ASY	1332 LM	96.3 LM/W	4700	2209 LM	97.8 LM/W	7798	4335 LM	88.2 LM/W	14053
4000K 48"	7° X 60°	1995 LM	107.0 LM/W	7323	3369 LM	110.0 LM/W	12377	6731 LM	98.0 LM/W	24725
	10° X 10°	1864 LM	100.5 LM/W	34021	3132 LM	103.0 LM/W	57372	6316 LM	91.2 LM/W	117530
	10° X 60°	1607 LM	86.6 LM/W	5809	2696 LM	88.4 LM/W	9741	5417 LM	77.3 LM/W	19943
	20° X 20°	1895 LM	102.1 LM/W	15315	3202 LM	102.4 LM/W	25965	6475 LM	93.3 LM/W	52385
	20° X 60°	1723 LM	92.8 LM/W	3786	2902 LM	96.2 LM/W	6413	5828 LM	84.6 LM/W	12758
	40° X 40°	2002 LM	108.0 LM/W	2790	3375 LM	110.7 LM/W	4675	6784 LM	98.8 LM/W	9466
	40° X 60°	1792 LM	96.7 LM/W	1448	2993 LM	98.6 LM/W	2422	6078 LM	88.1 LM/W	4939
	60° X 60°	1985 LM	107.1 LM/W	1763	3332 LM	109.3 LM/W	2970	6708 LM	97.7 LM/W	5998
	80° X 80°	1824 LM	98.2 LM/W	1169	3049 LM	100.1 LM/W	1952	6161 LM	88.8 LM/W	3960
	100° X 100°	1239 LM	86.8 LM/W	525	3928 LM	93.3 LM/W	1658	6459 LM	94.4 LM/W	2739
	ASY	1776 LM	96.3 LM/W	6267	2945 LM	97.8 LM/W	10397	5780 LM	88.2 LM/W	18787

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MEDLEY EXTERIOR REMOTE (MER)

PERFORMANCE LINEAR | WHITE LIGHT & STATIC COLOR SPECIFICATION

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WIRING

MAXIMUM FIXTURES PER POWER SUPPLY (CIRCUITS MAY NOT BE LOADED OVER 10 AMPS)

Data provided is based on 75% of the Power Supply's total wattage capacity

	LOW OUTPUT (3.5 W/FT)			MEDIUM OUTPUT (9.0 W/FT)			HIGH OUTPUT (15.0 W/FT)		
NOMINAL FIXTURE LENGTH	CONTRA STAND. POWER 96W OUTPUT	CONTRA HIGH POWER 240W OUTPUT	CONTRA DUAL HIGH POWER (2)-240W	CONTRA STAND. POWER 96W OUTPUT	CONTRA HIGH POWER 240W OUTPUT	CONTRA DUAL HIGH POWER (2)-240W	CONTRA STAND. POWER 96W OUTPUT	CONTRA HIGH POWER 240W OUTPUT	CONTRA DUAL HIGH POWER (2)-240W
12"	27	68	136	10	26	52	5	14	28
24"	13	34	68	5	13	26	2	7	14
36"	9	23	46	3	8	16	2	4	8
48"	6	17	34	2	6	12	1	3	6

REMOTE DISTANCE LIMITS

Noncompliance with recommended remote wiring distances may void warranty

WIRE GAUGE	MAX DISTANCE
20 AWG	25.0 FT
18 AWG	30.0 FT
16 AWG	40.0 FT
14 AWG	60.0 FT
12 AWG	100.0 FT

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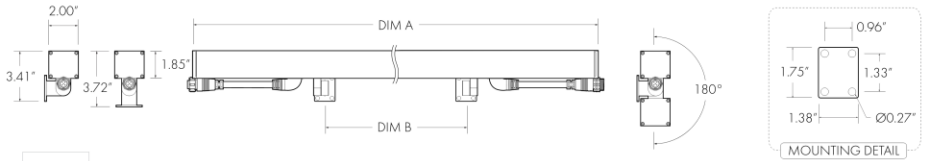
DIMENSIONS

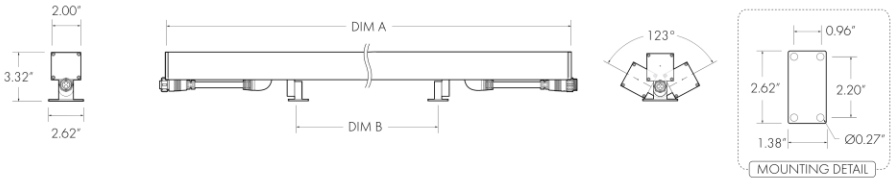
	12"	24"	36"	48"
DIM A	12.10"	23.85"	35.60"	47.35"
DIM B	9.28"	4.00" MIN | 6.00" MAX	12.00" MIN | 18.00" MAX	18.00" MIN | 30.00" MAX

SURFACE MOUNT (SM)

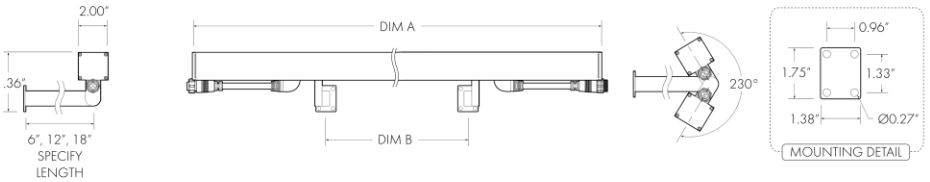


5G
ANSI C136.31

GROUND MOUNT (GM)



EXTENDED ARM (EA-X)



3G
ANSI C136.3

3G RATED WITH 6.00" ARM

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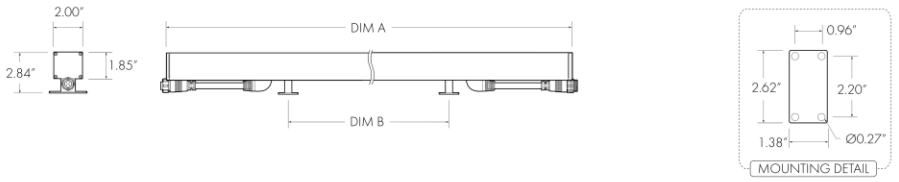
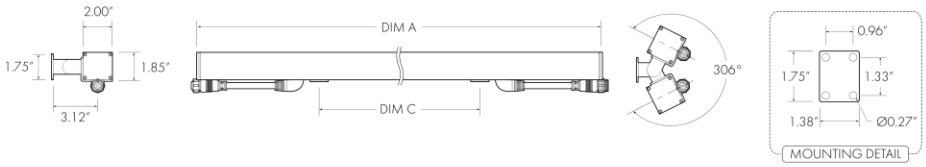
DIMENSIONS

