

DIVISION SIXTEEN

ELECTRICAL

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SECTION 16010

ELECTRICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.01 DESCRIPTION [ENGINEER MUST EDIT]

- A. It is the intent of this Specification that this Contractor furnish and install all material, labor, equipment, apparatus, tools, transportation, and other incidentals required to provide the following: electrical service(s); power distribution (both normal and stand-by emergency power); branch circuit wiring; low voltage wiring; wiring devices; grounding; lighting (both interior and exterior); lighting control systems; fire detection and alarm system; security intrusion system; door video access entry system; wireless master clock and program system; sound and intercommunications system and program system; classroom amplification systems; auxiliary sound reinforcement systems; auditorium sound reinforcement system; black box theater sound reinforcement system; gymnasium sound reinforcement systems; band, choral, and orchestra sound reinforcement systems; athletic fields sound reinforcement systems; dance and gymnastics sound reinforcement systems; telecommunications system; cable television/broadband distribution system; and multi-media systems as shown on Drawings and as described in these Specifications.

1.02 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.
- B. Provisions of this Section apply to each and every Section of this Division.

1.03 SCOPE

- A. It is the intention of these Specifications and the Contract Drawings to call for finished work, tested and ready for operation.
- B. Any apparatus, appliances, materials, or work not indicated but mentioned in these Specifications, or vice versa, or any incidental accessories necessary to make the work complete and perfect in all respects and ready for operation, even if not particularly specified, shall be furnished, delivered, and installed by this Contractor at no additional expense to the Owner.
- C. Minor details not usually shown or specified, but necessary for the proper installation and operation shall be included the same as if herein specified or shown on the Drawings.

- D. With submission of bid, this Contractor shall give written notice to the Architect/Engineer of any materials or apparatus believed: inadequate or unsuitable; in violation of federal, state, and local laws, codes, and ordinances, including Fairfax County's electrical inspection rules or regulations; and any necessary items of the work which have been omitted. In the absence of such written notice, it shall be mutually agreed that the Contractor has included the cost of all required items in the proposal and that the Contractor shall be responsible for the approved satisfactory functioning of the entire electrical system and low voltage electrical systems at no additional expense to the Owner.

1.04 APPLICABLE SPECIFICATIONS, CODES, STANDARDS, AND PERMITS

- A. Materials, equipment, and installation shall be in accordance with the requirements of the latest adopted editions of the National Electrical Code (NEC), the Virginia Uniform Statewide Building Code, and these Specifications.
- B. Unless otherwise specified herein the work and material shall conform to the applicable requirements of the (latest editions or currently adopted) following codes, standards, and regulations:
1. American National Standards Institute (ANSI)
 2. Americans with Disabilities Act Code of Federal Regulation (ADA)
 3. Canadian Standards Association (CSA)
 4. Electronic Industries Association / Telecommunications Industry Association (EIA/TIA)
 5. Fairfax County Fire Marshal's Office
 6. Illuminating Engineering Society (IES)
 7. International Building Code (IBC)
 8. International Code Council (ICC)
 9. National Electrical Code (NEC)
 10. National Electrical Contractor's Association (NECA)
 11. National Electrical Manufacturer's Association (NEMA)
 12. National Fire Protection Association (NFPA)
 13. Occupational Safety and Health Association (OSHA)

14. Underwriters Laboratories, Inc. (UL)
 15. Virginia Occupational Safety and Health Program (VOSH)
 16. Virginia Uniform Statewide Building Code (VUSBC)
- C. All electrical materials and equipment shall be new, listed by UL, and bear the UL label. This applies to all equipment for which UL standards have been established and label service is regularly furnished.
- D. Equipment not UL (or other testing agencies recognized by VUSBC) labeled and equipment assembled in the field using UL components and not UL labeled as an "assembly", for which standards have not been promulgated, shall be accepted upon certification by A.B.M. ELECTRICAL POWER SOLUTIONS (MET ELECTRICAL TESTING), 4390 Parliament Place, Suite Q, Lanham, MD 20706 telephone: 240-487-1900 or ELECTRICAL TESTING CORPORATION, 1701 Edmondson Avenue, #201, Baltimore, Maryland, 21228, Telephone 410-526-4700. Cost of such certification shall be included in the base bid and in each quoted cost for alternates and proposed change orders. Electrical equipment that requires certification shall be tested by this Contractor at no additional cost to the Owner.
- E. Workmanship shall conform to the "Standard of Installation" published by the NECA. This Contractor shall provide a minimum of one (1) valid licensed journeyman electrician (Foreman) to be present at all times while work is being performed. License shall be issued by the Commonwealth of Virginia. Such certification shall be provided to the Architect/Engineer upon request.
- F. This Contractor shall: give all necessary notices; obtain all permits (including a low voltage wiring permit); pay all government taxes, fees, and other costs including, but not limited to the Fairfax County Fire Marshal's Office shop drawing review fees; file all necessary plans; prepare all documents; and obtain required certificates of inspection for work and deliver same to the Architect/Engineer before any request for acceptance and final payment for the work.
- G. This Contractor shall be responsible for purchasing equipment and appliances that bear the label of an agency as approved by the Fairfax County Department of Public Works and Environmental Services (DPWES). It shall be the responsibility of the Contractor to pay for any label testing of equipment or appliances that are installed without the label of a DPWES approved agency.

1.05 REVIEWS AND SHOP DRAWINGS

- A. The materials, workmanship, design, and arrangement of all work installed under this contract shall be subject to the review of the Architect/Engineer and Owner.

- B. Where any specified materials, process, or method of construction or manufactured article is specified by name, or by reference to the catalog number of a manufacturer, the specifications are to be used as a guide and are not intended to take precedence over the basic duty and performance specified or noted on the Drawings.
- C. In all cases, the Contractor shall verify the duty and available electric characteristics with the specific characteristics of the equipment offered for review.
- D. All component parts of each item of equipment or device shall bear the manufacturer's name plate giving name of manufacturer, description, size, type, serial or model number, electrical characteristics, etc., in order to facilitate maintenance or replacement. The nameplate of a Contractor will not be acceptable.
- E. If materials or equipment are installed before they have been reviewed by the Architect/Engineer, the Contractor shall be liable for their removal and replacement at no additional expense to the Owner, if in the opinion of the Architect/ Engineer, material or equipment does not meet the intent of the Drawings and Specifications.
- F. This Contractor shall call to the attention of the Architect/Engineer by letter or on shop drawing submittals, any instance in which the shop drawings differ from the requirements of the Drawings and Specifications.
- G. Data and shop drawings shall be coordinated and included in a single submission in a bound format. Multiple submissions are not acceptable except where prior approval has been obtained from the Architect/Engineer. In such cases, a list of data to be submitted later shall be included with the first submission. No delays in construction occasioned by the Contractor's failure to submit material in accordance with the approval schedule will be excused.
- H. Catalogs, pamphlets, or other documents submitted to describe items on which review is being requested shall be specific and identifications in catalog, pamphlets, etc., of items submitted shall be clearly made in a contrasting ink. Data of a general nature shall not be acceptable.
- I. Submitted samples, drawings, specifications, catalogs, and the like shall be properly labeled and shall indicate: specified service for which the material or equipment is to be used; Section and Article number of Specifications governing; contractor's name; and name of the job.
- J. Data and shop drawings shall be identified in accordance with SECTION 01340. In addition, shop drawings shall be identified by the name of the item, system and the applicable Specification number. This Contractor shall submit the

following components/systems described herein and as specified in other Sections of this Specification. **(Engineers must edit.)**

1. Athletic fields sound reinforcement systems.
2. Auditorium lighting controls and performance lighting
3. Auditorium sound reinforcement system
4. Auxiliary sound reinforcement systems
5. Band, orchestra, and choral rooms sound reinforcement systems
6. Black box theater performance lighting controls and lighting.
7. Black box theater sound reinforcement system.
8. Boxes including device, junction, outlet, and pull types
9. Cable hook (J-hook) support systems
10. Cable television/broadband distribution system
11. Cable tray systems
12. CCTV surveillance system
13. Classroom amplifications systems.
14. Conduit and associated fittings
15. Dance and gymnastics sound reinforcement systems.
16. Disconnect /safety switches.
17. Distribution switchboard(s)
18. Door access video entry system
19. Dry type transformers.
20. Emergency/standby engine generator set, remote annunciator panel, and automatic transfer switch(es)
21. Enclosed circuit breakers.
22. Feeder type busway.

23. Fire detection and alarm system
24. Fuses and spare fuse cabinet
25. Generator quick connect switchboard
26. Grounding system, including rods, connectors, and welds
27. Gymnasium sound reinforcement system
28. Lighting control systems
29. Lighting fixtures including lamps, ballasts, and poles
30. Lighting occupancy sensors
31. Middle school stage performance lighting controls and lighting
32. Multi-media systems
33. Motor control centers
34. Panelboards, including distribution and branch circuit
35. Rooftop conduit support system
36. School zone warning signals
37. Security intrusion system
38. Sound and intercommunications and program system
39. Sports field lighting systems
40. Surface metal raceways and fittings
41. Surge protective devices
42. Telecommunications system including outlets, equipment racks, and cables
43. Television studio performance lighting controls and lighting
44. Track busway system
45. Wireless master clock system

46. Wires, cables, and connectors
47. Wiring devices
- K. No item or system listed in the schedule above shall be delivered to the site or installed until successful completion of the review. After review of the proposed materials has been successfully completed, no substitution shall be permitted except where approved by the Architect/Engineer in writing. Should the Contractor fail to comply with the requirements of this paragraph, the Owner reserves the right to select any and all items and systems required by this Specification. Materials so selected shall be used in the work at no additional expense to the Owner.
- L. The successful review rendered on shop drawings shall not be considered as a guarantee of building conditions. Where shop drawings have been successfully reviewed, said review does not mean that the drawings have been checked in detail and does not in any way relieve the Contractor from the responsibility, nor the necessity of furnishing the material or performing the work as required by the Drawings and Specifications.
- M. Failure to submit shop drawings that meet the requirements of the Drawings and Specifications in ample time for review shall not entitle the Contractor to an extension of contract time, and no claim for extension by reason of such default shall be allowed.
- N. All equipment and materials to be furnished under this Division of these Specifications shall be as manufactured by the manufacturer(s) listed on the Drawings or herein specified. All requests by any bidder to provide equipment and/or material manufactured by a manufacturer not listed on the Drawings or specified herein, including equipment identified as "OR EQUAL" to a listed manufacturer, must be submitted to the Architect/Engineer not less than ten (10) calendar days prior to the bid date. Any and all replies to said requests will be made in the form of an addendum which shall be made available to all bidders. Any equipment and/or materials installed by this Contractor not manufactured by a specified manufacturer or covered under an addendum shall be removed by this Contractor and the proper equipment or materials installed at no additional expense or delay to the Owner.
- O. This Contractor shall furnish to the Owner, after approval of shop drawings, two (2) wiring sample boards. Each sample board shall be made of minimum space $\frac{1}{2}$ " thick plywood and sized as required to accommodate all wiring samples. Each board shall be painted white and shall have samples of fire alarm, all sound reinforcement systems (divided by system), multi-media, security, CATV, door access video entry, and telecommunications wiring. Each wiring sample shall be a minimum of 6 inches long with the manufacturer and model number clearly visible. Each wiring sample shall be properly labeled for its intended purpose using a labeling machine.

1.06 EQUIPMENT DEVIATIONS

- A. Where this Contractor proposes to use, and/or uses, an item of equipment other than that specified or detailed on the Drawings, which requires any redesign of any other part of the electrical, mechanical, or architectural layout, all such redesign and all new drawings and detailing required shall be prepared by this Contractor at no additional expense to the Owner and shall be reviewed by the Architect/Engineer.
- B. Where such approved deviation requires a different quantity and arrangement of duct work, piping, wiring, conduit, and equipment, this Contractor shall furnish and install any such duct work, piping, structural supports, insulation, controllers, motors, starters, electrical wiring and conduit, and any other additional equipment required by the system at no additional expense to the Owner.

1.07 QUALIFICATIONS FOR BIDDERS

- A. This Contractor shall examine drawings and Specifications relating to the work of all trades and become fully informed as to the extent and character of work required and its relation to all other work in the project prior to submission of bid or prior to the start of any construction.
- B. Before submitting bid, this Contractor is encouraged to visit the site and examine all adjoining existing buildings, equipment, and space conditions including areas above accessible ceilings on which his work is in any way dependent, for the best workmanship and operation according to the intent of the Specifications and Drawings. This Contractor shall verify dimensions and become fully informed as to the nature and scope of the proposed work and also the conditions under which it is to be conducted. This Contractor shall report to the Architect/Engineer any conditions which, in their estimation, might preclude them from installing the equipment and work in the manner as intended and noted on the Drawings and in this Specification. Failure to take the above precaution shall in no way relieve this Contractor from his obligation to provide the material and work as indicated and as specified at no additional expense to the Owner within the stipulated completion time period.
- C. No consideration or allowance shall be granted for failure to visit the site, or for any alleged misunderstanding of materials to be furnished, or work to be done, it being agreed that tender of proposal carried with it agreement to items and conditions referred to herein or indicated in the Drawings.

1.08 TEMPORARY FACILITIES:

- A. Temporary facilities shall be as specified under SECTION 01510 TEMPORARY UTILITIES. Requirements therein are hereby made a part of this Section as if

fully specified herein.

- B. Contractor shall coordinate with the construction phasing of the building in order for this contractor to provide power and systems cabling and devices for the temporary relocation of the existing administrative offices, media center and other essential school operational areas as directed by the Owner.

1.09 DRAWINGS

- A. The Drawings are diagrammatic and indicate the general arrangement of systems and work included in the Contract. Do not scale the drawings. Consult the Drawings for the exact location of fixtures and equipment. Where same are not definitely located, this Contractor shall obtain this information from the Architect/Engineer.
- B. This Contractor shall follow the Drawings in laying out work and check the Drawings of other trades to verify spaces in which work is to be installed. This Contractor shall maintain maximum headroom and space conditions at all points. Where headroom or space conditions appear inadequate, this Contractor shall notify the Architect/Engineer before proceeding.
- C. This Contractor shall call to the attention of the Architect/Engineer of any conflicting information in the Contract Drawings and/or Specifications, by letter or Request for Information (RFI) process. Contractor shall not proceed in error. Conflicts must be resolved.
- D. If directed by the Architect/Engineer, this Contractor shall, at no additional expense to the Owner, make reasonable modifications in the layout as needed to prevent conflict with other trades for proper execution.
- E. When failure by this Contractor to comply with the work set forth in the above paragraphs results in a conflict, the work shall be modified by this Contractor as directed by the Architect/Engineer at no additional expense to the Owner.

1.10 CONTRACTOR'S WARRANTY

- A. This Contractor shall warrant the workmanship, materials, and equipment against defects and/or non-operation as described in SECTION 01740 WARRANTIES AND BONDS.

1.11 COOPERATION WITH OTHER TRADES

- A. This Contractor shall give full cooperation to other trades and shall furnish in writing to the Architect/Engineer any information necessary to permit the work of all trades to be installed satisfactorily with the least possible interference or delay.

- B. Where the work of this Contractor will be installed in close proximity to work of other trades, or where there is evidence that work shall interfere with the work of other trades, this Contractor shall assist in working out space conditions to make a satisfactory adjustment. This Contractor shall prepare composite working drawings at a scale not less than 1/4 inch equals 1'-0", clearly showing how the work is to be installed in relation to the work of the other trades. If this Contractor installs the work before coordinating with other trades or as to cause any interference with work of other trades, this Contractor shall make necessary changes to the work to correct the condition at no additional expense to the Owner.
- C. This Contractor shall furnish to other trades, all necessary templates, patterns, setting plans, and shop details for the proper installation of the work and for the purpose of coordinating adjacent work.

PART 2 - PRODUCTS

2.01 STANDARD PRODUCTS

- A. Unless otherwise shown on the Drawings or herein specified, each item of equipment furnished by this Contractor shall be essentially the standard product of the manufacturer. Where two (2) or more equipment items of the same kind or class or equipment are required, they shall be the product of a single manufacturer.
- B. For equipment consisting of an assembly of multiple components, such multiple components do not have to be the products of a single manufacturer.

2.02 PERFORMANCE DATA

- A. All performance data specified herein shall be considered actual performance of equipment as installed. If installation details are such that actual operating conditions unfavorably affect performance as compared to conditions under which the equipment was rated, suitable allowance shall be made by this Contractor.

2.03 QUIET OPERATION

- A. All equipment, including the emergency engine generator set, shall operate under all conditions of load without transmission of sound and/or vibration which is found to be objectionable in the opinion of the Architect/Engineer. In case of sound or vibration noticeable outside of the room or space in which it is installed, or annoyingly noticeable inside its' own room or space, it shall be considered objectionable. Sound or vibration eliminators as recommended to eliminate any objectionable sound or vibration shall be furnished and installed by this

Contractor if deemed necessary by the Architect/Engineer.

2.04 ELECTRICAL WORK

- A. All electrical motors for plumbing and mechanical equipment shall be furnished and installed under Division 15.
- B. All starters and phase failure relays required for equipment shall be furnished under Division 15, and shall be installed and wired under this Division of these Specifications.
- C. All other electrical devices such as variable frequency drives (VFD), pushbutton stations, selector switches, flow switches, pilot lights, thermostats, etc., for the control or operation of mechanical and plumbing equipment shall be furnished and installed under Division 15. These items shall comply with all Sections of this Division of these Specifications.
- D. In all cases where VFDs or starters are actuated by automatic controls or other devices specified, all necessary components to actuate VFDs or starters shall be furnished and installed under Division 15.
- E. Wiring for automatic temperature control and boiler emergency shut-off shall be furnished and installed under Division 15. All other line voltage control wiring, including interlock wiring for equipment, shall be furnished and installed under this Division unless otherwise noted.
- F. Power supply wiring for all equipment shall be furnished and installed under this Division of these Specifications.
- G. This Contractor shall coordinate with Division 15 for wiring of approved equipment, and shall coordinate specified control functions.
- H. This Contractor shall install all starters furnished under Division 15, and provide all wiring from the power source, through the starter, to the motor. Starters shall not be located above ceilings or other concealed locations. If locations are not shown on the Drawings, this Contractor shall locate starters in utilitarian locations such as electrical rooms, janitor closets, etc., as approved by the Architect/Engineer.
- I. This Contractor shall provide all power wiring for VFDs from the power source, through the VFD, to the motor.
- J. This Contractor shall make final power connections to all items of equipment and electrical heat furnished under Division 15.

2.05 PLATES AND SLEEVES

- A. All electrical system conduit shall have sleeves for passing through slabs except concrete slabs in contact with grade. All conduit 1-1/2 inch and larger shall have sleeves where the conduit passes through masonry, concrete, tile, and gypsum wall construction. Conduit passing through concrete slabs on grade shall not require sleeves.
- B. This Contractor shall furnish and install sleeves in exterior walls below grade for conduits and, the space between the conduit and the sleeve shall be packed with silicon and made completely watertight.
- C. This Contractor shall fasten sleeves securely in floors and walls so that they will not become displaced when concrete is poured or when other construction is built around them. This Contractor shall take precautions to prevent concrete, plaster, or other materials from being forced into the space between the conduit and sleeve during construction.
 - 1. This Contractor shall terminate sleeves flush with walls, partitions, and ceilings.
 - 2. In areas where conduits are concealed, this Contractor shall terminate sleeves flush with the floor.
 - 3. In finished areas, where conduits are exposed, this Contractor shall terminate sleeves below the floor and cap. In rooms having floor drains, this Contractor shall extend sleeves 3/4 inch above the floor.
- D. Escutcheon plates shall be furnished and installed by this Contractor for all exposed conduits passing through walls, floors, and ceilings. Plates shall be nickel-plated, of the split ring type, and of a size to match the conduit. Where plates are provided for conduits passing through sleeves that extend above the floor surface, this Contractor shall furnish and install deep recessed plates to conceal the sleeves.
- E. Sleeves shall be constructed of solid piece galvanized rigid steel conduit unless otherwise indicated on Drawings. Split sleeves are not allowed unless approved by the Owner.

2.06 FOUNDATIONS FOR EQUIPMENT

- A. The Contractor shall construct reinforced concrete foundations for floor mounted equipment where indicated on the Drawings. Foundations generally shall be built up from structural floor slabs and shall be made of 3000 psi concrete four (4) inches thick unless otherwise indicated or specified. Top edges shall be beveled. All exposed surfaces shall be finished with cement mortar troweled smooth. Reinforcing shall be 6 x 6-10/10 welded wire mesh.

- B. This Contractor shall provide reinforced concrete pole base foundations of cast-in-place for the exterior site lighting poles. The poles bases shall be sized and made of 3000 psi, air entrained, concrete with reinforcing as detailed on the Drawings. The top edges of the bases shall be beveled (chamfered) by using the proper type mold, not by grinding the edge once the concrete has set. All exposed surfaces shall be finished smooth without leaving any of the forms imperfections.
 - 1. Cast-in-place concrete pole base foundations shall require this Contractor to provide all excavation and forms.
- C. Equipment shall be secured to foundations by this Contractor with anchor bolts embedded in the concrete of ample size and proper arrangements to suit equipment furnished.

PART 3 - EXECUTION

3.01 INSTALLATION OF WORK

- A. This Contractor shall examine the site and all Drawings before proceeding with the layout and installation of this work.
- B. This Contractor shall arrange the work essentially as shown on the Drawings, exact layout shall be made on the job to suit actual conditions. This Contractor shall confer and cooperate with other trades on the job so all work shall be installed in proper relationship. Precise location of parts to coordinate with other work shall be the responsibility of this Contractor.
- C. This Contractor shall arrange for required sleeves and openings. This Contractor shall be liable for cutting or patching made necessary by failure to make proper arrangements in this respect.
- D. This Contractor shall provide a full time Job Foreman who shall oversee and coordinate the work with other trades and make proper layout of the work to suit the job conditions and to satisfy the general requirements of the Contract.

3.02 DELIVERY AND STORAGE

- A. All materials and equipment shall be delivered in the manufacturer's original packages with seals unbroken and with manufacturer's name and contents legibly marked thereon. This Contractor shall store all materials off the ground, under cover, and protected from the weather and construction.

3.03 SCAFFOLDING, RIGGING, AND HOISTING

- A. Unless otherwise specified, this Contractor shall furnish all scaffolding, rigging, hoisting, shoring, and services necessary for the erection and delivery into the premises of any equipment and apparatus furnished and removal of same from premises when no longer required.

3.04 EXCAVATING AND BACKFILLING

- A. Mass excavation to approximate building level shall be carried out under DIVISION 1 of these Specifications. This Contractor shall do all trench and pit excavation and backfilling required for the electrical work inside and outside the building, including: repairing of finished surfaces; all required shoring, bracing, pumping; re-stripping; and all protection of safety of persons and property. The method of backfilling shall conform to the requirements of Fairfax County. In addition, it shall be the responsibility of this Contractor to check the indicated elevations of utilities entering and leaving the building. If such elevations require excavations lower than the footing levels, the Architect/Engineer shall be notified of such conditions and redesign shall be made before excavations are commenced. It shall also be the responsibility of this Contractor to make the excavations at the minimum required depths in order not to undercut the footings.
- B. Conduits installed below the ground floor level shall have the bottom of the trench excavated to grade so that the conduit shall rest on a solid bed of undisturbed earth. If rock is encountered, the trench shall be excavated to not less than three (3) inches below required grade and filled to required grade with sand so as to provide a solid bed under the entire length of conduit.
- C. Where the trench is excavated below the required depth, the trench shall be filled with sand and fine gravel so that the entire length of conduit rests on solid bed of sand.
- D. Backfilling to one (1) foot above the top of the conduit pipe shall be done by hand, using clean dirt free of rocks or other debris. All backfill shall be properly compacted in accordance with DIVISION 2 of this Specification. Utility tracing tape shall be placed by this Contractor above underground electrical work approximately one (1) foot below finished grade for the entire length of the installation.

3.05 ACCESSIBILITY

- A. This Contractor shall be responsible for the sufficiency of the size of shafts and chases, the adequate thickness of partitions, and the adequate clearance in double partitions and hung ceilings for the proper installation of the work. This Contractor shall cooperate with all other trades whose work is in the same space, and shall advise each trade of their requirements. Such spaces and clearances shall, however, be kept to the minimum size required.

- B. This Contractor shall locate all equipment that must be serviced, operated, or maintained in fully accessible positions. This equipment shall include, but not be limited to, disconnect switches, panelboards, transformers, controllers, switchgear, motor control centers, generators, junction boxes and pullboxes, and the like. If required for better accessibility, this Contractor shall furnish access doors or panels for this purpose. Minor deviations from the Drawings may be made to allow for better accessibility, and all changes shall be approved by the Architect/Engineer.
- C. This Contractor shall furnish and install access panels as required for access to junction boxes, etc. The panels shall be twelve (12) inches square, unless otherwise required to be larger, with hinged metal door and metal frames. Door and frame shall be not lighter than sixteen (16) gauge sheet steel. Access panels shall be the flush type with screwdriver latching device. The frame shall be constructed so that it can be secured to the building material. Access panels and their locations shall meet with the approval of the Architect/Engineer.

3.06 DEMOLITION

- A. This Contractor shall perform all demolition work as shown on the Drawings and specified herein.
- B. The procedures used for the accomplishment of demolition work shall provide for safe conduct of the work, careful removal and disposition of material specified to be salvaged, protection of property which is to remain undisturbed, coordination with other work in progress, and timely disconnection of utility services.
- C. Work shall be performed in sequence, locations, and time periods as agreed to by the Owner prior to commencement of work.
- D. The amount of dust resulting from demolition shall be controlled to avoid creation of a nuisance in the surrounding area. Masks shall be worn for protection against dust inhalation by all persons in the vicinity of work involving removal of masonry.
- E. Protection of existing work:
 - 1. Existing work and finishes to remain shall be protected from damage. Work damaged by this Contractor shall be repaired to match existing work at no additional expense to the Owner.
 - 2. This Contractor shall cover equipment as necessary to protect it from dust.
 - 3. Floors shall be protected by this Contractor from damage.

4. At the end of each workday and during inclement weather, this Contractor shall close exterior openings with weatherproof covers.
 5. At the end of each workday this Contractor shall broom clean the entire project.
- F. This Contractor shall comply with all Federal and local regulations pertaining to environmental protection.
- G. Existing equipment and materials shall be dismantled and/or cut-up so as to be removable through existing access passages. No alterations to the building shall be made for the purpose of removing existing equipment and material.
- H. All equipment removed shall remain in the property of the Owner and shall be stored or disposed of as directed.
- I. Clean-up:
1. This Contractor shall remove debris and rubbish from the site. Do not allow to accumulate in building or on site.
 2. This Contractor shall remove and transport debris in a manner so as to prevent spillage on site or adjacent areas.
 3. Local regulations regarding hauling and disposal shall apply.
- J. Modifications to Existing Electrical Systems:
1. This Contractor shall ensure that all demolition and modifications to existing electrical systems and associated equipment shall be by a qualified electrician.
 2. This Contractor shall remove such existing work as called for on the Drawings and/or as required to clear the areas for new construction. Remove each item of equipment, devices including low voltage devices, luminaires (lighting fixtures), etc. and it's associated circuitry back to the source of power (switchboard, panelboard, controller, control panel, equipment rack, etc.). Associated circuitry includes conduit, conductors, boxes, wiring devices, coverplates, lamps, ballasts, wireways, switches, starters, etc. which are associated with the item being removed.
 3. Except as otherwise noted on the Drawings, all existing electrical work which will not be rendered obsolete and which may be disturbed due to any changes required under this Contract shall be restored to it's original operating condition. Contractor shall make all necessary provisions to maintain **ALL** electrical systems, including communications and other low

voltage systems, by extending wiring, conduit, relocating equipment, installing new temporary equipment and/or wiring, etc.

4. Electrical work or material rendered obsolete shall be abandoned where concealed in walls and floor slabs and removed where exposed, and/or where made exposed by the removal of walls and/or ceilings. Where a concealed conduit is abandoned and the terminated end is exposed above an accessible ceiling the end shall be capped or sealed in an approved manner. Where a concealed abandoned conduit is terminated in a finished space the conduit shall be removed to below the finished surface (minimum three inches for concrete floor slabs) and the void filled with non-shrinking grout and finished to match the surrounding surfaces.
5. Unused flush device outlet boxes or junction boxes shall be provided with blank coverplates.
6. Where equipment is identified or required to be relocated its associated circuitry shall also be removed, as herein before described, along with it's associated devices, etc. Provide all electrical connections to the relocated equipment to new or extended circuitry as indicated on the Drawings and/or required to make the equipment fully functional.
7. Power, communications and other low voltage systems that will be reconnected or extended permanently or temporarily shall be identified and marked above the ceiling during the demolition and phased construction periods.
8. Where existing electrical work interferes with new work, and where such installations are to remain in use, the installation shall be disconnected and/or reconnected to coordinate with the work indicated on the Drawings and as herein specified.
9. Except as otherwise indicated, panelboard cabinets shall not be used for other purposes than circuit protection and distribution points and shall not be used as junction or pullboxes.

3.07 CUTTING AND PATCHING

- A. All cutting and patching of existing construction required for work under this DIVISION of these Specifications shall be performed by this Contractor in accordance with SECTION 01045 CUTTING AND PATCHING.

3.08 PERSONNEL INSTRUCTION AND OPERATING INSTRUCTIONS

- A. This Contractor shall furnish to the Architect/Engineer for delivery to the Owner, four (4) bound and indexed copies of an approved operations and maintenance instruction booklet along with a copy of the submittal data for each item of

equipment installed under this Contract. The submittal data shall include all low voltage "special systems" drawings and floor plans, updated to include any deviations to the system(s) and/or the building layout to properly reflect "as built" conditions.

- B. After all tests are conducted and approved as specified below, this Contractor shall furnish a competent operations engineer for a period of two (2) days to instruct and demonstrate to the Owner, or his authorized representative, the operation of each system. This Contractor shall notify the Architect/Engineer in writing of the person to whom this instruction was given and the date given. This Contractor shall provide at least one (1) week's notice to the Owner when conducting tests or demonstrations of equipment.
- C. This Contractor shall furnish to the Owner as part of the Owner's operating and personnel instruction package, one (1) bound set of marked up drawings indicating any changes made during construction to the original contract drawings. The set shall be clearly labeled, "As Built Plans."
- D. This Contractor shall furnish complete Technical Service Manuals with component schematics and parts lists as indicated in appropriate section for each system.

3.09 EQUIPMENT SUPPLIERS INSPECTION

- A. The following equipment and systems shall not be placed in operation until a competent installation and service representative of the manufacturer has made an on the job inspection of the installation, has certified that the equipment is properly installed and lubricated, that preliminary operating instructions have been given, and that equipment is ready for operation. **(ENGINEER MUST EDIT.)**
 - 1. Athletic fields sound reinforcement systems
 - 2. Auditorium lighting controls and performance lighting systems
 - 3. Auditorium sound reinforcement system
 - 4. Auxiliary sound and reinforcement systems
 - 5. Band, Orchestra, and Choral rooms sound reinforcement systems
 - 6. Black box theater lighting controls and performance lighting systems
 - 7. Black box theater sound reinforcement system
 - 8. Cable television/broadband distribution system (CATV)

9. CCTV surveillance system
10. Classroom amplification systems
11. Dance and gymnastics sound reinforcement systems
12. Door access video entry system
13. Emergency engine generator set and automatic transfer switch(es)
14. Fire detection and alarm system
15. Gymnasium sound reinforcement system
16. Lighting control systems
17. Middle school stage performance lighting controls and lighting
18. Multi-media systems
19. School zone warning signals
20. Security intrusion system
21. Sound, intercommunications and program systems
22. Sports fields lighting systems, including fixture aiming
23. Telecommunications system including networking equipment
24. Television studio lighting controls and performance lighting systems
25. Wireless master clock system

3.10 TESTS

- A. This Contractor shall, at his expense, conduct a capacity and general operating test on each system. The test shall demonstrate the specified capacities of the various pieces of equipment, and shall be conducted in the presence of the Architect/Engineer and the Owner. The general operating tests shall demonstrate that the entire equipment system is functioning in accordance with the Drawings and Specifications. This Contractor shall furnish all instructions, test equipment, and utilities.
- B. After all systems are completely tested, this Contractor shall submit four (4) copies of the test results to the Architect/Engineer for review. Final inspection shall not be made until test results have been reviewed by the

Architect/Engineer.

3.11 CLEANING

- A. This Contractor shall thoroughly clean all electrical equipment installed under this DIVISION of these Specifications after the system has been completed or used for temporary service, but in any case prior to final inspection by the Owner's representatives.
- B. Cleaning shall include, but not be limited to, luminaires (lighting fixtures), wiring devices, cover plates, distribution equipment, and the like.

3.12 GUARANTEE

- A. This Contractor shall guarantee by acceptance of the contract that all work installed shall be free from any and all defects in workmanship and/or materials, and that all apparatus shall develop capacities and characteristics specified, and that if during the phased construction and warranty period such defects in workmanship, materials, or performance appear, this Contractor shall with no additional expense to the Owner, remedy such defects within a reasonable time. In default thereof, Owner may have such work done and charge the cost to this Contractor.

3.13 IDENTIFICATION

- A. This Contractor shall furnish an "As-Built" power systems riser diagram indicating service entrance switchboard, panelboards, emergency engine generator set, automatic transfer switch, dimming systems, and safety switches. Diagram shall indicate size of feeders and conduit, breakers, circuit, and fuses. The diagram shall be neatly drawn, using mechanical drafting methods, at least 24 inches x 36 inches, laminated, and hung from the wall adjacent to service entrance switchboard as directed by the Owner.
- B. This Contractor shall refer to the appropriate sections of these Specifications for identification requirements for junction boxes, branch and feeder conductors, underground wiring, low voltage special systems wiring and the like.

3.14 LOCK-OUT/TAG-OUT PROCEDURES

- A. This Contractor shall have an established lock-out/tag-out procedure which meets the requirements of VOSH Standard 29 CFR Part 1910, Subpart J, Subsection 147, entitled "Control of Hazardous Energy Sources". This Contractor shall coordinate with the Owner's representative to insure conformance with the Owner's lock-out/tag-out program requirements.

END OF SECTION

SECTION 16015

SHORT CIRCUIT/COORDINATION STUDY/ARC-FLASH ANALYSIS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 1 through Division 16 Specification Sections, apply to the Work of this Section.

1.02 RELATED WORK

- A. Electrical and Emergency Power Distribution

1.03 SHORT CIRCUIT/COORDINATION STUDY/ARC-FLASH ANALYSIS

- A. Short circuit /coordination study/arc flashing analysis report is included herein.
- B. This Contractor shall engage the equipment manufacturer's service group or alternately a qualified independent testing firm to perform field adjustment of the protective devices as required for placing the equipment in final operating condition. The settings shall be in accordance with the attached short-circuit study and protective device evaluation/coordination study.
- C. Necessary field settings of devices and adjustments and minor modifications to equipment to accomplish conformance with the attached short-circuit and protective device coordination study, shall be carried out by the equipment manufacturer's service group or qualified independent testing firm.
- D. Notify Owner in writing of any required major equipment modifications.
- E. Apply arc-flash warning labels to equipment. The labels shall be located so as to be clearly visible to qualified persons before examination, adjustment, servicing, or maintenance of the equipment.

END OF SECTION

REPORT TO FOLLOW

SECTION 16110

CONDUITS, RACEWAYS, FITTINGS AND CABLE TRAYS

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work covered under this Section shall consist of furnishing and installing conduits, raceways, cable trays, and fittings for all systems as shown on the Drawings and herein specified.

1.03 QUALITY ASSURANCE

- A. All equipment, materials, and their installation shall conform to the requirements of the National Electrical Code (NEC), local code requirements, and these Specifications.
- B. All equipment and materials shall be listed by Underwriters Laboratories, Inc. (UL) for their intended use and shall bear the UL label.
- C. Equipment shall be constructed in accordance with National Electrical Manufacturer's Association (NEMA) standards.
- D. Submittals are required in accordance with SECTION 16010 of these Specifications for conduits, raceways, fittings, wiring troughs, cable hooks, cable trays and associated support systems.
 - 1. Cable tray submittals shall include product data and drawings of cable tray and accessories including clamps, brackets, hanger rods, splice plate connectors, expansion joint assemblies and fittings showing accurately scaled components.
 - 2. Cable tray product data shall include, but not be limited to, types of materials, finishes, rung spacing, inside depths, and fitting radii. For side rails and rungs, submit cross sectional properties including Section Modulus (Sx) and Moment of Inertia (Ix).

PART 2 - PRODUCTS

2.01 CONDUITS

- A. Minimum conduit size shall be 1/2 inch. No more than six (6) No. 12 AWG conductors shall be pulled in 1/2 inch conduit. For conductors larger than No. 12 AWG or quantities of No. 12 greater than six (6) conductors, 3/4 inch conduit shall be the minimum size. Other sizes shall be as indicated on the plans, or as required by the NEC for number and size of conductors installed. Materials shall be new and full length. Crushed and/or deformed conduits shall not be used.
- B. The conduits for the fire alarm system shall be red in color.
- C. Rigid steel and intermediate metal (IMC) conduits shall be full weight threaded and galvanized steel pipe of standard pipe dimensions.
- D. Electrical metallic tubing (EMT) shall be threadless thin wall conduit, galvanized or zinc metallized.
- E. Flexible steel conduit shall be single-strip type, galvanized. Use for short connections where rigid type conduits are impractical, for expansion joint crossing, from outlet box to a recessed luminaire (lighting fixture) (minimum, 4 feet; maximum, 6 feet in length), for final connections to motor terminal boxes or other vibrating equipment. Use only steel connectors approved for flexible conduit. Provide an internal ground wire with proper fittings. Other uses on the project shall not be permitted.
- F. Flexible weatherproof conduit shall have polyvinyl sheathing similar to AMERICAN METAL HOSE "Sealtite" type "UA" and shall be used where exposed to the weather to connect all motors; all rooftop mounted equipment, and all other wet locations, where rigid type conduits connections are impractical. Weatherproof flexible conduit installations shall have maximum lengths of ± twenty-four (24) inches. Use only steel connectors approved for flexible weatherproof conduit. Provide an internal ground wire with proper fittings. Other uses on the project shall not be permitted, except where indicated hereinafter in these specifications or as shown on the drawings.
- G. Plastic conduits shall be installed only underground or in a concrete slab on grade. Only heavywall (Schedule 40) plastic conduit shall be used. Where conduit turns out of a concrete slab or finished grade, inside or outside the building, provide a rigid steel conduit elbow and suitable adaptor between plastic and steel conduits. No plastic conduit shall be used inside the building or exposed outside the building, unless otherwise noted on the Drawings.
- H. This contractor can use for exterior, underground, pole mounted luminaire branch circuit wiring, schedule 40 high-density polyethylene (HDPE) piping.

Where conduit turns out above finished grade, provide a rigid steel conduit elbow and suitable adaptor between plastic and steel conduits. No plastic conduit shall be used exposed outside the building, unless otherwise noted on the Drawings. A HDPE pipe that meets this specification is DURA-LINE Cat. No. EPEC-40/SCH 40 (black) or approved equal.

2.02 FITTINGS

- A. Fittings, couplings, and accessories shall be compatible with the conduit material.
- B. Unions, couplings, and fittings for rigid and IMC conduits shall be of galvanized steel of conventional dimensions and shall be internally threaded at each end to fit the nontapered thread standard for the corresponding size conduit. Couplings and fittings for electrical metallic tubing shall be of steel and shall be of the compression or setscrew type. Cast pot metal and crimp types are not acceptable.
- C. Conduit bodies used with conduits 1 ½ inches and larger shall be galvanized cast iron "mogul conduit bodies" complete with a domed and angled cover, neoprene gasket, stainless steel screws, and rated for "wet locations".

2.03 BUSHINGS AND LOCKNUTS

- A. Use OZ/GEDNEY type 'B' insulated or type 'BLG' bushing where necessary to bond conduit to ground connection. Bushings shall be as manufactured by OZ/GEDNEY, THOMAS & BETTS, or CROUSE-HINDS.
- B. Locknuts shall be used on both sides of conduit connections to a box or a panelboard in addition to the bushing. Where a larger size opening occurs than the size of the conduit, use reducing locknuts. Do not use reducing washers.
- C. Cables pulled through sleeves without bushings, cut bushings, or wrapped with tape will not be accepted and shall be replaced by the Contractor.

2.04 WIRING TROUGHS

- A. Wiring troughs complete with screwed covers shall be used where indicated and for mounting groups of switches and/or starters. Wiring troughs shall be the standard manufactured product of a company regularly producing wiring troughs and shall not be a local shop assembled unit. Wiring trough shall be UL listed and of sizes indicated or as required by NEC, if not indicated. The interior, including couplings shall be completely open without interference. Finish shall be ASA #49 medium light gray enamel over a rust inhibitor. Wiring troughs shall be UL listed "Suitable For Wet Locations" and so labeled where indicated "WP" on the Drawings.
- B. Wiring connection taps within wiring troughs shall be made using clear self-

sealing, self-insulating, multi-tap connectors with transparent flexible insulating covers. The connectors shall be securely fastened. The multi-tap connector shall be manufactured by ILSCO, Series "PCT" ClearTap or approved equal.

2.05 CABLE TRAY

- A. Ladder type cable tray shall be used where indicated on the Drawings, for low voltage cabling systems. Low voltage cabling systems shall be as hereinafter specified in other sections of these specifications. Ladder type cable trays may also be used for type MC Cable as hereinafter specified in other sections of these specifications.
- B. Cable tray systems shall be made of straight sections, fittings, and accessories as shown on the Drawings, described herein, and as defined in the latest NEMA standards publication VE-1. Cable tray shall be UL classified as an equipment-grounding conductor.
- C. Ladder type cable tray shall be metal (aluminum or pre-galvanized steel) of the types, classes and sizes indicated; with splice plates bolts, nuts and washers for connecting units. Construct units with rounded edges and smooth surfaces; in compliance with applicable standards and these specifications.
- D. Cable tray materials and finish shall be as follows:
 - 1. Aluminum: Straight section and fitting side rails and rungs shall be extruded from Aluminum Association Alloy 6063. All fabricated parts shall be made from Aluminum Association Alloy 5052.
 - 2. Pre-Galvanized Steel: Straight sections, fitting side rails, and rungs shall be made from structural quality steel meeting the minimum mechanical properties and mill galvanized in accordance with ASTM A653 SS, Grade 33, Coating Designation G90.
- E. Ladder type cable tray shall consist of two (2) longitudinal members (side rails) with transverse members (rungs) welded to the side rails. Rungs shall be spaced six (6) inches on center. Rung spacing in radiused fittings shall be nine (9) inches and measured at the center of the tray's width. Rungs shall have a minimum cable bearing surface of 7/8 inches with radiused edges. No portion of the rungs shall protrude below the bottom plane of the side rails. Each rung must be capable of supporting the cable load, with a safety factor of 1.5, and a 200 lb. concentrated load when tested with NEMA VE 1, section 5.4.
- F. Ladder type cable tray shall have an overall side rail height of four (4) inches with a minimum loading depth of three (3) inches. Cable tray width shall be twelve (12) inches, eighteen (18) inches, or twenty-four (24) inches as shown on the Drawings. Straight section side rails shall be of "I-beam" design with a rung retaining weld bead. All straight sections shall be supplied in standard lengths of twelve (12) feet, except where shorter lengths are permitted to facilitate tray assembly lengths as shown on the Drawings. Fittings radius shall be twenty-four

(24) inches. Side rails of straight sections and fittings shall be compatible so that standard splice plates can be used to join straight sections and fittings. Fittings shall have three (3) inch tangents beyond the curved section to accommodate the standard splice plates.

- G. Splice plates shall be the bolted type made as indicated below for each tray type. The resistance to fixed splice connections between an adjacent section of tray shall not exceed .00033 ohm. Splice plate construction shall be such that a splice may be located anywhere within the support span without diminishing rated loading capacity of the cable tray.
1. Aluminum Tray: Splice plates shall be made of 6063-T6 aluminum, using four square neck bolts and serrated flange locknuts. Hardware shall be zinc plated in accordance with ASTM B633, SC1.
 2. Pre-Galvanized Steel Tray: Splice plates shall be manufactured of high strength steel, meeting the minimum mechanical properties of ASTM A1011 HSLAS, Grade 50, Class 1. Each splice plate shall be attached with ribbed neck carriage bolts and serrated flange locknuts. Hardware shall be zinc plated in accordance with ASTM B633 SC1.

Splice plates shall be furnished with straight sections and fittings.

- H. Cable Tray Supports
1. Supports shall be constructed from 12 gauge steel formed shape channel members 1 5/8 inch by 1 5/8 inch with necessary hardware such as trapeze support kits furnished by manufacturer of cable tray (or engineer approved equal). Cable trays installed adjacent to walls shall be supported on wall-mounted brackets furnished by manufacturer of cable tray (or engineer approved equal).
 2. Trapeze hanger supports shall be supported by ½ inch (minimum) diameter rods.
 3. Cable tray fitting supports shall be located such that they meet the strength requirements of straight sections. Install fitting supports per NEMA VE-2 guidelines, and in accordance with manufacturer's instructions.
- I. Accessories shall be furnished as required to protect, support, and install a cable tray system. Accessories shall consist of but not be limited to: section splice plates, expansion plates, blind-end plates, specially designed ladder dropouts, etc.
- J. Cable tray shall be capable of carrying a uniformly distributed load of 126 lbs./ft. for aluminum on a 12 ft. support span or 103 lbs./ft for pre-galvanized steel on a 12 ft. support span (NEMA Class 12C) with a safety factor of 1.5 when supported

as a simple span and tested per NEMA VE 1, section 5.2. In addition to the uniformly distributed load, the cable tray shall support 200 lbs. concentrated load at mid-point of span. Load and safety factors specified are applicable to both the side rails and rung capacities. Cable tray shall be made to manufacturing tolerances as specified by NEMA.

- K. Cable tray manufacturers shall be B-LINE SYSTEMS, INC. Series 24A for aluminum and 248 for pre-galvanized steel or equal as manufactured by CABLOFIL, CHALFANT CABLE TRAY, COPE CABLE TRAY, SQUARE D, or THOMAS & BETTS CORPORATION.

2.06 CABLE HOOK SUPPORT SYSTEMS

- A. Cable hooks (also known as "J" hooks) shall be provided for low voltage cable systems as hereinafter specified in other sections of these specifications.
- B. Cable hooks shall provide a flat bottom bearing surface of sufficient width to comply with required bend radii of high-performance cables.
- C. Cable hooks shall have flare edges to prevent damage while installing cables.
- D. Cable hooks shall be designed so the mounting hardware is recessed to prevent cable damage.
- E. Cable hooks sized 1 5/16 inches and larger shall have a stainless steel cable latch retainer to provide containment of cables within the hook. The retainer shall be removable and reusable and be suitable for use in air handling spaces.
- F. Cable hooks shall be factory assembled for direct attachment to walls, hanger rods, beam flanges, purlins, strut, floor posts, etc. to meet job conditions.
- G. Multi-tiered cable hook assemblies shall be used where required to provide separate cabling compartments, or where additional capacity is needed. Assemblies may be factory assembled or assembled from pre-packaged kits. Assemblies shall consist of a steel angled hanger bracket holding up to six (6) cable hooks.
- H. Cable hooks for non-corrosive areas shall be pre-galvanized steel, ASTM A653. Where additional strength is required, cable hooks shall be spring steel with a zinc-plated finish, ASTM B633, SC3. Cable hooks for corrosive areas shall be stainless steel, AISI Type 304.
- I. Cable hooks shall be capable of supporting a minimum of 30 pounds with a safety factor of 3. Spring steel cable hooks shall be capable of supporting a minimum of 100 pounds with a safety factor of 3 where extra strength is required.
- J. Cable hook manufacturer shall be B-LINE SYSTEMS, INC. Series BCH21,

BCH32, BCH64, or equal as manufactured by ERICO CADDY.

2.07 PULL-LINES (CORDAGE)

- A. Pull-lines (rope and cordage) types and strengths must be selected and calculated by the Contractor. The selection must be based on the intended use and expected pulling load applications. Design Factor (DF) selections and Working Load Limits (WLL) must be calculated with consideration of exposures to risk and actual conditions of use for each application. Pull-lines shall be in compliance with the latest Cordage Institute Standards and Guidelines.
- B. The minimum pull-line tensile strength for insertion into conduits shall be 500 pounds and of the low-friction type.
- C. Each utility service entrance conduit (raceway) for power company, telephone company and/or cable television (CATV) company shall have a MULETAPE® pulling tape with numerical values having sequential footage (feet and inches) markings, without splices. The MULETAPE® shall have a minimum tensile strength of 2500 pounds and shall be of the low-friction type with prelubrication, high abrasion resistant yarns.
- D. Where minimum pull-line strengths are given, they do not negate the Contractor's responsibility for proper selections and calculations for higher strength pull-lines to suit the application.

2.08 ROOFTOP CONDUIT SUPPORT STRUT SYSTEM

- A. Provide rooftop conduit support strut systems that will absorb thermal expansion and contraction of conduits, thus preventing damage to the roof membrane. This Contractor must select the support strut system's load capacity necessary to carry the weights and sizes of conduits.
- B. The conduit support base shall have gently rounded edges to prevent damage to the roof and shall be UV resistant polycarbonate resin or 100% recycled rubber and polyurethane prepolymer, and all other metal parts made of hot-dip galvanized or stainless steel.
- C. Conduits shall rest on the strut system made of hot-dip galvanized or stainless steel. Provide fasteners sized for the conduit.
- D. Rooftop conduit support system manufacturers shall be MIRO INDUSTRIES, INC. or equal as manufactured by CABLOFIL (CABLO-PORT), COOPER B-LINE (DURA-BLOK™) or approved equal.

PART 3 - EXECUTION

3.01 CONDUITS

- A. Panelboard feeders shall be run in electrical metallic tubing (EMT), galvanized rigid steel conduit, intermediate grade metal conduit, or plastic conduit as described herein.
- B. Branch circuit raceways for motors twenty (20) horsepower (or tons) and larger, or a combination of motors totaling twenty (20) horsepower and larger requiring a single point connection shall be EMT, galvanized rigid steel conduit, intermediate grade metal conduit, or plastic conduit as described herein.
- C. Branch circuit raceways for motors served by variable frequency drives (VFD) shall be electrical metallic tubing (EMT), galvanized rigid steel conduit, or intermediate grade metal conduit from the load side of the VFD to the line side of the motor. Do not use plastic conduit.
- D. Feeders, branch circuits, fire alarm system wiring, and other low voltage systems wiring (required to be in conduit) installed indoors in dry locations shall be run in electrical metallic tubing (EMT), galvanized rigid steel conduit, or intermediate grade metal conduit above hung ceilings (accessible and non-accessible), in hollow block walls, in furred spaces, in vertical and horizontal pipe chases, and in exposed dry locations as describe herein and other sections of these specifications.
- E. Feeders, branch circuits, fire alarm system wiring, and other low voltage systems wiring installed underground, under slab on grade, in concrete, in crawl spaces, or in wet locations shall be run in galvanized rigid steel conduit, intermediate grade metal conduit, or plastic conduit as described herein.
- F. Low voltage systems plenum rated wiring or cables run indoors in dry locations shall be in electrical metallic tubing (EMT), galvanized rigid steel conduit, or intermediate grade metal conduit when run above non-accessible ceilings, in hollow block walls, and in exposed dry locations other than communications rooms or in a cable tray. Refer to the respective low voltage systems sections of the specifications for other conduit requirements.
- G. Conduits run exposed in boiler rooms, elevator machine rooms, mechanical rooms, pump rooms, fire sprinkler service room, and all other similar spaces, located between the floor and a height of 10'-0" above the finished floor, shall be galvanized rigid steel conduit, or intermediate grade metal conduit as described herein. Conduits above 10'-0" may be EMT, unless otherwise indicated on the Drawings, or required by codes.

3.02 RACEWAY SYSTEM

- A. Raceways shall be continuous from outlet to outlet; from outlet to cabinets, junction boxes, or pullboxes; and secured to all boxes so that each system is electrically continuous from service to outlets. Provide termination of raceways with double lock nuts and bushings.
- B. Raceways shall be securely and rigidly supported to the building structure in a neat and workmanlike manner, and wherever possible, parallel runs or horizontal conduit shall be grouped together on adjustable trapeze hangers. Raceways shall be supported independently from other disciplines (i.e. mechanical, sprinkler, etc). Support shall be provided at appropriate intervals not exceeding ten (10) feet with straps, hangers, and brackets specifically designed for the application. Channels shall be 1 inch for 24-inch wide trapeze and 1-1/2 inch for larger than 24 inch. Perforated steel straphangers or tie-wire supports are not acceptable. Conduits installed along wall surfaces shall be supported with galvanized steel brackets specifically designed for conduits and sized for the conduit used. Conduit brackets shall be fastened to the wall using appropriate anchors and screws, the use of drive pins and/or other methods using compressed air or gases are not acceptable. Raceways and supports shall not terminate or be fastened directly to the roof decking. Raceways under roof decking shall not be less than 1½ inches from the nearest surface of the roof decking. Supports attached to structural steel joists shall only be attached within 3" of the top of the joist panel points. Supports attached at the bottom or beyond 3" of the joist panel points must be approved, in writing, by the Structural Engineer of record and the Owner before attaching.
- C. Run exposed raceways parallel with or at right angles to walls. In mechanical rooms and similar utilitarian spaces where exposed conduits are used, provide "condulets", and similar fittings in lieu of junction boxes. Exposed outlet boxes of adequate size, however, shall be used to contain wire junctions.
- D. No raceway shall be installed within three (3) inches of hot water pipes, or appliances, except at crossings where raceway shall be at least one (1) inch from pipe cover.
- E. Install raceway to prevent collection of trapped condensation and be devoid of traps. Slope underground raceways away from the building or provide weep holes when sloping away from the building is not possible.
- F. Do not terminate in, or fasten raceways to, motor foundations.
- G. Raceways installed outside underground shall have a minimum of twenty-four (24) inches top cover. Separate electric raceways from telephone (and other low voltage systems) raceways shall be provided with a minimum of twelve (12) inches of well-tamped earth, or six (6) inches of concrete.
- H. Joints in raceways in concrete or underground shall be watertight. Steel conduits shall have ends cut square. Ream smooth and paint male threads with graphite-base pipe compound and draw up tight with conduit couplings. Do not

paint female threads; where required, use Erickson, or equal, conduit fittings. Running threads shall not be permitted. Place caps in ends of conduits as soon as located to prevent entry of foreign material. Screwed on caps shall be used for threaded conduits. Unused (abandoned) conduits shall be capped. The use of tape, paper or rag wads in not acceptable for conduit caps.

- I. After conduit installation, clean and paint marred surfaces affecting galvanizing with asphaltum, galvanized-iron primer.
- J. Run conduit above suspended ceilings for outlets in suspended ceilings. Keep clear of planned ductwork where turning down from slab into suspended ceiling.
- K. Horizontal or cross runs in solid partitions and walls shall not be permitted.
- L. Conduits designated on the Drawings as empty conduits (EC) shall have a properly sized pull-line.
- M. Flexible metal conduit used for connection of luminaires (lighting fixtures), receptacles outlets, telepower poles, and as otherwise shown on the Drawings, shall be supported and bonded in accordance with NEC Article 348.
- N. Conduit runs in under concrete slabs shall be installed only where shown on the Drawings or approved by the Owner and shall be limited to 3/4-inch conduit. Conduit shall be run in the gravel under the slab not in the slab.
- O. Where embedded conduits cross building expansion joints, the Contractor shall furnish and install an offset expansion joint or a sliding expansion joint. Sliding expansion joints shall be provided with bonding strap and clamp. Where conduits are exposed, provide expansion fittings or flexible conduit as required.
- P. In all wet and damp locations, boiler rooms, elevator machine rooms, kitchens, mechanical rooms, pump rooms, fire sprinkler service room, and all other similar spaces, all final electrical connections to any and all equipment, regardless of the type, shall consist of conductors run in polyvinyl sheathed flexible metal conduit ("Sealtite") with maximum lengths as hereinbefore specified.
- Q. Conduits/raceways shall not be permitted to be run exposed on top of finished floors or grade, unless specifically shown on the drawings or approved by the Owner in advance.
- R. Raceways or sleeves known to be subjected to different temperatures and where condensation is known to be a problem, as in cold storage areas of (or in) the building or where passing from the interior to the exterior of the building, the raceway or sleeve shall be filled with an approved material to prevent the circulation of warm air to a cold section of the raceway or sleeve, per NEC 300.7.
- S. Conduits run shall not be more than one hundred (100) feet in length and two hundred seventy (270) total degrees of bend without the use of pull box(s).

3.03 CABLE TRAY

- A. Installation shall be in accordance with equipment manufacturer's instructions and with recognized industry practices (NEMA VE 2), to ensure that cable tray equipment complies with requirements of the NEC and applicable portions of NFPA 70B.
- B. Cable tray shall be supported from the building structure. Supports attached to structural steel joists shall only be attached within 3" of the joist panel points, top or bottom. Supports attached beyond 3" of the joist panel points must be approved, in writing, by the Structural Engineer of Record and the Owner before attaching.
- C. Coordinate cable tray with other electrical work and other trades' work as necessary to properly integrate installation of cable tray work with other work.
- D. Provide sufficient space encompassing cable trays to permit access for installing and maintaining cables.
- E. Test cable trays to ensure electrical continuity of bonding and grounding connections and to demonstrate compliance with specified minimum grounding resistance. Refer to NFPA 70B, Chapter 18, for testing requirements and test methods.

3.04 CABLE HOOK SUPPORT SYSTEM

- A. Installation and configurations shall conform to the requirements of the current revision levels of ANSI/EIA/TIA Standards 568 & 569, NEC, the manufacturer's installation instructions and other sections of these project specifications.
- B. Cable hook assemblies shall be supported from the building structure. Where fastened to walls use appropriate anchors and screws, the use of drive pins and/or other methods using compressed air or gases are not acceptable. Supports shall not terminate or be fastened directly to the roof decking. Cables installed under roof decking shall not be less than 1½ inches from the nearest surface of the roof. Cable hook supports attached to structural steel joists shall only be attached within 3" of the top of the joist panel points. Supports attached at the bottom or beyond 3" of the joist panel points must be approved, in writing, by the Structural Engineer of Record and the Owner before attaching.
- C. Install cables using techniques, practices, and methods that are consistent with Category 5 cables or higher requirements and that support Category 5 or higher performance of completed and linked signal paths, end to end.
- D. Install cables without damaging conductors, shield, or jacket.
- E. Do not bend cables, in handling or in installing, to smaller radii than minimums

recommended by cable manufacturers.

- F. Do not exceed load ratings and allowable fill capacity specified by the cable hook manufacturer.
- G. Install cable hooks to maintain a minimum three (3) inch clear or higher vertical space above the accessible ceiling tiles for the horizontal cabling and pathway.

3.05 CUTTING AND HOLES

- A. Locate holes in advance where they are proposed in structural sections such as ribs or beams. Prior to drilling through any structural section or member, obtain the written approval of the Architect/Structural Engineer of Record and the Owner.
- B. Cut holes through concrete and masonry structures with a diamond core drill or concrete saw. Pneumatic hammer, impact electric, hand or manual hammer type drills are not allowed, except where permitted in advance by the Architect/Engineer and Owner, due to limited working space.
- C. Openings in floor slabs or fire-rated walls or partitions for raceways and other electrical equipment shall, after installation of the raceway, be fire stopped using a product similar to THOMAS & BETTS "Flame-Safe" fire retardant.

3.06 ROOFTOP CONDUIT SUPPORT STRUT SYSTEM

- A. Rooftop conduit support struts shall be installed in accordance with manufacturer's instructions and recommendations.
- B. Determine that the structure, roof insulation, and roof membrane are structurally adequate to support weight of conduits (with conductors), supports and hangers.
- C. Install supports at maximum spacing of 10 feet, unless closer spacing is required due to weight of conduits or as shown on the Drawings. Do not exceed manufacturer's recommended load limits.
- D. Support pads: Remove rock or gravel from area to be covered by pad, apply on clean area, and center bases on top of support pads.
- E. Set conduit in support without dropping or causing undue impact. Install properly sized clamps to suit conduit sizes.
- F. Always consult roofing manufacturer for roof membrane compression capacities. If necessary, a compatible sheet of roofing material (rubber pad) may be installed under rooftop support to disperse concentrated loads and add further membrane protection.
- G. Contractor shall adjust conductor sizes in raceways in accordance with the

National Electrical Code section 310.15(B)(2)(c) based on an average ambient temperature of 84°F.

END OF SECTION

SECTION 16115

SURFACE METAL RACEWAYS

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work covered under this Section shall include furnishing and installing surface mounted metal raceways complete for all electrical systems as shown on the Drawings and herein specified. Surface raceway systems shall consist of raceway bases, covers, appropriate fittings, dividers, and device mounting plates necessary for a complete installation.

1.03 QUALITY ASSURANCE

- A. All equipment, materials, and their installation shall conform to the requirements of the National Electrical Code (NEC), local code requirements, and these Specifications.
- B. All equipment and materials shall be listed by Underwriters Laboratories, Inc. (UL) for their intended use and shall bear the UL label.
- C. Equipment shall be constructed in accordance with National Electrical Manufacturer's Association (NEMA) standards.
- D. Submittals are required in accordance with SECTION 16010 of these Specifications.

1.04 USES PERMITTED

- A. Surface mounted metal raceway shall be used primarily where new wiring is required on existing walls and on new walls as noted on the Drawings.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Deliver raceway systems in factory labeled packages.
- B. Store and handle in strict compliance with manufacturer's written instructions and recommendations.

- C. Protect from damage due to weather, excessive temperature, and construction operations.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Surface metal raceways shall be as manufactured by THE WIREMOLD COMPANY or equal product as manufactured by HUBBELL INCORPORATED, as described herein as the basis of design.
- B. All components and fittings shall be of the same manufacturer, or UL listed as an assembly.

2.02 MATERIALS AND COMPONENTS

- A. All surface metal raceways shall be galvanized steel, unless otherwise indicated. Finish shall be ivory in color (unless otherwise indicated) having a scratch-resistant surface (a polyester topcoat over ivory base) and shall be suitable for field repainting to match surroundings.
- B. A full complement of fittings must be available including but not limited to mounting clips and straps, couplings, flat, internal and external elbows, cover clips, tees, entrance fittings, wire clips, support clips, c-hangers, end caps, conduit connectors, bushings, and take-off fittings to adapt to flush wall boxes. The covers shall be painted with an enamel finish, ivory in color to match the raceway. They shall overlap the raceway to hide uneven cuts. All fittings shall be supplied with a base where applicable to eliminate mitering. Transition fittings shall be available to adapt to other raceways manufactured by The Wiremold Company. This Contractor shall provide all fittings, etc. for a complete installation.
- C. Device boxes shall be suitable for the type of raceways provided and for mounting standard devices and faceplates. Device boxes shall be provided in single- and multiple-gang configurations, up to six-gang. Single-gang boxes shall allow for snap-on and fastener applications. They shall range in depth from 0.94" to 2.75". Extension boxes shall be provided to adapt to existing standard flush switch and receptacle boxes.
- D. The raceway manufacturer shall provide a complete line of connectivity outlets and modular inserts for UTP/STP, fiber optic, coaxial and other cabling types with face plates and bezels to facilitate mounting. A complete line of preprinted station and port identification labels, snap-in icon buttons as well as write-on station identification labels shall be available. Provide as needed for a complete installation.

- E. Raceways used for communications cabling shall have a complete line of full capacity corner elbows and tee fittings, and used where required or shown on the Drawings, to maintain a controlled 2" cable bend radius which meets the specifications for Fiber Optic and UTP/STP cabling and exceeds the TIA 569 requirements for communications pathways.

2.03 SURFACE METAL RACEWAYS

- A. **WIREMOLD Series V500 or V700** raceway shall be one-piece design with a base and cover factory assembled. The total width shall be 3/4" x 17/32" high with a capacity of 1.19 square inches for V500 or 3/4" x 21/32" with a capacity of 0.26 square inches for V700. The raceway base and cover shall be a minimum thickness of 0.040". The raceway shall be available in five (5) foot and ten (10) foot lengths.
- B. **WIREMOLD Series V2400** raceway shall be a single-channel two-piece design with a metal base and snap-on metal cover. The assembled base and cover shall be 1 7/8" wide x 7/8" high with a capacity of 1.39 square inches. The raceway base and cover shall be a minimum thickness of 0.040". The raceway base shall be available in ten (10) foot lengths and the cover shall be available in five (5) foot lengths.
- C. **WIREMOLD Series V3000** raceway shall be a single-channel two-piece design with a metal base and snap-on metal cover. The assembled base and cover shall be 2 3/4" wide x 1 17/32" high with a capacity of 3.70 square inches. The raceway base and cover shall be a minimum thickness of 0.040". The raceway base shall be available in ten (10) foot lengths and the cover shall be available in five (5) foot lengths.
 - 1. Device brackets shall be provided for mounting standard single or two-gang devices within the raceway.
- D. **WIREMOLD Series V4000** raceway shall be a single-or dual-channel two-piece design with a metal base and snap-on metal cover. Base shall be dividable by means of a removable barrier section into two equal compartments. The assembled base and cover shall be 4 3/4" wide x 1 3/4" high with a capacity of 7.20 square inches for undivided raceway and a capacity of 3.10 square inches for each compartment of the divided raceway. The raceway base shall be a minimum thickness of 0.050 inches and the cover with a minimum thickness of 0.040". The raceway base shall be available in ten (10) foot lengths and the cover shall be available in five (5) foot lengths.
 - 1. Plastic device mounting bracket and trim plates shall be provided to install devices horizontally within the raceway. Trim plate shall overlap the cover-eliminating seam. Faceplates shall accept a variety of power

and data/communication devices. Plastic must be compatible with UL 94 for Plastic Materials. Device brackets and trim plates shall be colored to match the raceway.

- E. **WIREMOLD Series S4000** raceway shall be a dual-channel two-piece design with a Type 302 stainless steel base and snap-on cover having a Number 4 brushed finish. Base shall be dividable by means of a removable barrier section into two equal compartments. The assembled base and cover shall be 4 ¾" wide x 1 ¾" high with a capacity of 7.20 square inches for each compartment of the divided raceway. The raceway base shall be a minimum thickness of 0.050 inches and the cover with a minimum thickness of 0.040". The raceway base shall be available in ten (10) foot lengths and the cover shall be available in five (5) foot lengths.
1. Plastic device mounting bracket and trim plates shall be provided to install devices horizontally within the raceway. Trim plate shall overlap the cover-eliminating seam. Faceplates shall accept a variety of power and data/communication devices. Plastic must be compatible with UL 94 for Plastic Materials. Device brackets and trim plates shall be colored to match the raceway.
- F. **WIREMOLD Series V6000** raceway shall be a single-or dual-channel two-piece design with a metal base and snap-on metal cover. Base shall be dividable by means of a removable barrier section into two equal compartments. The assembled base and cover shall be 4 ¾" wide x 3 9/16" high with a capacity of 16.00 square inches for undivided raceway and a capacity of 7.20 square inches for each compartment of the divided raceway. The raceway base shall be a minimum thickness of 0.050 inches and the cover with a minimum thickness of 0.040". The raceway base shall be available in ten (10) foot lengths and the cover shall be available in five (5) foot lengths.
1. Plastic device mounting bracket and trim plates shall be provided to install devices horizontally within the raceway. Trim plate shall overlap the cover-eliminating seam. Faceplates shall be available to accept a variety of power and data/communication devices. Plastic must be compatible with UL 94 for Plastic Materials. Device brackets and trim plates shall be colored to match the raceway.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine conditions under which surface raceways, boxes, distribution systems, accessories, and fittings are to be installed and substrate that will support raceways. Notify the Architect/Engineer and Owner of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory

conditions have been corrected.

3.02 INSTALLATION

- A. Surface raceways shall be installed in strict compliance with the manufacturer's installation instructions and recommendations and approved shop drawings. Coordinate installation with adjacent work to ensure proper clearances and to prevent electrical hazards.
- B. Surface raceways shall be installed parallel with or at right angles to building structure and at the mounting heights noted on Drawings.
- C. Surface raceway systems shall be mechanically continuous and connected to all electrical outlets, boxes, device mounting brackets, and cabinets, in accordance with manufacturer's installation sheets.
- D. Metal raceways shall be electrically continuous and bonded in accordance with the National Electrical Code for proper grounding.
- E. Surface raceway shall be supported at intervals not exceeding five (5) feet or in accordance with manufacturer's installation sheets using appropriate anchors and screws. The use of drive pins and/or other methods using compressed air or gases are not acceptable.
 - 1. V500 and V700 shall be supported using two (2) hole straps specifically designed for the application secured with plastic anchors and No. 6 screws.
- F. Provide accessories as required for a complete installation, including insulated bushings and inserts where required by the manufacturer.
- G. Close all unused raceway openings using manufacturer's recommended accessories.
- H. All surface raceway connections to outlet and/or junction boxes shall be made using adjustable offset connectors or combination connectors as detailed on the Drawings. The connectors shall be furnished by the manufacturer of the surface raceway.
- I. Field cutting of surface raceways base and covers shall be accomplished by the use of the manufacturer's raceway cutters specifically designed for this purpose.

3.03 CLEANING AND PROTECTION

- A. Clean exposed surfaces using non-abrasive materials and methods

recommended by manufacturer.

- B. Protect raceways and boxes until final acceptance by the Owner.
- C. Repaint marred and scratched surfaces with touch-up paint to match original finish.

END OF SECTION

SECTION 16118

POWER POLE SYSTEMS

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work covered under this Section shall include furnishing and installing power pole systems using Tele-Power Poles and/or Vertical Chase Power Communications Delivery Systems (multi-outlet systems) in steel and aluminum, used to provide branch circuit wiring, convenience power outlets, multi-media and other low voltage communications wiring and outlets as shown on the Drawings and herein specified.
 - 1. Tele-Power Poles shall consist of the Tele-Power Pole Multi-outlet Assembly, appropriate fittings and accessories to complete the installation.
 - 2. Vertical Chase Power Communications Delivery Systems (multi-outlet systems) assemble shall consist of modular vertical channels, and appropriate fittings. The system shall consist of a pre-punched support, aluminum end covers and a metallic center panel, which can be adorned with laminate products. Options may include furniture feeds or wired receptacle harnesses, and appropriate fittings to complete the installation.

1.03 QUALITY ASSURANCE

- A. All equipment, materials, and their installation shall conform to the requirements of the National Electrical Code (NEC), local code requirements, and these Specifications.
- B. All equipment and materials shall be listed by Underwriters Laboratories, Inc. (UL) for their intended use and shall bear the UL label.
- C. Equipment shall be constructed in accordance with National Electrical Manufacturer's Association (NEMA) standards.
- D. Submittals are required in accordance with SECTION 16010 of these Specifications.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Deliver power pole systems in factory labeled packages.
- B. Store and handle in strict compliance with manufacturer's written instructions and recommendations.
- C. Protect from damage due to weather, excessive temperature, and construction operations.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Power pole systems shall be as manufactured by THE WIREMOLD COMPANY, as described herein as the basis of design, or equal product as manufactured by HUBBELL INCORPORATED.
- B. All components and fittings shall be of the same manufacturer, or UL listed as an assembly.

2.02 TELE-POWER POLES

- A. The Tele-Power Pole shall be WIREMOLD Cat. No. 30TP-4V.
 - 1. The Tele-Power Pole channel shall be steel, ivory baked enamel finish with a cross section of 3" x 2.75" with two (2) separate compartments. One compartment is to be factory wired with two (2) duplex 2 pole, 3 wire, 20A, 125V NEMA 5-20R receptacles (Pass & Seymour Cat. No. 5362AI), ivory colored to match the pole finish. The harness is to be single circuit (2 conductor plus ground) with #12 AWG solid type THHN conductors, factory assembled to the receptacles, unless otherwise shown on the Drawings. Minimum 6" conductor leads shall be furnished for termination to the overhead wiring system.
 - 2. The second compartment shall be for field installation of low voltage communications cabling. A 12" removable cover section in this compartment must be provided to assemble and mount communications connectors. This section must be removable without dismantling or removing the Tele-Power Pole after installation. The cover section is to have four (4) knockouts for modular voice-data, video, multi-media outlets or ports and a 1.375" x 2.7" rectangular knockout for a modular furniture outlet. A "mouse hole" knockout with furnished grommet shall

be included for straight through communication cable access.

3. The Tele-Power Pole shall be 10'-5" or 12'-5" long to suit the location installed.
- B. Fittings: A full complement of fittings for the Tele-Power Pole shall include, but not limited to, entrance end fitting for top of the electrical channel, ceiling trim plate, pole-mounted bracket, Velco™ carpet gripper pad and adhesive pad. Provide all fittings necessary for a complete installation.
1. If for air handling spaces, an entrance end fitting must be furnished for the low voltage communications channel.
- C. Add-On Device Covers:
1. The Tele-Power Pole must be UL listed for field modification, changes and additions of receptacles, devices and circuits. Field installed device plates shall be available to add duplex, single 1.40" and 1.59" diameter, and rectangular type receptacles. These plates must be ivory in color to match the pole.
 2. Add-on communications covers must be available to mount workstation device faceplates, inserts, and specialty mounting bezels. The power pole manufacturer shall provide a complete line of connectivity outlets and multi-media modular inserts for UTP, fiber optic, coaxial, and other cabling types to suit the project requirements.
 3. UTP inserts shall feature a unique recessed area for port labeling and shall be able to accommodate designation icon buttons or icon labels. Custom label capabilities shall be available using templates that can be downloaded from the Internet.

2.03 VERTICAL CHASE POWER & COMMUNICATIONS DELIVERY ASSEMBLIES

- A. The Vertical Power & Communications Deliver Assemblies shall be the WIREMOLD VISTA ARCHITECTURAL COLUMN SYSTEM SERIES. **[Engineer, provide a complete catalog number here or on the drawings if more than one type is needed for the project]**
- B. Frames shall be mill finished 6063-T6 aluminum with snap on steel and/or aluminum covers and satin anodized aluminum end caps. Covers and access panels may also be painted over and are suitable for field painting.
1. The frame shall be a four (4) piece design with two center supports and snap-on covers and end caps, yielding a total of three (3) useable wire and cable channels. The product shall be available in two (2) sizes –

- small and large, as shown on the Drawings or indicated herein. The total small width shall be 8.9" x 3.8" deep. The large size shall be 13.4" wide x 3.8" deep. The aluminum extrusions shall be a minimum thickness of 0.06", and steel covers 0.040". The system shall be available in 10'-6" height. The system shall be provided with an extension kit that includes aluminum tubes to allow for varying ceiling heights up to 15'-0" where needed. Access panels and covers up to a height of 30" above finished floor shall provide access to wiring and devices.
2. The frame supports shall include factory pre-punched holecuts for communication receptacles and trade knockouts for electrical termination.
- C. The panels finishes and colors shall be as selected by the Architect/Engineer or as shown on the Drawings. The finishes and panels availability shall be a follows:
1. The center panels shall be constructed of painted steel, aluminum or stainless steel in 96", 30", 24", and 6" heights. The center panel finishes available from the manufacturer shall include wood laminate, metal laminate, nonmetallic laminate, fabric, and a painted surface. Perforated metal in painted steel and glass panels shall be available for the upper sections. An open center option shall also be offered. This option consists of a metallic panel from the floor to 30" high. The remainder of the center section is open to the ceiling. **[Engineer to coordinate with the Architect and edit as needed. If necessary develop types to be used if they are more than one type. A schedule on the drawings may need to be developed with catalog numbers if not done above.]**
- D. A full complement of fittings shall include, but not limited to, internal braces with knockouts, snap-in dividers and wire clips, ceiling and carpet trim pieces. The fittings shall be manufactured of extruded aluminum, galvanized steel, and/or plastic.
- E. Multi-outlet wiring harnesses shall consist of 2 pole, 3 wire, 20A, 125V NEMA 5-20R receptacles (Pass & Seymour Cat. No. 5362AI). The harness shall be a single circuit (2 conductor plus ground) or two circuit (4 conductor plus ground) wiring configurations as indicated on the Drawings. The wires shall be #12 AWG solid type THHN conductors, factory assembled to the receptacles.
- F. A plate with openings and knockouts shall be provided for a furniture feed option, when shown on the Drawings, to feed a modular furniture system.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine conditions under which power pole systems, accessories, and fittings are to be installed and substrate that will support systems. Notify the Architect/Engineer and Owner of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Prior to and during installation, refer to the system layout drawing containing all elements of the system. Contractor shall comply with detailed manufacturer's instruction sheets, which shall accompany system components as well as complete system instruction sheets, using whichever is applicable. Coordinate installation with adjacent work to ensure proper clearances and to prevent electrical hazards.
- B. System poles shall be plumb and securely supported at the ceiling and the floor in accordance with manufacturer's installation sheets.
- C. All systems shall be mechanically continuous and connected to all electrical outlets, boxes, device mounting brackets, and cabinets, in accordance with manufacturer's installation sheets.
- D. The system shall be electrically continuous and bonded in accordance with the National Electrical Code for proper grounding.
- E. Provide accessories as required for a complete installation, including insulated bushings and inserts where required by the manufacturer.
- F. Close all unused openings where wire is exposed using manufacturer's recommended accessories.

3.03 CLEANING AND PROTECTION

- A. Clean surfaces using non-abrasive materials and methods recommended by manufacturer.
- B. Protect power poles until final acceptance by the Owner.
- C. Repaint marred and scratched surfaces with touch-up paint to match original finish.

END OF SECTION

SECTION 16120

WIRE, CABLE, AND CONNECTORS

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work covered under this Section shall include furnishing and installing wire, metal-clad cable, two hour fire rated conduit cable, and connectors for all power wiring systems as shown on the Drawings and herein specified.
- B. Wiring for data, communication, electronic, fire alarm, or other low voltage and special systems shall be provided as specified in the appropriate specialty Section of these Specifications.

1.03 QUALITY ASSURANCE

- A. All equipment, materials, and their installation shall conform to the requirements of the National Electrical Code (NEC), local code requirements, and these Specifications.
- B. All equipment and materials shall be listed by Underwriters Laboratories, Inc. (UL) for their intended use and shall bear the UL label.
- C. Equipment shall be constructed in accordance with National Electrical Manufacturer's Association (NEMA) standards.
- D. Submittals are required in accordance with SECTION 16010 of these Specifications.
 - 1. Submittals shall include a preliminary schedule to perform the infrared scans described in Part 3 of this specification. The schedule shall be based on the contractual substantial completion date for this project.

PART 2 - PRODUCTS

2.01 MATERIALS AND COMPONENTS

- A. All conductors shall be new soft drawn high conductivity copper and shall be

delivered to the site in their original unbroken packages plainly marked as follows:

1. UL Label.
 2. Size, type and insulation rating of the wire marked every four (4) feet along the length.
 3. Name of the manufacturing company and the trade name of the wire.
- B. All conductors shall have 600 volt insulation, unless specified otherwise. The minimum operating temperature of the conductor's insulation shall be 75° C.
- C. Where conductors are installed in a raceway, in dry and damp locations, conductor insulation shall be rated 75° C. Type THWN or dual rated THWN/THHN.
- D. Where conductors are installed in a raceway, exposed to excessive temperatures, conductor insulation shall be rated 90° C. Type THHN, THWN/THHN (dual rated), XHHW or XHHW-2.
- E. Where conductors are installed in a raceway, in wet locations, conductor insulation shall be rated 75° C. Type XHHW (wet locations), or XHHW-2 rated 90° C. (dry and wet locations) as appropriate.
- F. Conductors on the secondary side of variable frequency drives (VFD) shall be Type XHHW or XHHW-2 as appropriate.
- G. The minimum conductor size shall be No. 12 AWG, except for control wiring (minimum size shall be No. 14 AWG), and as stated in other Sections of these Specifications, or as shown on the Drawings. Conductors for 120/277 volt control signals shall not be considered as control wiring.
- H. Branch circuits for emergency lighting, including illuminated exit signs, shall be a minimum of No. 10 AWG.
- I. Conductors smaller than No. 8 shall be solid; No. 8 and larger shall be stranded.
- J. All conductors throughout the project shall be color coded to identify phases, neutral, and ground. Color-coding shall be as follows:

<u>CONDUCTORS</u>	<u>SYSTEM VOLTAGE</u>	
	<u>120/208</u>	<u>277/480</u>
Phase A	Black	Brown
Phase B	Red	Orange
Phase C	Blue	Yellow

Neutral
Ground

White
Green

Gray
Green

- K. Insulated conductors size No. 6 A.W.G. and smaller shall have the insulation color-code identification factory applied for the entire length of the conductor. On larger sizes, provide color-coded phasing tape at each box and connection. White or gray colored insulation shall only be used for grounded (neutral) conductors. For multiple neutrals run in the same conduit, provide separate neutral conductors with a continuous, factory applied tracer stripe matching the color of the respective phase conductor. Green colored insulation shall only be used for equipment grounding conductors.
- L. Where conductor size is not indicated, its current carrying capacity shall be equal to or greater than the rating of its overcurrent protective device.
- M. Where conductor sizes are increased for voltage drop or other reasons the equipment grounding conductor (when provided) shall be increased in size proportionately.
- N. Where conductor sizes are increased for voltage drop they may be reduced in size within ten feet of the termination in order to fit under the lugs available on the overcurrent protective device but not less than the ampacity of the frame size of the overcurrent protective device.

2.02 METAL-CLAD CABLE

- A. The Contractor shall furnish and install where shown on the Drawings or specified herein, metal-clad cable, type "MC", of the size and number of conductors noted on the Drawings. The metal-clad cable shall be a factory assembly of one or more conductors, including a green insulated ground wire enclosed in a galvanized steel interlocked metallic sheath. Metal-clad cable with an aluminum sheath will not be acceptable.
- B. Conductors shall be copper with a minimum size of No. 18 A.W.G., solid (through No. 10 A.W.G.) or stranded (No. 8 and larger), Type THHN/THWN (90° C.), and 600 volt. Color-coding of conductors shall be as hereinbefore described.
- C. Fittings for metal-clad cable shall be all steel, approved for use with metal-clad cable. Cast pot metal types are not acceptable.
- D. Metal-clad cable shall be UL listed and marked in accordance with NEC Article 310.120. Manufacturer's standard color-coding on the exterior sheath may be used. Metal-clad cable shall be as manufactured by AFC CABLE SYSTEMS or CM & ELKINS (CME) WIRE AND CABLE or SOUTHWIRE COMPANY.

PART 3 - EXECUTION

3.01 IDENTIFICATION OF CONDUCTORS

- A. All branch circuits, including grounded (neutral) conductors, shall be tagged in the panelboards, in all gutters, and in all junction boxes where circuits terminate for the purpose of identifying the various circuits.
- B. Feeders and mains shall be tagged in the distribution switchboards, panelboards, and within junction and pull boxes.
- C. The method of tagging shall be with an adhesive type of marker. Tagging shall clearly distinguish between 120/208 volt and 277/480 volt conductors.
- D. Tags shall be applied after wire is installed in conduit.
- E. Where it is impractical to use printed markers on certain wires or cables, use blank type with identification marked thereon in indelible pencil.

3.02 INSTALLATION

- A. Conduit/raceway system shall be complete prior to pulling in wires.
- B. Any run of conduit/raceway which does not permit conductors to be pulled in readily shall be condemned and replaced to the satisfaction of the Architect/Engineer and Owner.
- C. Conductors shall be continuous between outlets or junction boxes and no splices shall be made except in outlet boxes, junction boxes, and handholes.
- D. Do not combine systems of various voltages or circuits from separate sources in the same raceway or conduit system, regardless of the voltage rating of the conductors, unless otherwise shown on the Drawings.
- E. All joints, splices and taps for conductor sizes No. 10 and smaller (including luminaire pigtails) shall be connected with approved type crimp connectors, or spring type screw-on connectors (wire-nuts) with insulating skirts; No. 8 and larger shall be connected with solderless THOMAS & BETTS high pressure connectors with heat shrink insulation that possess equivalent or better mechanical strength and insulation ratings than that of the unspliced conductor. Refer to Specification Section 16110 for splices and taps within wiring troughs. The use of pressure connectors is **not** acceptable.
- F. Oil, grease or silicon, which could damage the insulation of the conductors or

- cables, shall not be used when pulling conductors. Use only UL approved cable lubricants approved for the purpose.
- G. Train conductors neatly in panelboards, cabinets, and other electrical equipment. Installed conductors shall allow for a minimum of one (1) future re-termination.
 - H. Tighten pressure type lugs on switchboards, panelboards, motors and other equipment to the manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and 486B.
 - I. Conductors in vertical conduit runs shall be supported with split-wedge type fittings that clamp each conductor and tighten under the weight of the conductors at intervals required by the NEC.
 - J. All wiring within the building structure, crawlspaces, and slabs shall be installed in conduit unless indicated or specified otherwise.
 - K. Homeruns longer than seventy five (75) feet from a 120/208 volt panelboard or one hundred seventy five (175) feet from a 277/480 volt panelboard shall be not less than No. 10 AWG, copper.
 - L. No more than three (3) current carrying phase conductors shall be installed in any one conduit, unless explicitly shown on the drawings.
 - M. Connect circuits and feeders as shown on the Drawings. Drawings are diagrammatic and do not show every detail required in the wiring system.
 - N. Install wiring so conductors are not in tension in completed systems.
 - O. All conductors making up parallel feeders shall be the same size, same type, same insulation and all cut the same length. Bond each group of conductors making up a phase or neutral at both ends in an approved manner. Parallel conductors shall not be run in the same raceway.
 - P. Provide a separate neutral and grounding conductor (or conduit ground) for all GFI circuits or GFI devices to ensure an adequate ground-fault path.
 - Q. Branch circuits requiring a neutral conductor shall have one neutral conductor per phase conductor when installed in a common raceway, unless specifically shown otherwise on the Drawings.
 - R. Conductors or cables installed in conduit or tubing exposed to direct sunlight on rooftops require temperature adjustment factors in accordance with the values in NEC 2008 Table 310.15(B)(2)(c).

3.03 METAL-CLAD CABLE

- A. Metal-clad cable may be used in dry locations for connections in casework, for “fished” applications in existing partitions or walls, above accessible ceilings in classrooms, offices and similar locations and within newly installed drywall partitions. Metal-clad cable may also be used as a “whip” connection from an outlet box (secured to the building structure) to a recessed luminaire (lighting fixture) (minimum, 4 feet; maximum, 6 feet in length) above accessible ceilings in lieu of flexible metal conduit as stated in Section 16110.
- B. Metal-clad cable may not be used for feeders, homeruns or within corridors, except for recessed luminaire (lighting fixture) connections as described above. Metal-clad cable shall not be used in areas without a ceiling, in areas without an accessible ceiling or from corridors into adjacent rooms.
- C. Metal-clad cable shall be installed and supported in accordance with NEC Article 330.30 and these specifications. Supports shall be zinc-coated or equivalent corrosion protection. Individual hangers, straps or similar fittings shall be used and installed at intervals so as not to damage the cable. Where fastened to walls use appropriate anchors and screws, the use of drive pins and/or other methods using compressed air or gases are not acceptable. Supports shall **not** terminate or be fastened directly to the roof decking. MC Cable under roof decking shall not be less than 1½ inches from the nearest surface of the roof decking. Supports attached to structural steel joists shall only be attached within 3” of the top of the joist panel points. Supports attached at the bottom or beyond 3” of the top of the joist panel points must be approved, in writing, by the Structural Engineer of Record and the Owner before attaching. Staples are not permitted to be used for supports.
- D. Bending radius for the metal-clad cable shall be in accordance with NEC Article 330.24.
- E. Fittings used for connecting the metal-clad cable to boxes, cabinets, or other equipment shall be all steel UL listed and identified for such use.
- F. Metal-clad cable shall be installed parallel or perpendicular to walls. No diagonal runs shall be permitted.
- G. Metal-clad cable shall not be installed within three (3) inches of hot water pipes, or appliances, except at crossings where metal-clad cable shall be a least one (1) inch from pipe cover.
- H. Metal-clad cable shall not interfere with accessible ceiling tiles. Access to electrical or other equipment shall not be denied by runs of MC cable that prevent removal of panels, including suspended ceiling panels.
- I. Flattened, dented, deformed, or open armor is not permitted. If damaged during installation, damaged cables shall be replaced with new undamaged material.

- J. Horizontal or cross runs in solid masonry partitions or walls shall not be permitted.
- K. All horizontal penetrations through new or existing walls (except solid walls) shall be sleeved. No other type of wiring systems shall occupy the same penetration sleeve with the MC cable. Sleeve penetrations through fire-rated walls, after installation of MC cables, shall be fire stopped using a product similar to THOMAS & BETTS "Flame-Safe" fire retardant.

3.04 FIELD QUALITY CONTROL

- A. After installing conductors and cables and before electrical circuitry has been energized, perform the following visual and mechanical inspections:
 - 1. Verify cables and conductors comply with the contract documents.
 - 2. Verify cables and conductors are braced for short circuit stresses where specified.
 - 3. Verify cables and conductors are correctly identified at each termination, splice and tap where applicable.
 - 4. Verify correct phase rotation is maintained throughout project.
 - 5. Verify color coding and identification complies with specifications and the National Electrical Code.
 - 6. Inspect all exposed sections of cables and conductors for physical damage and correct connection.
 - 7. Inspect all bolted and compression connections.
- B. Verify phase identification is A, B, C, left to right, front to back and top to bottom. If corrections are required, change feeder and branch circuit identification at each end of circuit so that correct phase identification is maintained throughout the project. If incorrect identification is noted on existing systems, notify the Architect/Engineer and Owner for action to be taken.
- C. Infrared Scanning: After Substantial Completion, but not more than sixty (60) days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger and a complete infrared scan of each panel board, switchboard, and lug terminations of each chiller and motor terminations 20 HP and larger. Remove box and equipment covers so splices and lugs are accessible to portable scanner.
 - 1. Perform a follow-up infrared scan for all splices and terminations previously described approximately eleven (11) months after date of

- Substantial Completion, but must be during normal school (business) operating hours.
2. Contractor shall submit to the Architect/Engineer and Owner, at time of final inspection, a schedule to perform the infrared scans during normal school (business) operating hours while the building is in full operation, under load. Re-terminations requiring any power shut-downs must be coordinated with the Owner and performed during non-school (business) hours.
 3. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 4. Record of Infrared Scanning: Prepare a certified report that identifies equipment and splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.
- D. Remove and replace malfunctioning units, then verify, inspect and retest as specified above.

END OF SECTION

SECTION 16121

WIRE, CABLE, AND CONNECTORS

(Engineer: Use this section in lieu of 16120 when directed by FCPS)

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work covered under this Section shall include furnishing and installing wire, metal-clad cable, two hour fire rated conduit cable, and connectors for all power wiring systems as shown on the Drawings and herein specified.
- B. Wiring for data, communication, electronic, or other low voltage and special systems shall be provided as specified in the appropriate specialty section of these Specifications.

1.03 QUALITY ASSURANCE

- A. All equipment, materials, and their installation shall conform to the requirements of the National Electrical Code (NEC), local code requirements, and these Specifications.
- B. All equipment and materials shall be listed by Underwriters Laboratories, Inc. (UL) for their intended use and shall bear the UL label.
- C. Equipment shall be constructed in accordance with National Electrical Manufacturer's Association (NEMA) standards.
- D. Submittals are required in accordance with SECTION 16010 of these Specifications.