	12"	24"	36"	48"
DIM A	12.10"	23.85"	35.60"	47.35"
DIM B	9.28"	4.00" MIN | 6.00" MAX	12.00" MIN | 18.00" MAX	18.00" MIN | 30.00" MAX

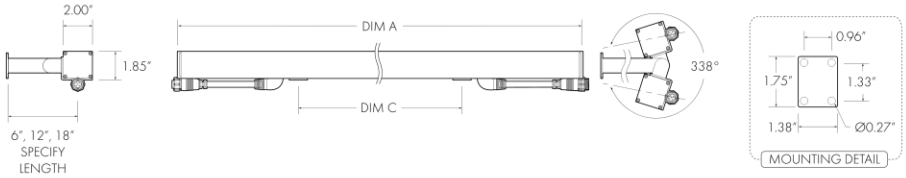
FIXED MOUNT (FM)



SURFACE, BACK MOUNT (SMB)



EXTENDED ARM, BACK MOUNT (EAB-X)



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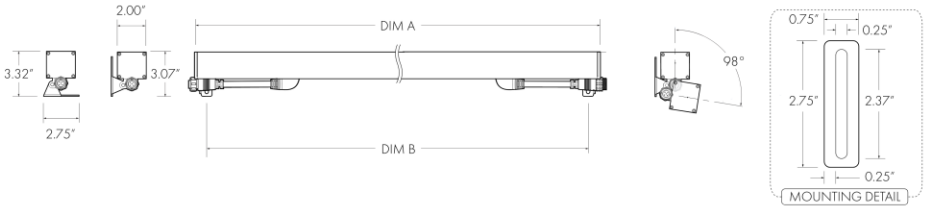
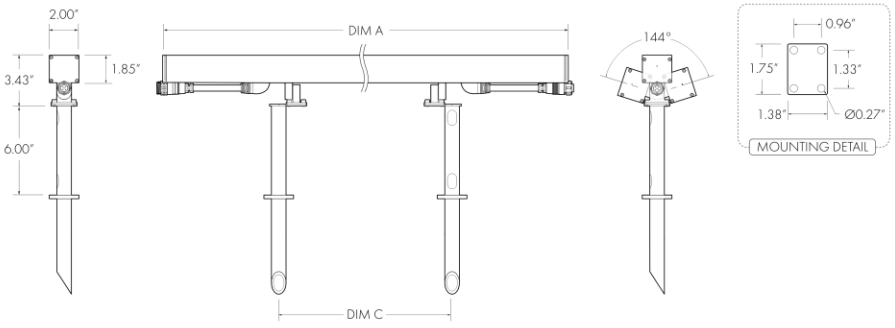
DIMENSIONS

	12.00"	24.00"	36.00"	48.00"
DIM A	12.10"	23.85"	35.60"	47.35"
DIM B	11.65	22.31"	34.06"	45.81"
DIM C	10.56"	4.00" MIN | 6.00" MAX	12.00" MIN | 18.00" MAX	18.00" MIN | 30.00" MAX

END MOUNT (EM)



STAKE MOUNT (STM)



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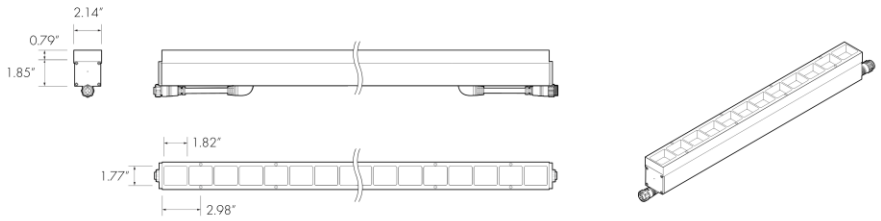
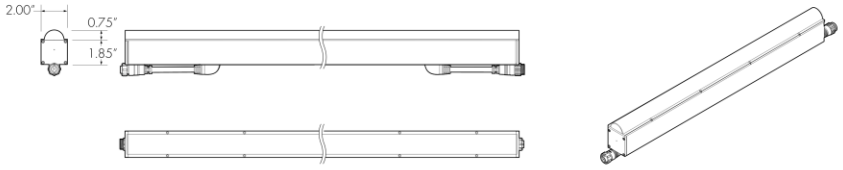
ACCESSORIES

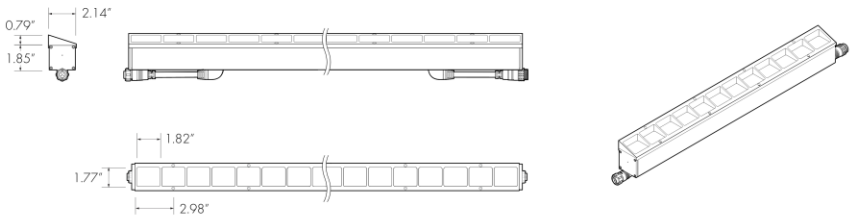
LOUVER (LV)



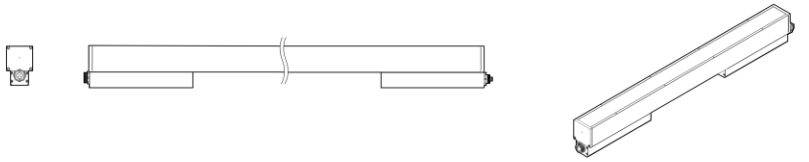
DIRECT VIEW LENS (DV)



VISOR (VS)



CONCEALED WIRING (CW)