PART 2 - PRODUCTS

2.01 MATERIALS AND COMPONENTS

- A. All conductors shall be new soft drawn high conductivity copper, except as otherwise allowed in these Specifications for aluminum conductors, and shall be delivered to the site in their original unbroken packages plainly marked as follows:

1. UL Label.
 2. Size, type, voltage rating and insulation rating of the wire marked every four (4) feet along the length.
 3. Name of the manufacturing company and the trade name of the wire.
- B. This Contractor may at his option provide distribution feeder conductors sizes No. 1/0 AWG to 1000 Kcmil made of aluminum alloy instead of copper conductors. Aluminum alloy conductors shall be compact stranded conductors of a recognized Aluminum Association 8000 Series aluminum alloy conductor material (AA-8000 series alloy) and shall be delivered to the site in their original unbroken packages plainly marked as follows:
1. UL Label.
 2. Size, type, voltage rating and insulation rating of the wire marked every four (4) feet along the length.
 3. Name of the manufacturing company and the trade name of the wire.
- C. AA-8000 series alloy shall be Alcan Cable STABILOY or approved equal.
- D. All conductors shall have 600 volt insulation, unless specified otherwise.
- E. The minimum operating temperature of copper conductor's insulation shall be 75° C.
- F. The minimum operating temperature of all aluminum conductors' insulation shall be 90° C. rated Type XHHW-2, suitable for dry and wet locations.
- G. Where copper conductors are installed in a raceway, in dry and damp locations, conductor insulation shall be rated 75° C. Type THWN or dual rated THWN/THHN.
- H. Where copper conductors are installed in a raceway, exposed to excessive temperatures, conductor insulation shall be rated 90° C. Type THHN, THWN/THHN (dual rated), XHHW or XHHW-2.
- I. Where copper conductors are installed in a raceway, in wet locations, conductor insulation shall be rated 75° C. Type XHHW (wet locations), or XHHW-2 rated 90° C. (dry and wet locations) as appropriate.
- J. Conductors on the secondary side of variable frequency drives (VFD) shall be copper type XHHW or XHHW-2 as appropriate.

- K. The minimum conductor size shall be No. 12 AWG except for control wiring (minimum size shall be No. 14 AWG), and as stated in other sections of these Specifications, or as shown on the Drawings. Conductors for 120/277 volt control signals shall not be considered as control wiring.
- L. Branch circuits for emergency lighting, including illuminated exit signs, shall be a minimum of No. 10 AWG.
- M. Conductors smaller than No. 8 shall be solid; No. 8 and larger shall be stranded.
- N. All conductors throughout the project shall be color coded to identify phases, neutral, and ground. Color-coding shall be as follows:

<u>CONDUCTORS</u>	<u>SYSTEM VOLTAGE</u>	
	<u>120/208</u>	<u>277/480</u>
Phase A	Black	Brown
Phase B	Red	Orange
Phase C	Blue	Yellow
Neutral	White	Gray
Ground	Green	Green

- O. Insulated conductors size No. 6 AWG and smaller shall have the insulation color-code identification factory applied for the entire length of the conductor. On larger sizes, provide color-coded phasing tape at each box and connection. White or gray colored insulation shall only be used for grounded (neutral) conductors. For multiple neutrals run in the same conduit, provide separate neutral conductors with a continuous, factory applied tracer stripe matching the color of the respective phase conductor. Green colored insulation shall only be used for equipment grounding conductors.
- P. Where conductor size is not indicated, its current carrying capacity shall be equal to or greater than the rating of its overcurrent protective device.
- Q. Where conductor sizes are increased for voltage drop or other reasons the equipment grounding conductor (when provided) shall be increased in size proportionately.
- R. Where conductor sizes are increased for voltage drop they may be reduced in size within ten feet of the termination in order to fit under the lugs available on the overcurrent protective device but not less than the ampacity of the frame size of the overcurrent protective device.

2.02 METAL-CLAD CABLE

- A. The Contractor shall furnish and install where shown on the Drawings or specified herein, metal-clad cable, type "MC", of the size and number of

conductors noted on the Drawings. The metal-clad cable shall be a factory assembly of one or more conductors, including a green insulated ground wire enclosed in a galvanized steel interlocked metallic sheath. Metal-clad cable with an aluminum sheath will not be acceptable.

- B. Conductors shall be copper with a minimum size of No. 18 A.W.G., solid (through No. 10 A.W.G.) or stranded (No. 8 and larger), type THHN/THWN (90° C), and 600 volt. Color-coding of conductors shall be as hereinbefore described.
- C. Fittings for metal-clad cable shall be all steel, approved for use with metal-clad cable. Cast pot metal types are not acceptable.
- D. Metal-clad cable shall be UL listed and marked in accordance with NEC Article 310.11. Manufacturer's standard color-coding on the exterior sheath may be used. Metal-clad cable shall be as manufactured by AFC CABLE SYSTEMS or CM & ELKINS (CME) WIRE AND CABLE or SOUTHWIRE COMPANY.

PART 3 - EXECUTION

3.01 IDENTIFICATION OF CONDUCTORS

- A. All branch circuits, including grounded (neutral) conductors, shall be tagged in the panelboards, in all gutters, and in all junction boxes where circuits terminate for the purpose of identifying the various circuits.
- B. Feeders and mains shall be tagged in the distribution switchboards and panelboards and within junction and pull boxes.
- C. The method of tagging shall be with an adhesive type of marker. Tagging shall clearly distinguish between 120/208 volt and 277/480 volt conductors.
- D. Tags shall be applied after wire is installed in conduit.
- E. Where it is impractical to use printed markers on certain wires or cables, use blank type with identification marked thereon in indelible pencil.

3.02 INSTALLATION

- A. Conduit/raceway system shall be complete prior to pulling in wires.
- B. Any run of conduit/raceway which does not permit conductors to be pulled in readily shall be condemned and replaced to the satisfaction of the Architect/Engineer and Owner.
- C. Conductors shall be continuous between outlets or junction boxes and no splices shall be made except in outlet boxes, junction boxes, and handholes.

- D. Do not combine systems of various voltages or circuits from separate sources in the same raceway or conduit system, regardless of the voltage rating of the conductors, unless otherwise shown on the Drawings.
- E. All joints, splices and taps for conductor sizes No. 10 and smaller (including fixture pigtails) shall be connected with approved type crimp connectors, or spring type screw-on connectors (wire-nuts) with insulating skirts; No. 8 and larger shall be connected with solderless THOMAS & BETTS high pressure connectors with heat shrink insulation that possess equivalent or better mechanical strength and insulation ratings than that of the unspliced conductor. Refer to Specification Section 16110 for splices and taps within wiring troughs.
- F. Oil, grease or silicon, which could damage the insulation of the conductors or cables, shall not be used when pulling conductors. Use only UL approved cable lubricants approved for the purpose.
- G. Train conductors neatly in panelboards, cabinets, and other electrical equipment. Installed conductors shall allow for a minimum on one (1) future re-termination.
- H. Tighten pressure type lugs on switchboards, panelboards, motors and other equipment to the manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and 486B.
- I. Conductors in vertical conduit runs shall be supported with split-wedge type fittings that clamp each conductor and tighten under the weight of the conductors at intervals required by the NEC.
- J. All wiring within the building structure, crawlspaces, and slabs shall be installed in conduit unless indicated or specified otherwise.
- K. Homeruns longer than seventy five (75) feet from a 120/208 volt panelboard or one hundred seventy five (175) feet from a 277/480 volt panelboard shall be not less than No. 10 AWG, copper.
- L. No more than three (3) current carrying phase conductors shall be installed in any one conduit, unless explicitly shown on the Drawings.
- M. Connect circuits and feeders as shown on the Drawings. Drawings are diagrammatic and do not show every detail required in the wiring system.
- N. Install wiring so conductors are not in tension in completed systems.
- O. All conductors making up parallel feeders shall be the same size, same type, same insulation and all cut the same length. Bond each group of conductors making up a phase or neutral at both ends in an approved manner. Parallel

- conductors shall not be run in the same raceway.
- P. Provide a separate neutral and grounding conductor (or conduit ground) for all GFI circuits or GFI devices to ensure an adequate ground-fault path.
 - Q. Branch circuits requiring a neutral conductor shall have one neutral conductor per phase conductor when installed in a common raceway, unless specifically shown otherwise on the Drawings.
 - R. Conductors or cables installed in conduit or tubing exposed to direct sunlight on rooftops require temperature adjustment factors in accordance with the values in NEC 2008 Table 310.15(B)(2)(c).

3.03 ALUMINUM CONDUCTORS

- A. All conductors shown on the Drawings are based on copper conductors. Should this Contractor choose to use aluminum conductors, then the Contractor shall submit to the Architect/Engineer detailed equivalent conductor and conduit conversion schedules and supporting data for each feeder using aluminum conductors. This shall be part of the shop drawing submittals.
- B. Aluminum conductors shall only be used for feeder connections between switchboards and panelboards, panelboards and panelboards, and transformers and panelboards. Connections to utilization equipment or devices ahead of or behind of utilization equipment shall not be allowed.
- C. Bus connections shall be made with compression-type lugs. Lugs shall be sized for aluminum conductors and marked with wire size, die index, number and location of crimps, and shall be suitably color coded. Lug barrel shall be factory pre-filled with a joint compound listed by UL. Terminations to copper bus shall be plated or galvanized harden steel bolts, nuts and Belleville conical spring washers of the types and materials recommended by the aluminum conductor manufacturer.
- D. Connectors shall be dual rated (AL7CU or AL9CU) and listed by UL for use with aluminum or copper conductors and sized to accept aluminum conductors of the ampacity specified.
- E. All terminations shall be protected with properly applied oxidation-inhibitors.
- F. Lubricate and tighten all hardware as per the manufacturer's recommendations.

3.04 METAL-CLAD (MC) CABLE

- A. Metal-clad cable may be used for connections in casework, for "fished" applications in existing partitions or walls, above accessible ceilings in classrooms, offices and similar locations and within newly installed drywall partitions. Metal-clad cable may also be used as a "whip" connection from an

outlet box (secured to the building structure) to a recessed luminaire (lighting fixture) (minimum, 4 feet; maximum, 6 feet in length) above accessible ceilings in lieu of flexible metal conduit as stated in Section 16110.

- B. Metal-clad cable may not be used for homeruns or within corridors, except for recessed luminaire (lighting fixture) connections as described above. Metal-clad cable shall not be used in areas without a ceiling, in areas without an accessible ceiling or from corridors into adjacent rooms.
- C. Metal-clad cable shall be installed and supported in accordance with NEC Article 330.30 and these Specifications. Supports shall be zinc-coated or equivalent corrosion protection. Individual hangers, straps or similar fittings shall be used and installed at intervals so as not to damage the cable. Supports shall not terminate or be fastened directly to the roof decking. MC cable under roof decking shall not be less than 1½ inches from the nearest surface of the roof decking. Supports attached to structural steel joists shall only be attached within 3" of the top of the joist panel points. Supports attached at the bottom or beyond 3" of the joist panel points must be approved, in writing, by the Structural Engineer of Record and the Owner before attaching. Staples are not permitted to be used for supports.
- D. Bending radius for the metal-clad cable shall be in accordance with NEC Article 330.24.
- E. Fittings used for connecting the metal-clad cable to boxes, cabinets, or other equipment shall be all steel UL listed and identified for such use.
- F. Metal-clad cable shall be installed parallel or perpendicular to walls. No diagonal runs shall be permitted.
- G. Metal-clad cable shall not be installed within three (3) inches of hot water pipes, or appliances, except at crossings where metal-clad cable shall be a least one (1) inch from pipe cover.
- H. Metal-clad cable shall not interfere with accessible ceiling tiles. Access to electrical or other equipment shall not be denied by runs of MC cable that prevent removal of panels, including suspended ceiling panels.
- I. Flattened, dented, deformed, or open armor is not permitted. If damaged during installation, damaged cables shall be replaced with new undamaged material.
- J. Horizontal or cross runs in solid masonry partitions or walls shall not be permitted.
- K. All horizontal penetrations through new or existing walls (except solid walls) shall be sleeved. No other type of wiring systems shall occupy the same penetration sleeve with the MC cable. Sleeve penetrations through fire-rated walls, after

installation of MC cables, shall be fire stopped using a product similar to THOMAS & BETTS "Flame-Safe" fire retardant.

3.05 FIELD QUALITY CONTROL

- A. After installing conductors and cables and before electrical circuitry has been energized, perform the following visual and mechanical inspections:
1. Verify cables and conductors comply with the contract documents.
 2. Verify cables and conductors are braced for short circuit stresses where specified.
 3. Verify cables and conductors are correctly identified at each termination, splice and tap where applicable.
 4. Verify correct phase rotation is maintained throughout project.
 5. Verify color coding and identification complies with Specifications and the National Electrical Code.
 6. Inspect all exposed sections of cables and conductors for physical damage and correct connection.
 7. Inspect all bolted and compression connections.
- B. Verify phase identification is A, B, C, left to right, front to back and top to bottom. If corrections are required change feeder and branch circuit identification at each end of circuit so that correct phase identification is maintained throughout the project. If incorrect identification is noted on existing systems, notify the Architect/Engineer and Owner for action to be taken.
- C. Infrared Scanning: After Substantial Completion, but not more than sixty (60) days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger and a complete infrared scan of each panel board, switchboard, and lug terminations of each chiller and motor terminations 20 HP and larger. Remove box and equipment covers so splices and lugs are accessible to portable scanner.
1. Perform a follow-up infrared scan for all splices and terminations previously described approximately eleven (11) months after date of Substantial Completion, but must be during normal school (business) operating hours.
 2. Contractor shall submit to the Architect/Engineer and Owner, at time of final inspection, a schedule to perform the infrared scans during normal school (business) operating hours while the building is in full operation, under load. Re-terminations requiring any power shut-downs must be

- coordinated with the Owner and performed during non-school (business) hours.
3. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 4. Record of Infrared Scanning: Prepare a certified report that identifies equipment and splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.
- D. Remove and replace malfunctioning units then verify, inspect and retest as specified above.

END OF SECTION

SECTION 16130

WIRING DEVICES

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work covered under this Section shall include furnishing and installing wiring devices, for all electrical systems as shown on the Drawings and herein specified.

1.03 QUALITY ASSURANCE

- A. All equipment, materials, and their installation shall conform to the requirements of the National Electrical Code (NEC), local code requirements and these Specifications.
- B. All equipment and materials shall be listed by Underwriters Laboratories, Inc. (UL) for their intended use and shall bear the UL label.
- C. All 125 volt and 250 volt, 15 amp and 20 amp receptacles (NEMA 5-15R, 5-20R, 6-15R, 6-20R, L5-15R, and L5-20R) shall be FSUL WC-596-G compliant and bear the FSUL label.
- D. All non-locking 125 volt and 250 volt, 15 amp and 20 amp receptacles (NEMA 5-15R, 5-20R, 6-15R and 6-20R) located in damp or wet locations shall be UL listed as "weather resistant".
- E. All lighting switches shall be FSUL WS-896 compliant and bear the FSUL label.
- F. Equipment shall be constructed in accordance with National Electrical Manufacturer's Association (NEMA) standards.
- G. Submittals are required in accordance with SECTION 16010 of these Specifications.
 - 1. Certain wiring devices and other equipment listed hereinafter may not be part of this project. This Contractor shall select from the listed devices the equipment necessary to be compliant with the Contract Documents and include in the submittals only the devices and equipment specific for this project.

PART 2 - PRODUCTS

2.01 LIGHTING SWITCHES

- A. Lighting switches shall be manufactured by PASS & SEYMOUR (P&S) as listed below or the equivalent as manufactured by COOPER (ARROW HART), HUBBELL, or LEVITON.
- B. Lighting switches shall be totally enclosed, 20 amp, 120-277 volt with screw-type wire terminals to accept No. 14 through No. 10 AWG solid copper conductors, ivory thermoplastic toggle, and grounding terminal, or Plug Tail Type. All locking type switches shall be keyed alike. Lighting switches shall be as follows:
- | | | |
|-----|---|------------------------|
| 1. | Single pole | P&S cat. no. PS20AC1I |
| 2. | Single pole (PlugTail type) | PT20AC1I |
| 3. | Single pole, locking type | P&S cat. no. PS20AC1IL |
| 4. | Single pole, double throw-
two circuit, center off | P&S cat. no. 1221I |
| 5. | Three –way | P&S cat. no. PS20AC3I |
| 6. | Three-way (PlugTail type) | PT20AC3I |
| 7. | Three-way, locking type | P&S cat. no. PS20AC3IL |
| 8. | Four-way | P&S cat. no. PS20AC4I |
| 9. | Four-way, locking type | P&S cat. no. PS20AC4IL |
| 10. | Momentary contact | P&S cat. no. 1251I |
| 11. | Momentary contact,
locking type | P&S cat. no. 1251L |
- C. All PlugTail lighting switches shall come complete minimum six (6) inch solid THHN Connector. Stranded connectors shall not be acceptable.
- D. Pilot lighting switches shall be totally enclosed, 20 amp, 120 volt and 277 volt with screw type wire terminals to accept No. 14 through No. 10 AWG solid copper conductors, red “lighted when ON” lighted toggle, and grounding terminal. Pilot lighted switches shall be as follows:

1. Single pole (120V) P&S cat. no. PS20AC1RPL
 2. Single pole (277V) P&S cat. no. PS20AC1RPL7
 3. Three-way (120V) P&S cat. no. PS20AC3RPL
 4. Three-way (277V) P&S cat. no. PS20AC3RPL7
- E. Digital lighting control switches required under Specification SECTION 16500 shall be part of the lighting control system.
- F. Wall switch occupancy sensors are specified under Specification SECTION 16506.

2.02 MOTOR SWITCHES

- A. Motor switches shall be totally enclosed, 30 amp, 600 volt with screw-type wire terminals to accept solid copper conductors and a grounding terminal. Motor switches shall be as follows:
1. Single phase, double pole P&S cat. no. 7802MD
 2. Three phase, three pole P&S cat. no. 7803MD
- B. Motor switches shall include a red pilot light with the switch or on a separate mounting strap in a two gang outlet box and suitable coverplate. Pilot light shall glow red when switch is ON. Pilot lights shall be suitable for the voltage supplied to the motor switch. Pilot light on a separate mounting strap shall be P&S cat. No. 2151RED or approved equal.
- C. Mechanical door limit switches shall be Mars Corporation part no. 99-014 – 250 volt, 1 phase, 20 amp, 1 HP max or approved equal.

2.03 WALL DIMMER SWITCHES

- A. Wall dimmer switches shall be with ivory faceplate 0 to 10 volt, of the voltage indicated. PASS & SEYMOUR cat. no. CD4FBL3PI, or equivalent.
- B. Wall dimmer switches for tubular daylighting device shall be 0 to 10 volt, of the voltage indicated; LUTRON "Diva" cat. no. DVSTV-453PH-WH or equal by PASS & SEYMOUR.

2.04 RECEPTACLES

- A. Receptacles shall be manufactured by PASS & SEYMOUR (P&S) as listed below or the equivalent as manufactured by COOPER (ARROW HART), HUBBELL, or LEVITON.

- B. All straight blade 15A and 20A receptacles in elementary schools only, shall be tamper-resistant type, except clock outlet receptacles. **[Engineer delete this if not an elementary school]**
- C. Receptacles shall be of the types listed below, complete with an impact resistant nylon face, screw type wire terminals to accept copper conductors, high strength thermoplastic back body, and grounding terminal, or Plug Tail type.
1. Duplex 2P, 3W, 20A, 125V, NEMA 5-20R:
P&S cat. no. 5362-AI
 2. Duplex (PlugTail type), 2P, 3W, 20A, 125V, NEMA 5-20R:
P&S cat. no. PT5362-AI
 3. Controlled receptacle, duplex 2P, 3W, 20A, 125V, NEMA 5-20R:
P&S cat. no. 5362-AGRY
 4. Controlled receptacle (PlugTail type), duplex 2P, 3W, 20A, 125V, NEMA 5-20R: P&S cat. no. PT5362-AGRY
 5. Duplex 2P, 3W, 20A, 125V, NEMA 5-20R
Tamper-resistant (safety) type with two
USB charging ports:
P&S cat. no. TR5362USBI
 6. Duplex 2P, 3W, 20A, 125V, NEMA 5-20R
Weather-resistant:
P&S cat. no. WR5362I
 7. Duplex 2P, 3W, 20A, 125V, NEMA 5-20R
Ground Fault Circuit Interrupter type with Safe Lock:
P&S cat. no. 2097I
 8. Duplex (Plugtail Type) 2P, 3W, 20A, 125V, NEMA 5-20R
Ground Fault Circuit Interrupter type with Safe Lock:
P&S cat. no. PT2095I
 9. Duplex 2P, 3W, 20A, 125V, NEMA 5-20R
Connected to an emergency circuit:
P&S cat. no. 5362-ARED
 10. Duplex (Plugtail Type) 2P, 3W, 20A, 125V, NEMA 5-20R
Connected to an emergency circuit:
P&S cat. no. PT5362-ARED

11. Duplex 2P, 3W, 20A, 125V, NEMA 5-20R
Tamper-resistant (safety) type:
P&S cat. no. TR63I
12. Duplex (PlugTail type), 2P, 3W, 20A, 125V, NEMA 5-20R
Tamper-resistant (safety) type:
P&S cat. no. PTTR63I
13. Controlled receptacle, duplex 2P, 3W, 20A, 125V, NEMA 5-20R
Tamper-resistant (safety) type:
P&S cat. no. TR63GRY
14. Controlled receptacle duplex (PlugTail type), 2P, 3W, 20A, 125V, NEMA 5-20R, Tamper-resistant (safety) type:
P&S cat. no. PTTR63I
15. Duplex 2P, 3W, 20A, 125V, NEMA 5-20R
Tamper-resistant (safety), Ground Fault Circuit Interrupter type with Safe Lock:
P&S cat. no. 2097TRI
16. Duplex 2P, 3W, 20A, 125V, NEMA 5-20R
Tamper-resistant (safety), Ground Fault Circuit Interrupter type with Safe Lock:
P&S cat. no. PT2097TRI
17. Duplex 2P, 3W, 20A, 125V, NEMA 5-20R
Weather-resistant and tamper-resistant, Ground Fault Circuit Interrupter type with Safe Lock:
P&S cat. no. 2097TRWRI
18. Single 2P, 3W, 20A, 125V, NEMA 5-20R connector:
P&S cat. no. 5369-X
19. Single 2P, 3W, 15A, 125V, NEMA L5-15R:
P&S cat. no. 4710
20. Single 2P, 3W, 20A, 125V, NEMA L5-20R:
P&S cat. no. L520R
21. Single 2P, 3W, 20A, 125V, NEMA L5-20R connector:
P&S cat. no. L520C
22. Single 2P, 3W, 30A, 125V, NEMA 5-30R:
P&S cat. no. 3802
23. Single 2P, 3W, 30A, 125V, NEMA L5-30R:
P&S cat. no. L530R

24. Single 2P, 3W, 15A, 250V, NEMA 6-15R:
P&S cat. no. 5662AI
 25. Single 2P, 3W, 20A, 250V, NEMA 6-20R:
P&S cat. no. 5862AI
 26. Single 2P, 3W, 30A, 250V, NEMA 6-30R:
P&S cat. no. 3801
 27. Single 2P, 3W, 50A, 250V, NEMA 6-50R:
P&S cat. no. 3804
 28. Single 3P, 4W, 20A, 125/250V, NEMA 14-20R:
P&S cat. no. 3820
 29. Single 3P, 4W, 30A, 125/250V, NEMA 14-30R:
P&S cat. no. 3864
 30. Single 3P, 4W, 50A, 125/250V, NEMA 14-50R:
P&S cat. no. 3894
 31. Single 3P, 4W, 60A, 125/250V, NEMA 14-60R:
Hubbell cat. no. HBL 9460A
 32. Single 3P, 4W, 20A, 250V, NEMA 15-20R:
Hubbell cat. no. HBL 8420
 33. Single 3P, 4W, 30A, 250V, NEMA 15-30R:
P&S cat. no. 5740
 34. Single 3P, 4W, 50A, 250V, NEMA 15-50R:
P&S cat. no. 5750
 35. Single 3P, 4W, 60A, 250V, NEMA 15-60R:
P&S cat. no. 5760
 36. Single 3P, 4W, 50A, 125/250V P&S cat. no. CS6369.
 37. Single 2P, 3W, 15A, 125V, NEMA 5-15R
Wireless clock outlet with stainless steel cover plate:
P&S cat. no. S3733-SS
- D. Outdoor charging station shall be LEGRAND part no. XCSP3GRUU-BZ. Complete with one (1) 20A weather resistant GCFI receptacle and two (2) 4-port, 4.2A USB receptacles.
- E. Wiring devices mounted in WIREMOLD V4000 surface metal raceways shall be

ivory or light almond in color to match the raceway in lieu of the colors indicated above, except red wiring devices shall not change.

- F. All PlugTail receptacles shall come complete minimum six (6) inch solid THHN Connector. Stranded connectors shall not be acceptable.

2.05 COVER PLATES

- A. A cover plate shall be furnished and installed over each wiring device. Plates shall be PASS & SEYMOUR Type 302 (non-magnetic) stainless steel with satin finish, 0.032" nominal thickness or the equivalent as manufactured by COOPER (ARROW HART), HUBBELL, LEVITON or MULBERRY for all the wiring devices including low voltage devices. All cover plates shall be UL listed.
 - 1. Wall switch occupancy sensors shall have stainless steel cover plates, not the plastic cover plates that may be included in the switch packaging.
- B. Cover plates shall be of a configuration to match the type of wiring device to be covered. Where more than one flush outlet (switch, receptacle, etc.) is indicated in the same location and at the same mounting height, all (except dimmer switches) shall be ganged in a single multi-gang outlet box under a common cover plate.
- C. Wiring devices located in wet or damp locations, or noted "WP" on the Drawings shall be complete with a die-cast weatherproof metallic cover plate. Receptacles in damp locations only, may use this type of weatherproof cover plate. All weatherproof cover plates shall be UL listed.
- D. All 15 amp and 20 amp receptacle type wiring devices located in wet locations, or noted "WP" on the Drawings, shall have hinged weatherproof "while-in-use" covers. Other receptacle type wiring devices located in wet and damp locations where equipment is intended to be plugged into it and not attended while in use shall also have hinged weatherproof "while-in-use" covers. Provide these types of weatherproof covers at other locations identified on the Drawings. Covers, body and plates shall be gray die-cast aluminum, fully gasketed and suitable for mounting horizontally and vertically. Mounting screws shall be 302 stainless steel. Cover assembly shall be UL listed.
- E. All receptacles on an emergency circuit shall have a coverplate, PASS & SEYMOUR Type 302 (non-magnetic), labeled with 1/8" high engraved and filled lettering "EMERGENCY".
- F. Cover plates for receptacles shall be labeled with the circuit number including panelboard designations. Labeling shall be done with a BROTHER® model no. PT-1400 (P-touch) professional label maker, or approved equal, using a laminated type extra strength adhesive tape, Letters/numerals shall be black with a white background, minimum 3/16" high.

- G. Cover plates for lighting control digital switches shall be labeled with the lighting control panel designation and room number designation or as shown on the Drawings. Labeling shall be done with a BROTHER® model no. PT-1400 (P-touch) professional label maker, or approved equal, using a laminated type extra strength adhesive tape, Letters/numerals shall be black with a white background, minimum 3/16" high.

2.06 POWER OUTLET PANELS

- A. Power Outlet Panels shall have one duplex 2P, 3W, 20A, 125V, NEMA 5-20R weather-resistant and tamper-resistant, Ground Fault Circuit Interrupter (GFCI) type receptacle; P&S cat. no. 2097TRWR or equal.
- B. Enclosure shall be rainproof NEMA 3R and fabricated from G90 galvanized steel with welded flange construction and a gray powder coat finish. The door cover shall swing up and able to be held in the open position and closed with plugs and cords inserted into the receptacle while maintaining the NEMA 3R rating. The door shall have rolled edges to protect cords from damage and with padlock provisions. The deadfront cover shall be angled with the receptacle to facilitate easier plug and cord attachments and shall be removable without interfering with factory wiring.
- C. All components shall be factory wired and have field termination lugs, including ground lug.
- D. Power Outlet Panels shall be MIDWEST ELECTRIC PRODUCTS, INC. catalog no. U010SEP or approved equal.

2.07 CORD REELS

- A. Cord reels designated on the Drawings as 'CR' shall be WOODHEAD cat. no. 9383-3080, having an open housing, a minimum 18 inch primary power cord and a NEMA 5-20P plug cap, a shock-absorbing ball stop, adjustable tension, built in ratchet locks, a swivel/pivot base (cat. no. 9507), and a twenty-five (25) foot secondary power cord (rated 16 amps, minimum) with an attached non-conductive rubber and plastic power outlet box having two (2) 2P, 3W, 20A duplex receptacles (NEMA 5-20R). The power cords shall be 'SJTOW' type with three (3) conductor, No. 12 AWG.
 - 1. This Contractor shall furnish and install a NEMA 5-20R single receptacle in/on the ceiling as shown on the Drawings for plugging in the cord reels primary cord.
 - 2. Contractor shall activate ratchet if not set by the factory.
- B. Cord reels designated on the Drawings, as 'CRL' shall be WOODHEAD cat. no.

980A-83, having an open housing with an automatic 'on/off' power switch located inside the reel, a minimum 18 inch primary power cord and a NEMA 5-15P plug cap, a shock-absorbing ball stop, adjustable tension, built in ratchet locks, a swivel/pivot base (cat. no. 9507), and a fifty (50) foot secondary power cord with an attached 13 watt fluorescent hand lamp having vinyl coated guard and rubber handle without a receptacle in the handle suitable for use in minor repair garages classified as a non-hazardous location per NEC Article 511.3(D)(1). The power cords shall be 'SJTOW' type with three (3) conductor, No. 16 AWG.

1. This Contractor shall furnish and install a NEMA 5-15R single receptacle in/on the ceiling as shown on the Drawings for plugging in the cord reels primary cord.
2. Contractor shall activate ratchet if not set by the factory.

2.08 DOORBELL SYSTEM

- A. This Contractor shall furnish and install where shown on the Drawings, a complete doorbell signaling system as specified herein:
 1. Bell: Edwards Signaling cat. no. 340-6G5 Adaptable. Bell shall be six (6) inches in diameter, 24 volts AC, having a sound level of 92 dB measured at 10 feet.
 2. Class 2 Signaling Transformer: Edwards Signaling cat. no. 592. Transformer shall have primary voltage of 120 volts AC and secondary voltage of 24 volts AC and 20 VA.
 3. Pushbutton Station: Trine Access Technology cat. no. 65P. Pushbutton shall be weatherproof, surface mount, and solid brass construction. The pushbutton shall have normally open momentary contacts, rated at 24 volts, 4 amps AC, 2 amps DC, a neoprene diaphragm to protect the internal phosphor bronze contact springs, and a bakelite back plate threaded for ½ inch conduit.

2.09 FIRE EVACUATION STAGING AREA (FESA) VISUAL NOTIFICATION SYSTEM

- A. This Contractor shall furnish and install where shown on the Drawings, a complete FESA visual notification system as specified herein:
 1. Signal Beacon: Federal Signal Corporation model no. FB2PST-120R exterior red strobe light rated at 120VAC, 0.25 amps, flash rate/minute of 90, candela ratings of 1,000,000 (peak) and 300 ECP (effective candela) suitable for mounting on ½" NPT pipe.
 2. Wall Mounting Bracket Kit: Federal Signal Corporation model no. LWMB2 wall mounting bracket for mounting the FESA exterior strobe

- light signal beacon. The wall bracket shall be wall mounted on a suitable outlet box and shall allow wiring to be run concealed within the wall bracket to the strobe light.
3. Activation Station (on/off): STI model no. SS-2231-ZA-EN with custom two (2) line label to read "FESA" (line 1), "SIGNAL BEACON" (line 2) and a STI model no. SUB-102722 Spacer (color to match shell). Mount over flush outlet box or surface mounted on Wiremold V5744S outlet box where indicated on the Drawings or required to be surface mounted.
 4. Transformer: Provide a transformer, when required to step down the voltage from 277 volts to 120 volts. Transformer shall be equal to ACME ELECTRIC catalog no. TB81301 rated at 50 VA, 277 volts primary to 120 volts secondary complete with a primary fuse block, part no, PL112700 and 0.6 amp time delay class CC fuses. Mount transformer and fuse block in a metal NEMA 1 vented enclosure with a latching hinged cover, HOFFMAN catalog no. A8N66/A8N6P with HOFFMAN catalog no. AVK23 louver vents field installed on two (2) side walls of enclosure. Mount enclosure above the ceiling or as shown on the Drawings.

2.10 S.O.L TESTING PORTABLE POWER DISTRIBUTION BOX

- A. S.O.L. testing portable power distribution boxes shall contain a minimum of six (6) NEMA 5-20R duplex receptacles, one (1) NEMA L5-30R single receptacle, one (1) 50A 125/250V locking inlet (CS6375) and one (1) 50A 125/250V locking outlet (CS6369). A circuit breaker panel box with a hinged door cover shall be provided. Each NEMA 5-20R duplex receptacle shall be protected by one (1) single pole, 20A circuit breaker and each NEMA L5-30R single receptacle shall be protected by one (1) 2 pole, 30A circuit breaker. The power distribution box shall have individual GFCI modules to protect the duplex receptacles against ground faults with manual GFCI reset configuration.
 1. The power distribution box shall be suitable for indoor or outdoor environments. Box shall have a reinforced steel housing and support legs and finished with a powder coat paint inside and out to prevent corrosion.
- B. Each portable power distribution box shall have one (1) factory assembled 50A, 125/250V, 50 ft. min. length cordset for connecting the unit from a CS6369 wall receptacle to the inlet (CS6375) of the power distribution box.
- C. An S.O.L. testing portable power distribution box that meets this specification is a COOPER (ARROW HART) cat. no. RB300M with PC50A cordset or as equal by ERICSON, or HUBBELL. This contractor shall furnish one (1) unit for each S.O.L. 50A receptacle shown on the Drawings.

PART 3 - EXECUTION**3.01 WIRING DEVICES**

- A. This Contractor shall furnish and install all wiring devices, material, and hardware as indicated on the Drawings, as specified, or as required for a complete installation.
- B. Before installation, the exact type of wiring devices shall be coordinated with all associated trades.
- C. This Contractor shall check all wiring devices for damages during construction and replace where necessary. All devices shall be cleaned and left in a complete operable condition.
- D. This Contractor shall verify all door swings before installing lighting switches.
- E. Receptacles shall be installed only on clear wall spaces, not in tackboards, chalkboards, pipe chases, mechanical equipment, or built-in type furniture and cabinets. If receptacles are shown on the Drawings to be installed therein, this Contractor shall call it to the attention of the Architect/Engineer and obtain a new location.
- F. Dimmer switches shall not be ganged together with other types of lighting switches. Multiple dimmer switches shall be ganged together using the number of outlet boxes and/or outlet box gangs in accordance with the manufacturer's instructions.

3.02 POWER OUTLET PANELS

- A. This Contractor shall furnish and install power outlet panels, material, and hardware as indicated on the Drawings, as specified, and as required for a complete installation. Power outlet panels generally will be mounted on the roof with the free standing safety switch assembly as detailed on the Drawings or other locations shown on the Drawings.
- B. All mounting openings not used must be permanently sealed to keep rain, moisture, insects, etc. from entering the box housing. The use of stainless steel screws/nuts with rubber washers and silicone sealant may be used, or another approved method for a completely sealed box housing.

3.03 S.O.L 50A POWER RECEPTACLES

- A. S.O.L. 50A receptacles shown on the Drawings shall be complete with flush mounted box lockable box with hinged cover: Hoffman model no. AHE12x12x6NK with cylindrical kit or approved equal.

3.04 CONNECTIONS

- A. Ground equipment according to Specification Section 16460 "Grounding" and the National Electrical Code.
- B. Connect wiring according to Specification Section 16120 "Wire, Cables and Connectors".
- C. Tighten electrical connections and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A/B.

3.05 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections:
 - 1. After installing wiring devices and after electrical circuitry has been energized, test for proper polarity, ground continuity, and compliance with requirements.
 - 2. Test GFCI operation with both local and remote fault simulations according to manufacturer's written instructions.
- B. Remove malfunctioning units, replace with new units, and retest as hereinbefore specified.

END OF SECTION

SECTION 16140

DEVICE AND OUTLET BOXES

PART I - GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. **[Engineer to edit]** The work covered under this Section shall include furnishing and installing device and outlet boxes, flush floor outlets (boxes) and Science Room multiplex service fittings complete for all electrical systems as shown on the Drawings and herein specified.

1.03 QUALITY ASSURANCE

- A. All equipment, materials, and their installation shall conform to the requirements of the National Electrical Code (NEC), local code requirements, and these Specifications.
- B. All equipment and materials shall be listed by Underwriters Laboratories, Inc. (UL) for their intended use and shall bear the UL label.
- C. Equipment shall be constructed in accordance with National Electrical Manufacturer's Association (NEMA) standards.
- D. Flush floor outlet boxes and/or poke-thru devices shall have been tested to meet UL514A and/or UL514C and bear the UL listing mark. Floor boxes/devices shall be classified for use in 2-hour rated unprotected reinforced concrete floors and concrete toppings (D900 Series Designs) or above grade concrete floors with suspended ceilings (fire resistive designs with suspended ceilings shall have provisions for accessibility in the ceiling below the floor boxes/devices). Floor boxes/devices shall also conform to the standards set in Section 300.21 of the National Electrical Code. Floor boxes/devices shall meet UL scrub water requirements, but are not suitable for wet or damp locations, or other areas subject to saturation with water or other liquids such as commercial kitchens. Floor boxes/devices shall also have been evaluated by UL to meet the applicable U.S. safety standards for scrub water exclusion when used on tile, bare concrete, terrazzo, wood, and carpet covered floors. Above grade floor boxes/devices shall be suitable for use in air handling spacers in accordance with Section 300.22 (C) of the National Electrical Code.

- E. Submittals are required in accordance with SECTION 16010 of these specifications.

PART 2 - PRODUCTS

2.01 MATERIALS AND COMPONENTS

- A. Boxes shall be steel, hot-dipped galvanized after fabrication, of the type and size for the intended use, and shall have only the holes necessary to accommodate the conduits at point of installation. Multi-gang boxes shall be used for multiple device locations utilizing a single multi-gang cover plate. Sectionalized boxes are not permitted. Boxes shall have barrier separations for conductors using different voltages within the same box.
- B. Outlet boxes for lighting switches and receptacles in finished walls shall be of a suitable size for the device to be mounted in the partitions in which they are installed. The boxes shall have covers with rectangular openings of appropriate size and shape. Provide covers with raised openings on all outlets in masonry walls with plaster or tile finishes. Wall switch outlets shall be located within eight (8) inches of the trim on the latch side of the door. Outlets shall be set flush with the wall.
- C. Single gang outlet boxes installed in concrete, masonry or gypsum wall board shall be a minimum four (4) inches square, 1-1/2 inches deep with appropriate tile ring, set flush with wall surface and provided with a single gang cover plate.
- D. Outlet boxes for exposed lighting switches and receptacles shall be of the cast "FS" type or "FD" type (when required for code required box volume).
- E. Outlet boxes for devices shown on the Drawings to be flush mounted in existing gypsum wallboard partitions shall be minimum three (3) inches by two (2) inches by 2-3/4 inches deep gangable switch box type complete with ears and conduit knockouts.

2.02 FLUSH FLOOR OUTLETS

- A. Flush floor outlets designated on the Drawings as "Type 1" shall consist of a WIREMOLD Model No. EFB6S-OG floor box manufactured from stamp steel approved for use with on-grade concrete floor applications. Boxes shall have the ability to accept a component (EFB610BTC) that will allow the box to be installed surface on polished concrete or terrazzo floors. Boxes shall be painted with a fusion-bonded epoxy designed for use on metal reinforcement bar and related accessories before encapsulation in concrete, and be approved for use on-grade and above grade floors. Boxes shall be 15-1/8" L x 13-3/16" W x 4-1/16" H [384mm x 284mm x 103mm]. Provide boxes with six (6) independent wiring compartments that allow for up to six (6) duplex receptacles, communication

and/or audio/video services. Boxes shall have removable and relocatable dividers to permit custom configuration of compartments as well as permit feed to adjacent compartments. Boxes shall permit feed to compartments on the opposite side of the box through a tunnel. Each of the four (4) outer compartments shall have a minimum wiring capacity of 32-in³ [524ml]. Each of the two (2) center compartments shall have a minimum wiring capacity of 38.5-in³ [630ml]. Each of the six (6) compartments shall have a minimum depth of 3-7/8" [98mm] behind the plate. Provide boxes with removable compartments to facilitate installation. The compartments shall be removable from the top of the floor box. Provide boxes with two (2) cable guides to organize and maintain the cables egress out of the box. The box shall contain the following number of knockouts: 10 1" trade size, six (6) 1-1/4" trade size, and six (6) 3/4" trade size. Boxes shall be fully adjustable, accommodating a maximum 2-inch [51mm] pre-concrete pour and a maximum 1/2" [12.7mm] post-concrete pour adjustment. The box shall be able to accept 2-3/4" x 4-1/2" standard size wall plates. Include mounting brackets with the boxes that will accommodate 15 amp, 20 amp straight blade, 20 amp turn loc, 30 amp straight blade and 30 amp turn loc receptacles, Ortronics® workstation connectivity and modular adapters, a variety of audio/video devices from most manufacturers, and other open system devices.

1. This floor box shall contain three (3) two pole, three wire, 20 amp, 125 volt, NEMA 5-20R duplex receptacles as hereinbefore specified complete with coverplates; one (1) two (2) port modular jack kit complete with one (1) RJ-45 (568A) voice port and one (1) RJ-45 (568A) data port; and two (2) blank single gang coverplates.
 2. Floor boxes shall be complete with die-cast aluminum activation covers. Activation covers shall be surface mount (EFB610BTC) type and in tile floor areas shall be surface mount (EFB610BTC) type. Provide covers with two (2) gaskets (one (1) for carpet and one (1) for tile) to go under the trim flange to maintain scrub watertightness. Covers shall be 16-15/16" x 12-1/2" x 3/16" [430mm x 318mm x 4mm]. Secure the cover to the flange and enable cover to rotate greater than 180 degrees to reduce trip hazards and provide maximum amount of working space. Provide covers with spring-loaded self-closing slide egress doors to reduce egress opening when cables are exiting and reduce trip hazards. Each of the two (2) egress openings shall have a minimum of 4-in² [102mm²], or a minimum of 8-in² [203mm²] per cover assembly. Covers shall have a powder coat finish with one of the following colors to be selected by the Architect: [black] [gray] [brass] [nickel] [bronze].
- B. Flush floor outlets designated on the Drawings as "Type 2" shall consist of a WIREMOLD Model No. EFB6S-OG floor box manufactured from stamp steel approved for use with on-grade concrete floor applications. Boxes shall have the ability to accept a component (EFB610BTC) that will allow the box to be installed surface on polished concrete or terrazzo floors. Boxes shall be painted with a

fusion-bonded epoxy designed for use on metal reinforcement bar and related accessories before encapsulation in concrete, and be approved for use on-grade and above grade floors. Boxes shall be 15-1/8" L x 13-3/16" W x 4-1/16" H [384mm x 284mm x 103mm]. Provide boxes with six (6) independent wiring compartments that allow for up to six (6) duplex receptacles, communication and/or audio/video services. Boxes shall have removable and relocatable dividers to permit custom configuration of compartments as well as permit feed to adjacent compartments. Boxes shall permit feed to compartments on the opposite side of the box through a tunnel. Each of the four (4) outer compartments shall have a minimum wiring capacity of 32-in³ [524ml]. Each of the two (2) center compartments shall have a minimum wiring capacity of 38.5-in³ [630ml]. Each of the six (6) compartments shall have a minimum depth of 3-7/8" [98mm] behind the plate. Provide boxes with removable compartments to facilitate installation. The compartments shall be removable from the top of the floor box. Provide boxes with two (2) cable guides to organize and maintain the cables' egress out of the box. The box shall contain the following number of knockouts: 10 1" trade size, six (6) 1-1/4" trade size, and six (6) 3/4" trade size. Boxes shall be fully adjustable, accommodating a maximum 2-inch [51mm] pre-concrete pour and a maximum 1/2" [12.7mm] post-concrete pour adjustment. The box shall be able to accept 2-3/4" x 4-1/2" standard size wall plates. Include mounting brackets with the boxes that will accommodate 15 amp, 20 amp straight blade, 20 amp turn loc, 30 amp straight blade and 30 amp turn loc receptacles, Ortronics® workstation connectivity and modular adapters, a variety of audio/video devices from most manufacturers, and other open system devices.

1. This floor box shall contain three (3) two pole, three wire, 20 amp, 125 volt, NEMA 5-20R duplex receptacles as hereinbefore specified complete with coverplates; and four (4) two port modular jack kits complete with two (2) RJ-45 (568A) ports in each, for a total of eight (8) ports.
 2. Floor boxes shall be complete with die-cast aluminum activation covers. Activation covers shall be surface mount (EFB610BTC) type and in tile floor areas shall be surface mount (EFB610BTC) type. Provide covers with two (2) gaskets (one (1) for carpet and one (1) for tile) to go under the trim flange to maintain scrub watertightness. Covers shall be 16-15/16" x 12-1/2" x 3/16" [430mm x 318mm x 4mm]. Secure the cover to the flange and enable cover to rotate greater than 180 degrees to reduce trip hazards and provide maximum amount of working space. Provide covers with spring-loaded self-closing slide egress doors to reduce egress opening when cables are exiting and reduce trip hazards. Each of the two (2) egress openings shall have a minimum of 4-in² [102mm²], or a minimum of 8-in² [203mm²] per cover assembly. Covers shall have a powder coat finish with one of the following colors to be selected by the Architect: [black] [gray] [brass] [nickel] [bronze].
- C. Flush floor outlets designated on the Drawings as "Type 3" shall consist of a

WIREMOLD Model No. EFB8S-OG floor box manufactured from stamp steel approved for use with on-grade concrete floor applications. Boxes shall have the ability to accept a component (EFB610BTC) that will allow the box to be installed surface in polished concrete or terrazzo floors. Boxes shall be painted with a fusion-bonded epoxy designed for use on metal reinforcement bar and related accessories before encapsulation in concrete, and be approved for use on-grade and above grade floors. Boxes shall be 15-1/8" L x 13-3/16" W x 6" H [384mm x 284mm x 152mm]. Provide boxes with six (6) independent wiring compartments that allow for up to six (6) duplex receptacles, communication and/or audio/video services. Boxes shall have removable and relocatable dividers to permit custom configuration of compartments as well as permit feed to adjacent compartments. Boxes shall permit feed to compartments on the opposite side of the box through a tunnel. Each of the four (4) outer compartments shall have a minimum wiring capacity of 32-in³ [524ml]. Each of the two (2) center compartments shall have a minimum wiring capacity of 38.5-in³ [630ml]. Each of the six (6) compartments shall have a minimum depth of 3-7/8" [98mm] behind the plate. Provide boxes with removable compartments to facilitate installation. The compartments shall be removable from the top of the floor box. Provide boxes with two (2) cable guides to organize and maintain the cables' egress out of the box. The box shall contain the following number of knockouts: 10 1" trade size, six (6) 1-1/4" trade size, and six (6) 3/4" trade size. Boxes shall be fully adjustable, accommodating a maximum 2-inch [51mm] pre-concrete pour and a maximum 1/2" [12.7mm] post-concrete pour adjustment. The box shall be able to accept 2-3/4" x 4-1/2" standard size wall plates and 2 gang multi media devices. Include mounting brackets with the boxes that will accommodate 15 amp, 20 amp straight blade, 20 amp turn loc, 30 amp straight blade and 30 amp turn loc receptacles, Ortronics® workstation connectivity and modular adapters, a variety of audio/video devices from most manufacturers, and other open system devices.

1. This floor box shall contain with three (3) two pole, three wire, 20 amp, 125 volt, NEMA 5-20R duplex receptacles as hereinbefore specified complete with coverplates; one (1) three port modular jack kit complete with two (2) RJ-45 (568A) ports and one (1) F-Connector; and one (1) EXTRON Part No. XTP-T-UWP-202 multi-media system presentation system outlet consisting of a HD15, 3.5mm audio, and HDMI connectors.
2. Floor boxes shall be complete with die-cast aluminum activation covers. Activation covers shall be surface mount (EFB610BTC) type and in tile floor areas shall be surface mount (EFB610BTC) type. Provide covers with two (2) gaskets (one (1) for carpet and one (1) for tile) to go under the trim flange to maintain scrub watertightness. Covers shall be 16-15/16" x 12-1/2" x 3/16" [430mm x 318mm x 4mm]. Secure the cover to the flange and enable cover to rotate greater than 180 degrees to reduce trip hazards and provide maximum amount of working space. Provide covers with spring-loaded self-closing slide egress doors to reduce egress opening when cables are exiting and to reduce trip hazards. Each of the two (2) egress openings shall have a minimum of 4-in² [102mm²],

or a minimum of 8-in² [203mm²] per cover assembly. Covers shall have a powder coat finish with one of the following colors to be selected by the Architect: [black] [gray] [brass] [nickel] [bronze].

- D. Flush floor outlets designated on the Drawings as Type “4” shall be THOMAS & BETTS (STEEL CITY) Cat. No. 643, 3-gang case iron floor box complete with three (3) separate wiring compartments; cast iron watertight body, one (1) P64DS duplex brass mop tight coverplate, two (2) P64-GFCI brass mop tight coverplates, one (1) OPODEC-XLRF-WH rectangular microphone jack adaptor, one (1) OPODEC3-WH device plate with three (3) keystone ports; one (1) ORTRONICS Cat. No. OR-KS35STST 3.5mm keystone adaptor insert and two (2) ORTRONICS Cat. No. OR-KS6A RJ-45, Cat. 6, 568A track jack adaptor inserts. The body shall be divided having one (1) NEMA 5-20R duplex receptacle as previously specified, one (1) microphone jack and one (1) 3.5mm jack for MP3 and two (2) RJ-45, Cat 6 data jacks. The trim shall be completely flush with the finished floor.
- E. Flush floor outlets designated on the Drawings as “Type 5” shall be THOMAS & BETTS (STEEL CITY) Cat. No. 642, 2-gang cast iron floor box complete two (2) P64DS duplex brass mop tight coverplates, two (2) NEMA 5-20R duplex receptacles as previously specified. The trim, shall be completely flush with the finished floor. Each floor outlet shall be complete with carpet flange assembly in carpeted areas and non-skid top in non-carpeted areas.
- F. Flush floor outlets designated on the Drawings as “Type 6” shall be WIREMOLD Cat. No. 8ATCP fire-rated poke-thru assembly unit, for use in existing concrete floors, or approved equal. This assembly consists of an insert and an activation cover. Overall poke-thru assembly length shall be 16 3/4”. The insert body shall recess the devices a minimum of 3-1/4” and have a polyester based backing enamel finished interior (ivory). There shall be necessary channels to provide complete separation of power and communication services. There shall be five (5) compartments that allow for up to three (3) duplex receptacles and/or twelve (12) communications ports and/or ten (10) of Extron® Electronics MAAP™ and/or two (2) AAP™ devices. The body shall consist of an intumescent fire stop material to maintain the fire rating of the floor slab. The intumescent material will be held securely in place in the insert body and shall not have to be adjusted to maintain fire rating of the unit and the floor slab. The insert shall have retaining feature that will hold the poke-thru device in the floor slab without additional fasteners. The poke-thru insert shall also consist of a 3/4” trade size conduit stub that is connected to the insert body and a 24.5 cubic inch stamped steel junction box for wire splices and connections. The stamped steel junction box shall also contain the necessary means to electrically ground the poke-thru device to the system ground. **Communication Modules Mounting Accessories:** The poke-thru manufacturer shall have available open modular inserts to facilitate mounting UTP (including Category 5, 5e, 6), STP, fiber optic, coaxial, and data/communications devices. The activation shall have three (3) locations to mount communication connectors. Connectors shall be mounted

using a mounting bracket. Where indicated, provide connectivity outlets and modular inserts by Ortronics or approved equal.

1. This floor box shall contain two (2) proprietary two pole, three wire, 20 amp, 125 volt, NEMA 5-20R duplex receptacles with mounting plates; one (1) '8TRAC' device mounting plate for use in the center compartment only, complete with one (1) RJ-45 (568A) TracJack voice device and one (1) RJ-45 (568A) TracJack data device; and three (3) blank TracJack inserts and two (2) 8B single gang blank device plates.
 2. Flush Floor Poke-Thru shall be complete with die-cast aluminum activation covers. Two gaskets (one for carpet and one for tile) shall be provided to go under the trim flange to maintain scrub water tightness. The activation cover shall be 9 1/4" in diameter. The activation covers shall be available in carpet and tile versions. The carpet covers shall be surface mounted (8CTC) and the tile covers shall be surface (8CTC) with the finished floor coverings. The cover shall have spring loaded slides to allow cables to egress out of the unit and maintain as small an egress opening as possible. Covers shall have a powder coat finish with one of the following colors to be selected by the Architect: [black] [gray] [brass] [nickel] [bronze].
- G. Flush floor outlets designated on the Drawings as "Type 7" shall be WIREMOLD Cat. No. 8ATCP fire-rated Poke-Thru Assembly Unit, for use in existing concrete floors, or approved equal. This assembly consists of an insert and an activation cover. Overall poke-thru assembly length shall be 16 3/4". The **INSERT** body shall recess the devices a minimum of 3-1/4" and have a polyester based backing enamel finished interior (ivory). There shall be necessary channels to provide complete separation of power and communication services. There shall be five (5) compartments that allow for up to five (5) duplex receptacles and/or twenty-two (22) communications ports and/or sixteen (16) of Extron® Electronics MAAP™ and/or four (4) AAP™ devices. The body shall consist of an intumescent fire stop material to maintain the fire rating of the floor slab. The intumescent material will be held securely in place in the insert body and shall not have to be adjusted to maintain fire rating of the unit and the floor slab. The insert shall have retaining feature that will hold the poke-thru device in the floor slab without additional fasteners. The poke-thru insert shall also consist of a 3/4" trade size conduit stub that is connected to the insert body and a 24.5 cubic inch stamped steel junction box for wire splices and connections. The stamped steel junction box shall also contain the necessary means to electrically ground the poke-thru device to the system ground. **Communication Modules Mounting Accessories:** The poke-thru manufacturer shall have available open modular inserts to facilitate mounting UTP (including Category 5, 5e, 6), STP, fiber optic, coaxial, and data/communications devices. Where indicated, provide connectivity outlets and modular inserts by Ortronics or approved equal.
- H.
1. This floor box shall contain two (2) proprietary two pole, three wire, 20

- amp, 125 volt, NEMA 5-20R duplex receptacles with mounting plates; one (1) duplex mounting plate (8DP) with one (1) two pole, three wire, 20 amp, 125 volt, NEMA 5-20R duplex receptacle to be used in the center compartment; two '8TRAC' device mounting plates for use in the center compartment only, complete with eight (8) RJ-45 (568A) TracJack devices; and four (4) blank TracJack inserts.
2. Flush floor poke-thru shall be complete with die-cast aluminum Activation Covers. Two gaskets (one for carpet and one for tile) shall be provided to go under the trim flange to maintain scrub water tightness. The activation cover shall be 9 1/4" in diameter. The activation covers shall be available in carpet and tile versions. The carpet covers shall be surface mounted (8CTC) and the tile covers shall be surface (8CTC) with the finished floor coverings. The cover shall have spring loaded slides to allow cables to egress out of the unit and maintain as small an egress opening as possible. Covers shall have a powder coat finish with one of the following colors to be selected by the Architect: [black] [gray] [brass] [nickel] [bronze].
 - I. Flush floor outlets designated on the Drawings as "Type 8" shall be WIREMOLD Cat. No. 8ATCP fire-rated Poke-Thru Assembly Unit, for use in existing or new concrete floors, or approved equal. This assembly consists of an insert and an activation cover. Overall poke-thru assembly length shall be 16 3/4". The **INSERT** body shall recess the devices a minimum of 3-1/4" and have a polyester based backing enamel finished interior (ivory). There shall be necessary channels to provide complete separation of power and communication services. There shall be five (5) compartments that allow for up to five (5) duplex receptacles and/or twenty-two (22) communications ports and/or sixteen (16) of Extron® Electronics MAAP™ and/or four (4) AAP™ devices. The body shall consist of an intumescent fire stop material to maintain the fire rating of the floor slab. The intumescent material will be held securely in place in the insert body and shall not have to be adjusted to maintain fire rating of the unit and the floor slab. The insert shall have retaining feature that will hold the poke-thru device in the floor slab without additional fasteners. The poke-thru insert shall also consist of a 3/4" trade size conduit stub that is connected to the insert body and a 24.5 cubic inch stamped steel junction box for wire splices and connections. The stamped steel junction box shall also contain the necessary means to electrically ground the poke-thru device to the system ground. **Communication Modules Mounting Accessories:** The poke-thru manufacturer shall have available open modular inserts to facilitate mounting UTP (including Category 5, 5e, 6), STP, fiber optic, coaxial, and data/communications devices. Where indicated, provide connectivity outlets and modular inserts by Ortronics or approved equal.
 1. This floor box shall contain two (2) proprietary two pole, three wire, 20 amp, 125 volt, NEMA 5-20R duplex receptacles with mounting plates; one '8TRAC' device mounting plate for use in the center compartment only, complete with two (2) RJ-45 (568A)TracJack devices, one (1) "F"

Connector TracJack device, and three (3) blank TracJack devices; and one (1) EXTRON Part No. XTP-T-UWP-202 multi-media presentation system 'decorator style' outlet consisting of a HD-15, 3.5mm audio and HDMI connectors.

2. Flush Floor Poke-Thru shall be complete with die-cast aluminum activation covers. Two gaskets (one for carpet and one for tile) shall be provided to go under the trim flange to maintain scrub water tightness. The activation cover shall be 9 1/4" in diameter. The activation covers shall be available in carpet and tile versions. The carpet covers shall be surface mounted (8CTC) and the tile covers shall be surface (8CTC) with the finished floor coverings. The cover shall have spring loaded slides to allow cables to egress out of the unit and maintain as small an egress opening as possible. Covers shall have a powder coat finish with one of the following colors to be selected by the Architect: [black] [gray] [brass] [nickel] [bronze].

2.03 MULTIPLEX SERVICE FITTINGS

- A. Multiplex service fittings designated on the Drawings as Type "1" shall consist of the following field assembly by this Contractor as detailed on the Drawings: one (1) WIREMOLD Cat. No. MP8 dual service fitting including housing, base, mounting frames, integral divider, and mounting hardware; one (1) WIREMOLD Cat. No. M-2DR dual duplex opening faceplate; two (2) NEMA 5-20R duplex receptacles as previously specified; one (1) WIREMOLD Cat. No. LTF48-ACT communications face plate; one (1) WIREMOLD Cat. No. 2A245-C5E dual-port, RJ-45 (568A) workstation insert; two (2) WIREMOLD Cat. No. 2A-BL blank inserts; and two (2) WIREMOLD Cat. No. LTF48-B blank face plates.
- B. Multiplex service fittings designated on the Drawings as Type "2" shall consist of the following field assembly by this Contractor as detailed on the Drawings: one (1) WIREMOLD Cat. No. MP4 single service fitting including housing, base, mounting frames, integral divider, and mounting hardware; one (1) WIREMOLD Cat. No. M-2DR dual duplex opening face plate; two (2) NEMA 5-20R duplex receptacles as previously specified; and one (1) WIREMOLD Cat. No. LTF48-B blank face plate.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Before locating outlet boxes, check all of the Drawings for the type of construction and to make sure that there is no conflict with other equipment. The outlet boxes' location shall not interfere with other work or equipment and shall be accessible after completion.

- B. Outlet boxes shown on the Drawings to be flush mounted in existing gypsum wallboard partitions shall be installed using metal switch box supports similar to STEEL CITY Cat. No. 820-D.
- C. Outlet boxes for devices shown on the Drawings to be installed on opposite sides of the same wall shall be separated horizontally by not less than six (6) inches and if connected with each other, the ends of the raceway shall be filled with sound insulating material after wiring has been installed to fill the voids around the wire. For fire rated walls provide minimum 24" separation or use approved fire assembly.
- D. Provide only the conduit openings necessary to accommodate the conduits at the individual location. Plug any unused openings.
- E. Thoroughly coordinate casework and backsplash heights with mounting heights of boxes.
- F. Device and outlet boxes shall not be fastened in place with drive pins and/or other methods using compressed air or gases.
- G. Device and outlet boxes located under roof decking shall not be less than 1½ inches from the nearest surface of the roof decking.

3.02 FLUSH FLOOR OUTLET BOXES INSTALLATION

- A. Examine conditions under which boxes and fittings are to be installed. Notify the Architect/Engineer in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected.
- B. Strictly comply with manufacturer's installation instructions and recommendations. Coordinate installation with adjacent work to ensure proper clearances and to prevent electrical hazards.
- C. Floor boxes shall permit all wiring to be completed at floor level. The "FC" models, when used, shall be used as defined by the UL Fire Resistance Directory at a minimum spacing of 24 inches (610 mm) on center.

3.03 FLUSH FLOOR POKE-THRU ASSEMBLY UNITS

- A. Examine conditions under which boxes and fittings are to be installed. Notify the Architect/Engineer in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected. Flush floor poke-thru assemblies require the floor to be core drilled. Coordinate exact locations with the building structure and other trades before core drilling and **obtain written approval from the Structural Engineer and Architect before core drilling.**

- B. Strictly comply with manufacturer's installation instructions and recommendations. Coordinate installation with adjacent work to ensure proper clearances and to prevent electrical hazards.
- C. Units shall permit all wiring to be completed at floor level. Use is defined by the UL Fire Resistance Directory as a minimum spacing of "2 ft. on center and not more than one device per each 65 sq. ft. of floor area in each span."
- D. Poke-thru assemblies installation shall be completed by pushing unit down into the cored hole. The unit shall contain a retainer for securing the device in the slab, as well as the necessary intumescent material to seal the cored hole under fire conditions.

END OF SECTION

SECTION 16150

JUNCTION AND PULL BOXES

PART I - GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work covered under this Section shall include furnishing and installing junction and pull boxes complete for all electrical systems as shown on the Drawings and herein specified.

1.03 QUALITY ASSURANCE

- A. All equipment, material, and their installation shall conform to the requirements of the National Electrical Code (NEC), local code requirements, and these Specifications.
- B. All equipment and materials shall be listed by Underwriters Laboratories, Inc. (UL) for their intended use and shall bear the UL label.
- C. Equipment shall be constructed in accordance with National Electrical Manufacturer's Association (NEMA) standards.
- D. Submittals are required in accordance with SECTION 16010 of these Specifications.

PART 2 - PRODUCTS

2.01 MATERIALS AND COMPONENTS

- A. Junction and pull boxes shall be provided where indicated and required and shall be of the type and size for the installation of the electrical system. Junction or pull boxes not over one hundred (100) cubic inches in volume shall be constructed in accordance with the requirements of NEC. All junction boxes shall have removable screwed covers and be accessible after completion of the building. Removable covers shall not exceed three (3) feet in size in any direction and split covers shall be used for boxes larger than three (3) feet in any direction. Where several feeders pass through a common pull box, the feeders shall be tagged to indicate clearly their electrical characteristics and branch

circuit numbers and panelboard designation. This same information shall be stenciled in paint on the cover of each box.

- B. Pull and junction boxes shall be made of code gauge galvanized sheet steel with removable screw covers. Minimum size shall be 4 inch x 4 inch x 2-1/8 inches deep.
- C. Cast metal pull boxes shall be provided in damp or wet locations, with a gasketed screwed cover, and drilled and tapped holes as required. Screws shall be brass or bronze.
- D. Pull boxes shall be provided in any conduit run which exceeds one hundred (100) feet in length, or any run having more than two hundred seventy (270) total degrees of bend.

2.02 UNDERGROUND BOXES AND ENCLOSURES

- A. Underground boxes, enclosures and covers shall conform to all test provisions of the most current ANSI/SCTE 77 "Specifications For Underground Enclosure Integrity" for Tier 15 applications. When multiple tiers are specified the boxes must physically accommodate and structurally support compatible covers while possessing the highest tier rating. In no assembly can the cover design load exceed the design load of the box. All components in an assembly (box and cover) shall be manufactured using matched surface tooling. All covers are required to have a minimum coefficient of friction of 0.05 in accordance with ASTM C1028 and the corresponding tier level embossed on the top surface. Assemblies not U.L. Listed shall have independent third party verification or test reports stamped by a registered Professional Engineer certifying that all test provisions of this specification have been met are required with each submittal.
- B. Underground boxes, enclosures and covers shall be as manufactured by QUAZITE or approved equal.
 - 1. Communication service inground enclosure box and cover shall be QUAZITE Cat. No. PG3048BA36 box with Cat. No. PG3048HS0010 cover.
 - 2. Sports field lighting pole ground rod hand hole enclosure box and cover shall be QUAZITE Cat. No. PG1118BA18 box with Cat. No. PG1118CA0024 cover.
 - 3. Other applications requiring the use of exterior underground boxes or enclosures shall use QUATIZE "PG" Series enclosure boxes appropriately sized complete with the proper cover with logo designating the use of the box or enclosure.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Pull and junction boxes shall be installed where indicated on the Drawings or as herein specified. Boxes shall be located so as to be inaccessible to the general public.
- B. All boxes and conductors therein shall be marked as hereinbefore specified to indicate the voltage and circuit numbers.
- C. Boxes shall not be fastened in place with drive pins and/or other methods using compressed air or gases.
- D. Boxes located under roof decking shall not be less than 1½ inches from the nearest surface of the roof decking.
- E. Pull and junction boxes shall be concealed except in electrical and mechanical equipment rooms, spaces architecturally designed to have an open structure without ceilings or as otherwise indicated on the Drawings.
- F. All system pull and junction box covers shall be painted as follows:
 - 1. 120/208 Volt - Black
 - 2. 277/480 Volt - Orange
 - 3. Clocks and Program Clocks - Green
 - 4. Emergency - White
 - 5. Fire Alarm - Red
 - 6. Security System - Gray
 - 7. Sound - Blue
 - 8. Telecommunications - Yellow
 - 9. Cable Television/Broadband - Tan
 - 10. Cox Communications I-NET (fiber) - Purple

3.02 UNDERGROUND BOXES AND ENCLOSURES

- A. Exterior underground boxes and enclosures shall be installed per manufacturer's recommendations and the following minimum requirements:
1. After the proper location of the underground enclosure has been established and the conduits, underground cables or ground rods, etc. are installed or located, the hole for the enclosure shall be excavated and shall be at least six (6) to eight (8) inches deeper than the depth of the enclosure and shall have a minimum of six (6) inches of gravel in the bottom of the hole or as shown on the Drawings. The gravel base shall extend past the side walls of the enclosure by at least four (4) to six (6) inches. Once the enclosure is positioned on top of the gravel base and the elevation check, the enclosure shall be back-filled.
 2. Back-filling shall have 95% compaction or greater.
 3. Provide internal bracing during back-filling to ensure minimal box sidewall deflections. Bracing supports shall be 2x4's or similar material sized to hold the box at mid-depth.
 4. Top of the box and cover shall be flush with the finished grade.

3.03 CONDUCTORS

- A. All conductors entering junction and pull boxes shall be of the same voltage. Do not mix voltages regardless of the conductors' voltage rating, unless specifically shown on the Drawings.
- B. Branch circuit conductors and feeder conductors shall not occupy the same junction or pull box. Maintain separate boxes for branch circuits and separate boxes for feeders, unless specifically shown otherwise on the drawings.

3.04 ARC-PROOFING

- A. All feeders entering a pull box containing more than one (1) feeder, or more than one (1) parallel feeder, shall be arc-proofed as follows. Conductors of the same feeder, including each set of a parallel feeder, shall be tightly grouped together and held in place with random wrapped 3M No. 33 tape. Grouped cables shall be arc proofed using spirally wound one half-lapped layer of 3M No. 77 fire and arc-proofed tape which shall be held in place with random wrapped 3M No. 69 glass cloth electrical tape.

END OF SECTION

SECTION 16160

FUSES

PART I - GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work covered under this Section shall include furnishing and installing fuses complete for all electrical systems and a spare fuse cabinet as shown on the Drawings and herein specified.

1.03 QUALITY ASSURANCE

- A. All equipment, materials, and their installation shall conform to the requirements of the National Electrical Code (NEC), local code requirements, and these Specifications.
- B. All equipment and materials shall be listed by Underwriters Laboratories, Inc. (UL) for their intended use and shall bear the UL label.
- C. Equipment shall be constructed in accordance with National Electrical Manufacturer's Association (NEMA) standards.
- D. Submittals are required in accordance with SECTION 16010 of these Specifications.

PART 2 - PRODUCTS

2.01 MATERIALS AND COMPONENTS

- A. Fuses shall be listed and meet UL and/or NEMA Standards for Class RK5, J, L, and RK1 fuses, or as indicated on the Drawings.
- B. Dual element cartridge fuses shall be Class RK5, or as indicated on the Drawings, high interrupting capacity with current limiting effect, 200,000 ampere RMS symmetrical at rated voltage minimum, and a minimum time delay of ten (10) seconds at five hundred percent (500%) load. Unless otherwise indicated on Drawings, Class RK-5 fuses shall be used for individual motor circuit protection, for motor control centers, and motor starter panelboard protection.

- C. Class J and L fuses shall be provided as indicated on the Drawings for protection of non-motor loads.
- D. Fuse voltage rating shall be 250 volts for 120/208 volt system and 480 or 600 volts for 277/480 volt system.
- E. Fuses shall be as manufactured by EATON BUSSMANN, GENERAL ELECTRIC, LITTLEFUSE or MERSEN (FERRAZ SHAWMUT).
- F. Fuses over 600 amps up to 6,000 amps shall be UL Class 'L' time-delay fuses equal to BUSSMANN "HI-CAP" KRP-C. The fuses shall hold five hundred percent (500%) of rated current for a minimum of four (4) seconds and clear twenty (20) times rated current in .01 seconds or less.
- G. Fuses up to 600 amps used for service entrance equipment shall be UL Class RK1 dual-element fuses equal to BUSSMANN "LOW-PEAK" LPN-RK for 250 volts or LPS-RK for 600 volts. The fuses shall hold five hundred percent (500%) of rated current for a minimum of ten (10) seconds.
- H. Fuses protecting other than service entrance equipment rated over 100 amps up to 600 amps shall be UL Class RK5 dual-element fuses equal to BUSSMANN "FUSETRON" FRN-R for 250 volts or FRS-R for 600 volts unless otherwise noted on the Drawings.
- I. Fuses 100 amps and under shall be UL Class RK5 dual-element fuses equal to BUSSMAN "FUSETRON" FRN-R for 250 volts or FRS-R for 600 volts unless otherwise noted on the Drawings.

2.02 SPARE FUSE CABINET

- A. All spare fuses shall be stored in their original cartons in the spare fuse cabinet furnished and installed by this Contractor. The cabinet shall be steel, surface mounted, with a hinged door and flush lock, finished with gray baked enamel, and sized as required to house all spare fuses. A directory listing type and location of each fuse shall be mounted on the inside of the door. Spare fuse cabinet shall be similar to BUSSMANN Cat. No. SFC.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. This Contractor shall furnish and install all fuses required for the electrical equipment furnished under this Division of these Specifications including all fusible safety switches, switchboards, distribution panels, motor control centers,

etc.

- B. Fuses shall be of the proper size, type and ampere rating required by the device accepting the fuses. The use of fuse reducers will not be allowed.

3.02 SPARE FUSES

- A. This Contractor shall provide one set of spare fuses for every set installed and shall be stored in the original boxes in the spare fuse cabinet.

END OF SECTION

SECTION 16210

STANDBY ELECTRICAL POWER SYSTEM

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work covered under this Section shall include furnishing and installing the standby electrical power system consisting of an emergency engine generator set and automatic transfer switch as shown on the Drawings and herein specified.
- B. The existing standby electrical power system shall remain in operation and shall continue to serve the building's emergency power during the construction period until the new system has been installed and tested, ready for operation. After the new system has assumed the building's entire emergency power load, the existing system shall be removed as shown on the Drawings.

1.03 QUALITY ASSURANCE

- A. All applicable parts of the standby electrical power system shall meet National Electrical Manufacturer's Association (NEMA) and National Fire Protection Association (NFPA) standards, International Building Code (IBC) and be Underwriter's Laboratories, Inc. (UL) listed to UL 2200 and bear the UL label. The system shall be installed to meet the requirements of the National Electric Code (NEC) and all applicable state and local codes, and these Specifications.
- B. This system shall be completely built, tested, and shipped by a manufacturer who has been regularly engaged in the production of such equipment for the past ten (10) years and who has had parts and service facilities available locally (within a 50 mile radius of the job site) for the past five (5) years.
- C. The supplier of the standby electrical power system shall have and shall be able to demonstrate fully stocked service vehicles. The supplier shall also have factory trained and factory certified maintenance technicians on staff.
- D. The performance of the standby electrical power system shall be certified by an independent testing laboratory as to the unit's full power rating, voltage, and frequency regulation.

- E. The standby electrical power system shall provide standby for the emergency white and exit lights and other such auxiliary power as indicated on the Drawings so as to operate automatically in the event of a utility power failure of the "normal" power system.
- F. Submittals are required in accordance with SECTION 16010 of the Specifications. The manufacturer shall furnish printed literature and brochures describing the standard series specified (not a one of a kind fabrication). The manufacturer shall furnish schematic and wiring diagrams for the engine generator set and automatic load transfer switch; and an interconnecting diagram showing connections to individual components which constitute the standby electrical power system.
- G. The performance tests of the generating set series shall be in accordance with procedures certified by an independent testing laboratory. The manufacturer shall have successfully tested a prototype of the generating set series offered which shall include: maximum power level; maximum motor starting capacity; structural soundness; torsigraph analysis; fuel consumption; engine-alternator cooling air flow; transient response and steady state governing; alternator temperature rise per NEMA MG1-22.40; single step load pickup per NFPA 76A-822; harmonic analysis and voltage waveform deviation; and three-phase short circuit test for mechanical and electrical strength.
- H. The generator set manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.
- I. The manufacturer shall maintain model and serial number records for each engine generator set and automatic load transfer switch provided for at least 20 years.

PART 2 - PRODUCTS

2.01 DESCRIPTION

- A. The standby electrical power system shall be furnished and installed by this Contractor as shown on the Drawings and as herein specified. The system shall be manufactured by CUMMINS POWER GENERATION as listed herein or equal as manufactured by CATERPILLAR (OLYMPIAN) or KOHLER POWER SYSTEMS.
- B. The standby electrical power system shall be an electric plant rated for continuous standby service at 35 KW, 0.8 power factor, 277/480 volts, three phase, four wire, 60 Hertz. A standby electrical power system that will meet this

specification is CUMMINS POWER GENERATION Model Number C36N6.
The system shall be a package of new and current equipment consisting of:
(ENGINEER TO EDIT OUT ONE OF THE #1 PARAGRAPHS.)

1. A natural gas fueled engine generator set, as indicated on the Drawings, to provide standby electrical power.
2. A propane fueled engine generator set with vaporizer-regulator, as indicated on the Drawings, to provide standby electrical power.
3. An automatic transfer switch to provide automatic starting and stopping of the engine generator set and switching of the load.
4. Mounted accessories as herein specified.
5. Three pole, 70 amp output main circuit breaker.
6. Engine mounted start-stop control system.
7. Integral rubber pad type vibration isolators.

2.02 ENGINE GENERATOR SET

A. Engine **(ENGINEER TO EDIT FOR NATURAL GAS OR PROPANE)**

1. The engine shall be **(natural gas) (propane)** fueled, four (4) cycle, water cooled, with natural aspiration, mounted radiator, fan, and water pump. It shall have four (4) cylinders with a minimum displacement of 143.5 cubic inches, with a minimum rating of 77.3-brake horsepower at operating speed of 1800 RPM. Free-turn overhead valves shall be alloy steel with hard chrome-cobalt alloy. Full pressure lubrication shall be supplied by a gear oil pump. The engine shall have a replaceable, full-flow oil filter and gaseous fuel pressure regulation and solenoid valve. Engine speed shall be governed by an electronic governor for isochronous frequency regulation. The engine shall have a twelve (12) volt, DC, battery charging alternator (50A) automatically controlled by a solid state voltage regulator. Starting shall be by a twelve (12) volt electric starter.
2. The complete engine shall be furnished with a start control that operates on contact closing and a stop control that operates on contact opening. A cranking limiter shall be provided to open the starting circuit in approximately forty five (45) seconds if the plant is not started within that time.

- B. The alternator shall be a four (4) pole revolving field type with static exciter and torque matched voltage regulator. No commutator or commutator brushes shall

be allowed. The starter shall be directly connected to the engine flywheel housing, and the rotor shall be driven through a rigid coupling to insure permanent alignment. Voltage regulation shall be within plus or minus two percent (2%) of rated voltage, from no-load to full-load. Recovery to stable operation shall occur within two (2) seconds. Stable or steady-state operation is defined as operation with terminal voltage remaining constant within plus or minus one (1%) percent of rated voltage. Temperature rise shall not be more than one hundred twenty-five (125) degrees F over forty (40) degrees ambient at rated load. The excitation boost system shall sustain current for selective operation and coordination of overcurrent devices. The excitation boost system shall provide 135 Skva at 90% sustained voltage.

- C. The engine generator set control panel shall be wired, tested, and shock mounted on the generator set by the manufacturer of the alternator. It shall contain: panel lighting; RUN-STOP-REMOTE selector switch; coolant temperature gauge; DC voltmeter; running time meter; LED test switch; oil pressure gauge; fault reset switch; cycle cranking; and low coolant level shutdown. The microprocessor control panel shall contain a monitor panel with the following: green RUN LED; yellow PREWARNING FOR LOW OIL PRESSURE LED; yellow PREWARNING FOR HIGH COOLANT TEMPERATURE LED; red LOW OIL PRESSURE SHUTDOWN light; red HIGH COOLANT TEMPERATURE SHUTDOWN LED; red OVERCRANK SHUTDOWN LED; red OVERSPEED SHUTDOWN LED; flashing red SWITCH OFF LED; yellow LOW COOLANT TEMPERATURE LED; yellow LOW FUEL LED; and two (2) spare programmable alarms. **[Engineer: delete LOW FUEL LED when using natural gas, keep for propane]**
- D. The engine generating set shall be mounted on a welded steel base which shall provide for suitable mounting by this Contractor to any level surface.
- E. Accessories required for the proper operation of the engine generator set shall be furnished by the manufacturer. These shall include, but not be limited to, the following:
1. Flexible exhaust connectors
 2. Twelve (12) volt lead acid type starting batteries
 3. Battery rack and cables
 4. Additional solenoid valve (shipped loose)
 5. This Contractor shall install the additional DC voltage solenoid valve supplied, prior to the flexible fuel line and wire as directed by the engine generator manufacturer to the control circuit to open with the engine operation.

6. Flexible gas lines
 7. Gaseous fuel pressure regulator (to be supplied by the Division 15 Contractor).
 8. Single phase, 1.0 kW, 120 volt crank case heater, direct connected
 9. Fifty percent (50%) ethylene glycol antifreeze solution to fill engine cooling system
 10. Two (2) 12 volt Form C dry contacts for connection to the fire alarm system graphic annunciator panel for "Generator Run" and "Generator Fault" indications.
 11. Two (2) 12 volt Form C dry contacts for connection to the security intrusion system panel for "Generator Run" and "Generator Fault" indications.
- F. The engine generator set shall be enclosed with a weather protective housing. The housing shall be rated for sound attenuation of sixty-three (63) dB(A) average at seven (7) meters when using an eight (8) position measurement system using tests conducted per ANSI S1.13-1971. Acoustical materials shall be oil and water-resistant. A critical silencer muffler shall be mounted inside the housing with raincap and rainshield. The housing shall be attached to the skid base of the generator set and constructed of minimum 14-gauge metal using non-marring fasteners. The access doors shall have both key-lockable door handles and provisions for padlocking and mounted using stainless steel hinges. Paint protection shall be epoxy primer and dual coat electrodeposition method for all sides and all metal surfaces. Overspray of hoses, clamps, wiring and harnesses, and other serviceable items shall not be acceptable.

2.03 AUTOMATIC TRANSFER SWITCH

- A. The complete automatic transfer switch shall be suitable for utility power (source 1) to engine generator set (source 2) application, be completely factory assembled with digital electronic controls designed for surge voltage isolation, and including voltage sensors on all phases of both sources, linear operator, permanently attached manual handles, positive mechanical and electrical interlocking, and mechanically held contacts.
- B. The automatic transfer switch shall conform to the requirements of the following codes and standards (latest editions):
1. UL1008. The transfer switch shall be UL listed and labeled.

2. CSA C22.2, No. 14 – M91 Industrial Control Equipment.
 3. CSA 282, Emergency Electrical Power Supply for Buildings.
 4. NFPA110 – Emergency and Standby Power Systems. The transfer switch shall meet all requirements for level 1 systems.
 5. IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.
 6. NEMA ICS10 – AC Automatic Transfer Switches.
- C. The transfer switch manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.
- D. Transfer switch equipment specifications for this project are based on microprocessor-based transfer switches. The transfer switch shall be CUMMINS POWER GENERATION Model CXTC or an equal as manufactured by AUTOMATIC SWITCH COMPANY (ASCO) Model 7000 Series.
- E. Ratings
1. The transfer switch shall be three pole, four wire, 277/480 volt, 60 hertz, 150 amp.
 2. Main contacts shall be rated for 600 volts AC minimum.
 3. Transfer switch(es) shall be rated to carry 100 percent of rated current continuously in the enclosure supplied, in ambient temperatures of - 40 to + 60 degrees C, relative humidity up to 95% (non-condensing), and altitudes up to 10,000 feet (3000M).
 4. Transfer switch equipment shall have a minimum 3 cycle (0.05s) withstand and closing ratings (WCR) in RMS symmetrical amperes greater than the available fault currents, but not less than 65,000 at the specified voltage. Additionally, transfer switch equipment shall have 30 cycle (0.5s) withstand and closing ratings (WCR) in RMS symmetrical amperes greater than the available fault currents, but not less than 35,000A at the specified voltage. The transfer switch and its upstream protection shall be third party listed and labeled for use with the specific protective device(s) installed in the application.
- F. Construction

1. Transfer switch(es) shall be double-throw, electrically and mechanically interlocked, and mechanically held in the source 1 and source 2 positions. The transfer switch shall be specifically designed to transfer to the best available source if it inadvertently stops in a neutral position.
2. Transfer switches shall be equipped with manual operating handles and quick-break, quick-make over-center contact mechanisms.
3. Main switch contacts shall be high-pressure silver alloy. Contact assemblies shall have arc chutes for positive arc extinguishing. Arc chutes shall have insulating covers to prevent inter-phase flashover.
4. Transfer switch internal wiring shall be composed of pre-manufactured harnesses that are permanently marked for source and destination. Harnesses shall be connected to the control system by means of locking disconnect plug(s), to allow the control system to be easily disconnected and serviced without disconnecting power from the transfer switch mechanism.
5. Transfer switch shall be provided with flame retardant transparent covers to allow viewing of switch contact operation but prevent direct contact with line voltage components.
6. Transfer switches shall be provided with a neutral bus and lugs. The neutral bus shall be sized to carry 100% of the current designed on the switch rating.

G. Connections

1. Field control connections shall be made on a common terminal block that is clearly and permanently labeled.
2. Transfer switch shall be provided with AL/CU mechanical lugs sized to accept the full output rating of the generator set.

H. Transfer Switch Control

1. Operator Panel. Each transfer switch shall be provided with a control panel to allow the operator to view the status and control operation of the transfer switch. The operator panel shall be a sealed membrane panel rated NEMA 3R/IP53 or better (regardless of enclosure rating) that is permanently labeled for switch and control functions. The operator panel shall be provided with the following features and capabilities.
 - a) High intensity LED lamps to indicate the source that the load is connected to (source 1 or source 2); and which source(s) are

available. Source available LED indicators shall operate from the control microprocessor to indicate the true condition of the sources as sensed by the control.

- b) High intensity LED lamps to indicate that the transfer switch is “not in auto” (due to control being disabled or due to bypass switch enabled or in operation) and “Test/Exercise Active” to indicate that the control system is testing or exercising the generator set.
- c) “OVERRIDE” pushbutton to cause the transfer switch to bypass any active time delays for start, transfer, and retransfer and immediately proceed with its next logical operation.
- d) “TEST” pushbutton to initiate a preprogrammed test sequence for the generator set and transfer switch. The transfer switch shall be programmable for test with load or test without load.
- e) “RESET/LAMP TEST” pushbutton that will clear any faults present in the control, or simultaneously test all lamps on the panel by lighting them.
- f) The control system shall continuously log information on the number of hours each source has been connected to the load, the number of times transferred, and the total number of times each source has failed. This information shall be available via the service tool or an operator display panel.
- g) Vacuum fluorescent alphanumeric display panel with push-button navigation switches. The display shall be clearly visible in both bright (sunlight) and no light conditions. It shall be visible over an angle of at least 120 degrees. The Alphanumeric display panel shall be capable of providing the following functions and capabilities.
 - 1) Display source condition information, including AC voltage for each phase of normal and emergency source, frequency of each source. Voltage for all three phases shall be displayed on a single screen for easy viewing of voltage balance.
 - 2) Display source status, to indicate source is connected or not connected.
 - 3) Display load data, including 3-phase AC voltage, 3-phase AC current, frequency, KW, KVA, and power factor.

- Voltage and current data for all phases shall be displayed on a single screen.
- 4) The display panel shall allow the operator to view and make the following adjustments in the control system, after entering an access code:
 - i. Set nominal voltage and frequency for the transfer switch.
 - ii. Adjust voltage and frequency sensor operation set points.
 - iii. Set up time clock functions.
 - iv. Set up load sequence functions.
 - v. Enable or disable control functions in the transfer switch, including program transition.
 - vi. Set up exercise and load test operation conditions, as well as normal system time delays for transfer time, time delay start, stop, transfer, and retransfer.
 - 5) Display real-time clock data, including date, and time in hours, minutes, and seconds. The real-time clock shall incorporate provisions for automatic daylight savings time and leap year adjustments. The control shall also log total operating hours for the control system.
 - 6) Display service history for the transfer switch. Display source connected hours, to indicate the total number of hours connected to each source. Display number of times transferred, and total number of times each source has failed.
 - 7) Display fault history on the transfer switch, including condition, and date and time of fault. Faults to include controller checksum error, low controller DC Voltage, ATS fail to close on transfer, ATS fail to close on retransfer, battery charger malfunction, network battery voltage low, network communications error.
 - 8) Display information for other transfer switches in the system, including transfer switch name, real time load in KW on the transfer switch, current source condition, and

current operating mode.

I. Internal Controls

1. The transfer switch control system shall be configurable in the field for any operating voltage level up to 600VAC. Provide RMS voltage sensing and metering that is accurate to within plus or minus 1% of nominal voltage level. Frequency sensing shall be accurate to within plus or minus 0.2%. Voltage sensing shall be monitored based on the normal voltage at the site. Systems that utilize voltage monitoring based on standard voltage conditions are not acceptable.
2. Transfer switch voltage sensors shall be close differential type, providing source availability information to the control system based on the following functions:
 - a) Monitoring all phases of the normal service (source 1) for under voltage conditions (adjustable for pickup in a range of 85 to 98% of the normal voltage level and dropout in a range of 75 to 98% of normal voltage level).
 - b) Monitoring all phases of the emergency service (source 2) for under voltage conditions (adjustable for pickup in a range of 85 to 98% of the normal voltage level and dropout in a range of 75 to 98% of pickup voltage level).
 - c) Monitoring all phases of the normal service (source 1) and emergency service (source 2) for voltage imbalance.
 - d) Monitoring all phases of the normal service (source 1) and emergency service (source 2) for loss of a single phase.
 - e) Monitoring all phases of the normal service (source 1) and emergency service (source 2) for phase rotation.
 - f) Monitoring all phases of the normal service (source 1) and emergency service (source 2) for over voltage conditions (adjustable for dropout over a range of 105 to 135% of normal voltage, and pickup at 95-99% of dropout voltage level).
 - g) Monitoring all phases of the normal service (source 1) and emergency service (source 2) for over or under frequency conditions.
 - h) Monitoring the neutral current flow in the load side of the transfer switch. The control shall initiate an alarm when the neutral current

exceeds a preset adjustable value in the range of 100-150% of rated phase current for more than an adjustable time period of 10 to 60 seconds.

3. All transfer switch sensing shall be configurable from a Windows XP or NT PC-based service tool, to allow setting of levels, and enabling or disabling of features and functions. Selected functions including voltage sensing levels and time delays shall be configurable using the operator panel. The transfer control shall incorporate a series of diagnostic LED lamps.
 4. The transfer switch shall be configurable to control the operation time from source to source (program transition operation). The control system shall be capable of enabling or disabling this feature, and adjusting the time period to a specific value. A phase band monitor or similar device is not an acceptable alternate for this feature.
 5. The transfer switch shall incorporate adjustable time delays for generator set start (adjustable in a range from 0-15 seconds); transfer (adjustable in a range from 0-120 seconds); retransfer (adjustable in a range from 0-30 minutes); and generator stop (cooldown) (adjustable in a range of 0-30 minutes).
 6. The control system shall be designed and prototype tested for operation in ambient temperatures from -20°C to $+60^{\circ}\text{C}$.
 7. The control shall have optically isolated logic inputs, high isolation transformers for AC inputs, and relays on all outputs, to provide optimum protection from line voltage surges, RFI and EMI.
 8. A battery charger for the generator set starting batteries, either wall or transfer switch mounted shall be provided. The battery charger shall be a float type charger rated 10 amps. The battery charger shall include an ammeter for display of charging current and shall have fused AC inputs and DC outputs. The charger shall also include fault indications for high and low DC voltage and supply power failed, and dry contacts for external indication of these fault conditions. Supply power failed indication shall be displayed on the ATS control panel.
- J. Control Interface
1. The transfer switch will provide an isolated relay contact for starting of a generator set. The relay shall be normally held open, and close to start the generator set. Output contacts shall be form C, for compatibility with any generator set.

2. Provide one set of form C auxiliary contacts on both sides, operated by transfer switch position, rated 10 amps 250 VAC.
- K. Enclosure
1. Enclosures shall be UL listed, NEMA Type 1. The enclosure shall provide NEC wire bend space. The cabinet door shall be key-locking.
- L. Operation
1. Transfer switch normally connects an energized utility power source (source1) to loads and a generator set (source 2) to the loads when normal source fails. The normal position of the transfer switch is source 1 (connected to the utility), and no start signal is supplied to the genset.
 2. Generator Set Exercise (Test) With Load Mode. The control system shall be configurable to test the generator set under load. In this mode, the transfer switch shall control the generator set in the following sequence:
 - a) Transfer switch shall initiate the exercise sequence at a time indicated in the exercise timer program, or when manually initiated by the operator.
 - b) When the control systems senses the generator set at rated voltage and frequency, it shall operate to connect the loads to the generator set by opening the normal source contacts, and closing the alternate source contacts a predetermined time period later. The timing sequence for the contact operation shall be programmable in the controller.
 - c) The generator set shall operate connected to the load for the duration of the exercise period. If the generator set fails during this period, the transfer switch shall automatically reconnect the generator set to the normal service.
 - d) On completion of the exercise period, the transfer switch shall operate to connect the loads to the normal source by opening the alternate source contacts, and closing the normal source contacts a predetermined time period later. The timing sequence for the contact operation shall be programmable in the controller.
 - e) The transfer switch shall operate the generator set unloaded for a cooldown period, and then remove the start signal from the generator set. If the normal power fails at any time when the generator set is running, the transfer switch shall immediately connect the system loads to the generator set.

3. Generator Set Exercise (Test) Without Load Mode. The control system shall be configurable to test the generator set without transfer switch load connected. In this mode, the transfer switch shall control the generator set in the following sequence:
 - a) Transfer switch shall initiate the exercise sequence at a time indicated in the exercise timer program, or when manually initiated by the operator.
 - b) When the control systems senses the generator set at rated voltage and frequency, it shall operate the generator set unloaded for the duration of the exercise period.
 - c) At the completion of the exercise period, the transfer switch shall remove the start signal from the generator set. If the normal power fails at any time when the generator set is running, the transfer switch shall immediately connect the system loads to the generator set.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. This Contractor shall furnish and install complete the standby electrical power system including the engine generator set, automatic transfer switch, batteries, exhaust system, vibration isolation, cooling system, electrical system, concrete pad, and accessories in accordance with the system manufacturer's recommendations.
- B. The Contractor shall furnish and install a six (6) inch high by six (6) inch greater all sides concrete base foundation for the engine generator set.
 1. Concrete foundation shall be as follows:
 - a. Minimum compressive strength at 28 days – 3500 PSI
 - b. Maximum nominal aggregate size – 1 inch
 - c. Maximum W/C ratio by mass – 0.45
 - d. Air content – $5 \pm 1\%$
 - e. Slump – $2" \pm 0.75"$
 2. Top of concrete bases shall be trowel finished smooth and level with beveled edges. Top surface shall not vary by more than 1/8" in depth as measured across the widest surface.