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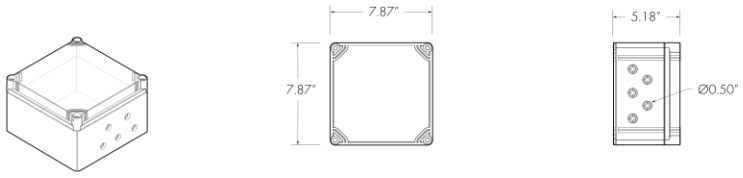
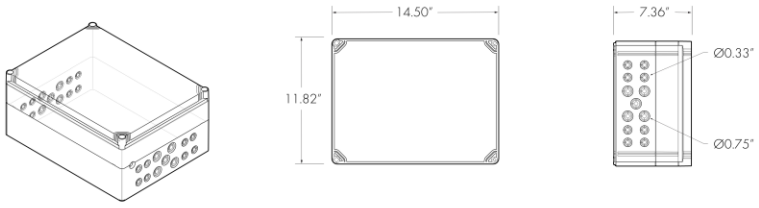
CONTRA EXTERIOR LOW POWER SUPPLY - CEL



CONTRA EXTERIOR STANDARD AND HIGH POWER SUPPLY - CES / CEH



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END OF SECTION 26 5010

SECTION 26 51 00 - INTERIOR LIGHTING – BACK OF HOUSE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Interior lighting fixtures, lamps, and ballasts.
   2. Exit signs.
   3. Lighting fixture supports.
   4. Indoor lighting is indicated by Contract Documents and shall include work necessary and incidental to completion and performance of the work.
   5. Related Sections include the following:
   6. Division 26 Section "Stand Alone Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

B. The fixture catalog numbers listed on Drawings indicate manufacturer, fixture design, appearance, and performance desired. Verify ceiling system and coordinate lighting fixture trim and support requirements. Fixtures shall be modified, if necessary, to comply with drawing and specification requirements.

C. The omission of a type in the fixture schedule shall not relieve Contractor of responsibility of furnishing all required fixtures, of proper type, as shown on Drawings.

D. Do not utilize permanent lighting fixtures for temporary use unless prior written approval has been obtained from Engineer or Owner.

1.3 DEFINITIONS

1.
2. CRI: Color-rendering index.
3. CU: Coefficient of utilization.
4. LER: Luminaire efficacy rating.
5. Luminaire: Complete lighting fixture, including ballast housing if provided.
6. RCR: Room cavity ratio.

1.4 SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
   1. Physical description of lighting fixture including dimensions.
   2. Driver
   3. Energy-efficiency data.

4. Life, output, and energy-efficiency data for lamps.
5. Photometric data, in IESNA format, based on laboratory tests of each lighting fixture type, outfitted with lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.

B. Shop Drawings: Show details of nonstandard or custom lighting fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.
1. Wiring Diagrams: Power and control wiring.
2. Detail wiring for fixtures and differentiate between manufacturer-installed and field-installed wiring.

C. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
1. Lighting fixtures.
2. Suspended ceiling components.
3. Structural members to which suspension systems for lighting fixtures will be attached.
4. Other items in finished ceiling including the following:
   a. Air outlets and inlets.
   b. Speakers.
   c. Sprinklers.
   d. Smoke and fire detectors.
   e. Occupancy sensors.
   f. Access panels.
   g. Projectors
   h. IR Sensors
   i. Wireless Access Points

D. Samples for Verification: Interior lighting fixtures designated for sample submission in Interior Lighting Fixture Schedule. Each sample shall include the following:
1. Lamps: Specified units installed.
2. Accessories: Cords and plugs.

E. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, signed by product manufacturer.

F. Operation and Maintenance Data: For lighting equipment and fixtures to include in operation, and maintenance manuals.

G. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Manufacturer Qualifications: Manufacturer shall have 5 years minimum documented experience in design, production, fabrication and installation of type work required for the work. Upon request, provide proof of qualifications.

C. Comply with NFPA 70.

D. Comply with UL 468A, UL 468B and UL924

E. FMG Compliance: Lighting fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FMG.

F. NFPA 101 Compliance: Comply with visibility and luminance requirements for exit signs and emergency lighting.

G. Mockups: Provide interior lighting fixtures for room or module mockups, complete with power and control connections.
   1. Obtain Architect's approval of fixtures for mockups before starting installations.
   2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
   3. Approved fixtures in mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 PRODUCT HANDLING

A. Deliver lighting fixtures in factory-fabricated containers or wrappings, which properly protect fixtures from damage.

B. Store lighting fixtures in original packaging. Store inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, humidity, laid flat and blocked off ground. Do not store fixtures outside under any circumstances.

C. Handle lighting fixtures carefully to prevent damage, breaking, and scoring of finishes. Do not install damaged units or components; replace with new.

1.7 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.8 MAINTENANCE MATERIALS

A. Provide to Owners authorized representative:
   1. Ten (10) of each size/type of fuses
   2. 2% of each type and wattage of lamp installed, but in no case less than six (6) of each type.

1.9 WARRANTY

A. Special Warranty for Drivers and Ballasts: Manufacturer's standard form in which manufacturer agrees to repair or replace drivers or ballasts that fail in materials within specified warranty period.
   1. Warranty Period for Electronic Drivers and Ballasts: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Lighting Fixture Products: Subject to compliance with requirements, products that may be incorporated into the Work include the products indicated in the Lighting Fixture Schedule.

2.2 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

A. Provide lighting fixtures, of sizes, types and ratings indicated; complete with, but not limited to, housing, specified lamps, lamp holders, reflectors, specified ballasts, starters and wiring.

B. Ship fixtures factory assembled, with those components required for a complete installation.

C. Design fixtures with concealed hinges and catches, with metal parts grounded as common unit, and so constructed as to dampen fixture/component generated noise.

D. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

E. Metal Parts: Free of burrs and sharp corners and edges.

F. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

G. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

H. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
   1. White Surfaces: 85 percent.
   2. Specular Surfaces: 83 percent.
   3. Diffusing Specular Surfaces: 75 percent.
   4. Laminated Silver Metallized Film: 90 percent.

I. Plastic Diffusers, Covers, and Globes:
   1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
      a. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless different thickness is indicated.
      b. UV stabilized.
   2. Glass: Annealed crystal glass, unless otherwise indicated.

2.3 LED LIGHTING

A. Manufacturers
   1. Manufacturer shall have at least five years of experience designing, selling, and supporting LED lighting.

B. Photometrics and characteristics

1. All LEDs used in the LED fixture shall be high brightness and of proven quality from established and reputable LED manufacturers.
2. Manufacturer shall utilize an advanced production LED binning process such as Optibin® from Philips Color Kinetics to deliver a common and repeatable color point to maintain color consistency from fixture to fixture and project to project over time, while ensuring a reliable supply of LEDs from the supplier.
3. Manufacturer shall provide optical performance, polar diagrams, and photometric data in various formats including IES file format in accordance with IES LM-79-08.
4. Photometric data shall be based on test results from an independent NIST traceable testing lab. IES data must be available and downloadable from manufacturer's Web Site.
5. Fixture shall provide a lumen output equal to that of the specified design selection.

C. General
1. High-power LED fixtures shall be thermally protected using metal core board, gap pad, and/or internal monitoring firmware thermal management techniques. LED fixture housing shall be designed to transfer heat from the LED board to the outside environment.
2. All hardwired connections to LED fixture shall be reverse-polarity protected and shall provide high-voltage protection in the event that connections are reversed or shorted during installation.
3. LED fixtures shall pass temperature range operational testing from –20° C to 50° C, pass high-temperature operating testing up to 50° C, meet lumen maintenance standards as defined in IESNA LM-80-08.
4. LED fixture shall be UL listed or UL/cUL classified, CE certified, FCC Class B compliant and California Title 24 Compliant.

D. Compliance
1. Manufacturer shall ensure that products undergo and successfully meet appropriate design and manufacturability testing, including Design FMEA, Process FMEA, environmental engineering considerations, and laboratory tests.
2. Manufacturer shall be able to provide documentation supporting the product's compliance with third-party regulations.
3. All LED fixtures shall undergo a minimum 24-hour burn-in test during manufacturing. The LED fixture shall be operated at constant and carefully regulated current levels. LEDs shall not be overdriven beyond their specified nominal voltage and current.

E. Warranty
1. LED fixtures complete including driver, must have a minimum 5 year manufacturer's warranty.

2.4 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Division 26 Section "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 (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two, 1/2-inch (13-mm) steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

D. Wires: Stainless Steel aircraft cable 1/16" minimum.

E. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.

F. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

2.5 SAFETY REQUIREMENTS FOR INDIVIDUAL LIGHTING FIXTURES

A. Fixtures located overhead shall have at least 1 redundant point of support. That is if one support fails the fixture shall not be capable of falling to the ground. Provide aircraft cable with nico press crimps for redundant support of fixtures with only 1 point of connection.

B. Fluorescent fixtures with lamps exposed shall have wire guards and clear tube guards to prevent the lamps or glass from falling.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.

B. Install all lighting fixtures in accordance with the manufacturer's instructions and recommendations.

C. Sequence lighting installation with other work to minimize possibility of damage and soiling during remainder of construction. Protect installed fixtures from dirt and debris upon completion of installation. Clean fingerprints and smudges from fixtures and lenses.

D. Install flush mounted fixtures properly to eliminate light leakage between fixture frame and finished surface.

E. Support for Lighting Fixtures in or on Grid-Type Suspended Ceilings: Use grid as a support element.
   1. Install a minimum of two ceiling support system rods or wires for each fixture. Locate not more than 6 inches (150 mm) from lighting fixture corners.
   2. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch (20-mm) metal channels spanning and secured to ceiling tees.
   3. Fixtures supported by suspended ceiling systems shall be securely fastened to the ceiling framing member by mechanical means, such as bolts, screws, or rivets. Ceiling framing members must be securely attached to each other and to the building structure as required by all applicable codes and standards. Use of integral clips is not permitted.

F. Suspended Lighting Fixture Support:
   1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
   2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
   3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
   4. Provide redundant support for all suspended lighting fixtures.
   5. Provide threaded swivel support for fixtures mounted on sloped ceilings.

G. Support surface mounted fixtures greater than 2 feet in length at a point in addition to the outlet box fixtures stud.

H. Provide equipment grounding connections for indoor lighting fixtures.

I. Adjust aimable lighting fixtures to provide required light intensities.

J. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

K. Install clear tube guards on all exposed lamp fluorescent fixtures.

3.2 CONNECTIONS

A. Ground equipment.
   1. 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 and UL 486B.

3.3 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

B. Inspect each installed fixture for damage. Replace damaged fixtures and components.

C. Advance Notice: Give dates and times for field tests.

D. Provide instruments to make and record test results.

E. Tests: As follows:
   1. Verify normal operation of each fixture after installation.
   2. Emergency Lighting: Interrupt electrical supply to demonstrate proper operation.
   3. Verify normal transfer to battery source and retransfer to normal.
   4. Report results in writing.

F. Malfunctioning Fixtures and Components: Replace or repair, then retest. Repeat procedure until units operate properly.

G. Corroded Fixtures: Replace during warranty

3.4 CLEANING

A. Clean fixtures internally and externally after installation. Use methods and materials recommended by manufacturer.

3.5 TRAINING

A. Instruct Owner on testing and maintenance responsibilities required by NFPA 101 related to normal egress lighting, emergency battery units and exit fixtures.

B. END OF SECTION 26 51 00

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SECTION 26 61 00 - 400-HERTZ FREQUENCY CONVERTERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and the following project Specification Sections apply to this Section.

1. Section 26 00 00 series of specifications.

B. The requirements in this section of the specification are in addition to all requirements in sections referenced above.

1.02 SUMMARY: This Section specifies all 60-Hz to 400-Hz solid-state point of use frequency converters and accessories.

1.03 DESCRIPTION

A. The Contractor shall furnish and install 60-Hz to 400-Hz frequency converters as indicated in schedule on drawings, and in this Section.

1. The frequency converters shall be mounted under the aircraft end of each passenger boarding bridge.

2. The Contractor shall supply aircraft cables with aircraft plugs and aircraft cable hoists.

1.04 REFERENCES AND REGULATORY REQUIREMENTS

A. Applicable Standards:

1. Military Standards:

a. MIL-STD-461 Electromagnetic Interference Characteristics Requirements for Equipment.
b. MIL-STD-704E- Aircraft Electric Power Characteristics.

2. Institute of Electrical and Electronic Engineers (IEEE):

a. IEEE C62.41 - (1991) Surge Voltages in Low Voltage AC Power Circuits.
b. IEEE C62.45-1995- Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits.
c. IEEE 127 - Aerospace Equipment and Frequency Rating.
d. IEEE 519 - Harmonic Control and Reactive Compensation of Static Power Converters.

3. American National Standards Institute (ANSI):

a. ANSI C2 -National Electrical Safety Code.
b. ANSI C84.1 - Voltage Ratings for Electrical Power Systems and Equipment.