3. All concrete shall be fully vibrated.
 4. Reinforcing Steel – Reinforcing to meet ASTM requirements. Spacing of bars shall be adjusted to suit conduit spacing.
- C. This Contractor shall ground the generator set as per the NEC, as shown on the Drawings, and as herein specified.
- D. All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired. Equipment shall be thoroughly cleaned to remove all dirt and debris.

3.02 START-UP SERVICE AND ACCEPTANCE TEST

- A. Start-up Service: The standby electrical power system's equipment shall be initially started, operated and tested by the manufacturer's representative prior to the "on-site acceptance test".
- B. On-Site Acceptance Test: The manufacturer shall furnish service personnel and all testing equipment and temporary cable connections to completely service and field test, in the presence of the Owner, the standby electrical power system. The test shall include, but not be limited to, a "cold start" test, a minimum period of four (4) hours with a load bank at one hundred percent (100%) of the nameplate rating of the engine generator set and a one step rated load pick-up test in accordance with NFPA 110. The manufacturer shall make any adjustments to the system to assure proper operation. The manufacturer shall then instruct the Owner's personnel as to proper maintenance and operation and furnish three (3) sets of operating, technical, factory service manuals and maintenance instructions, including descriptive literature of equipment, parts list, and the names and telephone numbers of manufacturer's representatives.
- C. Manufacturer's software shall be available online for download at no charge. If software is not available online, it shall be provided in CD form with the most up to date software.

3.03 WARRANTY

- A. The warranty for the complete standby electric power system shall be unconditional for a period of two (2) years with unlimited operating hours from the date of the successful acceptance test. The warranty shall be furnished by the system manufacturer. Said coverage shall be for all equipment provided under this specification section whether or not it is manufactured by the standby electrical system manufacturer and shall include parts, labor, travel expenses, and labor to remove/reinstall said equipment per the manufacturer's standard published warranty. There shall be no deductibles applied to said warranty. Multiple warranties for individual components, engine alternator, controls, etc. will

not be acceptable. Satisfactory warranty documents shall be furnished. Refer to SECTION 01740 WARRANTIES AND BONDS.

- B. Contractor shall provide Warranty Coverage Labels mounted conspicuously on the engine generator control section and on the door of the automatic load transfer switch. The labels shall identify the one source supplier/manufacturer's address and telephone number, coverage description, coverage type, start-up date, model number, serial number, system registration number and other information deemed pertinent by the supplier/manufacturer. It is the intent of this warranty specification to have a single source contact for the Owner to call for warranty service for all standby electrical power system equipment.
- C. The manufacturer shall be prepared to offer a service contract for the maintenance of the standby electric power system after the warranty period and/or an extended warranty.

END OF SECTION

SECTION 16211

STANDBY ELECTRICAL POWER SYSTEM

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work covered under this Section shall include furnishing and installing the standby electrical power system consisting of an emergency engine generator set and automatic transfer switch as shown on the Drawings and herein specified.
- B. The existing standby electrical power system shall remain in operation and shall continue to serve the building's emergency power during the construction period until the new system has been installed and tested, ready for operation. After the new system has assumed the building's entire emergency power load, the existing system shall be removed as shown on the Drawings.

1.03 QUALITY ASSURANCE

- A. All applicable parts of the standby electrical power system shall meet National Electrical Manufacturer's Association (NEMA) and National Fire Protection Association (NFPA) standards, and be Underwriter's Laboratories, Inc. (UL) listed to UL 2200. The system shall be installed to meet the requirements of the National Electric Code (NEC) and all applicable state and local codes, and these Specifications.
- B. This system shall be completely built, tested, and shipped by a manufacturer who has been regularly engaged in the production of such equipment for the past ten (10) years and who has had parts and service facilities available locally (within a 50 mile radius of the job site) for the past five (5) years.
- C. The supplier of the standby electrical power system shall have and shall be able to demonstrate fully stocked service vehicles. The supplier shall also have factory trained and factory certified maintenance technicians on staff.
- D. The performance of the standby electrical power system shall be certified by an independent testing laboratory as to the unit's full power rating, voltage, and frequency regulation.
- E. The standby electrical power system shall provide standby for the emergency

white and exit lights and other such auxiliary power as indicated on the Drawings so as to operate automatically in the event of an utility power failure of the "normal" power system.

- F. Submittals are required in accordance with SECTION 16010 of the Specifications. The manufacturer shall furnish printed literature and brochures describing the standard series specified (not a one of a kind fabrication). The manufacturer shall furnish schematic and wiring diagrams for the engine generator set and automatic load transfer switch; and an interconnecting diagram showing connections to individual components which constitute the standby electrical power system.
- G. The performance tests of the generating set series shall be in accordance with procedures certified by an independent testing laboratory. The manufacturer shall have successfully tested a prototype of the generating set series offered which shall include: maximum power level; maximum motor starting capacity; structural soundness; torsigraph analysis; fuel consumption; engine-alternator cooling air flow; transient response and steady state governing; alternator temperature rise per NEMA MG1-22.40; single step load pickup per NFPA 76A-822; harmonic analysis and voltage waveform deviation; and three-phase short circuit test for mechanical and electrical strength.
- H. The generator set manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.
- I. The manufacturer shall maintain model and serial number records for each engine generator set and automatic load transfer switch provided for at least 20 years.

PART 2 - PRODUCTS

2.01 DESCRIPTION

- A. The standby electrical power system shall be furnished and installed by this Contractor as shown on the Drawings and as herein specified. The system shall be manufactured by CUMMINS POWER GENERATION as listed herein or equal as manufactured by CATERPILLAR (OLYMPIAN) or KOHLER POWER SYSTEMS.
- B. The standby electrical power system shall be an electric plant rated for continuous standby service at 45 KW, 0.8 power factor, 277/480 volts, three phase, four wire, 60 hertz. A standby electrical power system that will meet this specification is CUMMINS POWER GENERATION Model Number C456N. The system shall be a package of new and current equipment consisting of:

(ENGINEER TO EDIT OUT ONE OF THE #1 PARAGRAPHS.)

1. A natural gas fueled engine generator set, as indicated on the Drawings, to provide standby electrical power.
2. A propane fueled engine generator set with vaporizer-regulator, as indicated on the Drawings, to provide standby electrical power.
3. An automatic transfer switch to provide automatic starting and stopping of the engine generator set and switching of the load.
4. Mounted accessories as herein specified.
5. Three pole, 90 amp output main circuit breaker.
6. Engine mounted start-stop control system.
7. Spring type vibration isolators.
8. Remote annunciator panel.

2.02 ENGINE GENERATOR SET

A. Engine **(ENGINEER TO EDIT FOR NATURAL GAS OR PROPANE)**

1. The engine shall be **(natural gas) (propane)** fueled, four (4) cycle, water cooled, with natural aspiration, mounted radiator, fan, and water pump. It shall have six (6) cylinders with a minimum displacement of 359 cubic inches, with a minimum rating of 84.8-brake horsepower at operating speed of 1800 RPM. Free-turn overhead valves shall be alloy steel with hard chrome-cobalt alloy. Full pressure lubrication shall be supplied by a gear oil pump. The engine shall have a replaceable, full-flow oil filter and gaseous fuel pressure regulation and solenoid valve. Engine speed shall be governed by an electronic governor for isochronous frequency regulation. The engine shall have a twelve (12) volt, DC, battery charging alternator (52) automatically controlled by a solid state voltage regulator. Starting shall be by a twelve (12) volt electric starter.
2. The complete engine shall be furnished with a start control that operates on contact closing and a stop control that operates on contact opening. A cranking limiter shall be provided to open the starting circuit in approximately forty five (45) seconds if the plant is not started within that time.

- B. The alternator shall be a four (4) pole revolving field type with static exciter and torque matched voltage regulator. No commutator or commutator brushes shall be allowed. The starter shall be directly connected to the engine flywheel

housing, and the rotor shall be driven through a rigid coupling to ensure permanent alignment. Voltage regulation shall be within plus or minus two percent (2%) of rated voltage, from no-load to full-load. The instantaneous voltage dip shall be less than twenty percent (20%) of rated voltage when full-load and rated power factor is applied to the alternator. Recovery to stable operation shall occur within four (4) seconds. Stable or steady-state operation is defined as operation with terminal voltage remaining constant within plus or minus one (1%) percent of rated voltage. Temperature rise shall not be more than one hundred five (105) degrees F over forty (40) degrees ambient at rated load. A permanent magnet generator shall provide excitation power to the automatic voltage regulator for immunity from voltage distortion caused by non-linear SCR controlled loads on the unit. The permanent magnet generator shall sustain short circuit current for selective operation and coordination of overcurrent devices. Starting Kva for sustained 90% voltage shall be 191 Skva.

- C. The engine generator set control panel shall be wired, tested, and shock mounted on the generator set by the manufacturer of the alternator. It shall contain: panel lighting; RUN-STOP-REMOTE selector switch; coolant temperature display; DC voltmeter; running time meter; lamp test switch; oil pressure display; fault reset switch; cycle cranking; and low coolant level shutdown. The panel shall contain a monitor panel with the following LED's: green RUN LED; yellow PREWARNING FOR LOW OIL PRESSURE LED; yellow PREWARNING FOR HIGH COOLANT TEMPERATURE LED; red LOW OIL PRESSURE SHUTDOWN LED; red HIGH COOLANT TEMPERATURE SHUTDOWN light; red OVERCRANK SHUTDOWN LED; red OVERSPEED SHUTDOWN light; flashing red SWITCH OFF LED; yellow LOW COOLANT TEMPERATURE LED; yellow LOW FUEL LED. The control system shall include the following AC protection-over/under voltage, over current, short circuit, loss of voltage reference, and over excitation shut down protection. There shall be an overload warning, and overcurrent warning alarm. **[Engineer: delete LOW FUEL light when using natural gas, keep for propane]**
- D. The engine generating set shall be mounted on a welded steel base which shall provide for suitable mounting by this Contractor to any level surface. This Contractor shall furnish and install vibration isolators of the number and size required for the total weight of the unit between the steel base and mounting pad.
- E. Accessories required for the proper operation of the engine generator set shall be furnished by the manufacturer. These shall include, but not be limited to, the following:
1. Flexible exhaust connectors
 2. Twelve (12) volt lead acid type starting batteries
 3. Battery rack and cables

4. Additional solenoid valve (shipped loose)
 5. This Contractor shall install the additional DC voltage solenoid valve supplied, prior to the flexible fuel line and wire as directed by the engine generator manufacturer to the control circuit to open with the engine operation.
 6. Flexible gas lines
 7. Gaseous fuel pressure regulator (to be supplied by the Division 15 Contractor).
 8. Single phase, 1.5 kW, 120 volt crank case heater, direct connected
 9. Fifty percent (50%) ethylene glycol antifreeze solution to fill engine cooling system.
 10. Eight (8) auxiliary configurable inputs and eight (8) configurable relay outputs, two (2) 12 volt Form C dry contacts for connection to the fire alarm system graphic annunciator panel for "Generator Run" and "Generator Fault" indications.
 11. Eight (8) auxiliary configurable inputs and eight (8) configurable relay outputs, two (2) 12 volt Form C dry contacts for connection to the security intrusion system panel for "Generator Run" and "Generator Fault" indications.
- F. The engine generator set shall be enclosed with a weather protective housing. The housing shall be rated for sound attenuation of 69.3 dB(A) average at seven (7) meters when using an eight (8) position measurement system using tests conducted per ANSI S1.13-1971. Acoustical materials shall be oil and water-resistant. A critical silencer muffler shall be mounted inside the housing with raincap and rainshield. The housing shall be attached to the skid base of the generator set and constructed of aluminum using non-marring fasteners. The access doors shall have both key-lockable door handles and provisions for padlocking and mounted using stainless steel hinges. A base barrier shall be included for the elevated generator set. Paint protection shall be epoxy primer and dual coat electrodeposition method for all sides and all metal surfaces. Overspray of hoses, clamps, wiring and harnesses, and other serviceable items shall not be acceptable.

2.03 AUTOMATIC TRANSFER SWITCH

- A. The complete automatic transfer switch shall be suitable for utility power (source 1) to engine generator set (source 2) application, be completely factory assembled with digital electronic controls designed for surge voltage isolation, and including voltage sensors on all phases of both sources, linear operator,

- permanently attached manual handles, positive mechanical and electrical interlocking, and mechanically held contacts.
- B. The automatic transfer switch shall conform to the requirements of the following codes and standards (latest editions):
1. UL1008. The transfer switch shall be UL listed and labeled.
 2. CSA C22.2, No. 14 – M91 Industrial Control Equipment
 3. CSA 282, Emergency Electrical Power Supply for Buildings
 4. NFPA110 – Emergency and Standby Power Systems. The transfer switch shall meet all requirements for level 1 systems.
 5. IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.
 6. NEMA ICS10 – AC Automatic Transfer Switches
- C. The transfer switch manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.
- D. Transfer switch equipment specifications for this project are based on microprocessor-based transfer switches. The transfer switch shall be CUMMINS POWER GENERATION Model CXTC or equal as manufactured by AUTOMATIC SWITCH COMPANY (ASCO) Model 7000 Series.
- E. Ratings
1. The transfer switch shall be three pole, four wire, 277/480 volt, 60 hertz, 150 amp.
 2. Main contacts shall be rated for 600 volts AC minimum.
 3. Transfer switch(es) shall be rated to carry 100 percent of rated current continuously in the enclosure supplied, in ambient temperatures of - 40 to + 60 degrees C, relative humidity up to 95% (non-condensing), and altitudes up to 10,000 feet (3000M).
 4. Transfer switch equipment shall have a minimum 3 cycle (0.05s) withstand and closing ratings (WCR) in RMS symmetrical amperes greater than the available fault currents, but not less than 65,000 at the specified voltage. Additionally, transfer switch equipment shall have 30 cycle (0.5s) withstand and closing ratings (WCR) in RMS symmetrical amperes greater than the available fault currents, but not less than

35,000 at the specified voltage. The transfer switch and its upstream protection shall be third party listed and labeled for use with the specific protective device(s) installed in the application.

F. Construction

1. Transfer switch(es) shall be double-throw, electrically and mechanically interlocked, and mechanically held in the source 1 and source 2 positions. The transfer switch shall be specifically designed to transfer to the best available source if it inadvertently stops in a neutral position.
2. Transfer switches shall be equipped with manual operating handles and quick-break, quick-make over-center contact mechanisms.
3. Main switch contacts shall be high-pressure silver alloy. Contact assemblies shall have arc chutes for positive arc extinguishing. Arc chutes shall have insulating covers to prevent inter-phase flashover.
4. Transfer switch internal wiring shall be composed of pre-manufactured harnesses that are permanently marked for source and destination. Harnesses shall be connected to the control system by means of locking disconnect plug(s), to allow the control system to be easily disconnected and serviced without disconnecting power from the transfer switch mechanism.
5. Transfer switch shall be provided with flame retardant transparent covers to allow viewing of switch contact operation but prevent direct contact with line voltage components.
6. Transfer switches shall be provided with a neutral bus and lugs. The neutral bus shall be sized to carry 100% of the current designed on the switch rating.

G. Connections

1. Field control connections shall be made on a common terminal block that is clearly and permanently labeled.
2. Transfer switch shall be provided with AL/CU mechanical lugs sized to accept the full output rating of the generator set.

H. Transfer Switch Control

1. Operator Panel. Each transfer switch shall be provided with a control panel to allow the operator to view the status and control operation of the transfer switch. The operator panel shall be a sealed membrane panel rated NEMA 3R/IP53 or better (regardless of enclosure rating) that is

permanently labeled for switch and control functions. The operator panel shall be provided with the following features and capabilities.

- a) High intensity LED lamps to indicate the source that the load is connected to (source 1 or source 2); and which source(s) are available. Source available LED indicators shall operate from the control microprocessor to indicate the true condition of the sources as sensed by the control.
- b) High intensity LED lamps to indicate that the transfer switch is “not in auto” (due to control being disabled or due to bypass switch enabled or in operation) and “Test/Exercise Active” to indicate that the control system is testing or exercising the generator set.
- c) “OVERRIDE” pushbutton to cause the transfer switch to bypass any active time delays for start, transfer, and retransfer and immediately proceed with its next logical operation.
- d) “TEST” pushbutton to initiate a preprogrammed test sequence for the generator set and transfer switch. The transfer switch shall be programmable for test with load or test without load.
- e) “RESET/LAMP TEST” pushbutton that will clear any faults present in the control, or simultaneously test all lamps on the panel by lighting them.
- f) The control system shall continuously log information on the number of hours each source has been connected to the load, the number of times transferred, and the total number of times each source has failed. This information shall be available via the service tool or an operator display panel.
- g) Vacuum fluorescent alphanumeric display panel with push-button navigation switches. The display shall be clearly visible in both bright (sunlight) and no light conditions. It shall be visible over an angle of at least 120 degrees. The alphanumeric display panel shall be capable of providing the following functions and capabilities.
 - 1) Display source condition information, including AC voltage for each phase of normal and emergency source, frequency of each source. Voltage for all three phases shall be displayed on a single screen for easy viewing of voltage balance.
 - 2) Display source status, to indicate source is connected or not connected.

- 3) Display load data, including 3-phase AC voltage, 3-phase AC current, frequency, KW, KVA, and power factor. Voltage and current data for all phases shall be displayed on a single screen.
- 4) The display panel shall allow the operator to view and make the following adjustments in the control system, after entering an access code:
 - i. Set nominal voltage and frequency for the transfer switch.
 - ii. Adjust voltage and frequency sensor operation set points.
 - iii. Set up time clock functions.
 - iv. Set up load sequence functions.
 - v. Enable or disable control functions in the transfer switch, including program transition.
 - vi. Set up exercise and load test operation conditions, as well as normal system time delays for transfer time, time delay start, stop, transfer, and retransfer.
- 5) Display real-time clock data, including date, and time in hours, minutes, and seconds. The real time clock shall incorporate provisions for automatic daylight savings time and leap year adjustments. The control shall also log total operating hours for the control system.
- 6) Display service history for the transfer switch. Display source connected hours, to indicate the total number of hours connected to each source. Display number of times transferred, and total number of times each source has failed.
- 7) Display fault history on the transfer switch, including condition, and date and time of fault. Faults to include controller checksum error, low controller DC voltage, ATS fail to close on transfer, ATS fail to close on retransfer, battery charger malfunction, network battery voltage low, network communications error.
- 8) Display information for other transfer switches in the

system, including transfer switch name, real time load in KW on the transfer switch, current source condition, and current operating mode.

I. Internal Controls

1. The transfer switch control system shall be configurable in the field for any operating voltage level up to 600VAC. Provide RMS voltage sensing and metering that is accurate to within plus or minus 1% of nominal voltage level. Frequency sensing shall be accurate to within plus or minus 0.2%. Voltage sensing shall be monitored based on the normal voltage at the site. Systems that utilize voltage monitoring based on standard voltage conditions are not acceptable.
2. Transfer switch voltage sensors shall be close differential type, providing source availability information to the control system based on the following functions:
 - a) Monitoring all phases of the normal service (source 1) for under voltage conditions (adjustable for pickup in a range of 85 to 98% of the normal voltage level and dropout in a range of 75 to 98% of normal voltage level).
 - b) Monitoring all phases of the emergency service (source 2) for under voltage conditions (adjustable for pickup in a range of 85 to 98% of the normal voltage level and dropout in a range of 75 to 98% of pickup voltage level).
 - c) Monitoring all phases of the normal service (source 1) and emergency service (source 2) for voltage imbalance.
 - d) Monitoring all phases of the normal service (source 1) and emergency service (source 2) for loss of a single phase.
 - e) Monitoring all phases of the normal service (source 1) and emergency service (source 2) for phase rotation.
 - f) Monitoring all phases of the normal service (source 1) and emergency service (source 2) for over voltage conditions (adjustable for dropout over a range of 105 to 135% of normal voltage, and pickup at 95-99% of dropout voltage level).
 - g) Monitoring all phases of the normal service (source 1) and emergency service (source 2) for over or under frequency conditions.
 - h) Monitoring the neutral current flow in the load side of the transfer switch. The control shall initiate an alarm when the neutral current

exceeds a preset adjustable value in the range of 100-150% of rated phase current for more than an adjustable time period of 10 to 60 seconds.

3. All transfer switch sensing shall be configurable from a Windows XP or NT PC-based service tool, to allow setting of levels, and enabling or disabling of features and functions. Selected functions including voltage sensing levels and time delays shall be configurable using the operator panel. The transfer control shall incorporate a series of diagnostic LED lamps.
 4. The transfer switch shall be configurable to control the operation time from source to source (program transition operation). The control system shall be capable of enabling or disabling this feature, and adjusting the time period to a specific value. A phase band monitor or similar device is not an acceptable alternate for this feature.
 5. The transfer switch shall incorporate adjustable time delays for generator set start (adjustable in a range from 0-15 seconds); transfer (adjustable in a range from 0-120 seconds); retransfer (adjustable in a range from 0-30 minutes); and generator stop (cooldown) (adjustable in a range of 0-30 minutes).
 6. The control system shall be designed and prototype tested for operation in ambient temperatures from -20°C to $+60^{\circ}\text{C}$.
 7. The control shall have optically isolated logic inputs, high isolation transformers for AC inputs, and relays on all outputs, to provide optimum protection from line voltage surges, RFI and EMI.
 8. A battery charger for the generator set starting batteries, either wall or transfer switch mounted, shall be provided. The battery charger shall be a float type charger rated 10 amps. The battery charger shall include an ammeter for display of charging current and shall have fused AC inputs and DC outputs. The charger shall also include fault indications for high and low DC voltage and supply power failed, and dry contacts for external indication of these fault conditions. Supply power failed indication shall be displayed on the ATS control panel.
- J. Control Interface
1. The transfer switch will provide an isolated relay contact for starting of a generator set. The relay shall be normally held open, and close to start the generator set. Output contacts shall be Form C, for compatibility with any generator set.
 2. Provide one set of Form C auxiliary contacts on both sides, operated by

- transfer switch position, rated 10 amps 250 VAC.
- K. Enclosure
1. Enclosures shall be UL listed, NEMA Type 1. The enclosure shall provide NEC wire bend space. The cabinet door shall be key-locking.
- L. Operation
1. Transfer switch normally connects an energized utility power source (source1) to loads and a generator set (source 2) to the loads when normal source fails. The normal position of the transfer switch is source 1 (connected to the utility), and no start signal is supplied to the genset.
 2. Generator Set Exercise (Test) With Load Mode. The control system shall be configurable to test the generator set under load. In this mode, the transfer switch shall control the generator set in the following sequence:
 - a) Transfer switch shall initiate the exercise sequence at a time indicated in the exercise timer program, or when manually initiated by the operator.
 - b) When the control systems senses the generator set at rated voltage and frequency, it shall operate to connect the loads to the generator set by opening the normal source contacts, and closing the alternate source contacts a predetermined time period later. The timing sequence for the contact operation shall be programmable in the controller.
 - c) The generator set shall operate connected to the load for the duration of the exercise period. If the generator set fails during this period, the transfer switch shall automatically reconnect the generator set to the normal service.
 - d) On completion of the exercise period, the transfer switch shall operate to connect the loads to the normal source by opening the alternate source contacts, and closing the normal source contacts a predetermined time period later. The timing sequence for the contact operation shall be programmable in the controller.
 - e) The transfer switch shall operate the generator set unloaded for a cool down period, and then remove the start signal from the generator set. If the normal power fails at any time when the generator set is running, the transfer switch shall immediately connect the system loads to the generator set.
 3. Generator Set Exercise (Test) Without Load Mode. The control system shall be configurable to test the generator set without transfer switch load

connected. In this mode, the transfer switch shall control the generator set in the following sequence:

- a) Transfer switch shall initiate the exercise sequence at a time indicated in the exercise timer program, or when manually initiated by the operator.
- b) When the control systems senses the generator set at rated voltage and frequency, it shall operate the generator set unloaded for the duration of the exercise period.
- c) At the completion of the exercise period, the transfer switch shall remove the start signal from the generator set. If the normal power fails at any time when the generator set is running, the transfer switch shall immediately connect the system loads to the generator set.

(ENGINEER: USE THIS ONLY WHEN BUILDING HAS A BUILDING ENGINEER'S OFFICE)

2.04 REMOTE ALARM ANNUNCIATOR PANEL

- A. Provide and install a 20-light LED type remote alarm annunciator with horn, located as shown on the drawings in the building engineer's office. The remote annunciator shall provide all the audible and visual alarms called for by NFPA Standard 110 for level 1 systems for the local generator control panel. Spare lamps shall be provided to allow future addition of other alarm and status functions to the annunciator. Provisions for labeling of the annunciator in a fashion consistent with the specified functions shall be provided. Alarm silence and lamp test switch(es) shall be provided. LED lamps shall be replaceable, and indicating lamp color shall be capable of changes needed for specific application requirements. Alarm horn shall be switchable for all annunciation points. Alarm horn (when switched on) shall sound for first fault, and all subsequent faults, regardless of whether first fault has been cleared, in compliance with NFPA110 3-5.6.2. The interconnecting wiring between the annunciator and other system components shall be monitored and failure of the interconnection between components shall be displayed on the annunciator panel.
- B. The annunciator shall include the following alarm labels, audible annunciation features, and lamp colors:

<u>Condition</u>	<u>Lamp Color</u>	<u>Audible Alarm</u>
Normal Power (to Loads)	Green	No
Genset Supplying Load	Amber	No
Genset Running	Green	No
Not in Auto	Red (Flashing)	Yes
High Battery Voltage	Red	Yes
Low Battery Voltage	Red	Yes

Charger AC Failure	Red	Yes
Fail to Start	Red	Yes
Low Engine Temperature	Amber	Yes
Pre-High Engine Temperature	Amber	Yes
High Engine Temperature	Red	Yes
Pre-Low Oil Pressure	Amber	Yes
Low Oil Pressure	Red	Yes
Overspeed	Red	Yes
Low Coolant Level	Amber	Yes
Low Fuel Pressure	Amber	Yes
Network OK	Green	Yes
(3) Spares	Configurable	Configurable

Low battery voltage lamp shall also be lighted for low cranking voltage or weak battery alarm.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. This Contractor shall furnish and install complete the standby electrical power system including the engine generator set, automatic transfer switch, batteries, exhaust system, vibration isolation, cooling system, electrical system, concrete pad, and accessories in accordance with the system manufacturer's recommendations.
- B. The Contractor shall furnish and install a six (6) inch high by six (6) inch greater all sides concrete base foundation for the engine generator set.
 1. Concrete foundation shall be as follows:
 - a. Minimum compressive strength at 28 days – 3500 PSI
 - b. Maximum nominal aggregate size – 1 inch
 - c. Maximum W/C ratio by mass – 0.45
 - d. Air content – $5 \pm 1\%$
 - e. Slump – $2'' \pm 0.75''$
 2. Top of concrete bases shall be trowel finished smooth and level with beveled edges. Top surface shall not vary by more than 1/8" in depth as measured across the widest surface.
 3. All concrete shall be fully vibrated.
 4. Reinforcing Steel – Reinforcing to meet ASTM requirements. Spacing of bars shall be adjusted to suit conduit spacing.

- C. This Contractor shall ground the generator set as per the NEC, as shown on the Drawings, and as herein specified.
- D. All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired. Equipment shall be thoroughly cleaned to remove all dirt and debris.

3.02 START-UP SERVICE AND ACCEPTANCE TEST

- A. Start-up Service: The standby electrical power system's equipment shall be initially started, operated and tested by the manufacturer's representative prior to the "on-site acceptance test".
- B. On-Site Acceptance Test: The manufacturer shall furnish service personnel and all testing equipment and temporary cable connections to completely service and field test, in the presence of the Owner, the standby electrical power system. The test shall include, but not be limited to, a "cold start" test, a minimum period of four (4) hours with a load bank test at one hundred percent (100%) of the nameplate rating of the engine generator set and a one step rated load pickup test in accordance with NFPA 110. The manufacturer shall make any adjustments to the system to assure proper operation. The manufacturer shall then instruct the Owner's personnel as to proper maintenance and operation and furnish three (3) sets of operating, technical, factory service manuals and maintenance instructions, including descriptive literature of equipment, parts list, and the names and telephone numbers of manufacturer's representatives.
- C. Manufacturer's software shall be available online for download at no charge. If software is not available online, it shall be provided in CD form with the most up to date software.

3.03 WARRANTY

- A. The warranty for the complete standby electric power system shall be unconditional for a period of two (2) years with unlimited operating hours from the date of the successful acceptance test. The warranty shall be furnished by the system manufacturer. Said coverage shall be for all equipment provided under this specification section whether or not it is manufactured by the standby electrical system manufacturer and shall include parts, labor, travel expenses, and labor to remove/reinstall said equipment per the manufacturer's standard published warranty. There shall be no deductibles applied to said warranty. Multiple warranties for individual components, engine alternator, controls, etc. will not be acceptable. Satisfactory warranty documents shall be furnished. Refer to SECTION 01740 WARRANTIES AND BONDS.
- B. Contractor shall provide warranty coverage labels mounted conspicuously on the engine generator control section and on the door of the automatic load transfer switch. The labels shall identify the one source supplier/manufacturer's address

and telephone number, coverage description, coverage type, start-up date, model number, serial number, system registration number and other information deemed pertinent by the supplier/manufacturer. It is the intent of this warranty specification to have a single source contact for the Owner to call for warranty service for all standby electrical power system equipment.

- C. The manufacturer shall be prepared to offer a service contract for the maintenance of the standby electric power system after the warranty period and/or an extended warranty.

END OF SECTION

SECTION 16212

STANDBY ELECTRICAL POWER SYSTEM

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work covered under this Section shall include furnishing and installing the standby electrical power system consisting of an emergency engine generator set and automatic transfer switch as shown on the Drawings and herein specified.
- B. The existing standby electrical power system shall remain in operation and shall continue to serve the building's emergency power during the construction period until the new system has been installed and tested, ready for operation. After the new system has assumed the building's entire emergency power load, the existing system shall be removed as shown on the Drawings.

1.03 QUALITY ASSURANCE

- A. All applicable parts of the standby electrical power system shall meet National Electrical Manufacturer's Association (NEMA) and National Fire Protection Association (NFPA) standards, and be Underwriter's Laboratories, Inc. (UL) listed to UL 2200 and bear the UL label. The system shall be installed to meet the requirements of the National Electric Code (NEC) and all applicable state and local codes, and these Specifications.
- B. This system shall be completely built, tested, and shipped by a manufacturer who has been regularly engaged in the production of such equipment for the past ten (10) years and who has had parts and service facilities available locally (within a 50 mile radius of the job site) for the past five (5) years.
- C. The supplier of the standby electrical power system shall have and shall be able to demonstrate fully stocked service vehicles. The supplier shall also have factory trained and factory certified maintenance technicians on staff.
- D. The performance of the standby electrical power system shall be certified by an independent testing laboratory as to the unit's full power rating, voltage, and frequency regulation.
- E. The standby electrical power system shall provide standby for the emergency

white and exit lights and other such auxiliary power as indicated on the Drawings so as to operate automatically in the event of a utility power failure of the "normal" power system.

- F. Submittals are required in accordance with SECTION 16010 of the Specifications. The manufacturer shall furnish printed literature and brochures describing the standard series specified (not a one of a kind fabrication). The manufacturer shall furnish schematic and wiring diagrams for the engine generator set and automatic load transfer switch; and an interconnecting diagram showing connections to individual components which constitute the standby electrical power system.
- G. The performance tests of the generating set series shall be in accordance with procedures certified by an independent testing laboratory. The manufacturer shall have successfully tested a prototype of the generating set series offered which shall include: maximum power level; maximum motor starting capacity; structural soundness; torsigraph analysis; fuel consumption; engine-alternator cooling air flow; transient response and steady state governing; alternator temperature rise per NEMA MG1-22.40; single step load pickup per NFPA 76A-822; harmonic analysis and voltage waveform deviation; and three-phase short circuit test for mechanical and electrical strength.
- H. The generator set manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.
- I. The manufacturer shall maintain model and serial number records for each engine generator set and automatic load transfer switch provided for at least 20 years.

PART 2 - PRODUCTS

2.01 DESCRIPTION

- A. The standby electrical power system shall be furnished and installed by this Contractor as shown on the Drawings and as herein specified. The system shall be manufactured by CUMMINS POWER GENERATION as listed herein or equal as manufactured by CATERPILLAR (OLYMPIAN) or KOHLER POWER SYSTEMS.
- B. The standby electrical power system shall be an electric plant rated for continuous standby service at 100 KW, 0.8 power factor, 277/480 volts, three phase, four wire, 60 hertz. A standby electrical power system that will meet this specification is CUMMINS POWER GENERATION model number C100N6. The system shall be a package of new and current equipment consisting of:

(ENGINEER TO EDIT OUT ONE OF THE #1 PARAGRAPHS.)

1. A natural gas fueled engine generator set, as indicated on the Drawings, to provide standby electrical power.
2. A propane fueled engine generator set with vaporizer-regulator, as indicated on the Drawings, to provide standby electrical power.
3. An automatic transfer switch to provide automatic starting and stopping of the engine generator set and switching of the load.
4. Mounted accessories as herein specified.
5. Three pole, 200 amp output main circuit breaker.
6. Engine mounted start-stop control system.
7. Spring type vibration isolators.
8. Remote annunciator panel.

2.02 ENGINE GENERATOR SET

A. Engine **(ENGINEER TO EDIT FOR NATURAL GAS OR PROPANE)**

1. The engine shall be (natural gas) (propane) fueled, four (4) cycle, water cooled, turbo charged with mounted radiator, fan, and water pump. It shall have six (6) cylinders with a minimum displacement of 359 cubic inches, with a minimum rating of 200.3 brake horsepower at operating speed of 1800 RPM. Free-turn overhead valves shall be alloy steel with hard chrome-cobalt alloy. Full pressure lubrication shall be supplied by a gear oil pump. The engine shall have a replaceable, full-flow oil filter and gaseous fuel pressure regulation and solenoid valve. Engine speed shall be governed by an electronic governor for isochronous frequency regulation. The engine shall have a twelve (12) volt, DC, battery charging alternator (52A) automatically controlled by a solid state voltage regulator. Starting shall be by a twelve (12) volt electric starter.
2. The complete engine shall be furnished with a start control that operates on contact closing and a stop control that operates on contact opening. A cranking limiter shall be provided to open the starting circuit in approximately forty five (45) seconds if the plant is not started within that time.

- B. The alternator shall be a four (4) pole revolving field type with permanent magnet exciter and torque matched voltage regulator. No commutator or commutator brushes shall be allowed. The starter shall be directly connected to the engine

flywheel housing, and the rotor shall be driven through a rigid coupling to insure permanent alignment. Voltage regulation shall be within plus or minus two percent (2%) of rated voltage, from no-load to full-load. The instantaneous voltage dip shall be less than thirty eight percent (38%) of rated voltage when full-load and rated power factor is applied to the alternator. Recovery to stable operation shall occur within five and one-half (5.5) seconds. Stable or steady-state operation is defined as operation with terminal voltage remaining constant within plus or minus one (1%) percent of rated voltage. Temperature rise shall not be more than one hundred five (105) degrees F over forty (40) degrees ambient at rated load. A permanent magnet generator shall provide excitation power to the automatic voltage regulator for immunity from voltage distortion caused by non-linear SCR controlled loads on the unit. The permanent magnet generator shall sustain short circuit current for selective operation and coordination of overcurrent devices. Starting kVA for 90% sustained voltage shall be 497 kVA.

- C. The engine generator set control panel shall be wired, tested, and shock mounted on the generator set by the manufacturer of the alternator. It shall contain: panel lighting; RUN-STOP-REMOTE selector switch; coolant temperature display; DC voltmeter; running time display; lamp test switch; oil pressure gauge; fault reset switch; cycle cranking; and low coolant level shutdown. The panel shall contain a monitoring panel with the following LEDs: green RUN LED; yellow PREWARNING FOR LOW OIL PRESSURE LED; yellow PREWARNING FOR HIGH COOLANT TEMPERATURE LED; red LOW OIL PRESSURE SHUTDOWN LED; red HIGH COOLANT TEMPERATURE SHUTDOWN LED; red OVERCRANK SHUTDOWN LED; red OVERSPEED SHUTDOWN LED; flashing red SWITCH OFF LED; yellow LOW COOLANT TEMPERATURE LED; yellow LOW FUEL LED. The control system shall include the following AC protection-over/under voltage, over current, short circuit, loss of voltage reference, and over excitation shut down protection. There shall be an overload warning, and overcurrent warning alarm. **[Engineer: delete LOW FUEL light when using natural gas, keep for propane].**
- D. The engine generating set shall be mounted on a welded steel base which shall provide for suitable mounting by this Contractor to any level surface. This Contractor shall furnish and install vibration isolators of the number and size required for the total weight of the unit between the steel base and mounting pad.
- E. Accessories required for the proper operation of the engine generator set shall be furnished by the manufacturer. These shall include, but not be limited to, the following:
1. Flexible exhaust connectors
 2. Twelve (12) volt lead acid type starting batteries
 3. Battery rack and cables

4. Additional solenoid valve (shipped loose)
 5. This Contractor shall install the additional DC voltage solenoid valve supplied, prior to the flexible fuel line and wire as directed by the engine generator manufacturer to the control circuit to open with the engine operation.
 6. Flexible gas lines
 7. Gaseous fuel pressure regulator (to be supplied by the Division 15 Contractor)
 8. Single phase, 1.5 kw, 120 volt crank case heater, direct connected
 9. Fifty percent (50%) ethylene glycol antifreeze solution to fill engine cooling system
 10. Eight (8) auxiliary configurable inputs and eight (8) configurable relay outputs, two (2) for 12 volt Form C dry contacts for connection to the fire alarm system graphic annunciator panel for "Generator Run" and "Generator Fault" indications.
 11. Two (2) 12 volt Form C dry contacts for connection to the security intrusion system panel for "Generator Run" and "Generator Fault" indications.
- F. The engine generator set shall be enclosed with a weather protective housing. The housing shall be rated for sound attenuation to seventy one (71) dB(A) average at seven (7) meters when using an eight (8) position measurement system using tests conducted per ANSI S1.13-1971. Acoustical materials shall be oil and water-resistant. A critical silencer muffler shall be mounted inside the housing with raincap and rainshield. The housing shall be attached to the skid base of the generator set and constructed of aluminum using non-marring fasteners. The access doors shall have both key-lockable door handles and provisions for padlocking and mounted using stainless steel hinges. A base barrier shall be included for the elevated generator set. Paint protection shall be epoxy primer and dual coat electrodeposition method for all sides and all metal surfaces. Overspray of hoses, clamps, wiring and harnesses, and other serviceable items shall not be acceptable.

2.03 AUTOMATIC TRANSFER SWITCH

- A. The complete automatic transfer switch shall be suitable for utility power (source 1) to engine generator set (source 2) application, be completely factory assembled with digital electronic controls designed for surge voltage isolation, and including voltage sensors on all phases of both sources, linear operator, permanently attached manual handles, positive mechanical and electrical

interlocking, and mechanically held contacts.

- B. The automatic transfer switch shall conform to the requirements of the following codes and standards (latest editions):
1. UL1008. The transfer switch shall be UL listed and labeled.
 2. CSA C22.2, No. 14 – M91 Industrial Control Equipment
 3. CSA 282, Emergency Electrical Power Supply for Buildings
 4. NFPA110 – Emergency and Standby Power Systems. The transfer switch shall meet all requirements for level 1 systems.
 5. IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
 6. NEMA ICS10 – AC Automatic Transfer Switches
- C. The transfer switch manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.
- D. Transfer switch equipment specifications for this project are based on microprocessor-based transfer switches. The transfer switch shall be CUMMINS POWER GENERATION Model CXTC or equal as manufactured by AUTOMATIC SWITCH COMPANY (ASCO) Model 7000 Series.
- E. Ratings
1. The transfer switch shall be three pole, four wire, 277/480 volt, 60 hertz, 225 amp.
 2. Main contacts shall be rated for 600 volts AC minimum.
 3. Transfer switch(es) shall be rated to carry 100 percent of rated current continuously in the enclosure supplied, in ambient temperatures of - 40 to + 60 degrees C, relative humidity up to 95% (non-condensing), and altitudes up to 10,000 feet (3000M).
 4. Transfer switch equipment shall have a minimum 3 cycle (0.05s) withstand and closing ratings (WCR) in RMS symmetrical amperes greater than the available fault currents, but not less than 65,000 at the specified voltage. Additionally, transfer switch equipment shall have 30 cycle (0.5s) withstand and closing ratings (WCR) in RMS symmetrical amperes greater than the available fault currents, but not less than

35,000 at the specified voltage. The transfer switch and its upstream protection shall be third party listed and labeled for use with the specific protective device(s) installed in the application.

F. Construction

1. Transfer switch(es) shall be double-throw, electrically and mechanically interlocked, and mechanically held in the source 1 and source 2 positions. The transfer switch shall be specifically designed to transfer to the best available source if it inadvertently stops in a neutral position.
2. Transfer switches shall be equipped with manual operating handles and quick-break, quick-make over-center contact mechanisms.
3. Main switch contacts shall be high-pressure silver alloy. Contact assemblies shall have arc chutes for positive arc extinguishing. Arc chutes shall have insulating covers to prevent inter-phase flashover.
4. Transfer switch internal wiring shall be composed of pre-manufactured harnesses that are permanently marked for source and destination. Harnesses shall be connected to the control system by means of locking disconnect plug(s), to allow the control system to be easily disconnected and serviced without disconnecting power from the transfer switch mechanism.
5. Transfer switch shall be provided with flame retardant transparent covers to allow viewing of switch contact operation but prevent direct contact with line voltage components.
6. Transfer switches shall be provided with a neutral bus and lugs. The neutral bus shall be sized to carry 100% of the current designed on the switch rating.

G. Connections

1. Field control connections shall be made on a common terminal block that is clearly and permanently labeled.
2. Transfer switch shall be provided with AL/CU mechanical lugs sized to accept the full output rating of the generator set.

H. Transfer Switch Control

1. Operator Panel. Each transfer switch shall be provided with a control panel to allow the operator to view the status and control operation of the transfer switch. The operator panel shall be a sealed membrane panel rated NEMA 3R/IP53 or better (regardless of enclosure rating) that is

permanently labeled for switch and control functions. The operator panel shall be provided with the following features and capabilities.

- a. High intensity LED lamps to indicate the source that the load is connected to (source 1 or source 2); and which source(s) are available. Source available LED indicators shall operate from the control microprocessor to indicate the true condition of the sources as sensed by the control.
- b. High intensity LED lamps to indicate that the transfer switch is “not in auto” (due to control being disabled or due to bypass switch enabled or in operation) and “Test/Exercise Active” to indicate that the control system is testing or exercising the generator set.
- c. “OVERRIDE” pushbutton to cause the transfer switch to bypass any active time delays for start, transfer, and retransfer and immediately proceed with its next logical operation.
- d. “TEST” pushbutton to initiate a preprogrammed test sequence for the generator set and transfer switch. The transfer switch shall be programmable for test with load or test without load.
- e. “RESET/LAMP TEST” pushbutton that will clear any faults present in the control, or simultaneously test all lamps on the panel by lighting them.
- f. The control system shall continuously log information on the number of hours each source has been connected to the load, the number of times transferred, and the total number of times each source has failed. This information shall be available via the service tool or an operator display panel.
- g. Vacuum fluorescent alphanumeric display panel with push-button navigation switches. The display shall be clearly visible in both bright (sunlight) and no light conditions. It shall be visible over an angle of at least 120 degrees. The Alphanumeric display panel shall be capable of providing the following functions and capabilities.
 - 1) Display source condition information, including AC voltage for each phase of normal and emergency source, frequency of each source. Voltage for all three phases shall be displayed on a single screen for easy viewing of voltage balance.
 - 2) Display source status, to indicate source is connected or not connected.

- 3) Display load data, including 3-phase AC voltage, 3-phase AC current, frequency, kW, kVA, and power factor. Voltage and current data for all phases shall be displayed on a single screen.
- 4) The display panel shall allow the operator to view and make the following adjustments in the control system, after entering an access code:
 - a) Set nominal voltage and frequency for the transfer switch.
 - b) Adjust voltage and frequency sensor operation set points.
 - c) Set up time clock functions.
 - d) Set up load sequence functions.
 - e) Enable or disable control functions in the transfer switch, including program transition.
 - f) Set up exercise and load test operation conditions, as well as normal system time delays for transfer time, time delay start, stop, transfer, and retransfer.
- 5) Display real-time clock data, including date, and time in hours, minutes, and seconds. The real time clock shall incorporate provisions for automatic daylight savings time and leap year adjustments. The control shall also log total operating hours for the control system.
- 6) Display service history for the transfer switch. Display source connected hours, to indicate the total number of hours connected to each source. Display number of times transferred, and total number of times each source has failed.
- 7) Display fault history on the transfer switch, including condition, and date and time of fault. Faults to include controller checksum error, low controller DC voltage, ATS fail to close on transfer, ATS fail to close on retransfer, battery charger malfunction, network battery voltage low, network communications error.
- 8) Display information for other transfer switches in the

system, including transfer switch name, real time load in KW on the transfer switch, current source condition, and current operating mode.

I. Internal Controls

1. The transfer switch control system shall be configurable in the field for any operating voltage level up to 600VAC. Provide RMS voltage sensing and metering that is accurate to within plus or minus 1% of nominal voltage level. Frequency sensing shall be accurate to within plus or minus 0.2%. Voltage sensing shall be monitored based on the normal voltage at the site. Systems that utilize voltage monitoring based on standard voltage conditions are not acceptable.
2. Transfer switch voltage sensors shall be close differential type, providing source availability information to the control system based on the following functions:
 - a. Monitoring all phases of the normal service (source 1) for under voltage conditions (adjustable for pickup in a range of 85 to 98% of the normal voltage level and dropout in a range of 75 to 98% of normal voltage level).
 - b. Monitoring all phases of the emergency service (source 2) for under voltage conditions (adjustable for pickup in a range of 85 to 98% of the normal voltage level and dropout in a range of 75 to 98% of pickup voltage level).
 - c. Monitoring all phases of the normal service (source 1) and emergency service (source 2) for voltage imbalance.
 - d. Monitoring all phases of the normal service (source 1) and emergency service (source 2) for loss of a single phase.
 - e. Monitoring all phases of the normal service (source 1) and emergency service (source 2) for phase rotation.
 - f. Monitoring all phases of the normal service (source 1) and emergency service (source 2) for over voltage conditions (adjustable for dropout over a range of 105 to 135% of normal voltage, and pickup at 95-99% of dropout voltage level).
 - g. Monitoring all phases of the normal service (source 1) and emergency service (source 2) for over or under frequency conditions.
 - h. Monitoring the neutral current flow in the load side of the transfer

switch. The control shall initiate an alarm when the neutral current exceeds a preset adjustable value in the range of 100-150% of rated phase current for more than an adjustable time period of 10 to 60 seconds.