4. National Electrical Manufacturers Association (NEMA):

a. ICS-1 - General Standards for Industrial Control Devices and Systems.
b. ICS-6 - Enclosures for Industrial Control Devices and Systems.
c. ST 20 - Dry Type Transformers for General Applications.

5. National Fire Protection Association (NFPA):

a. NFPA-70- National Electric Code (NEC).

6. Underwriters Laboratory (UL):

a. UL 1012 - Power Units Other Than Class 2.

7. Air Transport Association of America (ATA): Comply with all applicable ATA Guidelines.

1.05 SUBMITTALS:

A. See section 3323 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
B. Product Data: Submit manufacturer's technical product data, including specifications and installation instructions, for each size of solid state frequency converter specified. Include data substantiating that materials comply with requirements.
C. Test Reports: Submit all factory and field test reports to the Engineer within 14 days of actual test.
D. Harmonic Distortion Test:

1. Submit manufacturer factory harmonic distortion testing procedures and test data with contract bid documents. Submit independent laboratory testing procedures and test data within eight (8) weeks of Notice to Proceed.

E. Certification:

1. Provide certification from each manufacturer or a third party that frequency converter is capable of supplying the aircraft load from Boeing, McDonnell Douglas and Airbus.
2. Provide certification from Underwriter's Laboratories or another Nationally Recognized Testing Laboratory that converter complies with UL 1012.

F. Solid State Frequency Converter Details. Submit the following:

1. Drawing of unit to scale with dimensions and weights.
2. Operating details, schematic layout, diagrams, sufficient to completely describe converter.
3. Wiring diagrams with all terminal points and conductors clearly identified.
4. Spare parts list.
5. List of special tools required, if any.

G. Operation and Maintenance Manuals for each unit provided.

H. Warranty: The products modified or furnished and installed under this Section shall be warranted against defective parts and workmanship for a period of not less than two (2) years from the date of final acceptance testing at the project site. Warranty shall include all parts, labor, and travel time and expenses necessary for repairs or defective units.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with the following requirements:

1. 400 Hz frequency converter shall be a product of a manufacturer regularly engaged in the engineering and fabrication of 400 Hz, solid state, point of use 60 Hz to 400 Hz frequency converters.

2. The manufacturer shall provide evidence of at least 5 years of satisfactory experience in the design and fabrication of point of use passenger boarding bridge mounted solid state frequency converters serving commercial aircraft loads.

B. Manufacturer shall be one of the following:

1. FMC/Jetway Systems.
2. FCX Systems, Inc.
3. Inet Airport Systems.
4. Hobart Airport Systems.

2.02 60-HZ TO 400-HZ SOLID STATE FREQUENCY CONVERTERS

A. General: Provide 400 Hertz output solid state frequency converters complete with all components, accessories, auxiliary equipment and associated equipment as specified. Provide two (2) different sized units, nominal 90 kVA and 180 kVA continuous output as shown and scheduled on the contract drawings. All 180 kVA units shall have dual aircraft cable and plug outputs; 90-kVA units shall have a single output cable and plug. 400 Hertz units shall include internal "spike protection" for voltage spikes.

B. The frequency converter shall be certified by Underwriters Laboratories or another

Nationally Recognized Testing Laboratory to conform to UL 1012.

C. Operational Life: The frequency converter shall have a 20-year life when operated within these specifications at any load from no-load to full load.

D. Ambient Conditions: The solid state frequency converters shall operate under any combination of the following ambient conditions without any mechanical or electrical damage, degradation of operating characteristics, or loss of normal life expectancy:

1. Operating Ambient Temperature: -40 degrees C to 50 degrees C.
2. Non-operating Temperature: -40 degrees C to 70 degrees C.
3. Relative Humidity: 10 percent to 100 percent non-condensing for all temperatures within the temperature range.
4. Operating Altitude: 0-6600 feet above sea level without derating.
5. Non-operating Altitude: 40,000 feet above sea level.
6. Wind: 90 mph steady, 125 mph gusts.
7. Precipitation: Unit maybe exposed to wind driven rain.
8. Lightning: Tampa is a lightning prone environment. Units must tolerate routine power disturbances associated with lightning with component destruction.

E. Input Power:

1. Voltage: Nominal voltage, 480 volts, 3 phase, 3 wire. Actual voltage 432 volts to 528 volts.
2. Input Power Factor: Unit shall be rated at 0.9 power factor at 480 volts from 50% of full load to full load.
3. Frequency: Nominal frequency 60 hertz. Actual frequency 59 hertz to 61 hertz.
4. Inrush Current: Shall not exceed 100 percent of rated full load current and shall be equipped with a fully automatic soft start circuit.
5. Protection: The frequency converter shall automatically shut down if any of the following input power conditions exist:

    a. Over current
    b. Thermal Overload
    c. Phase Loss
    d. Phases Out of Sequence
    e. Over/Under Voltage

6. Harmonic Distortion: The current harmonic distortion reflected back on the input power line with the frequency converter operating at 50 percent of full load shall not exceed 5 percent maximum and when operating at full load shall not exceed 6 percent maximum. The voltage harmonic distortion shall not exceed 5 percent with the frequency converter operating between 50 percent and full load. The units shall be tested (reference: IEEE 519) in accordance with Paragraph 3.03, A. of this Section.
7. Utility Provided Power: Units shall be designed and constructed to operate on the standard power provided by the utility company. Orlando is a lightning

prone environment and units must be internally protected from input power disturbances. Owner shall be required to enhance (condition) the power system in any way to accommodate the units.

F. Output Power:

1. Power Rating: Nominal ratings of units are 90 kVA and 180 kVA at 0.8 lagging power factor.
2. Voltage: Nominal voltage 200Y/115 volt, 3 phase, 4 wire, wye-connected. Actual single phase voltage 112.0 volts to 118.0 volts, measured at the aircraft plug.
3. Phase Rotation: Shall be ABC left to right, front to hack, top to bottom.
4. Frequency: Shall be 400 Hertz+ 0.05 percent at any load.
5. Overload Capacity: After reaching stabilized temperature at full load, the frequency converter shall be capable of carrying the following overloads:

    a. 115 percent for 1 hour, 150 percent for 5 minutes, 200 percent for 10 seconds.

6. Overload/Short Circuit: The frequency converter shall be isolated (solid state switching or output contactors) from the aircraft load by overload/short circuit protection specifically rated for 400 Hz operation. The converter shall be equipped with an instantaneous electronic overload alarm circuit designed to operate at not less than 250 percent of rated capacity.
7. Over/Under voltage Protection: An over/under voltage output protection shall be provided to automatically isolate the converter output power from the aircraft when it is exceeding limits of the MIL-STD-704D.
8. Efficiency: The efficiency of the frequency converter shall be 89 percent or better at 50 percent full load and rated power factor. The efficiency shall be 95 percent or better at full load and rated power factor.
9. Voltage Phase Balance: With frequency changer operating at any load within the rated kVA, the maximum difference in all line-to-neutral voltages shall not exceed 2 percent for balanced loads and within 2.5 percent for 25 percent unbalanced loads.
10. Phase Voltage Displacement: Shall be 120 +/-2.0 degrees for balanced loads, 120 +/-2.5 degrees for 33 percent unbalanced loads.
11. Voltage Regulation: Voltage regulation from no-load to rated load and from rated load to no-load shall be not more than 1 percent of rated voltage and shall be maintained with input line voltage variations of +/-10 percent.
12. Voltage Modulation: Voltage modulation shall not exceed 1.0 percent at any load from 0 to 100 percent.
13. Voltage Recovery: Transient voltage recovery shall meet or exceed MIL-STD-704D (not more than 200 msec for 100 percent load change).
14. Harmonic Distortion: The maximum total harmonic voltage distortion at any load shall not exceed 3.0 percent when measured line-to-line or line-to-neutral. The maximum single harmonic shall not exceed 1.5 percent of the fundamental voltage at steady state.
15. Frequency Regulation: Shall be 400Hz +/-0.05 percent and shall not be

affected by load.

16. Crest Factor: Shall be 1.414 +/-0.05.
17. Voltage Trim Adjustment: The output voltage trim adjustment shall be +/-15 percent of nominal output span.
18. Line Drop Compensation: Shall be 0 to 5 percent of voltage span and shall be adjustable.

G. Frequency Converter Control: The solid state frequency converter shall have the following control functions and equipment:

1. Momentary start stop push buttons mounted on the converter front panel.

    a. Power On: The remote "power on" push button shall make the 400 Hz power available to the aircraft plug. This power shall be available for only four (4) seconds unless the aircraft plug is connected to the aircraft and the 28 VDC safety circuit is complete. Provide separate Power On push buttons and contactors for each cable.
    b. Power Off: The remote "power off' push button shall tum power off to the aircraft plug. The 400 Hz power shall be turned off instantly if the aircraft plug is removed from the aircraft receptacles by breaking the 28 VDC safety circuit. Provide separate Power Off push buttons and contactors for each cable.
    c. Aircraft Interlock Circuit: The "E" and "F" interlock circuit shall instantaneously isolate the converter output in the absence of a 28 VDC signal from the aircraft. The "E" and "F" interlock circuit indicator shall be provided to display the status of "E" and "F" interlock.
    d. Bridge Control Interlock: The converter unit and the cable hoist shall be interlocked with the bridge control circuit so that the bridge cannot be moved away from the aircraft while frequency converter is plugged to the aircraft or the load cable is not fully stowed.

2. Isolated, fused 28 volt DC power supply for indication and control devices.
3. Automatic Reset: The reset function shall be accomplished by operation of the "power off" push button.
4. Aircraft Bypass Switch: For testing purposes, an aircraft bypass switch shall be provided inside the converter to allow the unit to deliver the output power without the 28 VDC power from the aircraft. An indicator shall be provided to indicate that the bypass circuit has been selected.
5. Output Voltage Adjust: A voltage adjusting potentiometer located on the back of the primary access panel shall be provided to permit adjustment of the converter output voltage.
6. Alarm Indicator Reset: A reset push button shall be provided to reset all alarm signals and indications on the inside of the front cover of the converter.
7. Line Drop Compensation: The voltage regulation means shall include an electronic line drop compensation circuit for maintaining the voltage regulation at a single point distance from the converter and shall be adjustable at full load to at least 5 percent of rated output voltage.

8. Over Temperature Protection: The converter shall automatically shutdown before the inside temperature reaches the maximum temperature rating of any component inside.

H. Meters and Indicators:

1. General: Provide the metering and switching specified by either individual meters or switches or by a combination key pad and LCD/LED readout.
2. Ammeter: The output ammeter shall have a single 0 to 400 A RMS scale for 90 kVA units and 0 to 800 A RMS scale for 180 kVA units in order to read output phase currents. The ammeter shall be calibrated for 400 Hz and shall have an accuracy of ±2 percent full scale.
3. Ammeter Selector Switch: A four-position selector switch shall be provided to monitor output phase line-to-neutral currents "A", "B", "C", with "OFF" position.
4. Frequency Meter: Meter shall have an accuracy of ±1 percent.
5. Voltmeter: The output voltmeter shall have a single 0 to 150 VAC scale in order to read line-to-neutral voltages. The voltmeter shall be calibrated for 400 Hz and shall have an accuracy of ±2 percent full scale.
6. Voltmeter Selector Switch: Four-position selector switch with "OFF" position shall be provided to monitor line-to-neutral voltages.
7. Run Time Meter: Non-resetable hour meter with range from 0-99,999 hours.
8. Status Indicators: Provide the following status indicator lights in the colors indicated:

    a. Input Power On – Amber
    b. Converter On – Green
    c. Module Fault –Red
    d. Input Voltage Fault – Red
    e. Output Voltage Fault- Red