3. All transfer switch sensing shall be configurable from a Windows XP or NT PC-based service tool, to allow setting of levels, and enabling or disabling of features and functions. Selected functions including voltage sensing levels and time delays shall be configurable using the operator panel. The transfer control shall incorporate a series of diagnostic LED lamps.
 4. The transfer switch shall be configurable to control the operation time from source to source (program transition operation). The control system shall be capable of enabling or disabling this feature, and adjusting the time period to a specific value. A phase band monitor or similar device is not an acceptable alternate for this feature.
 5. The transfer switch shall incorporate adjustable time delays for generator set start (adjustable in a range from 0-15 seconds); transfer (adjustable in a range from 0-120 seconds); retransfer (adjustable in a range from 0-30 minutes); and generator stop (cool down) (adjustable in a range of 0-30 minutes).
 6. The control system shall be designed and prototype tested for operation in ambient temperatures from -20°C to $+60^{\circ}\text{C}$.
 7. The control shall have optically isolated logic inputs, high isolation transformers for AC inputs, and relays on all outputs, to provide optimum protection from line voltage surges, RFI and EMI.
 8. A battery charger for the generator set starting batteries, either wall or transfer switch mounted shall be provided. The battery charger shall be a float type charger rated 10 amps. The battery charger shall include an ammeter for display of charging current and shall have fused AC inputs and DC outputs. The charger shall also include fault indications for high and low DC voltage and supply power failed, and dry contacts for external indication of these fault conditions. Supply power failed indication shall be displayed on the ATS control panel.
- J. Control Interface
1. The transfer switch will provide an isolated relay contact for starting of a generator set. The relay shall be normally held open, and close to start the generator set. Output contacts shall be Form C, for compatibility with any generator set.

2. Provide one set of Form C auxiliary contacts on both sides, operated by transfer switch position, rated 10 amps 250 VAC.
- K. Enclosure
1. Enclosures shall be UL listed, NEMA Type 1. The enclosure shall provide NEC wire bend space. The cabinet door shall be key-locking.
- L. Operation
1. Transfer switch normally connects an energized utility power source (source1) to loads and a generator set (source 2) to the loads when normal source fails. The normal position of the transfer switch is source 1 (connected to the utility), and no start signal is supplied to the genset.
 2. Generator Set Exercise (Test) With Load Mode. The control system shall be configurable to test the generator set under load. In this mode, the transfer switch shall control the generator set in the following sequence:
 - a. Transfer switch shall initiate the exercise sequence at a time indicated in the exercise timer program, or when manually initiated by the operator.
 - b. When the control systems senses the generator set at rated voltage and frequency, it shall operate to connect the loads to the generator set by opening the normal source contacts, and closing the alternate source contacts a predetermined time period later. The timing sequence for the contact operation shall be programmable in the controller.
 - c. The generator set shall operate connected to the load for the duration of the exercise period. If the generator set fails during this period, the transfer switch shall automatically reconnect the generator set to the normal service.
 - d. On completion of the exercise period, the transfer switch shall operate to connect the loads to the normal source by opening the alternate source contacts, and closing the normal source contacts a predetermined time period later. The timing sequence for the contact operation shall be programmable in the controller.
 - e. The transfer switch shall operate the generator set unloaded for a cool down period, and then remove the start signal from the generator set. If the normal power fails at any time when the generator set is running, the transfer switch shall immediately connect the system loads to the generator set.

3. Generator Set Exercise (Test) Without Load Mode. The control system shall be configurable to test the generator set without transfer switch load connected. In this mode, the transfer switch shall control the generator set in the following sequence:
 - a. Transfer switch shall initiate the exercise sequence at a time indicated in the exercise timer program, or when manually initiated by the operator.
 - b. When the control systems senses the generator set at rated voltage and frequency, it shall operate the generator set unloaded for the duration of the exercise period.
 - c. At the completion of the exercise period, the transfer switch shall remove the start signal from the generator set. If the normal power fails at any time when the generator set is running, the transfer switch shall immediately connect the system loads to the generator set.

2.04 REMOTE ALARM ANNUNCIATOR PANEL

- A. Provide and install a 20-light LED type remote alarm annunciator with horn, located as shown on the drawings in the building engineer's office. The remote annunciator shall provide all the audible and visual alarms called for by NFPA Standard 110 for level 1 systems for the local generator control panel. Spare lamps shall be provided to allow future addition of other alarm and status functions to the annunciator. Provisions for labeling of the annunciator in a fashion consistent with the specified functions shall be provided. Alarm silence and lamp test switch(es) shall be provided. LED lamps shall be replaceable, and indicating lamp color shall be capable of changes needed for specific application requirements. Alarm horn shall be switchable for all annunciation points. Alarm horn (when switched on) shall sound for first fault, and all subsequent faults, regardless of whether first fault has been cleared, in compliance with NFPA110 3-5.6.2. The interconnecting wiring between the annunciator and other system components shall be monitored and failure of the interconnection between components shall be displayed on the annunciator panel.
- B. The annunciator shall include the following alarm labels, audible annunciation features, and lamp colors:

<u>Condition</u>	<u>Lamp Color</u>	<u>Audible Alarm</u>
Normal Power (to Loads)	Green	No
Genset Supplying Load	Amber	No
Genset Running	Green	No
Not in Auto	Red (Flashing)	Yes
High Battery Voltage	Red	Yes

Low Battery Voltage	Red	Yes
Charger AC Failure	Red	Yes
Fail to Start	Red	Yes
Low Engine Temperature	Amber	Yes
Pre-High Engine Temperature	Amber	Yes
High Engine Temperature	Red	Yes
Pre-Low Oil Pressure	Amber	Yes
Low Oil Pressure	Red	Yes
Overspeed	Red	Yes
Low Coolant Level	Amber	Yes
Low Fuel Pressure	Amber	Yes
Network OK	Green	Yes
(3) Spares	Configurable	Configurable

Low battery voltage lamp shall also be lighted for low cranking voltage or weak battery alarm.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. This Contractor shall furnish and install complete the standby electrical power system including the engine generator set, automatic transfer switch, batteries, exhaust system, vibration isolation, cooling system, electrical system, concrete pad, and accessories in accordance with the system manufacturer's recommendations.
- B. The Contractor shall furnish and install a six (6) inch high by six (6) inch greater all sides concrete base foundation for the engine generator set.
 1. Concrete foundation shall be as follows:
 - a. Minimum compressive strength at 28 days – 3500 PSI
 - b. Maximum nominal aggregate size – 1 inch
 - c. Maximum W/C ratio by mass – 0.45
 - d. Air content – 5 + 1%
 - e. Slump – 2" + 0.75"
 2. Top of concrete bases shall be trowel finished smooth and level with beveled edges. Top surface shall not vary by more than 1/8" in depth as measured across the widest surface.
 3. All concrete shall be fully vibrated.
 4. Reinforcing Steel – reinforcing to meet ASTM requirements. Spacing of bars shall be adjusted to suit conduit spacing.

- C. This Contractor shall ground the generator set as per the NEC, as shown on the Drawings, and as herein specified.
- D. All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired. Equipment shall be thoroughly cleaned to remove all dirt and debris.

3.02 START-UP SERVICE AND ACCEPTANCE TEST

- A. Start-up Service: The standby electrical power system's equipment shall be initially started, operated and tested by the manufacturer's representative prior to the "on-site acceptance test".
- B. On-Site Acceptance Test: The manufacturer shall furnish service personnel and all testing equipment and temporary cable connections to completely service and field test, in the presence of the Owner, the standby electrical power system. The test shall include, but not be limited to, a "cold start" test, a minimum period of four (4) hours with a load bank test at one hundred percent (100%) of the nameplate rating of the engine generator set and a one step rated load pickup test in accordance with NFPA 110. The manufacturer shall make any adjustments to the system to assure proper operation. The manufacturer shall then instruct the Owner's personnel as to proper maintenance and operation and furnish three (3) sets of operating, technical, factory service manuals and maintenance instructions, including descriptive literature of equipment, parts list, and the names and telephone numbers of manufacturer's representatives.
- C. Manufacturer's software shall be available online for download at no charge. If software is not available online, it shall be provided in CD form with the most up to date software.

3.03 WARRANTY

- A. The warranty for the complete standby electric power system shall be unconditional for a period of two (2) years with unlimited operating hours from the date of the successful acceptance test. The warranty shall be furnished by the system manufacturer. Said coverage shall be for all equipment provided under this specification section whether or not it is manufactured by the Standby Electrical System Manufacturer and shall include parts, labor, travel expenses, and labor to remove/reinstall said equipment per the manufacturer's standard published warranty. There shall be no deductibles applied to said warranty. Multiple warranties for individual components, engine alternator, controls, etc. will not be acceptable. Satisfactory warranty documents shall be furnished. Refer to SECTION 01740 WARRANTIES AND BONDS.
- B. Contractor shall provide warranty coverage labels mounted conspicuously on the engine generator control section and on the door of the automatic load transfer

switch. The labels shall identify the one source supplier/manufacture's address and telephone number, coverage description, coverage type, start-up date, model number, serial number, system registration number and other information deemed pertinent by the supplier/manufacture. It is the intent of this warranty specification to have a single source contact for the Owner to call for warranty service for all standby electrical power system equipment.

- C. The manufacturer shall be prepared to offer a service contract for the maintenance of the standby electric power system after the warranty period and/or an extended warranty.

END OF SECTION

SECTION 16213

STANDBY ELECTRICAL POWER SYSTEM (EMERGENCY SHELTER SYSTEM)

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work covered under this Section shall include furnishing and installing a standby electrical power system as shown on the drawings and specified herein.
 - 1. Provide complete factory assembled generator set equipment with digital (microprocessor-based) electronic generator set controls, digital governor, digital voltage regulator, and remote annunciator panel.
 - 2. Provide complete factory assembled power transfer equipment with field programmable digital electronic controls designed for fully automatic operation and including: surge voltage isolation, voltage sensors on all phases of both sources, linear operator, permanently attached manual handles, positive mechanical and electrical interlocking, and mechanically held contacts for both sources.
 - 3. Provide generator-base fuel oil tank (UL 142).
 - 4. Provide a complete fuel oil transfer pumping system. **(ENGINEER EDIT OUT IF PROVIDED BY DIVISION 15)**
 - 5. Provide factory test, startup by a supplier authorized by the equipment manufacturer(s), and on-site testing of the system.
 - 6. The generator set manufacturer shall warrant all equipment provided under this section, whether or not it is manufactured by the generator set manufacturer, so that there is one source for warranty and product service. Technicians specifically trained and certified by the manufacturer to support the product and employed by the generator set supplier shall service the generator sets.

ENGINEER, CHOOSE PARAGRAPH 'B' OR 'C' and/or 'D' AS APPROPRIATE

- B. The existing standby electrical power system shall remain in operation and shall continue to serve the building's emergency power.

- C. The existing standby electrical power system shall remain in operation and shall continue to serve the building's emergency power during the construction period until the new system has been installed and tested, ready for operation. After the new system has assumed the building's entire emergency power load, the existing system shall be removed as shown on the Drawings.
- D. The standby "emergency" electrical power system for life safety is a separate system and not apart of this standby electrical power system.

1.03 QUALITY ASSURANCE

- A. The manufacturer of the generator set shall maintain service parts inventory at a central location which is accessible to the service location 24 hours per day, 365 days per year.
- B. The manufacturer shall maintain model and serial number records of each generator set provided for at least 20 years.
- C. The generator set shall be serviced by a local service organization that is trained and factory certified in generator set service. The supplier shall maintain an inventory of critical replacement parts at the local service organization and in service vehicles. The service organization shall be on call 24 hours per day, 365 days per year, who has had parts and service facilities available locally (within a 50 mile radius of the job site) for the last five (5) years. The local service organization shall be authorized to perform warranty repair on the engine generator and controls.
- D. Submittals are required in accordance with SECTION 16010 of the Specifications, which shall include the following minimum information for review:
 - 1. Manufacturer's product literature and performance data, sufficient to verify compliance to specification requirements.
 - 2. Manufacturer's certification of prototype testing.
 - 3. Manufacturer's published warranty documents.
 - 4. Shop drawings showing plan and elevation views with certified overall dimensions, as well as wiring interconnection details.
 - 5. Interconnection wiring diagrams showing all external connections required; with field wiring terminals marked in a consistent point-to-point manner.
 - 6. Manufacturer's installation instructions.
- E. Factory Testing:

1. The generator set manufacturer shall perform a complete operational test on the generator set prior to shipping from the factory. A certified test report shall be provided. Equipment supplied shall be fully tested at the factory for function and performance.
2. Generator set factory tests on the equipment shall be performed at rated load and rated power factor. Generator sets that have not been factory tested at rated power factor will not be acceptable. Tests shall include: run at full load, maximum power, voltage regulation, transient and steady-state governing, single step load pickup, and function of safety shutdowns.
3. The automatic transfer switch manufacturer shall perform a complete operational test on the transfer switch prior to shipping from the factory. A certified test report shall be available on request. Test process shall include calibration of voltage sensors.

1.04 CODES AND STANDARDS

- A. The generator set installation and on-site testing shall conform to the requirements of the following codes and standards, as applicable. The generator set shall include necessary features to meet the requirements of these standards:
 1. CSA 282, 1989 Emergency Electrical Power Supply for Buildings
 2. IEEE446-Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
 3. NFPA 37
 4. NFPA 70 – National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701 and 702.
 5. NFPA 99 – Essential Electrical Systems for Health Care Facilities
 6. NFPA 110 – Emergency and Standby Power Systems. The generator set shall meet all requirements for Level 1 systems. Level 1 prototype tests required by this standard shall have been performed on a complete and functional unit, component level type tests will not substitute for this requirement.
- B. The generator set and supplied accessories shall meet the requirements of the following standards, as applicable:
 1. NEMA MG1. Alternator shall comply with the requirements of the current version this standard as they apply to AC alternators.

2. UL142 – Sub base tanks
 3. UL2085 – Sub-base tanks
 4. UL1236 – Battery Chargers
 5. UL2200. The generator set shall be listed to UL2200 or submit to an independent third party certification process to verify compliance as installed.
- C. The control system for the generator set shall comply with the following requirements, as applicable:
1. CSA C22.2, No. 14 – M91 Industrial Control Equipment
 2. EN50082-2, Electromagnetic Compatibility – Generic Immunity Requirements, Part 2: Industrial.
 3. EN55011, Limits and Methods of Measurement of Radio Interference Characteristics of Industrial, Scientific and Medical Equipment.
 4. FCC Part 15, Subpart B.
 5. IEC8528 part 4. Control Systems for Generator Sets.
 6. IEC STD 801.2, 801.3, and 801.5 for susceptibility, conducted, and radiated electromagnetic emissions.
 7. UL508. The entire control system of the generator set shall be UL508 listed and labeled.
 8. UL1236. Battery chargers.
- D. The automatic transfer switch(es) installation and application shall conform to the requirements of the following codes and standards:
1. CSA 282, Emergency Electrical Power Supply for Buildings
 2. NFPA70 – National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702.
 3. NFPA99 – Essential Electrical Systems for Health Care Facilities
 4. NFPA110 – Emergency and Standby Power Systems. The transfer switch shall meet all requirements for Level 1 systems.
 5. IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.
 6. NEMA ICS10-1993 – AC Automatic Transfer Switches

- E. The transfer switch assembly shall comply with the following standards:
1. CSA C22.2, No. 14 – M91 Industrial Control Equipment.
 2. EN55011, Class B Radiated Emissions
 3. EN55011, Class B Conducted Emissions
 4. IEC 1000-4-5 (EN 61000-4-5); AC Surge Immunity.
 5. IEC 1000-4-4 (EN 61000-4-4) Fast Transients Immunity
 6. IEC 1000-4-2 (EN 61000-4-2) Electrostatic Discharge Immunity
 7. IEC 1000-4-3 (EN 61000-4-3) Radiated Field Immunity
 8. IEC 1000-4-6 Conducted Field Immunity
 9. IEC 1000-4-11 Voltage Dip Immunity.
 10. IEEE 62.41, AC Voltage Surge Immunity.
 11. IEEE 62.45, AC Voltage Surge.
 12. UL1008 – Transfer Switches. Transfer switches shall be UL1008 listed. UL1008 transfer switches may be supplied in UL891 enclosures if necessary to meet the physical requirements of the project.
- F. The generator set manufacturer and the automatic transfer switch manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

1.05 ACCEPTABLE MANUFACTURERS

- A. Generator set equipment specifications for this project are based on microprocessor-based generator sets manufactured by CUMMINS POWER GENERATION. Equipment by CATERPILLAR or KOHLER POWER SYSTEMS that meets the requirements of this specification shall be acceptable.
- B. Automatic transfer switch equipment specifications for this project are based on microprocessor-based transfer switches manufactured by CUMMINS POWER GENERATION Model CXT or equal as manufactured by AUTOMATIC SWITCH COMPANY (ASCO) Model 7000 Series.
- C. The Cummins Power Generation transfer switches shall be provided with the Cummins Power Generation generator set and the ASCO transfer switches shall be provided with the Caterpillar generator set, to ensure there is one source for warranty and product service.

PART 2 – PRODUCTS

2.01 GENERATOR SET

A. Ratings

1. The generator set shall operate at 1800 rpm and at a voltage of: 277/480 volts AC, three phase, four wire, 60 hertz.

ENGINEER TO SPECIFY FROM GENERATOR DATA/SPEC SHEETS

2. The generator set shall be rated at ___ kW, ___ kVA at 0.8 PF, standby rating, Model ____, based on site conditions of: altitude 1000 ft, ambient temperatures up to 122 degrees F.
3. The generator set rating shall be based on emergency/standby service.

B. Performance

1. Voltage regulation shall be plus or minus 0.5 percent for any constant load between no load and rated load for both parallel and non-parallel applications. Random voltage variation with any steady load from no load to full load shall not exceed plus or minus 0.5 percent.
2. Frequency regulation shall be isochronous from steady state no load to steady state rated load. Random frequency variation with any steady load from no load to full load shall not exceed plus or minus 0.5%.
3. The diesel engine-generator set shall be capable of single step load pick up of 100% nameplate kW and power factor, less applicable derating factors, with the engine-generator set at operating temperature.

ENGINEER SPECIFY MOTOR STARTING KVA FROM GENERATOR DATA/SPEC SHEETS USING 105° C TEMPERATURE RISE ALTERNATOR

4. Motor starting capability shall be a minimum of ___ kVA. The generator set shall be capable of recovering to a minimum of 90% of rated no load voltage with the application of the specified kVA load at near zero power factor applied to the generator set. Maximum voltage dip on application of this load, considering both alternator performance and engine speed changes shall not exceed 25%.
5. The alternator shall produce a clean AC voltage waveform, with not more than 5% total harmonic distortion at full linear load, when measured from line to neutral, and with not more than 3% in any single harmonic, and no 3rd order harmonics or their multiples. Telephone influence factor shall be less than 40.

- a. The generator set shall be certified by the engine manufacturer to be suitable for use at the installed location and rating, and shall meet all applicable exhaust emission requirements at the time of commissioning.
- C. Construction:
1. The engine-generator set shall be mounted on a heavy-duty steel base to maintain alignment between components. The base shall incorporate a battery tray with hold-down clamps within the rails.
 2. All switches, lamps, and meters in the control system shall be oil-tight and dust-tight. There shall be no exposed points in the control (with the door open) that operate in excess of 50 volts.
- D. Connections.
1. The generator set load connections shall be composed of silver or tin plated copper bus bars, drilled to accept mechanical or compression terminations of the number and type as shown on the Drawings.
 2. Sufficient lug space shall be provided for use with cables of the number and size as shown on the Drawings.
 3. Power connections to auxiliary devices shall be made at the devices, with required protection located at a wall-mounted common distribution panel.
 4. Generator set control interfaces to other system components shall be made on a common, permanently labeled terminal block assembly. Labels describing point functions shall be provided.

2.02 ENGINE AND ENGINE EQUIPMENT

ENGINEER, SPECIFY DISPLACEMENT, NUMBER OF CYLINDERS, AND EPA TIER RATING FROM THE GENERATOR DATA / SPEC SHEETS

- A. The engine shall be diesel, 4 cycle, radiator and fan cooled. Engine shall be EPA, Tier-? certified. Minimum displacement shall be ____ cubic inches, with ____ cylinders. The horsepower rating of the engine at its minimum tolerance level shall be sufficient to drive the alternator and all connected accessories. Two cycle engines are not acceptable. Engine accessories and features shall include:
1. An electronic governor system shall provide automatic isochronous frequency regulation. The governing system dynamic capabilities shall be controlled as a function of engine coolant temperature to provide fast, stable operation at varying engine operating temperature conditions. The control system shall actively control the fuel rate and excitation as

appropriate to the state of the generator set. Fuel rate shall be regulated as a function of starting, accelerating to start disconnect speed and accelerating to rated speed. The governing system shall include a programmable warm up at idle and cool down at idle function. While operating in idle state, the control system shall disable the alternator excitation system.

2. Skid-mounted radiator and cooling system rated for full load operation in 122 degrees F (50 degrees C) ambient as measured at the generator air inlet. Radiator fan shall be suitable for use in a system with 0.5 in H₂O restriction. Radiator shall be sized based on a core temperature which is 20°F higher than the rated operation temperature, or prototype tested to verify cooling performance of the engine/radiator/fan operation in a controlled environment. Radiator shall be provided with a duct adapter flange. The cooling system shall be filled with a 50/50-ethylene glycol/water mixture prior to shipping by the equipment manufacturer. Rotating parts shall be guarded against accidental contact.
3. Electric starter(s) capable of three complete cranking cycles without overheating.
4. Positive displacement, mechanical, full pressure, lubrication oil pump.
5. Full flow lubrication oil filters with replaceable spin-on canister elements and dipstick oil level indicator.
6. An engine driven, mechanical, positive displacement fuel pump. Fuel filter with replaceable spin-on canister element. Fuel cooler, suitable for operation of the generator set at full rated load in the ambient temperature specified shall be provided if required for operation due to the design of the engine and the installation.
7. Replaceable dry element air cleaner with restriction indicator.
 - a. Flexible supply and return fuel lines.
 - b. Engine mounted battery charging alternator, 40-ampere minimum, and solid-state voltage regulator.
 - c. Coolant heater.
 - i. Engine mounted, thermostatically controlled, coolant heater(s) for each engine. Heater voltage shall be as shown on the project drawings. The coolant heater shall be UL499 listed and labeled.
 - ii. The coolant heater shall be installed on the engine with high

temperature silicone hose connections. Steel tubing shall be used for connections into the engine coolant system wherever the length of pipe run exceeds 12 inches. The coolant heater installation shall be specifically designed to provide proper venting of the system. The coolant heaters shall be installed using quick disconnect couplers with provisions to isolate the heater for replacement of the heater element. The quick disconnect/automatic sealing couplers shall allow the heater element to be replaced without draining the engine cooling system or significant coolant loss.

- iii. The coolant heater shall be provided with a DC thermostat, installed at the engine thermostat housing. An AC power connection box shall be provided for a single AC power connection to the coolant heater system.
 - iv. The coolant heater(s) shall be sized as recommended by the engine manufacturer to warm the engine to a minimum of 104°F (40°C) in a 40°F (4°C) ambient, in compliance with NFPA110 requirements, or the temperature required for starting and load pickup requirements of this specification.
 - v. Provide vibration isolators, spring/pad type, quantity as recommended by the generator set manufacturer. Isolators shall include seismic restraints if required by site location. The generator shall include a 3rd party seismic certification as a system with the associated isolators.
 - vi. Starting and control batteries shall be calcium/lead antimony type, 24 volt DC, sized as recommended by the engine manufacturer, complete with battery cables and connectors. The batteries shall be capable of a minimum of three (3) complete 15-second cranking cycles at 40°F ambient temperature when fully charged.
- B. Provide exhaust silencer(s) for each engine of size and type as recommended by the generator set manufacturer and approved by the engine manufacturer. The exhaust silencer (muffler) shall be critical grade. Exhaust system shall be installed inside the generator set enclosure.
- C. Provide a minimum 12 amp battery charger either wall or transfer switch mounted for each generator set battery bank. Generator sets incorporating two battery banks shall be provided with two charger sets connected together and operated in parallel, with alarm outputs connected in parallel. The chargers shall include the following capabilities:
- 1. Chargers shall be UL 1236-BBHH listed and CSA or CUL certified for use

in emergency applications.

2. The charger shall be compliant with UL 991 requirements for vibration resistance.
3. The charger shall comply with the requirements of EN61000-4-5 for voltage surge resistance; EN50082-2 for immunity; EN61000-4-2 for ESD; EN-61000-4-3 for radiated immunity; ANSI/IEEE C62.41 category B and IN61000-4-4 for electrically fast transient; EN61000-4-6 for conducted emissions; and FCC Part 15 Class A for radiated emissions.
4. The charger shall be capable of charging a fully discharged battery without damage to the charger. It shall be capable of returning a fully discharged battery to fully charged condition within 24 hours. The charger shall be UL-labeled with the maximum battery amp-hour rating that can be recharged within 24 hours. The label shall indicate that the charger is suitable for charging of 220AH batteries per NFPA requirements.
5. The charger shall incorporate a 4-state charging algorithm, to provide trickle charge rate to restore fully discharged batteries, a bulk charge rate to provide fastest possible recharge after normal discharge, an absorption state to return the battery to 100 percent of charge, and a float stage to maintain a fully charged battery and supply battery loads when the generator set is not operating. In addition, the charger shall include an equalization timer. Charge rates shall be temperature compensated based on the temperature directly sensed at the battery.
6. The DC output voltage regulation shall be within plus or minus 1%. The DC output ripple current shall not exceed 1 amp at rated output current level.
7. The charger shall include the following features:
 - a. Two line alphanumeric display with programming keys to allow display of DC output ammeter and voltmeters (5% accuracy or better), display alarm messages, and perform programming;
 - b. LED indicating lamp(s) to indicate normal charging condition (green), equalize charge state (amber), and fault condition (red);
 - i. AC input overcurrent, over voltage, and undervoltage protection;
 - ii. DC output overcurrent protection;
 - iii. Alarm output relay;

- iv. Corrosion resistant aluminum enclosure.

2.03 GENERATOR – BASE FUEL TANK

ENGINEER, DETERMINE CAPACITY OF FUEL TANK TO OPERATE THE GENSET FOR APPROXIMATELY 24 HOURS, BUT NOT LARGER THAN 2000 GALLONS.

- A. Provide a dual wall sub-base fuel storage tank with ____ gallons capacity. The tank shall be constructed of corrosion resistant steel and shall be UL listed. The equipment, as installed, shall meet all local and regional requirements for above ground tanks.
- B. Certifications
 - 1. Underwriters Laboratories (UL) 142 Special-Purpose Flammable-Liquid Protected Secondary-Containment Generator-Base Tank Listing
 - 2. The internal and external tank shall be constructed in accordance with UL 142.
 - 3. The tank shall have an identifying UL nameplate attached with the following:
 - a. “Special Purpose Flammable Liquid Tank Protected Secondary Containment Generator Base Tank UL 142”
 - b. Tank serial number
 - c. “This Tank is Intended For Installation In Accordance With NFPA 30, NFPA 30A or NFPA 31, NFPA 37, NFPA 110”
 - d. Manufacturer’s name, location and telephone number
 - e. Date of manufacture
 - f. Model number of tank
 - g. Primary Tank Capacity in Gallons (____ gallons) **(ENGINEER FILL IN)**
 - h. Containment Percentage
 - i. “Tank Requires Emergency Relief Venting, Capacity Not Less Than ____ Cubic Feet Per Hour, PRIMARY TANK and ____ Cubic Feet Per Hour ANNULAR SPACE”.
 - j. “Maximum Generator Weight ____”.

- k. "Tank Is Intended for Stationary Installation Only. Tank shall be inspected to determine suitability after fire exposure".
 - l. "For Diesel Fuel Only"
 - m. "Pressurize Primary Tank When Pressure Testing Annular Space. Follow Installation Instructions".
- C. Painting
- 1. Sand blast tank to commercial sandblast standard.
 - 2. Prime coat with Industrial Primer.
 - 3. The entire exterior finish coating shall be petroleum-resistant two-part white.
 - 4. Bottom of tank to be coated with coal-tar epoxy.
- D. Construction
- 1. The internal tank shall be rectangular in shape, listed and constructed in accordance with UL 142 Standard for Generator-Base Tanks.
 - 2. The inner and outer steel tank shall be constructed of minimum 3/16" thick, A-36 Hot Rolled Steel.
 - 3. The tank shall meet seismic zone standards and provide the capability to be anchored as required by local codes for earthquake and/or flood.
 - 4. The internal tank shall be pressure tested and pass a test of 5 psi at the factory.
 - 5. The tank shall be designed with over-spill containment and shall have a 2" interstitial test monitoring pipe.
 - 6. The tank shall include atmospheric and emergency venting nozzles sized to UL requirements.
 - 7. The tank shall have signs to include: labels to meet applicable codes, product content, and tank capacity. Each nozzle on Flammable, No Smoking, the tank shall be identified for its intended use.
 - 8. The tank shall be designed to meet weight loads of the engine generator set.
 - 9. The tank shall be designed with earthquake, hurricane, and flood tie-

down points.

10. Leak detection provisions shall be provided and wired to the generator set control for local and remote alarm indicators.
 11. Tank shall be equipped with multiple float switches for high and low fuel levels alarms, activation of fuel oil transfer pumps and for any other requirements of the engine generator set manufacturer and as shown on the drawings. Switches shall be wired to the generator control for local and remote indications. **ENGINEER TO EDIT THIS PARAGRAPH, IF NECESSARY.**
 12. The fuel fill opening shall be recessed in the enclosure wall with a lockable door near the high fuel alarm box.
 13. Conduit stub-up sleeves shall be provided for generator set load and control wiring and cabling. Spare couplings shall be provided in tank and rupture basin for customer use. External to the base main rail beams shall be two grounding bosses, one each end opposite corners, for customer grounding requirements.
- E. Tank supplier shall also provide suitable steps and a man-way platform to provide complete maintenance access to the generator set and enclosure for instances where the circuit breaker handle in the up position is greater than 79". The platform and stairs shall be constructed of galvanized steel. The platform and stairs shall be minimum 3'-0" in width.

2.04 AC GENERATOR

- A. The AC generator shall be; synchronous, four pole, 2/3 pitch, revolving field, drip-proof construction, single prelubricated sealed bearing, air cooled by a direct drive centrifugal blower fan, and directly connected to the engine with flexible drive disc. All insulation system components shall meet NEMA MG1 temperature limits for Class H insulation system and shall be UL1446 listed. Actual temperature rise measured by resistance method at full load shall not exceed 105 degrees centigrade.
- B. The generator shall be capable of delivering rated output (kVA) at rated frequency and power factor, at any voltage not more than 5 percent above or below rated voltage.
- C. A permanent magnet generator (PMG) shall be included to provide a reliable source of excitation power for optimum motor starting and short circuit performance. The PMG and controls shall be capable of sustaining and regulating current supplied to a single phase or three phase fault at approximately 300% of rated current for not more than 10 seconds.

- D. The sub transient reactance of the alternator shall not exceed 15 percent, based on the standby rating of the generator set.

2.05 GENERATOR SET CONTROL

- A. The generator set shall be provided with a microprocessor-based control system that is designed to provide automatic starting, monitoring, and control functions for the generator set. The control system shall also be designed to allow local monitoring and control of the generator set, and remote monitoring and control as described in this specification.
- B. The control shall be mounted on the generator set. The control shall be vibration isolated and prototype tested to verify the durability of all components in the system under the vibration conditions encountered.
- C. The generator set mounted control shall include the following features and functions:
 - 1. Control Switches
 - a. Mode Select Switch. The mode select switch shall initiate the following control modes. When in the RUN or Manual position, the generator set shall start, and accelerate to rated speed and voltage as directed by the operator. A separate push-button to initiate starting is acceptable. In the OFF position the generator set shall immediately stop, bypassing all time delays. In the AUTO position, the generator set shall be ready to accept a signal from a remote device to start and accelerate to rated speed and voltage.
 - b. EMERGENCY STOP switch. Switch shall be red “mushroom-head” push-button. Depressing the emergency stop switch shall cause the generator set to immediately shut down, and be locked out from automatic restarting. Switch shall have a cover to prevent accidental activation.
 - c. RESET switch. The RESET switch shall be used to clear a fault and allow restarting the generator set after it has shut down for any fault condition.
 - d. PANEL LAMP switch. Depressing the panel lamp switch shall cause the entire panel to be lighted with DC control power. The panel lamps shall automatically be switched off 10 minutes after the switch is depressed, or after the switch is depressed a second time.
 - 2. Generator Set AC Output Metering. The generator set shall be provided

with a metering set including the following features and functions:

- a. Analog voltmeter, ammeter, frequency meter, and kilowatt (KW) meter. Voltmeter and ammeter shall display all three phases. Meter scales shall be color coded in the following fashion: green shall indicate normal operating condition, amber shall indicate operation in ranges that indicate potential failure, and red shall indicate failure impending. Metering accuracy shall be within 1% at rated output.
- b. Digital metering set, 1% accuracy, to indicate generator RMS voltage and current, frequency, output current, output KW, KW-hours, and power factor. Generator output voltage shall be available in line-to-line and line-to-neutral voltages, and shall display all three phase voltages (line to neutral or line to line) simultaneously.
- c. Both analog and digital metering are required. The analog and digital metering equipment shall be driven by a single microprocessor, to provide consistent readings and performance.
- d. The control system shall monitor the total load on the generator set, and maintain data logs of total operating hours at specific load levels ranging from 0 to 110% of rated load, in 10% increments. The control shall display hours of operation at less than 30% load and total hours of operation at more than 90% of rated load.
- e. The control system shall log total number of operating hours, total kWh, and total control on hours, as well as total values since reset.

3. Generator Set Alarm and Status Display

- a. The generator set shall include LED alarm and status indication lamps. The lamps shall be high-intensity LED type. The lamp condition shall be clearly apparent under bright lighting conditions. Functions indicated by the lamps shall include:
 - The control shall include five (5) configurable alarm-indicating lamps. The lamps shall be field adjustable for any status, warning, or shutdown function monitored by the generator set. They shall also be configurable for color, and control action (status, warning, or shutdown).
 - The control shall include green lamps to indicate that the generator set is running at rated frequency and voltage, and

that a remote start signal has been received at the generator set. The running signal shall be based on actual sensed voltage and frequency on the output terminals of the generator set.

- The control shall include a flashing red lamp to indicate that the control is not in automatic state, and red common shutdown lamp.
 - The control shall include an amber common warning indication lamp.
- b. The generator set control shall indicate the existence of the warning and shutdown conditions on the control panel. All conditions indicated below for warning shall be field-configurable for shutdown. Conditions required to be annunciated shall include:
- Low oil pressure (warning)
 - Low oil pressure (shutdown)
 - Oil pressure sender failure (warning)
 - Low coolant temperature (warning)
 - High coolant temperature (warning)
 - High coolant temperature (shutdown)
 - High oil temperature (warning)
 - Engine temperature sender failure (warning)
 - Low coolant level (warning)
 - Fail to crank (shutdown)
 - Fail to start/overcrank (shutdown)
 - Overspeed (shutdown)
 - Low DC voltage (warning)
 - High DC voltage (warning)
 - Weak battery (warning)
 - Low fuel-base tank (warning)
 - High AC voltage (shutdown)
 - Low AC voltage (shutdown)
 - Under frequency (shutdown)
 - Over current (warning)
 - Over current (shutdown)
 - Short circuit (shutdown)
 - Ground fault (warning) (optional – when required by code or specified)
 - Over load (warning)
 - Emergency stop (shutdown)
 - (4) configurable conditions

- c. Provisions shall be made for indication of four customer-specified alarm or shutdown conditions. Labeling of the customer-specified alarm or shutdown conditions shall be of the same type and quality as the above specified conditions. The non-automatic indicating lamp shall be red, and shall flash to indicate that the generator set is not able to automatically respond to a command to start from a remote location.
4. Engine Status Monitoring.
 - a. The following information shall be available from a digital status panel on the generator set control:
 - Engine oil pressure (psi)
 - Engine coolant temperature (degrees F)
 - Engine oil temperature (degrees F)
 - Engine speed (rpm)
 - Number of hours of operation (hours)
 - Number of start attempts
 - Battery voltage (DC volts)
 - b. The control system shall also incorporate a data logging and display provision to allow logging of the last 10 warning or shutdown indications on the generator set, as well as total time of operation at various loads, as a percent of the standby rating of the generator set.
5. Engine Control Functions
 - a. The control system provided shall include a cycle cranking system, which allows for user selected crank time, rest time, and # of cycles. Initial settings shall be for 3 cranking periods of 15 seconds each, with 15-second rest period between cranking periods.
 - b. The control system shall include an idle mode control, which allows the engine to run in the idle mode in the RUN position only. In this mode, the alternator excitation system shall be disabled.
 - c. The control system shall include an engine governor control, which functions to provide steady state frequency regulation as noted elsewhere in this specification. The governor control shall include adjustments for gain, damping, and a ramping function to control engine speed and limit exhaust smoke while the unit is starting.

- d. The control system shall include time delay start (adjustable 0-300 seconds) and time delay stop (adjustable 0-600 seconds) functions.
 - e. The control system shall include sender failure monitoring logic for speed sensing, oil pressure and engine temperature which is capable of discriminating between failed sender or wiring components, and an actual failure conditions.
6. Alternator Control Functions:
- a. The generator set shall include a full wave rectified automatic digital voltage regulation system that is matched and prototype tested by the engine manufacturer with the governing system provided. It shall be immune from misoperation due to load-induced voltage waveform distortion and provide a pulse width modulated output to the alternator exciter. The voltage regulation system shall be equipped with three-phase line to neutral RMS sensing and shall control buildup of AC generator voltage to provide a linear rise and limit overshoot. The system shall include a torque-matching characteristic, which shall reduce output voltage in proportion to frequency below an adjustable frequency threshold. Torque matching characteristic shall be adjustable for roll-off frequency and rate, and be capable of being curve-matched to the engine torque curve with adjustments in the field. The voltage regulator shall include adjustments for gain, damping, and frequency roll-off. Adjustments shall be broad range, and made via digital raise-lower switches, with an alphanumeric LED readout to indicate setting level. Rotary potentiometers for system adjustments are not acceptable.
 - b. A microprocessor-based protection device shall be provided to individually monitor all phases of the output current of the generator set and initiate an alarm (over current warning) when load current exceeds 110% of the rated current of the generator set on any phase for more than 60 seconds. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator (over current shutdown). The protective functions provided shall be in compliance to the requirements of NFPA 70 article 445.
 - c. A microprocessor-based protection device shall be provided to individually monitor all phases of the output current for short circuit conditions. The control/protection system shall monitor the current level and voltage. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator (short circuit shutdown).

The protective functions provided shall be in compliance to the requirements of NFPA 70 Article 445.

- d. Controls shall be provided to monitor the KW load on the generator set, and initiate an alarm condition (over load) when total load on the generator set exceeds the generator set rating for in excess of 5 seconds. Controls shall include a load shed control, to operate a set of dry contacts (for use in shedding customer load devices) when the generator set is overloaded.
 - e. A microprocessor-based protection device AC over/under voltage monitoring system that responds only to true RMS voltage conditions shall be provided. The system shall initiate shutdown of the generator set when alternator output voltage exceeds 110% of the operator-set voltage level for more than 10 seconds, or with no intentional delay when voltage exceeds 130%. Under voltage shutdown shall occur when the output voltage of the alternator is less than 85% for more than 10 seconds. The system shall monitor individual phases and be connected line to neutral on three-phase, four-wire generator sets, and for systems that are solidly grounded.
 - f. When required by the National Electrical Code or indicated on the Drawings, the Control System shall include a ground fault monitoring relay. The relay shall be adjustable from 3.8-1200 amps, and include adjustable time delay of 0-10.0 seconds. The relay shall be for indication only, and not trip or shut down the generator set. Note bonding and grounding requirements for the generator set, and provide relay that will function correctly in system as installed.
 - g. The generator set control shall include a 120 VAC-control heater.
7. Other Control Functions:
- a. The generator set shall be provided with a network communication module to allow Modbus RS485 compliant communication with the generator set control by remote devices. The control shall communicate all engine and alternator data, and allow starting and stopping of the generator set via the network in both test and emergency modes.
 - b. A battery monitoring system shall be provided which initiates alarms when the DC control and starting voltage is less than 25VDC or more than 32VDC. During engine cranking (starter engaged), the low voltage limit shall be disabled, and if DC voltage drops to less than 14.4 volts for more than two seconds a “weak

battery” alarm shall be initiated.

8. Control Interfaces for Remote Monitoring:
 - a. All control and interconnection points from the generator set to remote components shall be brought to a separate connection box. No field connections shall be made in the control enclosure or in the AC power output enclosure.
 - b. The control system shall provide four (4) programmable output relays. These relay outputs shall be configurable for any alarm, shutdown, or status condition monitored by the control. The relays shall be configured to indicate: 1) generator set operating at rated voltage and frequency; 2) common warning; 3) common shutdown; 4) load shed command.
 - c. A fused 10 amp switched 12 or 24VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit whenever the generator set is running.
 - d. A fused 10 amp 12 or 24VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit at all times from the engine starting/control batteries.
 - e. Provide two (2) Form C dry contacts for connection to the fire alarm system graphic annunciator panel for “Generator Run” and “Generator Fault” indications.
 - f. Provide two (2) Form C dry contacts for connection to the security intrusion system panel for “Generator Run” and “Generator Fault” indications.
 - g. The control shall be provided with a direct serial communication link for the Modbus RS 485 communication network interface as described elsewhere in this specification and shown on the Drawings.

2.06 MAIN LINE CIRCUIT BREAKER

- A. The generator set shall be provided with a mounted main line 100% rated circuit breaker, sized to carry the rated output current of the generator set. The circuit breaker shall incorporate an electronic trip unit that operates to protect the alternator under all overcurrent conditions, or a thermal-magnetic trip with other overcurrent protection devices that positively protects the alternator under overcurrent conditions. The supplier shall submit time overcurrent characteristic curves and thermal damage curve for the alternator, demonstrating the effectiveness of the protection provided.

2.07 REMOTE ALARM ANNUNCIATOR PANEL

- A. Provide and install a 20-light LED type remote alarm annunciator with horn, located as shown on the drawings in the building engineer's office or in a location directed by the Owner. The remote annunciator shall provide all the audible and visual alarms called for by NFPA Standard 110 for level 1 systems for the local generator control panel. Spare lamps shall be provided to allow future addition of other alarm and status functions to the annunciator. Provisions for labeling of the annunciator in a fashion consistent with the specified functions shall be provided. Alarm silence and lamp test switch(es) shall be provided. LED lamps shall be replaceable, and indicating lamp color shall be capable of changes needed for specific application requirements. Alarm horn shall be switchable for all annunciation points. Alarm horn (when switched on) shall sound for first fault, and all subsequent faults, regardless of whether first fault has been cleared, in compliance with NFPA110 3-5.6.2. The interconnecting wiring between the annunciator and other system components shall be monitored and failure of the interconnection between components shall be displayed on the annunciator panel.
- B. The annunciator shall include the following alarm labels, audible annunciation features, and lamp colors:

<u>Condition</u>	<u>Lamp Color</u>	<u>Audible Alarm</u>
Normal Power (to Loads)	Green	No
Genset Supplying Load	Amber	No
Genset Running	Green	No
Not in Auto	Red (Flashing)	Yes
High Battery Voltage	Red	Yes
Low Battery Voltage	Red	Yes
Charger AC Failure	Red	Yes
Fail to Start	Red	Yes
Low Engine Temperature	Amber	Yes
Pre-High Engine Temperature	Amber	Yes
High Engine Temperature	Red	Yes
Pre-Low Oil Pressure	Amber	Yes
Low Oil Pressure	Red	Yes
Overspeed	Red	Yes
Low Coolant Level	Amber	Yes
Low Fuel Pressure	Amber	Yes
Network OK	Green	Yes
Fuel Tank Leak	Amber	Yes
(2) Spares	Configurable	Configurable

- C. Low battery voltage lamp shall also be lighted for low cranking voltage or weak battery alarm.

2.08 OUTDOOR WEATHER-PROTECTIVE SOUND ATTENUATING HOUSING

- A. The generator set shall be provided with a sound-attenuating housing which allows the generator set to operate at full rated load in the ambient conditions previously specified. The enclosure shall reduce the sound level of the generator set while operating at full rated load to a maximum of **(Engineer to edit)** 76 dBA at any location 7 meters from the generator set in a free field environment. Housing configuration and materials used may be of any suitable design which meets application needs, except that acoustical materials used shall be non-hygroscopic and oil resistant. No foam materials shall be used unless they can be demonstrated to have the same durability and life as fiberglass.
- B. Radiator discharge outlet shall be deflected upward, ducted through built-in hood in an approved manner to allow recommended air flow for engine cooling, and to allow minimum clearance in front of the radiator and also help to reduce the sound level of the generator set.
- C. The enclosure shall be constructed of minimum 12 gauge steel for framework and 14 gauge steel for panels. All hardware and hinges shall be stainless steel.
- D. The enclosure shall include hinged access doors to maintain easy access for all operating and service functions. Key-locking and padlockable door latches shall be provided for all doors, and include retainers to hold the door open during service. Door hinges shall be stainless steel.
- E. Enclosure roof shall be cambered to prevent rainwater accumulation. The roof shall be designed for evenly distributed loading of 50 lbs./square foot. The roof shall also be designed to support the largest commercially available silencer in addition to two 250-lb men during normal maintenance procedures. Additional support added for project specific requirements shall be incorporated where required.
- F. Provide motorized louvers and dampers to minimize air flow through the enclosure when the generator set is not operating. Louvers shall include provisions to prevent accumulation of ice or snow that might prevent operation. **(Engineer to specify only after verification from manufacturer depending upon size of generator.)**
- G. Inlet ducts shall include rain hoods.
- H. The enclosure shall be provided with a factory mounted and wired electrical distribution panel to serve the generator set and enclosure. The provisions shall include: **(Engineer to specify only after verification from manufacturer depending upon size of generator.)**
 - 1. 120/208 VAC, 3-phase, 4-wire, 100 amp panelboard connected to the buildings utility service by this Contractor.

2. Two GFCI duplex receptacles, one inside the enclosure and one receptacle outside the enclosure with an "in-use" weatherproof cover.
 3. Two three-way switches controlling three AC lamps mounted in vapor tight and gasketed fixtures.
 4. Factory-wired normal AC service from the panelboard to the engine coolant heaters, alternator heaters, battery charger, etc.
- I. The enclosure shall be provided with an exhaust silencer which is mounted inside of the enclosure, and allows the generator set package to meet specified sound level requirements. The exhaust shall exit the enclosure through a rain collar and terminate with a rain cap. Exhaust connections to the generator set shall be through seamless flexible connections.
 - J. All sheet metal shall be primed for corrosion protection and finish painted in a color selected by the Architect. All surfaces of all metal parts shall be primed and painted.
 - K. Painting of hoses, clamps, wiring harnesses and other non-metallic service parts shall not be acceptable. Fasteners used shall be corrosion resistant, and designed to minimize marring of the painted surface when removed for normal installation or service work.
 - L. The enclosure shall include the following maintenance provisions:
 1. Flexible coolant and lubricating oil drains lines, which extend to the exterior of the enclosure, with internal drain valves.
 2. External radiator fill provision.
 - M. The enclosure shall have sufficient guards and screens to prevent entrance by small animals.

2.09 SEQUENCE OF OPERATION -- GENERATOR SET

- A. Generator set shall start on receipt of a start signal from remote equipment. The start signal shall be hardwired connection to the generator set control and a redundant signal over the required network connection.
- B. The generator set shall complete a time delay start period as programmed into the control.
- C. The generator set control shall initiate the starting sequence for the generator set. The starting sequence shall include the following functions:
 1. The control system shall verify that the engine is rotating when the starter

- is signaled to operate. If the engine does not rotate after two attempts, the control system shall shut down and lock out the generator set, and indicate "fail to crank" shutdown.
2. The engine shall fire and accelerate as quickly as practical to start disconnect speed. If the engine does not start, it shall complete a cycle cranking process as described elsewhere in this specification. If the engine has not started by the completion of the cycle cranking sequence, it shall be shut down and locked out, and the control system shall indicate "fail to start".
 3. The engine shall accelerate to rated speed and the alternator to rated voltage. Excitation shall be disabled until the engine has exceeded programmed idle speed, and regulated to prevent over voltage conditions and oscillation as the engine accelerates and the alternator builds to rated voltage.
- D. On reaching rated speed and voltage, the generator set shall operate as dictated by the control system in isochronous state.
 - E. When all start signals have been removed from the generator set, it shall complete a time delay stop sequence. The duration of the time delay stop period shall be adjustable by the operator.
 - F. On completion of the time delay stop period, the generator set control shall switch off the excitation system and shall shut down.
 - G. Any start signal received after the time stop sequence has begun shall immediately terminate the stopping sequence and return the generator set to isochronous operation.

ENGINEER USE AND EDIT THIS SECTION FOR STAND ALONE PROJECTS WITHOUT A DIVISION 15 SPEC. DELETE IF NOT NEEDED FOR THIS PROJECT.

2.10 FUEL OIL TRANSFER PUMPS

- A. Type: The pump shall be positive displacement internal gear rotary type in standard cast iron construction. Provide cast iron mounting foot.

ENGINEER, MAKE SURE PUMP FUEL FLOW IS GREATER THAN THE GENERATOR'S CONSUMPTION AT FULL LOAD.

- B. Capacity shall be: suitable for #2 fuel oil and rated for 120 GPH @ 100 PSIG, Motor ¼ horsepower; 120v , single phase.
- C. Rotor iron heads shall be hydraulically balanced to assure instant priming and constant flow. Rotor, shaft and idler shall be steel.

- D. Seal – the pump shall employ a mechanical face-type seal, with carbon graphite casing bushing.
- E. Bearings – the bearing shall be Teflon impregnated outboard type.
- F. Motor – pump shall be mounted on formed steel base direct connected through flexible coupling with guard to 1200-rpm open drip-proof motor.
- G. Starter – provide a manual starter for single-phase units and magnetic across-the-line starter for three phase units. The starter shall have ON-OFF switch and red running light.
- H. Provide electric alternator and control panel, control shall include fuel level sensors for pump on-off and high-low level alarms.
- I. Package pump set shall be mounted in a NEMA 3R enclosure with hinged access doors or generator enclosure.

2.11 AUTOMATIC TRANSFER SWITCH (ATS)

- A. The complete automatic transfer switch(es) shall be suitable for utility power (source 1) to engine generator set (source 2) application, be completely factory assembled with field programmable digital electronic controls designed for fully automatic operation and including: surge voltage isolation, and including voltage sensors on all phases of both sources, solenoid or linear motor driven manual handles, positive mechanical and electrical interlocking, and mechanically held contacts for both sources.
- B. Ratings
 - 1. Refer to Drawings for sizes and types of transfer equipment, voltage and ampere ratings, enclosure type, and accessories. Transfer switch(es) rated up to 125 amperes shall be three (3) pole, with solid neutral. Transfer switch(es) rated 150 amperes and above shall be four (4) pole.
 - 2. Main contacts shall be rated for 600 volts AC minimum. All switches shall have 3 cycle ratings. Switches 150A and larger shall have 3 and 30 cycle ratings.
 - 3. Transfer switch(es) shall be rated to carry 100 percent of rated current continuously in the enclosure supplied, in ambient temperatures of - 40 to + 60 degrees C, relative humidity up to 95% (non-condensing), and altitudes up to 10,000 feet (3000M).
 - 4. Transfer switch equipment shall have 3 cycle (0.05s) withstand and closing ratings (WCR) in RMS symmetrical amperes greater than the available fault currents, but not less than 30,000 for an ATS up to 120

amperes and 65,000 for an ATS at or larger than 150 amperes, at the specified voltage. Additionally, transfer switch equipment 150A and larger shall have 30 cycle (0.5s) withstand and closing ratings (WCR) in RMS symmetrical amperes greater than the available fault currents, but not less than 35,000A at the specified voltage. The transfer switch shall be third party listed and labeled for use with the specified protective device(s) installed in the application.

C. Construction

1. Transfer switch(es) shall be double-throw, electrically and mechanically interlocked, and mechanically held in the source 1 and source 2 positions. The transfer switch shall be specifically designed to transfer to the best available source if it inadvertently stops in a neutral position.
2. Transfer switches shall be equipped with manual operators for service use only under de-energized conditions.
3. Main switch contacts shall be high-pressure silver alloy. Contact assemblies shall have arc chutes for positive arc extinguishing. Arc chutes shall have insulating covers to prevent inter-phase flashover.
4. Transfer switch internal wiring shall be composed of pre-manufactured harnesses that are permanently marked for source and destination. Harnesses shall be connected to the control system by means of locking disconnect plug(s), to allow the control system to be easily disconnected and serviced without disconnecting power from the transfer switch mechanism.
5. Transfer switch shall be provided with flame retardant transparent covers to allow viewing of switch contact operation but prevent direct contact with line voltage components.
6. Four (4) pole transfer switches shall be provided with a switched neutral pole. The neutral pole shall be of the same construction and have the same ratings as the phase poles. All poles shall be switched simultaneously using a common crossbar. Equipment using overlapping neutral contacts is not acceptable.
7. Three (3) pole transfer switches shall be provided with a neutral bus and lugs. The neutral bus shall be sized to carry 100% of the current designated on the switch rating.

D. Connections

1. Field control connections shall be made on a common terminal block that is clearly and permanently labeled.

2. Transfer switch shall be provided with AL/CU mechanical lugs sized to accept the full output rating of the generator set. Lugs shall be suitable for the number and size of conductors shown on the drawings.
- E. Transfer Switch Control
1. Operator Panel. Each transfer switch shall be provided with a control panel to allow the operator to view the status and control operation of the transfer switch. The operator panel shall be a sealed membrane panel rated NEMA 3R/IP53 or better (regardless of enclosure rating) that is permanently labeled for switch and control functions. The operator panel shall be provided with the following features and capabilities.
 - a. High intensity LED lamps to indicate the source that the load is connected to (source 1 or source 2); and which source(s) are available. Source available LED indicators shall operate from the control microprocessor to indicate the true condition of the sources as sensed by the control.
 - b. High intensity LED lamps to indicate that the transfer switch is “not in auto” (due to control being disabled or due to bypass switch enabled or in operation) and “Test/Exercise Active” to indicate that the control system is testing or exercising the generator set.
 - c. “OVERRIDE” pushbutton to cause the transfer switch to bypass any active time delays for start, transfer, and retransfer and immediately proceed with its next logical operation.
 - d. “TEST” pushbutton to initiate a preprogrammed test sequence for the generator set and transfer switch. The transfer switch shall be programmable for test with load or test without load.
 - e. “RESET/LAMP TEST” pushbutton that will clear any faults present in the control, or simultaneously test all lamps on the panel by lighting them.
 - f. The control system shall continuously log information on the number of hours each source has been connected to the load, the number of times transferred, and the total number of times each source has failed. This information shall be available via a PC-based service tool and an operator display panel.
 - g. Vacuum fluorescent alphanumeric display panel with push-button navigation switches. The display shall be clearly visible in both bright (sunlight) and no light conditions. It shall be visible over an angle of at least 120 degrees. The alphanumeric display panel shall be capable of providing the following functions and

capabilities.

- 1) Display source condition information, including AC voltage for each phase of normal and emergency source, frequency of each source. Voltage for all three phases shall be displayed on a single screen for easy viewing of voltage balance. Line to neutral voltages shall be displayed for 4-wire systems.
- 2) Display source status, to indicate source is connected or not connected.
- 3) Display load data, including 3-phase AC voltage, 3-phase AC current, frequency, KW, KVA, and power factor. Voltage and current data for all phases shall be displayed on a single screen.
- 4) The display panel shall allow the operator to view and make the following adjustments in the control system, after entering an access code:
 - i. Set nominal voltage and frequency for the transfer switch.
 - ii. Adjust voltage and frequency sensor operation set points.
 - iii. Set up time clock functions.
 - iv. Set up load sequence functions.
 - v. Enable or disable control functions in the transfer switch, including program transition.
 - vi. Set up exercise and load test operation conditions, as well as normal system time delays for transfer time, time delay start, stop, transfer, and retransfer.
- 5) Display real time clock data, including date, and time in hours, minutes, and seconds. The real time clock shall incorporate provisions for automatic daylight savings time and leap year adjustments. The control shall also log total operating hours for the control system.
- 6) Display service history for the transfer switch. Display source connected hours, to indicate the total number of hours connected to each source. Display number of times

transferred, and total number of times each source has failed.

- 7) Display fault history on the transfer switch, including condition, and date and time of fault. Faults to include controller checksum error, low controller DC Voltage, ATS fail to close on transfer, ATS fail to close on retransfer, battery charger malfunction, network battery voltage low, network communications error.
- 8) Display information for other transfer switches in the system, including transfer switch name, real time load in KW on the transfer switch, current source condition, and current operating mode.

F. Internal Controls

1. The transfer switch control system shall be configurable in the field for any operating voltage level up to 600VAC. Provide RMS voltage sensing and metering that is accurate to within plus or minus 1% of nominal voltage level. Frequency sensing shall be accurate to within plus or minus 0.2%. Voltage sensing shall be monitored based on the normal voltage at the site. Systems that utilize voltage monitoring based on standard voltage conditions are not acceptable.
2. Transfer switch voltage sensors shall be close differential type, providing source availability information to the control system based on the following functions:
 - a) Monitoring all phases of the normal service (source 1) for under voltage conditions (adjustable for pickup in a range of 85 to 98% of the normal voltage level and dropout in a range of 75 to 98% of normal voltage level).
 - b) Monitoring all phases of the emergency service (source 2) for under voltage conditions (adjustable for pickup in a range of 85 to 98% of the normal voltage level and dropout in a range of 75 to 98% of pickup voltage level).
 - c) Monitoring all phases of the normal service (source 1) and emergency service (source 2) for voltage imbalance.
 - d) Monitoring all phases of the normal service (source 1) and emergency service (source 2) for loss of a single phase.
 - e) Monitoring all phases of the normal service (source 1) and emergency service (source 2) for phase rotation.

- f) Monitoring all phases of the normal service (source 1) and emergency service (source 2) for over voltage conditions (adjustable for dropout over a range of 105 to 135% of normal voltage, and pickup at 95-99% of dropout voltage level).
 - g) Monitoring all phases of the normal service (source 1) and emergency service (source 2) for over or under frequency conditions.
 - h) Monitoring the neutral current flow in the load side of the transfer switch. The control shall initiate an alarm when the neutral current exceeds a preset adjustable value in the range of 100-150% of rated phase current for more than an adjustable time period of 10 to 60 seconds.
3. All transfer switch sensing shall be configurable from a Windows XP or NT PC-based service tool, to allow setting of levels, and enabling or disabling of features and functions. Selected functions including voltage sensing levels and time delays shall be configurable using the operator panel. The transfer control shall incorporate a series of diagnostic LED lamps.
 4. The transfer switch shall be configurable to control the operation time from source to source (program transition operation). The control system shall be capable of enabling or disabling this feature, and adjusting the time period to a specific value. A phase band monitor or similar device is not an acceptable alternate for this feature.
 5. The transfer switch shall incorporate adjustable time delays for generator set start (adjustable in a range from 0-15 seconds); transfer (adjustable in a range from 0-120 seconds); retransfer (adjustable in a range from 0-30 minutes); and generator stop (cool down) (adjustable in a range of 0-30 minutes).
 6. The transfer switch shall be configurable to accept a relay contact signal and a network signal from an external device for load shedding purposes. On receipt of this signal, the transfer switch shall switch to a neutral position when connected to source 2. If source 1 is available when the load-shed signal is received, the transfer switch shall connect to source 1.
 7. The transfer switch shall be configurable to accept a relay contact signal and a network signal from an external device to prevent transfer to the generator service.
 8. The transfer switch shall provide a relay contact signal prior to transfer or retransfer. The time period before and after transfer shall be adjustable in a range of 0-50 seconds.

9. The control system shall be designed and prototype tested for operation in ambient temperatures from -40C to +70C. It shall be designed and tested to comply with the requirements of the noted voltage and RFI/EMI standards.
10. The control shall have optically isolated logic inputs, high isolation transformers for AC inputs, and relays on all outputs, to provide optimum protection from line voltage surges, RFI and EMI.
11. The transfer switch network monitoring equipment, when supplied, shall be provided with a battery based auxiliary power supply to allow monitoring of the transfer switch when both AC power sources are non-operational. The battery power supply shall be monitored for proper condition, and the transfer switch shall include an alarm condition to indicate low battery condition.

G. Control Interface

1. The transfer switch will provide an isolated relay contact for starting of a generator set. The relay shall be normally held open, and close to start the generator set. Output contacts shall be Form C, for compatibility with any generator set.
2. Provide one set of Form C auxiliary contacts on both sides, operated by transfer switch position, rated 10 amps 250 VAC.
3. The transfer switch shall provide relay contacts to indicate the following conditions: source 1 available, load connected to source 1, source 2 available, source 2 connected to load.
4. The transfer switch shall be provided with a network communication card, and configured to allow Modbus RS485 compliant communication with the transfer switch and other network system components. The network shall provide a redundant start signal to the generator set(s) in the system.

H. Enclosure

Enclosures shall be UL listed, NEMA Type 1 or better or as shown on the Drawings. The cabinet shall provide code-required wire bend space. Manual operating handles and all control switches (other than key-operated switches) shall be accessible to authorized personnel only by opening the key-locking cabinet door. Transfer switches with manual operating handles and/or non key-operated control switches located on outside of cabinet do not meet this specification and are not acceptable.

2.12. SEQUENCE OF OPERATION – AUTOMATIC TRANSFER SWITCH(ES)

- A. Transfer switch normally connects an energized utility power source (source1) to loads and a generator set (source 2) to loads when normal source fails. The normal position of the transfer switch is source 1 (connected to the utility), and no start signal is supplied to the generator set.
- B. Standby electrical power systems for Fairfax County Shelters shall have a remote manual override switch(es) of the type and locations shown on the Drawings. The override switch shall have two settings, NORMAL MODE and SHELTER MODE. NORMAL MODE switch position shall **not** allow the transfer switch to send a start signal to the generator set to operate upon loss of utility power. SHELTER MODE switch position **shall** allow the generator set to operate upon loss of utility power and the transfer switch to transfer the loads to the generator set.
- C. Generator Set Exercise (Test) With Load Mode. The control system shall be configurable to test the generator set under load. In this mode, the transfer switch shall control the generator set in the following sequence:
1. Transfer switch shall initiate the exercise sequence at a time indicated in the exercise timer program, or when manually initiated by the operator.
 2. When the control systems senses the generator set at rated voltage and frequency, it shall operate to connect the loads to the generator set by opening the normal source contacts, and closing the alternate source contacts a predetermined time period later. The timing sequence for the contact operation shall be programmable in the controller.
 3. The generator set shall operate connected to the load for the duration of the exercise period. If the generator set fails during this period, the transfer switch shall automatically reconnect the generator set to the normal service.
 4. On completion of the exercise period, the transfer switch shall operate to connect the loads to the normal source by opening the alternate source contacts, and closing the normal source contacts a predetermined time period later. The timing sequence for the contact operation shall be programmable in the controller.
 5. The transfer switch shall operate the generator set unloaded for a cool down period, and then remove the start signal from the generator set. If the normal power fails at any time when the generator set is running, the transfer switch shall immediately connect the system loads to the generator set only when the remote manual override switch is set to "SHELTER MODE", otherwise the generator set shall continue with the normal exercise sequence.
- D. Generator Set Exercise (Test) Without Load Mode. The control system shall be

configurable to test the generator set without transfer switch load connected. In this mode, the transfer switch shall control the generator set in the following sequence:

1. Transfer switch shall initiate the exercise sequence at a time indicated in the exercise timer program, or when manually initiated by the operator.
2. When the control systems senses the generator set at rated voltage and frequency, it shall operate the generator set unloaded for the duration of the exercise period.
3. At the completion of the exercise period, the transfer switch shall remove the start signal from the generator set. If the normal power fails at any time when the generator set is running, the transfer switch shall immediately connect the system loads to the generator set only when the remote manual override switch is set to "SHELTER MODE", otherwise the generator set shall continue with the normal exercise sequence.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. This Contractor shall furnish and install complete the standby electrical power system including the engine generator set, automatic transfer switch(es), batteries and charging system, exhaust system, vibration isolation, cooling system, electrical system, concrete pad, generator-base fuel tank, man-way platforms, enclosure, and accessories in accordance with the system manufacturer's recommendations.
- B. Equipment shall be installed by this Contractor in accordance with final submittals and contract documents. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction. Install equipment in accordance with manufacturer's instructions and instructions included in the listing or labeling of UL listed products.
- C. Installation of equipment shall include furnishing and installing all interconnecting wiring between all major equipment provided for the on-site power system. The contractor shall also perform interconnecting wiring between equipment sections (when required), under the supervision of the equipment supplier.
- D. The Contractor shall furnish and install a concrete base for the engine generator set and generator base fuel tank, as shown on the drawings. Equipment shall be permanently fastened to the concrete pad in accordance with the manufacturer's instructions.
 1. Concrete foundation shall be as follows:

- a. Minimum compressive strength at 28 days – 3500 PSI
 - b. Maximum nominal aggregate size – 1 inch
 - c. Maximum W/C ratio by mass – 0.45
 - d. Air content – 5 + 1%
 - e. Slump – 2" + 0.75"
2. Top of concrete bases shall be trowel finished smooth and level with beveled edges. Top surface shall not vary by more than 1/8" in depth as measured across the widest surface.
 3. All concrete shall be fully vibrated.
 4. Reinforcing Steel – reinforcing to meet ASTM requirements. Spacing of bars shall be adjusted to suit conduit spacing.
- E. This Contractor shall ground the generator set as per the NEC, as shown on the Drawings, and as herein specified.
- F. All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired. Equipment shall be thoroughly cleaned to remove all dirt and debris prior to initial operation and final testing of the system.
- G. All fuel tanks shall be field testing in accordance with the requirements of the authority having jurisdiction (AHJ). All fuel tanks shall be filled to full capacity by this Contractor after final testing and Owner acceptance.

3.02 START-UP SERVICE AND ACCEPTANCE TEST

- A. Start-up Service: The standby electrical power system's equipment shall be initially started, operated and tested by the manufacturer's representative prior to the "on-site acceptance test". The Owner shall be notified in advance before any testing in order to coordinate any possible disruption or downtime with the school or facility.
- B. On-Site Acceptance Test:
1. The manufacturer shall furnish service personnel and all testing equipment and temporary cable connections to completely service and field test, in the presence of the Owner, the standby electrical power system.
 2. The test shall include, but not be limited to, a "cold start" test, a minimum period of four (4) hours with a load bank test at one hundred percent (100%) of the nameplate rating of the engine generator set and a one step rated load pickup test in accordance with NFPA 110. The manufacturer shall make any adjustments to the system to ensure proper operation.

3. The manufacturer shall instruct the Owner's personnel as to proper maintenance and operation and furnish three (3) sets of operating, technical, factory service manuals and maintenance instructions, including descriptive literature of equipment, parts list, and the names and telephone numbers of manufacturer's representatives.

3.03 SOFTWARE AND TRAINING

- A. The manufacturer shall supply to the Owner a complete set of service and maintenance software for use in properly supporting the product. The software shall be provided at a training class attended by the Owner's personnel, to qualify them in proper use of the software. The software shall have the following features and capabilities:
 1. The software shall be 32 bit and shall be Windows '95, Windows '98, XP, and NT compatible.
 2. The software shall use the Windows "Explorer" format, for ease of use and commonality with other software in use at the facility.
 3. The software shall allow adjustment of all functions described herein via the tool; adjustment of operating levels of all protective functions; and programming of all optional functions in the controller. Adjustments shall be possible over modem from a facility that is remote from the generator set.
 4. The software shall allow simulation of fault conditions, to verify operation of all protective devices.
 5. The software shall include the ability to store and display data for any function monitored by the generator set control. This data shall be available in common file formats, and on graphical "strip chart" displays.
 6. The software shall automatically record all control operations and adjustments performed by any operator or software user, for tracking of changes to the control.
 7. The software shall display all warning, shutdown, and status changes programmed into transfer switch controller. For each event, the control shall provide information on the nature of the event, when it last occurred, and how many times it has occurred.
 8. The software shall include detailed operation and service information on the specific generator set supplied, so that no other documentation (other than schematic and wiring diagram drawings) is necessary for service of the product.

9. The software shall have been developed under strict quality control guidelines, and comply with the requirements of ISO 9001 and Mil Standard 498 for software development.
- B. After generator set installation and successful acceptance test, the generator set supplier shall conduct a complete operation, basic maintenance, and emergency service seminary for up to 10 persons employed by the Owner. The seminary shall include instruction on operation of the transfer equipment, normal testing and exercise, adjustments to the control system, use of the PC based service and maintenance tools provided under this contract, and emergency operation procedures. The class duration shall be at least 8 hours in length, and include practical operation with the installed equipment.

3.04 WARRANTY

- A. The warranty for the complete standby electric power system shall be unconditional for a period of two (2) years with unlimited operating hours from the date of the successful acceptance test. The warranty shall be furnished by the system manufacturer. Said coverage shall be for all equipment provided under this specification section whether or not it is manufactured by the Standby electrical system manufacturer and shall include parts, labor, travel expenses, and labor to remove/reinstall said equipment per the manufacturer's standard published warranty. There shall be no deductibles applied to said warranty. Multiple warranties for individual components, engine alternator, controls, etc. will not be acceptable. Satisfactory warranty documents shall be furnished. Refer to SECTION 01740 WARRANTIES AND BONDS.
- B. Contractor shall provide warranty coverage labels mounted conspicuously on the engine generator control section and on the door of the automatic load transfer switch. The labels shall identify the one source supplier/manufacturer's address and telephone number, coverage description, coverage type, start-up date, model number, serial number, system registration number and other information deemed pertinent by the supplier/manufacturer. It is the intent of this warranty specification to have a single source contact for the Owner to call for warranty service for all standby electrical power system equipment.
- C. The manufacturer shall be prepared to offer a service contract for the maintenance of the standby electric power system after the warranty period and/or an extended warranty.

END OF SECTION

SECTION 16410

UNDERGROUND ELECTRICAL SERVICE

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work covered under this Section shall include furnishing and installing an underground electrical service complete as shown on Drawings and herein specified.
- B. The existing underground and/or overhead electrical service(s) shall remain in operation and shall continue to serve the building during the construction period until the new service has been installed and tested, ready for operation. After the new service has assumed the building's entire power load, the existing service(s) shall be removed as shown on the Drawings.

1.03 QUALITY ASSURANCE

- A. All equipment, materials and their installation shall conform to the requirements of the National Electrical Code (NEC), local code requirements, and these Specifications.
- B. All equipment and material shall be listed by Underwriter's Laboratories, Inc. (UL) for their intended use and shall bear the UL label.
- C. Equipment shall be constructed in accordance with National Electrical Manufacturer's Association (NEMA) standards.
- D. All electrical work specified under this Section of these Specifications shall conform to the requirements of the electric utility company.
- E. The grounding systems shall comply with the National Electrical Code (NEC) and as hereinafter specified.

PART 2 - PRODUCTS

2.01 ELECTRICAL SERVICE

- A. Primary service shall be three phase with pad or pole mounted transformer(s) as shown on the Drawings and shall be furnished by **[ENGINEER TO EDIT]** (DOMINION ENERGY VIRGINIA) (NORTHERN VIRGINIA ELECTRIC COOPERATIVE).
- B. This Contractor shall furnish and install primary underground service conduits and electric utility company manhole(s) as shown on the Drawings. Electric utility company shall install all primary service conductors.
- C. This Contractor shall furnish and install secondary underground service conduits from the electrical utility company's transformer(s) into the building and extend the service to the metering equipment as shown on the Drawings. Secondary voltage, phase, and number of conduits shall be as shown on the Drawings. Electric utility company shall furnish and install all secondary service conductors, unless otherwise shown on the Drawings to be furnished and installed by this Contractor.
- D. All necessary devices, such as meter sockets, meter connection boxes, meter enclosures, current and/or potential transformers, manhole enclosure lid(s), and instrument transformer hangers shall be furnished to this Contractor by the electric utility company.
- E. This Contractor shall furnish and install the concrete transformer pad(s), unless other arrangements are made with the electric utility company to have the pads provided by the electric utility company. Contractor provided pads must meet all of the requirements of the electric utility company.
- F. This Contractor shall provide pull-lines in all primary and secondary service conduits, including spare raceways. Refer to Specification Section 16110.

2.02 MATERIALS AND COMPONENTS

- A. Primary and secondary electrical service entrance conduits shall be heavywall (Schedule 40) polyvinyl chloride (PVC) plastic as hereinbefore specified. Secondary electrical service entrance conduits shall be encased in concrete as detailed on the Drawings and specified herein.
- B. Concrete for the secondary electrical service entrance ductbank(s) shall be 3,000 psi, air entrained with 3/4 inch maximum aggregate size.
- C. Duct spacers shall be fabricated plastic, UL listed.
- D. Electrical service entrance conductors, where shown on the Drawings, shall be as hereinbefore specified.
- E. Cable lugs for termination of electrical service entrance conductors shall be

suitable for the application and as approved by the electrical utility company.

- F. Electric utility company manhole enclosures shall be installed, by this Contractor, and sized per the electric utility company requirements. Coordinate with the electric utility company.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. This Contractor shall furnish and install a metering system as shown on the Drawings and as required by the electric utility company serving the project.
- B. Conduits for the primary and secondary electrical service shall be installed a minimum thirty-six (36) inches below grade, or as required by the electrical utility company.
- C. This Contractor shall make all necessary final arrangements with the electric utility company for the installation of the permanent underground electrical service.
- D. This Contractor shall coordinate all scheduling of the installation with the electric utility company.
- E. Slope installation of electrical service to drain away from the building.
- F. Terminate primary and secondary service entrance raceways at transformer location(s) as directed by the electric utility company.
- G. This Contractor shall make all necessary final arrangements with the electric utility company for the phased removal of the existing electrical service(s) and associated equipment.

3.02 DUCTBANK

- A. Place concrete so that all voids around ducts are filled.
- B. Furnish and install a three (3) inch minimum concrete envelope around ducts with two (2) inch minimum concrete thickness between ducts.
- C. Adjust final slopes on site to coordinate with existing and new utilities.
- D. Install on undisturbed soil.
- E. After installation, clean and swab ducts.

- F. Cap spare ducts.
- G. Install a minimum thirty-six (36) inches below grade to top of ductbank or as indicated on the Drawings.

3.03 SERVICE INSTALLATION

- A. Furnish and install ductbank and/or conduits as indicated on Drawings complete from service location in building to transformer location(s). Seal raceways watertight at inside face of outside wall or where raceways pierce slab.

END OF SECTION

SECTION 16415

OVERHEAD ELECTRICAL SERVICE

PART 1 -GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work covered under this Section shall include furnishing and installing an overhead electrical service complete as shown on the Drawings and herein specified.

1.03 QUALITY ASSURANCE

- A. All equipment, materials and their installation shall conform to the requirements of the National Electrical Code (NEC), local code requirements, and these Specifications.
- B. All equipment and material shall be listed by Underwriter's Laboratories, Inc. (UL) for their intended use and shall bear the UL label.
- C. Equipment shall be constructed in accordance with National Electrical Manufacturer's Association (NEMA) standards.
- D. All electrical work specified under this Section of these Specifications shall conform to the requirements of the electrical utility company.
- E. The grounding systems shall comply with the NEC and as hereinafter specified.

PART 2 - PRODUCTS

2.01 ELECTRICAL SERVICE

- A. Primary service shall be three-phase with pole mounted transformer and shall be furnished by **[ENGINEER TO EDIT]** (DOMINION ENERGY VIRGINIA) (NORTHERN VIRGINIA ELECTRIC COOPERATIVE).
- B. This Contractor shall furnish and install secondary overhead service into the building and extend to metering equipment as shown on the Drawings. Secondary voltage, phase, and number of wires shall be as shown on the Drawings.

- C. All necessary devices, such as meter sockets, meter connection boxes, meter enclosures, current and/or potential transformers, instrument transformer hangers, and cabinets shall be furnished to this Contractor by the electric utility company.

2.02 MATERIALS AND COMPONENTS

- A. Materials shall be furnished and installed by this Contractor as shown on the Drawings and as herein specified.
- B. All components exposed to the weather shall be UL listed for the application and conditions.

PART 3 - EXECUTION

3.01 SERVICE INSTALLATION

- A. This Contractor shall furnish and install a metering system as shown on the Drawings and as required by the electric utility company serving the project.
- B. This Contractor shall make all necessary final agreements with the electric utility company for the installation of the permanent overhead electrical service.

END OF SECTION

SECTION 16418

SURGE PROTECTIVE DEVICES

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work under this Section shall include furnishing and installing Surge Protective Devices (SPDs), formerly TVSS, for the protection of AC electrical circuits as shown on the Drawings and herein specified.

1.03 QUALITY ASSURANCE

- A. All equipment, materials, and their installation shall conform to the requirements of the National Electrical Code (NEC), local code requirements, and these Specifications.
- B. SPD units and all components shall be designed, manufactured and tested in accordance with the most recent editions of ANSI/UL 1449 and UL 1283.
- C. Equipment shall be constructed in accordance with National Electrical Manufacturer's Association (NEMA) standards (NEMA LS-1).
- D. Submittals are required in accordance with SECTION 16010 of these Specifications. The submittals shall contain, at a minimum, the following:
 - 1. Provide verification that the SPD complies with the required ANSI/UL 1449 4th Edition listing by Underwriters Laboratories (UL) or other Nationally Recognized Testing Laboratory (NRTL) acceptable to Fairfax County Department of Public Works and Environmental Services. Compliance may be in the form of a file number that can be verified on UL's website or on any other NRTL's website, as long as the website contains the following information at a minimum: model number, SPD type, system voltage, phases, modes of protection, Short Circuit Current Rating (SCCR), Voltage Protection Ratings (VPRs) for all modes, Maximum Continuous Operating Voltage rating (MCOV) and Nominal Discharge Current (I_n). UL data and visual inspection takes precedence over manufacturer's published documentation.

2. For SPD external mounting applications include electrical/mechanical drawings showing unit dimensions, weights, installation instruction details, and wiring configuration.
3. Where applicable the following additional information shall be included in the submittals:
 - a. Descriptive bulletin
 - b. Product sheets

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance, the following SPD manufacturers are acceptable: ASCO POWER TECHNOLOGIES (ASCO) as listed herein or TOTAL PROTECTION SOLUTIONS (TPS) or SURGE SUPPRESSION INC or the switchboard manufacturer's SPDs for internal or external mounting in or on switchboards shall also be acceptable. Panelboard manufacturer's SPDs for external mounting only shall also be acceptable.
- 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.

2.02 VOLTAGE SURGE SUPPRESSION – GENERAL

- A. Electrical Requirements:
 1. Refer to Drawings for operating voltages and unit configurations.
 2. SPDs shall be UL labeled with 200kA Short Circuit Current Rating (SCCR). Fuse ratings shall not be considered in lieu of demonstrated withstand testing SPDs.
 3. Maximum Continuous Operating Voltage (MCOV):

<u>System Voltage</u>	<u>Allowable System Voltage Fluctuation (%)</u>	<u>MCOV</u>
208Y/120	25%	150V
480Y/277	15%	320V
 4. The suppression system shall incorporate thermally protected metal-oxide varistors (MOVs) as the core surge suppression component for the service entrance and all other distribution levels. The system shall not utilize silicon avalanche diodes, selenium cells, air gaps, or other

components that may crowbar the system voltage leading to system upset or create any environmental hazards.

5. The SPD shall provide surge current path for all modes of protection: L-N, L-G, and N-G for Wye systems; L-L, L-G in Delta and impedance grounded Wye systems.
6. All SPDs applied to the distribution system shall have a 20kA Nominal Discharge Current (I_n) rating regardless of their SPD Type (includes Types 1 and 2) or operating voltage. SPDs having an I_n less than 20kA shall not be acceptable.
7. ANSI/UL 1449 listed Voltage Protection Ratings (VPRs) shall not exceed the following:

<u>System Voltage</u>	<u>L-N</u>	<u>L-G</u>	<u>L-L</u>	<u>N-G</u>
208Y/120	800V	800V	1200V	800V
480Y/277	1200V	1200V	2000V	1200V

(Numerically lower is allowed/preferred; old-style Suppressed Voltage Ratings (SVRs) shall not be submitted, nor evaluated due to outdated less-strenuous testing).

B. SPD Design:

1. SPD shall be UL listed Type 2, intended for use on the load side of the service disconnect. Every suppression component of every mode, including N-G, shall be protected by internal overcurrent and thermal over temperature controls. SPDs relying upon external or supplementary installed safety disconnects do not meet the intent of this specification.
2. The SPD shall be maintenance free and shall not require any user intervention throughout its life. SPDs containing items such as replaceable modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.
3. The surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance. The surge suppression platform must provide equal impedance paths to each matched MOV. Designs incorporating replaceable SPD modules shall not be accepted.
4. SPD shall have UL 1283 EMI/RFI filtering with minimum attenuation of 50dB at 100kHz.

5. SPD shall include visual LED diagnostics including a minimum of one green LED indicator per phase, and one red service LED. SPD shall include an audible alarm with on/off silence function and diagnostic test function. SPDs for branch circuit panels not employing an on/off silence function will be acceptable.
 6. The SPD must include Form C dry contacts (one NO and one NC) for remote monitoring of its status. Both the NO and NC contacts shall change state under any fault condition or if power is removed from the SPD. Service entrance locations shall have two sets of NO and NC contacts for building power monitoring.
 7. SPDs at service entrance locations shall be provided with a surge event counter with a reset button allowing the surge counter to be zeroed. The surge event count shall have a lithium battery backup or be stored in non-volatile memory and displayed after power is restored.
 8. Internally mounted SPDs in switchboards shall be designed to interface with the electrical assembly via factory installed conductors only and not mounted directly to bus bars.
 9. Sidemount SPDs shall be factory sealed in order to prevent access to the inside of the unit. Sidemount SPDs shall have factory installed phase, neutral, ground and remote status contact conductors factory installed and shall have a pigtail of conductors protruding outside of the enclosure for field installation. Top mount SPDs for switchboards where sidemount is not feasible due to space constrictions or space allowed for future expansion.
- C. SPDs shall have NEMA 1 general purpose enclosures, unless otherwise noted or required for the environment. SPDs located in kitchens or other areas subject to possible water exposure shall be NEMA 4X.

2.03 SYSTEM APPLICATION

- A. The SPD applications covered under this section include switchboard assemblies, motor control centers (if present), distribution and branch circuit panelboards. All SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C, B, and A environments.
- B. The minimum current capability (single pulse rated) per phase shall be:

Service Entrance or Automatic Transfer Switch:	300kA
Distribution Panelboards & MCC:	200kA
Branch Circuit Panelboards:	100kA

- C. SPDs installed on the load side of the service entrance disconnect shall be Type 2.
- 2.04 SERVICE ENTRANCE SWITCHBOARD/PANELBOARD LOCATIONS **[Engineer to edit. Delete SE Distribution Panels if not using. These are used mostly for ball fields.]**
- A. The SPD application covered under this section is for service entrance switchboard(s) and service entrance distribution panelboard(s). Service entrance located SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C environments.
- B. The SPD shall be from the same manufacturer as the switchboard. The SPD shall be internal and panel mounted in the front face of the switchboard at the assembly point by the original equipment manufacturer. Alternatively, the SPD from the same or different manufacturer may be mounted external to the switchboard.
- C. The SPD for service entrance distribution panelboards shall be mounted external and adjacent to the panelboard.
- D. Locate the SPD (Type 2) on the load side of the main disconnect device, as close as possible to the phase conductors and the ground neutral bar.
- E. The SPD shall be connected through a three pole, 60A circuit breaker to serve as the disconnecting means for the SPD. This disconnect shall be located in immediate proximity to the SPD. Connections shall be made via conductors originating in the SPD and shall be kept as short as possible.
1. As an option, internal mounted SPDs in switchboards may be provided with an integral disconnect switch in lieu of using a 60A circuit breaker to serve as the SPD disconnecting means. Connections shall be made via conductors originating in the SPD and connected to the bus bars with suitably sized tap lugs, factory installed. Conductors shall be kept as short as possible.
- F. All monitoring and diagnostic features shall be visible from the front of the equipment.
- G. The service entrance distribution panelboard external SPD shall be ASCO POWER TECHNOLOGIES (ASCO) Model No.: **[Engineer to edit]**
- 460120YP30ACCE20 for 120/208V SE distribution panelboards
 - 460277YP30ACCE20 for 277/480V SE distribution panelboards

2.05 POWER DISTRIBUTION AND BRANCH CIRCUIT PANELBOARD LOCATIONS

- A. The SPD application covered under this section includes distribution and branch circuit panelboards. The SPD units shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category B environments.
- B. The SPD shall be mounted externally and adjacent to the panelboard. The SPD shall be connected through a three pole, 30A circuit breaker to serve as the disconnecting means for the SPD. Connections shall be made via conductors originating in the SPD and shall be kept as short as possible.
- C. SPDs shall be flush mounted adjacent to the flush mounted panelboards and surface mounted adjacent to or attached to surface mounted panelboards.
- D. The external SPD shall be ASCO POWER TECHNOLOGIES Model No.: **[Engineer to edit]**
- 430120YP20ACAJ20 for 120/208V distribution panelboards
 - 430277YP20ACAJ20 for 277/480V distribution panelboards
 - 430120YP10ACAJ20 for 120/208V branch circuit panelboards
 - 430277YP10ACAJ20 for 277/480V branch circuit panelboards
- E. SPDs for motor control centers (MCC) shall be from the same manufacturer as the MCC. The SPD shall be internal and panel mounted in the front face of the MCC at the assembly point by the original equipment manufacturer. Alternatively, the SPD from the same or different manufacturer may be mounted external to the MCC. All monitoring and diagnostic features shall be visible from the front of the equipment. **[Engineer edit out if not using MCCs.]**

PART 3 - EXECUTION

3.01 INSTALLATION

- A. SPD shall be installed per manufacturer's installation instructions with lead lengths as short (less than 24") and straight as possible. Gently twist conductors together.
- B. This Contractor may reasonably rearrange the circuit breaker locations to ensure the shortest and straightest possible leads for the SPD connections.
- C. Before energizing, this Contractor shall verify service and separately derived system neutral to ground bonding jumpers per the National Electrical Code.

- D. Repaint marred and scratched surfaces with touch-up paint to match original finish.

3.02 TRAINING

- A. This Contractor shall provide four (4) hours of technical service training to the Owner's technical and maintenance staff.
- B. The training session shall be conducted by a manufacturer's qualified representative. The training program shall consist of instruction on operation of the assembly.

3.03 WARRANTY

- A. SPDs and supporting components and accessories shall be guaranteed by the manufacturer to be free of defects in material and workmanship for a period of ten (10) years from the date of substantial completion of service and activation of the system to which the suppressor is attached. Additionally, during the applicable warranty period, any SPD which fails due to any electrical anomaly, including lightning, shall be replaced by the manufacturer without charge. Special or optional warranties in excess of the warranty period for purposes of this bid are not acceptable. Standard unit warranties in excess of the warranty period stated herein are acceptable. Refer to SECTION 01740 for the start of the warranty period.
- B. Since "Acts of Nature" or similar statements typically include the threat of lightning to which the SPDs shall be exposed, any such clause limiting warranty responsibility in the general conditions of this specification shall not apply to this particular section. The warranty must specifically provide for unlimited free replacements of the SPD in the event of failure caused by the effects of lightning and all other electrical anomalies. The warranty shall cover the entire device, not just various components, such as modules only.

END OF SECTION

SECTION 16420

DISTRIBUTION SWITCHBOARD

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work under this Section shall include furnishing and installing a complete distribution switchboard(s) as shown on the Drawings and herein specified.

1.03 QUALITY ASSURANCE

- A. All equipment, materials, and their installation shall conform to the requirements of the National Electrical Code (NEC), local code requirements, and these Specifications.
- B. All equipment and material shall be listed by Underwriter's Laboratories, Inc. (UL) for their intended use and shall bear the UL label.
- C. Equipment shall be constructed in accordance with National Electrical Manufacturer's Association (NEMA) standards.
- D. Submittals are required in accordance with SECTION 16010 of these Specifications. The manufacturer shall furnish printed product data and also provide drawings to include components, materials, finishes, detailed plan and elevation views, required conduit rough-in openings, anchors, accessories, and wiring diagrams. Submittals shall also include, but not be limited to the following:
 - 1. Lug sizes
 - 2. Bus arrangements with all ampere ratings noted.
 - 3. Type and spacing of bus supports
 - 4. Maximum short-circuit bracing
 - 5. Fusible switch units size, interrupting rating, and fuse rating.
 - 6. Circuit breaker trip ratings and frame sizes
 - 7. Circuit breaker and fusible switch units arrangements.

8. Overall dimensions
 9. Provisions for future
 10. Metering
 11. Wiring diagrams for the single phase protection, blown fuse protection, and ground fault protection systems.
 12. Surge protective devices when SPDs are integral with the switchboard. Provide submittals as described in Section 16418.
- E. The distribution switchboard's utility metering provisions shall be constructed to comply with all of the electric utility company's requirements.
- F. The distribution switchboard(s) shall be factory engineered and shall be a completely assembled unit, complete as shown on the Drawings and/or herein specified with provisions for electric utility company's metering equipment where required.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Deliver material and products in factory labeled packages. Store and handle in strict compliance with manufacturer's instructions and recommendations.
- B. Each switchboard section shall be delivered in individual shipping splits and individually wrapped for protection and mounted on shipping skids.
- C. Store in a clean, dry space. Maintain factory protection and /or provide an additional heavy canvas or heavy plastic cover to protect structure from dirt, water, construction debris, and traffic. Where applicable, provide adequate heating within enclosures to prevent condensation.
- D. Handle in accordance with NEMA PB2.1 and manufacturer's written instructions. Lift only by lifting means provided for this express purpose. Handle carefully to avoid damage to switchboard internal components, enclosure and finish.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. The distribution switchboard(s) shall be as manufactured by EATON, ABB or SIEMENS.

- B. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum of ten (10) years.

2.02 MATERIALS AND COMPONENTS

A. Enclosure Construction:

1. The switchboard shall be of the modular type construction, constructed in accordance with the latest NEMA PB-2 and UL 891 standards with the required number of vertical sections bolted together to form one metal enclosed rigid switchboard. Enclosure construction shall be NEMA 1 indoor. Service entrance switchboards shall be suitable for use as service equipment and shall be labeled in accordance with UL requirements.
2. The switchboard framework shall be fabricated on a dieformed steel base or base assembly consisting of formed steel channel welded or bolted together to rigidly support the entire shipping unit for moving on rollers and floor mounting. The framework shall be formed code gauge steel, rigidly welded and bolted together to support all coverplates, bussing, and component devices during shipment and installations.
3. Each switchboard section shall have an open bottom and individual removable top plate for installation and termination of conduits. The sides, top and rear shall be covered with removable screw-on code gauge steel plates. All edges of front covers or hinged front panels shall be formed. Provide adequate ventilation within the enclosure.
4. The switchboard shall include all protective devices, provision only spaces for future protective devices, and equipment as listed on the Drawings and specified herein with necessary interconnections, instrumentation and control wiring.
5. Top and bottom conduit area(s) shall be clearly shown and dimensioned on the shop drawings. The wireway front covers shall be hinged to permit access to the branch overcurrent protective device load side terminals without removing the covers.
6. All sections of the switchboard shall be rear aligned as shown on the Drawings. All protective devices shall be group mounted. Protective devices shall be front removable and load connections front accessible enabling the switchboard to be mounted against a wall. All sections of the switchboard shall also be front aligned unless specifically shown otherwise on the drawings.
7. The switchboard shall have fully equipped provision spaces for future protective devices as shown on the Drawings. Remaining space not

identified on the Drawings shall be fully bussed and pre-drilled for future protective devices that do not have established frame sizes. This is in addition to the scheduled space or spare branches specified or shown on the Drawings.