9. Lamp Test: The lamp tests push button, when depressed, shall test all door-mounted light indicators and digital display segments.
10. Diagnostic System: The solid state frequency converter shall be equipped with a complete diagnostic system including alarm message system. All of the converter's vital functions shall be continuously monitored by the diagnostic system.
11. System Indicators: The frequency converter shall be equipped with a light emitting diode (LED) status package to provide monitoring of the proper system modules operation.
12. Voltage Adjustment Device: Provide a device, located on the inside of the converter front panel, which can be used to adjust the output voltage while viewing the voltmeter.
13. Status Contacts: Each converter shall be provided with dry contacts to indicate the following:

    a. Run
    b. Summary Fault

c. Input current

I. Physical Characteristics:

1. The unit shall be so designed and constructed that parts will not work loose in service. It shall be designed to withstand the strains, jars, vibration and other conditions incident to shipping, storage, installation and service.
2. The physical size and weight of the unit shall be suitable to provide integrated loading bridge operation as indicated on the drawings and in specifications.
3. The converter section of the frequency changer shall be modularized solid state components. The standard construction shall have no moving parts and shall require minimum service or maintenance. All cards shall be equipped with vibration resistant latching mechanism.
4. Components shall be cooled by convection, natural draft cooling, use of heat sinks, or by forced draft cooling provide the overall efficiency of the unit is not reduced by the use of fans. All fans shall be equipped with permanent, washable aluminum mesh air filters.
5. The electronic compartments shall be equipped with environmentally safe vapor type corrosion inhibitors.
6. The frequency converter shall be equipped with approved weather tight fittings for all wiring that passes through the weather tight compartments to preclude the entrance of moisture and dust into electronic compartments.
7. All printed circuit boards shall be conformably coated to protect against the effects of humidity and corrosion. All integrated circuits shall be installed with soldered joints.
8. Provide digital panel meter in easily accessible location along with edge mounted LED indicators on circuit boards, allowing operator to check unit without opening it.
9. The frequency converter shall be so constructed that adjustments and repairs can be easily made by maintenance personnel.
10. All major components and sub-assemblies shall be stenciled or labeled with identification number or letter code on or near the device. The code shall be readily visible when servicing the frequency converter.
11. The cabinet enclosure shall be NEMA 3R. The cabinet shall be mounted in such manner that no damage will occur as a result of transportation. The complete frequency changer shall be designed for lifting and transporting by forklift. Means shall be provided for easy access to all components and sub-assemblies.
12. A door interlock switch shall be provided to shut down the unit when the enclosure door is opened and suitable warning labels or covers shall be provided where internal voltages decay slowly after shut down. There shall be a means to test the unit with the door open for maintenance purposes.
13. The control panel shall be an integral part of the converter cabinet. Provision shall be included for remote controls to operate the frequency converter from remote position. Remote control shall perform the following functions:

    a. Cable 1 Power On.
    b. Cable 1 Power Off.

c. Cable 2 Power On.
d. Cable 2 Power Off.
e. Cable hoist 1 up.
f. Cable hoist 2 up.
g. Cable hoist 1 down.
h. Cable hoist 2 down.

Provisions shall include furnishing and installing the remote control unit and all cable and conduit required. All cable on the boarding bridge shall be installed in galvanized rigid steel conduit. Prime and paint (2 coats Alkyd) conduit to match color of passenger boarding bridge. The remote control unit shall be stainless steel NEMA3R. The remote control shall be mounted on the lift column.

14. Steel surfaces shall be zinc coated (hot galvanized) and then finished with a tough 2-part polyurethane top coat with a heavy texture surface to match color of passenger loading bridge.
15. Aluminum surfaces shall be anodized or coated with manufacturer's standard coating.
16. Color of exposed surfaces of frequency converters installed on passenger boarding bridges shall match boarding bridge color.
17. The converter and associated parts to meet the harmonic voltage and current criteria specified herein shall be enclosed in a single enclosure. No external parts or equipment will be allowed.
18. Converter unit shall be capable of being padlocked closed.

J. No-Break Power Transfer (NBPT) Capability: The frequency converter shall be capable of withstanding reverse power flow caused by NBPT operations of all known aircraft without damage to any components in the unit or to the aircraft auxiliary power unit (APU).

K. Workmanship: The frequency converter, including all parts and accessories, shall be fabricated and finished in a workmanlike manner. Particular attention shall be given to freedom from defects, burrs, sharp edges, quality of soldering, welding, brazing, painting, wiring, riveting, alignment of parts and tightness of assembly screws, bolts, etc.

L. The converter shall have protection against surges on the input and output capable of protecting the converter internal equipment, including controls, in category C locations as described in and tested in accordance with IEEE C62.41 and shall allow the converter to operate with no alarms within the specified tolerance. The protection shall be located internal to the converter.

2.03 AIRCRAFT LOAD CABLE ASSEMBLES

A. The aircraft output cable assemblies shall be designed to carry a nominal 115/200 volt, 3 phase, 4 wire, and 400 Hz supply from the frequency converter to the aircraft.

B. Each cable assembly shall consist of conductors per A, B, and C phases and 1 center neutral conductor.

1. There shall be one or more No. 12 (or equivalent) control leads connected to a field-replaceable AN3430 plug with jumper installed between pins E and F.
2. All conductors shall be copper and consist of Class M stranding, extra flexible.
3. The cable shall be 60 foot in length and shall have a single, heavy duty, neoprene jacket eliminating the need for banding.
4. The cable assembly shall be easily removable for replacement or repair.
5. All cables shall be 60-feet in length.
6. Provide field-replaceable cable plug heads allowing the easy replacement of plug contacts and outer plug housing.

C. Each cable assembly shall be sized to handle 90 kVA.

2.04 ELECTRICALLY OPERATED 400-HZ CABLE HOIST:

A. The hoist system consisting of two cable hoists shall be permanently mounted on the aircraft side of the bridge and be encased in a protective housing. The housing· contains a motor, gear reducer, cable drum, and a limit switch which shuts the motor off when the wire cable supporting the 400-Hz cable is in the full retract position.

1. Cable: the system is equipped with sufficient length to keep the 60-foot aircraft cable above the pavement, 5/32-inch diameter steel wire rope tested in excess of 350 lbs. The cable attaches to a cable sling assembly which holds the 400-Hz cable with snap rings. A portion of the wire cable closest to the cable sling assembly has a heavy-duty circular disk affixed to it. As the cable is retracted when the cable drum turns, this disk makes contact with a four lead type limit switch which turns the motor off and applies the brake.

B. An electrically operated 400-Hz cable hoist and cable shall be provided for each 400-Hz converter output indicated on the drawings or in the specifications.
C. Power for the cable hoist shall be 480V, 3-phase, 60 Hz and shall be supplied in the converter box. Provide separate terminals and over current protection for the cable hoist power cables.
D. Alternative locations of the cable hoists shall be submitted to the Engineer for approval if the location of the cable hoists as indicated on the drawings is not possible.
E. Provide interlock with bridge that does not allow bridge travel until cable(s} are fully stowed. See Specification Section 14730 for additional requirements/interlocks with the bridge.
F. Cable retrieval system shall be painted to match the passenger boarding bridge. The aircraft output cable used with the cable retrievers shall have control push button within close proximity of the aircraft plug assembly. Provide limit switch for over-extension. The retrieval system shall be capable of rates of travel of up to 120 fpm.

PART 3 - EXECUTION

3.01 START-UP

A. The manufacturer of the units shall furnish a competent factory-based engineer to assist in placing the units in operation, field testing and instructing personnel in their proper use.
B. Inspection: Before starting equipment installation, Contractor shall examine and measure existing construction in the involved areas, report to the Owner all conditions that interfere with or prevent correct equipment installations and all conflicts between the drawings and actual conditions and shall not start installation where adverse conditions or conflicts occur without Owner's prior instructions.

3.02 INSTALLATION

A. Installation, initial start-up and testing shall be performed under the direction of the passenger boarding bridge manufacturer.
B. All welding required for converter installation shall be completed in the factory by the Passenger Boarding Bridge Manufacturer.
C. Contractor shall relocate all obstructions as required for converter mounting.
D. Installation: Contractor's mechanics shall assemble, install, connect, and adjust all materials and equipment in accordance with the approved submittals. Operating equipment shall be lubricated and serviced, and all made ready for operation. No equipment shall be installed in a damaged condition and any equipment which is scratched or damaged shall be replaced. Minor scratches and defects may be rectified at the discretion of the Owner. Provide wiring systems and related work to interconnect all equipment, and to connect equipment to distribution system.
E. Repair of Existing Construction: Contractor shall restore existing construction and improvements that are cut into, altered, or damaged due to the Contractor's operations to original conditions or to match the adjoining surfaces and finishes as directed and approved by the Owner, at the Contractor's expense.
F. No apron-mounted equipment shall be permitted.
G. Contractor shall be responsible for mounting and installation of frequency converters, cable hoists, controls, wiring and pantographs, and all related equipment on passenger boarding bridges in accordance with the drawings. Installation and loading shall conform to manufacturer's recommendations.

3.03 FACTORY TESTING

A. Harmonic Distortion: Provide independent laboratory test results of input harmonic currents and voltages for 90 kVA and 180 kVA typical (one unit each) frequency converters. The test shall be completed with a distortion analyzer within 5-feet of the frequency converter's input terminals with a maximum analyzer lead length of 3 feet. The test data shall include total harmonic distortion and amplitudes of individual harmonics in graphic representation for no-load, 25, 50, 75, and 100 percent load factors. Submit test procedure and test results from a certified independent laboratory within eight (8) weeks of Notice to Proceed. Provide manufacturer factory testing on each of the three sizes of frequency converters in

accordance with this section and submit testing procedures and test results with contract bid documents.

B. All frequency converters shall be load bank tested at power factor of 0.80 and 1.0 prior to shipping from the factory with test results submitted to the Engineer 20 days prior to shipping to the Work site.

1. Testing: One hour at 50 percent kW capacity and one hour at approximately 100 percent kW capacity.
2. Monitoring: At 15 minute intervals during testing monitor voltage, frequency and amperes.

C. The manufacturer shall surge protection test one unit of each rating and size converter to assure compliance with the specification. Apply input surges in accordance with IEEE C62.41, Category C and monitor output. Conduct a minimum of three consecutive successful tests on each unit listed. Confirm there is no interruption to 400 Hz output power, no alarms and voltage stays within specified regulation tolerances. Guidelines for testing methods may be obtained in IEEE C62.45 - 1992.

3.04 FIELD TESTING

A. Prior to acceptance of the installation, frequency converters shall be tested to show that they are free of defects and will be operated correctly.
B. The solid state frequency converters shall be subjected to load test through the use of portable load banks supplied for this purpose at the job site by the Contractor.
C. Load bank testing shall be done in the presence of the Engineer and Owner or his appointed representative only after all converters are permanently installed in accordance with the plans and specifications.

1. Testing: One hour at 50 percent kW capacity and one hour at approximately 100 percent kW capacity at power factor of 1.0.
2. Monitoring: At 15 minute intervals during testing monitor voltage, frequency and amperes at power factor of 1.0.

D. Contractor shall be responsible for supplying all material and labor for load bank testing of frequency converters on site.
E. The contractor shall demonstrate the following six (6) shut down features on all units to the Engineer and Construction Manager:

1. Removal of the plug connector from aircraft receptacle.
2. Sustained load exceeding 115 percent of rated power.
3. Over or under voltage.
4. Loss of phase or phase rotation reversal.
5. Loss of input power.
6. Loss or interruption of 28 volt DC monitoring voltage.

F. One unit of each of the three shall be selected by the Engineer for completion of the following field tests:

1. Input current and voltage harmonic distortion.
2. Output voltage harmonic distortion.
3. Output frequency from 0-100% loading.
4. Output voltage regulation.
5. Overload capacity.
6. Input power factor.
7. Converter unit efficiency.

The Contractor shall provide all material and labor necessary to conduct these tests including but not limited to load bank(s) and power monitoring equipment. The tests shall be conducted in the presence of the Engineer. The time of testing shall be coordinated with the Engineer. If the unit fails to meet the specification requirements for any of these parameters, it shall be replaced and all other units shall be tested at no additional cost to the Owner. All units not meeting the specification requirements shall be replaced at no additional cost to the Owner.

3.05 TRAINING

A. On-site training of eight (8) hours shall be provided to the Owner and their designated personnel in complete operation and maintenance of the units.

3.06 OPERATING AND MAINTENANCE MANUALS

A. Two manuals for each ground power unit shall be submitted prior to Final Acceptance. The manuals shall be complete with operational and repair parts data on all component devices.

3.07 SPARE PARTS

A. Provide three spare circuit board of each type.

PART 4 - METHOD OF MEASUREMENT

4.01 METHOD OF MEASUREMENT

A. 400Hz frequency converters will be paid on a per unit basis. Each unit shall be measured based on out put size and shall include all cables, hoists, connections, labor, materials, tools, etc. as required to get each unit operational.

PART 5 - BASIS OF PAYMENT

5.01 BASIS OF PAYMENT

A. Payment will be made on a per unit basis for each 400Hz frequency inverter.

Item 26 61 00 – 5.1	90 KVA 400Hz Inverter	Per unit
Item 26 61 00 – 5.2	180 KVA 400Hz Inverter	Per Unit

END OF SECTION 26 61 00