B. Bus Requirements:

1. Switchboard bussing shall be rigid bus bars of silver-plated copper having ninety eight (98) percent conductivity and shall be rated with a maximum average temperature rise sized for UL at sixty five (65) degrees C.
2. The bus bars shall be rigidly braced to comply with the integrated equipment rating of the switchboard. The neutral bus shall be full capacity and sized as shown on the Drawings. The main horizontal bus bars between sections shall be full size, non-tapered for the complete length of the switchboard and located to permit a maximum of available conduit area. The through bus on the end section shall be extended and pre-drilled to allow the addition of future sections. The bus bar supports, connections, and joints are to be bolted with grade five (5) carriage bolts and conical spring-type (Belleville) washers. All hardware used on conductors shall be high-tensile strength and zinc-plated.
3. A ground bus and lug shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the switchboard. Provisions for the addition of future switchboard sections shall be provided. The manufacturer shall furnish a bus bond between the neutral and ground bus bars.
4. The manufacturer shall furnish a 1/16 inch thick plastic mimic bus of a contrasting color. Tape will not be acceptable.

C. Wiring/Terminations:

1. Small wiring, necessary fuse blocks and terminal blocks within the switchboard shall be furnished as required. 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 wiring diagrams.
2. Mechanical-type terminals shall be provided for all line and load terminations suitable for copper or aluminum cable rated for 75 degrees C of the size as indicated on the Drawings.
3. Lugs shall be provided in the incoming line section for connections of the main grounding conductor. Additional lugs for connection of other grounding conductors shall be provided as indicated on the Drawings.

4. All control wiring shall be type SIS, bundled and secured with nylon ties. Insulated locking spade terminals shall be provided for all control connections, except where saddle type terminals are provided integral to a device. All current transformer secondary leads shall first be connected to conveniently accessible short-circuit terminal blocks before connecting to any other device. All groups of control wires leaving the switchboard shall be provided with terminal blocks with suitable numbering strips. Provide wire markers at each end of all control wiring.
- D. Ratings: The switchboard's system voltage and amperage shall be as indicated on the Drawings. The switchboard, as a complete unit, shall be given a single integrated equipment rating by the manufacturer of 65,000 amperes minimum **or as determined by the Short-Circuit Coordination Study whichever is higher** and shall be so labeled. Such rating shall be established by actual tests by the manufacturer on similar equipment available and shall be furnished with the submittal. **[ENGINEER, EDIT OUT SHORT-CIRCUIT STUDY PORTION IF NOT IN PROJECT]**
- E. Incoming Service:
1. The utility metering compartment (C/T cabinet) shall also serve as the incoming service entrance compartment. Suitable compression lugs in the quantity and size required to terminate incoming utility service entrance cables shall be provided in accordance with the Contract Drawings and the requirements of the local electric utility company. Bus work shall include provisions for mounting utility company current transformers and potential transformers or potential taps as required by the utility company. Provide service entrance label and provide necessary applicable service entrance features per NEC and local code requirements.
 2. The C/T cabinet shall be an integral part of the switchboard, complete with a barrier to separate the utility metering compartment from the rest of the switchboard. It shall be of the height necessary, and meet all other requirements of the electric utility company. The entire cabinet shall have a double hinged door with sealable hasp and knurled captive screws.
 3. A separate incoming cable pull section shall not be required.
- F. Fire Pump Tap: A fire pump tap section shall be provided as integral part of the switchboard. It shall be on the line side of the main disconnecting devices of the switchboard and contain only through bus and tap lugs to feed the fire pump. **[ENGINEER TO EDIT OUT IF FIRE PUMP IS NOT USED]**
- G. Bolted Pressure Switches:

1. All main switches indicated on the Drawings 800 amperes and larger shall be true bolted contact load-break type with provisions for NEMA Class L fuses (fuses shall be furnished and installed by this Contractor). The stored energy deadfront operating mechanism shall include disk springs, compressed and released by the operating handle, to provide quick-positive switching action independent of the speed with which it is operated. The mechanism shall be designed so that the switch can be closed only after the opening spring has been charged, ready for electrical opening by solenoid or manual opening by mechanical pushbutton.
 2. The operating handle shall be mechanically interlocked with the fuse access door and shall have provisions for padlocking in the OPEN position. An external mechanical flag shall be provided to identify whether the switch is either open or closed.
 3. Switches, with class L fuses installed, shall be rated for use on systems capable of withstanding and closing into circuits having available fault currents of 200,000 RMS symmetrical amperes at 600 VAC maximum. Switches shall have an interrupting rating of twelve (12) times the continuous rating at 240, 480, and 600 VAC and shall be capable of carrying 100% of rated current and shall have been tested in accordance with UL Subject 977. Switches shall have power terminals to accommodate either cable or bolted bus connections. Cable lugs, when used, shall be rated for use with 90 degrees C wire insulation (sized according to the 75 degree C temperature rating in the NEC). High-pressure contact switches do not meet the intent of these Specifications.
 4. The switch shall be complete with single phase protection to open the main device upon loss of any single phase but not upon simultaneous loss of all three (3) phases.
 5. The switch shall be complete with separate blown fuse protection to open the main bolted pressure switch if one (1) or more of the class L fuses operate. Blown fuse pilot light shall illuminate for the phase with the blown fuse. Pilot lights shall not be lit unless a fuse has blown.
 6. The switch shall have two (2) sets of auxiliary contacts (2 normally open and 2 normally closed) for switch position monitoring.
 7. Switch(es) shall be PRINGLE type CBC or approved equal.
 8. Fusible Switches 1200A and higher shall have an arc flash maintenance system that meets NEC 240.67.
- H. Ground Fault Protection:

1. A zero sequence type ground fault protection system shall be included for each main bolted pressure service switch as shown on the Drawings or as required by NEC. It shall consist of a current sensor enclosing all phase and neutral conductors of the circuit to be monitored, and appropriate relaying equipment to provide the desired ground fault current sensitivity and time-current response characteristics. The main switch shall be equipped to function in conjunction with the other elements of the ground fault protection system. Installation of the equipment shall be in all respects in accordance with the manufacturer's recommendations.
 2. A current sensor shall be provided of the size necessary to encircle the phase conductors and the neutral conductor of the circuit to be monitored. Current sensor output shall be coordinated with the required input to the relay. A test winding shall be included to simulate the flow of ground fault current through the current sensor in order to test the operation of the ground fault protection system including sensor pick-up relay and circuit protective device operation. The frame of the current sensor shall be so constructed that one leg can be opened to allow removal of installation around cable or bus without disturbing the cable or requiring drop-links in the bus.
 3. The ground fault relay shall be of solid state construction, except that a coil operated output relay shall be provided to control 120-volt power to operate the associated fusible bolted pressure switch ground fault trip mechanism. The relay shall require 120-volt power to operate the associated main device. Adjustable pickup current sensitivity for ground currents from 200 amperes to 1200 amperes shall be provided. A calibrated dial shall be provided for setting the current pickup point in the field. Settings for individual relays shall be 1200 amperes **or as determined by the Short-Circuit Coordination Study whichever is lower**. Time delay provided by the relay circuitry shall be nominally 0.2 seconds **or as determined by the Short-Circuit Coordination Study** and shall be permanently calibrated. A self-contained test circuit utilizing the test coil provided in the current sensor shall be incorporated in the system. The test circuit shall be part of the monitor panel that shall be mounted on the front cover of the switchboard. **[ENGINEER, EDIT OUT SHORT-CIRCUIT STUDY PORTIONS IF NOT IN PROJECT]**
- I. Fusible Switches: Main switches 600 amperes and smaller and feeder protective devices shall consist of fusible switch units as indicated on the Drawings. The fusible switch units shall be quick-make, quick-break type. The units shall be listed by UL for service entrance use. The fusible switch units shall be group mounted in panel-type construction. Each unit shall be enclosed in a separate steel enclosure. The enclosure shall employ a hinged cover for access to the

fuses which shall be interlocked with the operating handle to prevent opening the cover when the switch is in the ON position. This interlock shall be constructed so that it can be released with a standard electrician's tool for testing fuses without interrupting service. The units shall have padlocking provisions in the OFF position and the operating handle position shall give switch position indication, i.e., horizontal OFF, diagonal ON. This Contractor shall furnish and install BUSSMANN "LIMITRON", or approved equal, dual element fuses of the ratings noted on the Drawings. **[ENGINEER TO EDIT OUT IF FUSIBLE SWITCHES AREN'T USED]**

J. Molded Case Circuit Breakers:

1. Feeder protective devices shall consist of molded case circuit breakers as indicated on the Drawings, equipped with individually insulated, braced, and protected connectors. The front faces of all circuit breakers shall be flush with each other.
2. The circuit breakers shall be operated by a toggle type handle and shall have a quick-make, quick-break over-center switching mechanism that shall be mechanically trip free from the handle so that the contacts cannot be held closed against short circuits and abnormal currents. Tripping due to overload or short circuit shall be clearly indicated by the handle automatically assuming a position midway between the manual "ON" and "OFF" positions. All latch surfaces shall be ground and polished. All poles of a multi-pole breaker shall be so constructed that they open, close, and trip simultaneously.
3. The circuit breakers shall be completely enclosed in a molded case. Non-interchangeable trip breakers shall have their covers sealed; interchangeable trip breakers shall have the trip unit sealed to prevent tampering. Ampere ratings shall be clearly visible. Contacts shall be non-welding silver alloy. Arc extinction shall be accomplished by means of arc chutes consisting of metal grids mounted in an insulating support. Breakers shall be of the bolt-on or I-Line type; plug-in, plug-on, and clamp-on circuit breakers shall not be acceptable.
4. Circuit breakers shall be 80% rated unless indicated on the Drawings to be 100% rated.
5. Circuit breakers shall have a minimum symmetrical interrupting capacity as indicated on the Drawings. The interrupting ratings of the circuit breakers shall be at least equal to, or greater than, the available short circuit at the line terminals and not less than those values shown on the Drawings and specified in this specification section **or as determined by the Short-Circuit Coordination Study whichever is higher.** **[ENGINEER, EDIT OUT SHORT-CKT STUDY IF NOT IN PROJECT]**

6. Circuit breakers shall be listed with UL and conform to the applicable requirements of the latest issue of NEMA Standards Publication No. AB1.
7. Circuit breaker frames 250 ampere and below shall have thermal-magnetic trip units, with inverse time-current characteristics, unless otherwise indicated on the Drawings.
 - a. Automatic operation of all circuit breakers shall be obtained by means of thermal-magnetic tripping devices located in each pole providing inverse time delay and instantaneous circuit protection.
 - b. Circuit breaker frames shall be ambient compensating in that, as the ambient temperature increases over 40° C, the circuit breaker automatically derates itself to better protect its associated conductor.
 - c. Thermal-magnetic circuit breakers 250A and above shall have thermal magnetic interchangeable trip units, unless otherwise indicated on the Drawings.
8. Circuit breaker frames 400 ampere and above shall have microprocessor-based RMS sensing trip units, unless otherwise indicated on the Drawings.
 - a. Solid state sensing shall measure true RMS current with capability to measure through to the 13th harmonic. Automatic operation of all circuit breakers shall be obtained by means of solid state tripping elements providing inverse time delay and instantaneous and short-time circuit protection. Continuous current rating shall be adjustable from 40% to 100% of trip unit rating. Long-time delay and instantaneous trip ratings shall also be adjustable. The short time pick-up trip shall have adjustable pick-up settings at definite times and with I2t delay.
 - b. Long time current adjustment shall be possible without the need for a rating plug.
 - c. Feeder circuit breakers shall be provided with integral ground fault protection. Ground fault pick-up shall be adjustable from 20% to 70% of the breakers maximum continuous current rating, but in no case be greater than 1200A. Ground fault time delay shall be adjustable with three (3) I2t delay settings.
 - d. Solid state circuit breakers shall have built-in test ports for testing the long-time delay, instantaneous, and ground fault functions of the breaker by means of a test set.

- e. Provide a test set capable of testing all circuit breakers with a built-in test port.
 - 9. Circuit Breaker Accessories: Provide shunt trips, bell alarms and auxilliary switches, etc. as may be shown on the drawings. All accessories shall be UL listed for field installation.
 - 10. Circuit breakers shall be manufactured by the same manufacturer as the switchboard and factory installed.
 - 11. Where indicated, circuit breakers shall be UL listed for series application. **(ENGINEER TO EDIT OUT THIS PARAGRAPH IF NOT USING SERIES CONNECTED BREAKERS.)**
 - 12. Large permanent individual circuit numbers shall be affixed to each breaker in a uniform position.
- K. Nameplates:
- 1. Each device installed in the switchboard (including the C/T cabinet) shall be identified with a suitable nameplate, engraved as indicated on the Drawings. Nameplates shall be white phenolic with engraved black letters not less than 3/8" block style. The emergency service nameplates shall be red with white letters. Nameplates shall be screw fastened.
 - 2. Furnish master nameplate giving switchboard designation, voltage and ampere rating, short-circuit rating, manufacturer's name, general order number, and item number.
- L. All exterior and interior steel surfaces of the switchboard shall be properly cleaned and provided with a rust-inhibiting phosphatized coating. Color and finish of the switchboard shall be ANSI 61 gray.

2.03 METERING

- A. A separate digital meter shall be panel mounted in the front face of the switchboard. The information and capabilities provided by the meter shall include, but not be limited to the following:
- 1. Current (amperes) per phase.
 - 2. Voltage, phase-to-phase and phase-neutral.
 - 3. Real power (kW), per phase and three phase total.

4. Reactive power (kVAR), per phase and three phase total.
 5. Apparent power (kVA), per phase and three phase total.
 6. Power factor (true), per phase and three phase total.
 7. Frequency readings.
 8. Real energy (kWh), three phase total.
 9. Reactive energy (kVARh), three phase total.
 10. Apparent energy (kVAh), three phase total.
 11. Energy accumulation modes, signed, absolute, energy in, energy out.
 12. Neutral current measurements
 13. Demand current, per phase and neutral, present and peak.
 14. Real power demand (kWd) readings, three phase total, present and peak.
 15. Reactive power demand (kVARd) readings, three phase total, present and peak.
 16. Apparent power demand (kVAd) readings, three phase total, present and peak.
 17. Total Harmonic Distortion (THD) readings, voltage and current, per phase, provided as individual harmonic magnitudes up to the 31st harmonic, and as total odd, total even and total overall harmonic distortion; all readings given as a percentage of fundamental.
 18. Date and time stamping, peak demands, power up/restart and resets.
 19. Onboard alarms for over/under voltages (per phase L-L, L-N), and voltage unbalance.
 20. Minimum and maximum readings.
- B. The meter shall be accurate to 0.25% of readings plus 0.05% of full scale for voltage and current sensing, and 0.5% of reading plus 0.05% of full scale for power and energy, accurate through the 31st harmonic.
1. These accuracies shall be maintained for both light and full loads.

2. No annual re-calibration by users shall be required to maintain these accuracies.
 3. Voltage and current for all phases shall be sampled simultaneously to assure high accuracy.
- C. The meter shall be provided with a Modbus RTU serial or Modbus-TCP ethernet communications port for open protocol integration of the electrical data into the BAS. The meter manufacturer shall provide all register data and support to the BAS integrator onsite to provide a seamless integration of the data into the BAS.
 - D. The meter data communications shall be optically isolated to provide reliable operation.
 - E. The meter shall be equipped with backlit, two-line or greater LCD display.
 - F. All meter setup information and reset commands shall be password protected.
 - G. The meter shall have a KYZ pulse initiator for communication of kWh, kVARh, or kVAh information to third party energy management systems.
 - H. Metering transformers shall be provided to support the requirements of the meters specified herein, UL listed or recognized.

2.04 SURGE PROTECTIVE DEVICE (SPD)

- A. Provide surge protective devices (SPD) as specified in Specification Section 16418.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. The switchboard shall be installed in accordance with the manufacturer's recommendations, as shown on the Drawings, and as required by the electric utility company serving this project.
- B. The Contractor shall furnish and install a four (4) inch high by six (6) inch greater all sides (except rear when the switchboard is mounted against a wall) concrete housekeeping pad for the switchboard. Contractor shall ensure that the concrete pad is levelled and free of irregularities.
- C. The assembly shall be provided with adequate lifting means and shall be capable of being moved into installation position and bolted directly to Contractor-supplied floor sills to be set level in concrete per manufacturer's recommendations. All necessary hardware to secure the assembly in place shall

be provided by the Contractor.

- D. Install units plumb, level and rigid without distortion to the switchboard cubicles.
- E. Switchboard wiring for factory mounted devices shall be installed complete at the factory and adequately bundled and protected. All conductors across hinges, and all conductors for interconnections between shipping units, shall be flexible.
- F. Contractor shall install required safety labels.

3.02 START-UP SERVICE AND PERFORMANCE TEST

- A. The manufacturer shall provide factory personnel to completely inspect and test the switchboard(s) for proper installation and operation of all equipment, at the time of system start-up. Testing shall include, but not be limited to, performance testing of the bolted pressure switch(es), circuit breakers, SPDs, metering, single phase protection, blown fuse protection, and ground fault protection systems and equipment.
- B. All testing and start-up services shall be in the presence of the Engineer and the Contract Owner's Technical Representative (COTR). The tests shall be as stated in the manufacturer's literature. One (1) copy of the tests results shall be submitted to the Engineer and Owner for review.
- C. The completed equipment grounding system shall be subjected to a metered test at the switchboard ground bar to ensure that the ground resistance, without chemical treatment or other artificial means, does not exceed five (5) ohms. One (1) copy of the test results shall be submitted to the Engineer and Owner for review.
- D. Check tightness of all accessible mechanical and electrical connections to assure they are torqued to the minimum acceptable manufacturer's recommendations.
- E. Check the switchboard for proper grounding, fastening and alignment.

3.03 FIELD ADJUSTMENTS

- A. This Contractor shall perform field adjustments of the protective devices as required to place the equipment in final operating condition. Necessary field settings of devices and adjustments and minor modifications to equipment shall be carried out by this Contractor at no additional cost to the Owner.
- B. **(ENGINEER, DELETE THIS PARAGRAPH WHEN SECTION 16015 "SHORT-CIRCUIT/COORDINATION STUDY" IS NOT USED)** The settings shall be in

accordance with the approved protective device coordination study or as directed by the Engineer.

3.04 TRAINING

- A. This Contractor shall provide eight (8) hours of technical service training to the Owner's technical and maintenance staff.
- B. The training session shall be conducted by a manufacturer's qualified representative. The training program shall consist of instruction on operation of the assembly, circuit breakers, fused switches, metering, and major components within the assembly.

3.05 CLEANING

- A. Remove debris from switchboard and wipe dust and dirt from all components.
- B. Repaint marred and scratched surfaces with touch-up paint to match original finish.

3.06 RISER DIAGRAM

- A. This Contractor shall furnish one (1) set of the complete as-built power riser diagram showing all switchboards, panelboards, emergency electrical power system equipment, and their interconnections. The riser diagram shall be laminated and mounted by this Contractor as directed by the Owner at the location of the main distribution switchboard.

END OF SECTION

SECTION 16425

GENERATOR QUICK CONNECT SWITCHBOARD [FOR EMERGENCY SHELTER SYSTEM WITH ROLL-UP GENERATOR]

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work under this Section shall include furnishing and installing a complete generator quick connection switchboard(s), utilizing a main circuit protective device, generator lug and receptacle connections as shown on the Drawings and herein specified.

1.03 QUALITY ASSURANCE

- A. All equipment, materials, and their installation shall conform to the requirements of the National Electrical Code (NEC), local code requirements, and these Specifications.
- B. All equipment and material shall be listed by Underwriter's Laboratories, Inc. (UL) for their intended use and shall bear the UL label.
- C. Equipment shall be constructed in accordance with National Electrical Manufacturer's Association (NEMA) standards.
- D. Submittals are required in accordance with SECTION 16010 of these Specifications. The manufacturer shall furnish printed product data and also provide drawings to include components, materials, finishes, detailed plan and elevation views, required conduit rough-in openings, anchors, pad accessories, wiring diagrams, key interlock scheme drawings and sequence of operations. Submittals shall also include, but not be limited to the following:
 - 1. Lug sizes
 - 2. Bus arrangements with all ampere ratings noted.
 - 3. Type and spacing of bus supports
 - 4. Maximum short-circuit bracing

5. Circuit breaker trip ratings and frame sizes
 6. Circuit breaker arrangements
 7. Overall dimensions
 8. Metering
 9. Surge protective devices when SPDs are integral with the switchboard. Provide submittals as described in Section 16418.
 10. Wiring diagrams for the single-phase protection and ground fault protection systems.
- E. The generator quick connection switchboard(s) shall be factory engineered and shall be a completely assembled unit, complete as shown on the Drawings and/or herein specified.
- F. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.
- G. The manufacturer shall be ISO 9001 or 9002 certified for the equipment specified herein.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Deliver material and products in factory labeled packages. Store and handle in strict compliance with manufacturer's instructions and recommendations.
- B. Each switchboard section shall be delivered in individual shipping splits and individually wrapped for protection and mounted on shipping skids.
- C. Store in a clean, dry space. Maintain factory protection and /or provide an additional heavy canvas or heavy plastic cover to protect structure from dirt, water, construction debris, and traffic. Where applicable, provide adequate heating within enclosures to prevent condensation.
- D. Handle in accordance with NEMA PB2.1 and manufacturer's written instructions. Lift only by lifting means provided for this express purpose. Handle carefully to avoid damage to switchboard internal components, enclosure and finish.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. The generator quick connection switchboard(s) shall be as manufactured by EATON, ABB or SIEMENS.
- B. The listing of specific manufacturers does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed are not relieved from meeting these specifications in their entirety.
- C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum of ten (10) years.

2.02 MATERIALS AND COMPONENT

A. Construction:

1. The generator quick connection switchboard shall be of the modular type construction, constructed in accordance with the latest NEMA PB-2 and UL 891 standards with the required number of vertical sections bolted together to form one metal enclosed rigid switchboard. The sides and rear shall be covered with removable bolt-on covers. All edges of front covers and hinged front panels shall be formed. Provide adequate ventilation within the enclosure.
2. All sections of the switchboard shall be front and rear aligned as shown on the Drawings with depth as required by the manufacturer with all code required clearances maintained. All protective devices shall be grouped mounted. Devices shall be front removable and load connections front accessible enabling switchboard to be mounted against a wall.
3. The switchboard shall be provided with load connection options to cross bus or mechanical outgoing cable terminations, which shall be suitable for copper or aluminum conductors.
4. The assembly shall be provided with adequate lifting means.
5. The switchboard framework shall be fabricated on a dieformed steel base or base assembly consisting of formed steel channel welded or bolted together to rigidly support the entire shipping unit for moving on rollers and floor mounting. The framework shall be formed code gauge steel, rigidly welded and bolted together to support all coverplates, bussing, and component devices during shipment and installations.
6. Top and bottom conduit area(s) shall be clearly shown and dimensioned on the shop drawings.

[ENGINEER, CHOOSE INDOOR OR OUTDOOR FROM PARAGRAPH 'B' or 'C' THEN

EDIT]

B. Enclosure construction shall be NEMA Type 1 indoor.

C. Enclosure construction shall be NEMA Type 3R outdoor.

1. Outdoor enclosure shall be non-walk-in and meet applicable NEMA 3R UL requirements.
2. Enclosure shall have a flat roof.
3. Provide hinged cable entry trap door to allow cable access to generator connection receptacles and lugs while maintaining Type 3R enclosure integrity.
4. The enclosure shall be provided with bolt-on rear covers for each section.
5. Doors shall have provisions for pad locking.
6. Ventilating openings shall be provided.
7. The outdoor enclosure shall be provided with a space heater having adequate wattage to prevent the accumulation of moisture and shall be thermostatically controlled. Power for the space heater shall be obtained from a source as indicated on the Drawings. Supply voltage shall be 120 volts AC.

D. Bus Requirements:

1. Switchboard bussing shall be rigid bus bars of silver-plated copper having ninety eight (98) percent conductivity and shall be rated for a minimum of one (1) square inch per one thousand (1,000) ampere capacity with a maximum average temperature rise sized for UL at sixty five (65) degrees C. over a forty (40) degrees C. ambient (outside the enclosure).
2. The bus bars shall be rigidly braced to comply with the integrated equipment rating of the switchboard. The neutral bus shall be full capacity and sized as shown on the Drawings. The bus bar supports, connections, and joints are to be bolted with grade five (5) carriage bolts and Belleville washers.
3. A ground bus and lug shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the switchboard.

E. Wiring/terminations:

1. The switchboard shall be provided with both mechanical lugs and cam-

- type receptacle assembly for connection of generator power phases (A, B, C), neutral and grounding conductors. All connections for phases, neutral, ground, etc., shall be clearly marked via labeling.
2. Each single pole cam-type receptacle shall be rated for no less than 400 amps at 90 degrees C. Multiple receptacles per phase, neutral and ground shall be utilized when amperages over 400 are requested. Contact material of the receptacle shall be composed of brass.
 3. Cam-type receptacles shall be male type, unless otherwise directed by the Owner, and must be suitable for use in outdoor environments.
 4. Single pole Cam-type receptacles shall be UL 498 listed for Attachment Plugs and Receptacles and UL 1691.
 5. Small wiring, necessary fuse blocks and terminal blocks within the switchboard shall be furnished as required. 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 wiring diagrams.
 6. Where applicable all control wire shall be type SIS, bundled and secured with nylon ties. Insulated locking spade terminals shall be provided integral to a device. All current transformer secondary leads shall first be connected to conveniently accessible short-circuit terminal blocks before connection to any other device. All groups of control wires leaving the switchboard shall be provided with terminal blocks with suitable numbering strips. Provide wire markers at each end of all control wiring.
- F. Ratings: The switchboard's system voltage and amperage shall be as indicated on the Drawings. The switchboard, as a complete unit, shall be given a single integrated equipment rating by the manufacturer of 65,000 **(Engineer to edit)** amperes minimum **or as determined by the Short-Circuit Coordination Study whichever is higher** and shall be so labeled. Such rating shall be established by actual tests by the manufacturer on similar equipment available and shall be furnished with the submittal. **[ENGINEER, EDIT OUT SHORT-CIRCUIT STUDY PORTION IF NOT IN PROJECT]**
- G. Main Protective Device:
1. Main protective device shall consist of a molded case circuit breaker or insulated case circuit breaker as indicated on the Drawings, equipped with individually insulated, braced, and protected connectors, and single phase protection.

2. The circuit breaker shall be operated by a toggle type handle and shall have a quick-make, quick-break over-center switching mechanism that shall be mechanically trip free from the handle so that the contacts cannot be held closed against short circuits and abnormal currents. Tripping due to overload or short circuit shall be clearly indicated by the handle automatically assuming a position midway between the manual "ON" and "OFF" positions. All latch surfaces shall be ground and polished. All poles of a multi-pole breaker shall be so constructed that they open, close, and trip simultaneously.
3. The circuit breaker shall be completely enclosed in a molded case. Non-interchangeable trip breaker shall have the cover sealed; interchangeable trip breaker shall have the trip unit sealed to prevent tampering. Ampere ratings shall be clearly visible. Contacts shall be non-welding silver alloy. Arc extinction shall be accomplished by means of arc chutes consisting of metal grids mounted in an insulating support. Breaker shall be of the bolt-on type; plug-in, plug-on, blow-on, and clamp-on circuit breakers shall not be acceptable.
4. Circuit breakers shall be 80% rated unless indicated on the Drawings to be 100% rated.
5. Circuit breaker shall have a minimum symmetrical interrupting capacity of 65,000 **(Engineer to edit)** amperes. The interrupting ratings of the circuit breaker shall be at least equal to, or greater than, the available short circuit at the line terminals and not less than those values shown on the Drawings and specified in this specification section **or as determined by the Short-Circuit Coordination Study whichever is higher.**
[ENGINEER, EDIT OUT SHORT-CKT STUDY IF NOT IN PROJECT]
6. Circuit breaker shall be listed with UL, conform to the applicable requirements of the latest issue of NEMA Standards Publication No. AB1.
7. Circuit breaker frames 250 ampere and below shall have thermal-magnetic trip units, with inverse time-current characteristics, unless otherwise indicated on the Drawings.
 - a. Automatic operation of all circuit breakers shall be obtained by means of thermal-magnetic tripping devices located in each pole providing inverse time delay and instantaneous circuit protection.
 - b. Circuit breaker frames shall be ambient compensating in that, as the ambient temperature increases over 40° C, the circuit breaker automatically derates itself to better protect its associated conductor.

- c. Thermal-magnetic circuit breakers 250A and above shall have thermal magnetic interchangeable trip units, unless otherwise indicated on the Drawings.
8. Circuit breaker frames 400 ampere and above shall have microprocessor-based RMS sensing trip units, unless otherwise indicated on the Drawings.
 - a. Solid state sensing shall measure true RMS current with capability to measure through to the 13th harmonic. Automatic operation of all circuit breakers shall be obtained by means of solid state tripping elements providing inverse time delay and instantaneous and short-time circuit protection. Continuous current rating shall be adjustable from 20% to 100% of trip unit rating. Long-time delay and instantaneous trip ratings shall also be adjustable. The short time pick-up trip shall have adjustable pick-up settings at definite times and with I_{2t} delay.
 - b. Long time current adjustment shall be possible without the need for a rating plug.
 - c. Feeder circuit breakers shall be provided with integral ground fault protection. Ground fault pick-up shall be adjustable from 20% to 70% of the breakers maximum continuous current rating, but in no case be greater than 1200A. Ground fault time delay shall be adjustable with three (3) I_{2t} delay settings.
 - d. Solid state circuit breakers shall have built-in test ports for testing the long-time delay, instantaneous, and ground fault functions of the breaker by means of a test set.
 - e. Provide a test set capable of testing all circuit breakers with a built-in test port.
9. Circuit breaker accessories: In addition to single-phase protection, provide shunt trips, bell alarms and auxiliary switches, etc. as may be shown on the Drawings. All accessories shall be UL listed for field installation.
10. Circuit breaker shall be manufactured by the same manufacturer as the switchboard and factory installed.
11. Where indicated, circuit breakers shall be UL listed for series application. **(ENGINEER TO EDIT OUT THIS PARAGRAPH IF NOT USING SERIES CONNECTED BREAKERS.)**

12. Circuit Breakers or Fused Switches greater than or equal to 1200A shall meet the requirements of NEC 240.67 and 240.87 for Arc Flash Maintenance.
- H. Provide key interlocks between generator switchboard main and normal source breaker to prevent inadvertent interconnections and utility back feed or paralleling of unsynchronized sources. Key interlocks shall be as manufactured by KIRK KEY INTERLOCK COMPANY.
- I. All exterior and interior steel surfaces of the switchboard shall be properly cleaned and provided with a rust-inhibiting phosphatized coating. Color and finish of the switchboard shall be ANSI 61 gray.

2.03 NAMEPLATES

- A. Provide a switchboard designation engraved nameplate on the face of the switchboard. Each device installed in the switchboard shall be identified with a suitable nameplate, engraved as indicated on the Drawings. Engraved nameplates shall be white phenolic with engraved black letters not less than 3/8" block style. Each wiring termination assembly section shall also be identified with an engraved nameplate i.e.: QUICK CONNECT RECEPTACLES, GENERATOR INCOMING LUGS, GENERATOR BREAKER, etc.
- B. Furnish a master nameplate giving switchboard designation, voltage ampere rating, short-circuit rating, manufacturer's name, general order number, item number and other manufacturer's required information.
- C. Provide a set of permanent operating instructions affixed to the switchboard having simple instructions for operation. Through the inclusion of these instructions, any qualified generator technician can operate the mechanisms include in the assembly.

2.04 SURGE PROTECTION DEVICE

- A. Provide surge protective devices (SPD) as specified in Section 16418.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. The switchboard shall be installed in accordance with the manufacturer's recommendations and as shown on the Drawings.
- B. The Contractor shall furnish and install a four (4) inch high by six (6) inch greater

all sides (except rear when the switchboard is mounted against a wall) concrete housekeeping pad for the switchboard.

- C. The assembly shall be provided with adequate lifting means and shall be capable of being moved into installation position and bolted directly to Contractor-supplied floor sills to be set level in concrete per manufacturer's recommendations. All necessary hardware to secure the assembly in place shall be provided by the Contractor.
- D. Install units plumb, level and rigid without distortion to the switchboard cubicles.
- E. Switchboard wiring for factory mounted devices shall be installed complete at the factory and adequately bundled and protected. All conductors across hinges, and all conductors for interconnections between shipping units, shall be flexible.
- F. Contractor shall install required safety labels.

3.02 KEY INTERLOCKS

- A. Key interlocks shall be factory installed in the Generator Quick Connect Switchboard. Key interlocks shall be factory or field installed in the "normal source" main protective devices and shall not void the UL listing of the "normal source" protective device. If required, this Contractor shall have the "normal source" device manufacturer's authorized factory engineer or service technician install the Contractor provided key interlock switch.
- B. The sequence of operation shall be such that there will be only one key for the interlock sequence. To insert or withdraw the key the protective device must be in the OPEN position with the interlock bolt engaged. To close the protective device the key must be inserted and turned within the lock to withdraw the interlock bolt allowing the protective device to CLOSE. When the protective device is in the CLOSED position the key cannot be removed until the protective device is once again in the OPEN position with the key turned to insert the interlock bolt, locking the device OPEN.

3.03 START-UP SERVICE AND PERFORMANCE TEST

- A. The manufacturer shall provide factory personnel to completely inspect and test the switchboard(s) for proper installation and operation of all equipment, at the time of system start-up. Testing shall include, but not be limited to, performance testing of the circuit breakers, TVSS, metering, single-phase protection, and ground fault protection systems and equipment.
- B. All testing and start-up services shall be in the presence of the Engineer and the Contract Owner's Technical Representative (COTR). The tests shall be as stated in the manufacturer's literature. One (1) copy of the tests results shall be submitted to the Engineer and Owner for review.

- C. The completed equipment grounding system shall be subjected to a metered test at the switchboard ground bar to ensure that the ground resistance, without chemical treatment or other artificial means, does not exceed five (5) ohms. One (1) copy of the test results shall be submitted to the Engineer and Owner for review.
- D. Check tightness of all accessible mechanical and electrical connections to assure they are torqued to the minimum acceptable manufacturer's recommendations.
- E. Check the switchboard for proper grounding, fastening and alignment.

3.04 FIELD ADJUSTMENTS

- A. This Contractor shall perform field adjustments of the protective devices as required to place the equipment in final operating condition. Necessary field settings of devices and adjustments and minor modifications to equipment shall be carried out by this Contractor at no additional cost to the Owner.
- B. **(ENGINEER, DELETE THIS PARAGRAPH WHEN SECTION 16015 "SHORT-CIRCUIT/COORDINATION STUDY" IS NOT USED).** The settings shall be in accordance with the approved protective device coordination study or as directed by the Engineer.

3.05 TRAINING

- A. This Contractor shall provide eight (8) hours of technical service training to the Owner's technical and maintenance staff.
- B. The training session shall be conducted by a manufacturer's qualified representative. The training program shall consist of instruction on operation of the assembly, circuit breakers, metering, and major components within the assembly.

3.06 CLEANING

- A. Remove debris from switchboard and wipe dust and dirt from all components.
- B. Repaint marred and scratched surfaces with touch-up paint to match original finish.

3.07 RISER DIAGRAM

- A. This Contractor shall furnish one (1) set of the complete as-built power riser diagram showing all switchboards, panelboards, emergency electrical power system equipment, and their interconnections. The riser diagram shall be

laminated and mounted by this Contractor as directed by the Owner at the location of the main distribution switchboard or the generator quick connect switchboard.

END OF SECTION

SECTION 16430

DISTRIBUTION PANELBOARDS

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work covered under this Section shall include furnishing and installing distribution panelboards complete for all systems as shown on the Drawings and herein specified.

1.03 QUALITY ASSURANCE

- A. All equipment, materials, and their installation shall conform to the requirements of the National Electrical Code (NEC), local code requirements, and these Specifications.
- B. All equipment and materials shall be listed by Underwriter's Laboratories, Inc. (UL) for their intended use and shall bear the UL label.
- C. Equipment shall be constructed in accordance with National Electrical Manufacturer's Association (NEMA) standards.
- D. Submittals are required in accordance with SECTION 16010 of these Specifications. The manufacturer shall furnish, but not be limited to the following:
 - 1. Circuit breaker and/or fusible switch layout with dimensions and nameplate designation. **[Engineer, edit out fusible switch if not using]**
 - 2. Circuit breaker trip ratings and frame sizes.
 - 3. Fusible switch units size, interrupting rating, and fuse rating. **[Engineer, edit out fusible switch if not using]**
 - 4. Component list.
 - 5. Conduit entry/exit locations.
 - 6. Assembly ratings, including short-circuit rating, voltage, and continuous

current rating.

7. Bus material, including ground bar.
8. Cable terminal sizes.
9. Product data for each type of panelboard.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Deliver material and products in factory labeled packages. Store and handle in strict compliance with manufacturer's instructions and recommendations.
- B. Each distribution panelboard section shall be delivered in individual shipping splits and individually wrapped for protection and mounted on shipping skids.
- C. Store in a clean, dry space. Maintain factory protection and /or provide an additional heavy canvas or heavy plastic cover to protect structure from dirt, water, construction debris, and traffic. Where applicable, provide adequate heating within enclosures to prevent condensation.
- D. Handle in accordance with NEMA PB1.1 and manufacturer's written instructions. Handle carefully to avoid damage to panelboard internal components, enclosure and finish.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. The distribution panelboards shall be as manufactured by EATON, ABB or SIEMENS.

2.02 PANELBOARDS

- A. This Contractor shall furnish and install where indicated on the Drawings, deadfront distribution panelboards incorporating switching and branch circuit protective devices of the number, ratings, and type noted herein or as shown on the Drawings. Panelboards shall have NEMA 1 general purpose enclosures and shall be surface mounted. All distribution panelboards shall be rated for the intended voltage and shall be in accordance with UL's "Standard for Panelboards" and "Standard for Cabinets and Boxes" and shall be so labeled. Distribution panelboards shall also comply with NEMA "Standard PB1 For Panelboards" and the NEC. (Circuit breakers) (Switch and fuse units) shall conform to the paragraph, which follows in these Specifications.

B. Ratings: **[ENGINEER, EDIT OUT SHORT-CKT STUDY IF NOT IN PROJECT]**

1. Distribution panelboards rated 240 Vac or less shall have short-circuit ratings as shown on the Drawings **or as determined by the Short-Circuit Coordination Study whichever is higher**, but not less than 10,000-amperes RMS symmetrical.
2. Distribution panelboards rated 480 Vac shall have short-circuit ratings as shown on the Drawings **or as determined by the Short-Circuit Coordination Study whichever is higher**, but not less than 25,000-amperes RMS symmetrical.
3. Distribution panelboards used for service entrance shall have short-circuit ratings as shown on the Drawings **or as determined by the Short-Circuit Coordination Study whichever is higher**, but not less than 65,000 amperes RMS symmetrical at system voltage and be labeled as service entrance equipment in accordance with UL requirements.
4. **(ENGINEER, DELETE THIS PARAGRAPH IF NOT USING SERIES CONNECTED RATINGS)** Distribution panelboards shall have fully rated or series connected short-circuit rated interrupting ratings as indicated on the drawings and shall be labeled with a UL short-circuit rating. When series connected ratings are applied with integral or remote upstream devices, a label shall be provided. It shall state the conditions of the UL series connected ratings including:
 1. Size and type of upstream device
 2. Branch devices that can be used
 3. UL series short-circuit rating

C. Interiors:

1. All interiors shall be completely factory assembled with switching and protective devices, wire connectors, etc. All conductor connectors, except screw terminals, shall be of the anti-turn solderless type and all shall be suitable for copper conductors of the sizes indicated on the Drawings.
2. Interiors shall be designed so that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors and shall be so designed that circuits may be changed without matching, drilling, or tapping.

- D. All distribution panelboards shall be surface mounted on twelve (12) gauge formed steel channel having a cross section dimension at least 1-1/2 inches x 1-1/2 inches. The channel and fittings shall have a hot dipped galvanized finish to

resist rust formation. Channels shall be installed vertically and as detailed on the Drawings.

E. Bus Bars:

1. Bus bars for the mains shall be of copper sized in accordance with UL 67 Standards for temperature rise to limit temperature rise on any current carrying part to a maximum of 65 degrees C above an ambient of 40 degrees C maximum. Bus bar taps for distribution panelboards with single pole branches shall be arranged for sequence phasing of the branch circuit devices. Busing shall be braced throughout to conform to industry standard practice governing short circuit stresses in panelboards. Phase busing shall be full height without reduction. Cross connectors shall be copper.
2. Phase busing shall be manufactured to accept bolt-on circuit protective devices only.
3. The distribution panelboard shall have fully equipped provision spaces for future protective devices as shown on the Drawings. Remaining space not identified on the Drawings shall be fully bused and pre-drilled for future protective devices that do not have established frame sizes. This is in addition to the scheduled space or spare branches specified or shown on the Drawings.
4. A non-insulated copper ground bus shall be provided for each distribution panelboard.
5. Full size (100% rated) insulated neutral busing shall be included for panelboards shown with a neutral. Neutral busing shall have a suitable lug for each outgoing feeder or branch circuit requiring a neutral connection.
6. Lugs shall be rated for 75 degrees C terminations and shall bolt in place.

F. Backboxes:

1. Backboxes shall be made from unpainted galvanized code gauge steel having no knockouts.
2. Boxes shall have gutter and wiring space sized as required per NEC but not less than four (4) inches on all sides.
3. Backboxes shall also have sufficient space to safely attach clamp-on or split-core current transformers to the feeders for future portable or permanent check metering.

4. Backboxes for multiple (two or more) sections shall be of the same dimensions.
5. Each backbox shall include at least four (4) interior mounting studs.
6. The distribution panelboard identification number shall be on the backbox.

G. Trim:

1. **(ENGINEER TO EDIT THIS PARAGRAPH)** Hinged door fronts shall be provided with a door-in-door type, covering all circuit breaker handles and all live parts in all distribution panelboard trims. - **OR** - Distribution panelboards having individual switch and fuse units shall have hinged door trims which cover all live parts. Switching device handles shall be accessible. The use of door in a hinged cover type panelboard is prohibited.
2. Doors in distribution panelboard trims shall conform to the following:
 - a. In making device handles accessible, inboard doors shall not uncover any live parts. Outboard doors shall allow hinged access to the interior panel wiring without removal of the panel door assembly.
 - b. Doors shall have a semi-flush type cylinder lock and catch. Door hinges shall be concealed. Two (2) keys shall be furnished for each distribution panelboard door and all locks shall be keyed as requested by the Owner to match current standard. The outer door shall be keyed separately. Directory frame and card, having a transparent cover, shall be furnished on the inside of each door.
 - c. Directory cards shall be neatly typewritten indicating each branch circuit number and assignment. The assignment designation shall include the final room number(s) assigned by the Owner. Do not use the architectural room numbers shown on the Drawings. The directory cards shall also include the source (switchboard, panelboard, etc., with circuit number) feeding the panel.
3. The trims shall be fabricated from code gauge sheet steel.
4. All of the distribution panelboard's steel surfaces, exterior and interior shall be properly cleaned and finished with the manufacturer's standard paint over a rust-inhibiting phosphatized coating. The finish paint shall be of a type to which field applied paint will adhere.
5. Trims shall be mountable by a screwdriver without the need for special

tools.

2.03 CIRCUIT BREAKERS

- A. Electrical circuits shall be protected by molded case circuit breakers as indicated on the Drawings.
- B. The circuit breakers shall be operated by a toggle type handle and shall have a quick-make, quick-break over-center switching mechanism that shall be mechanically trip free from the handle so that the contacts cannot be held closed against short circuits and abnormal currents. Tripping due to overload or short circuit shall be clearly indicated by the handle automatically assuming a position midway between the manual "ON" and "OFF" positions. All latch surfaces shall be ground and polished. All poles of a multi-pole breaker shall be so constructed that they open, close, and trip simultaneously.
- C. The circuit breakers shall be completely enclosed in a molded case. Non-interchangeable trip breakers shall have their covers sealed; interchangeable trip breakers shall have the trip unit sealed to prevent tampering. Ampere ratings shall be clearly visible. Contacts shall be non-welding silver alloy. Arc extinction shall be accomplished by means of arc chutes consisting of metal grids mounted in an insulating support. Breakers shall be of the bolt-on type; plug-in, plug-on, blow-on, and clamp-on circuit breakers shall not be acceptable.
- D. Circuit breakers shall be 80% rated unless indicated on the Drawings to be 100% rated.
- E. Circuit breakers shall have a minimum symmetrical interrupting capacity as indicated on the Drawings. The interrupting ratings of the circuit breakers shall be at least equal to, or greater than, the available short circuit at the line terminals and not less than those values shown on the Drawings and specified in this specification section **or as determined by the Short-Circuit Coordination Study whichever is higher. [ENGINEER, EDIT OUT SHORT-CKT STUDY IF NOT IN PROJECT]**
- F. Circuit breakers shall be listed with UL, conform to the applicable requirements of the latest issue of NEMA Standards Publication No. AB1.
- G. Circuit breakers shall have thermal-magnetic trip units, with inverse time-current characteristics, unless otherwise noted on the Drawings and/or specified herein.

1. Automatic operation of all circuit breakers shall be obtained by means of thermal-magnetic tripping devices located in each pole providing inverse time delay and instantaneous circuit protection. Instantaneous pick-up settings for each phase shall be adjustable on all frames 250A and above.
 2. Circuit breakers shall be ambient compensating in that, as the ambient temperature increases over 40° C, the circuit breaker automatically derates itself to better protect its associated conductor.
 3. Circuit breakers 250A and above shall have thermal magnetic interchangeable trip units.
- H. Circuit breaker frames 400 ampere and above shall have microprocessor-based RMS sensing trip units on 480 volt systems and on 208 volt systems where indicated on the Drawings.
1. Solid state sensing shall measure true RMS current with capability to measure through to the 13th harmonic. Automatic operation of all circuit breakers shall be obtained by means of solid state tripping elements providing inverse time delay and instantaneous and short-time circuit protection. Continuous current rating shall be adjustable from 40% to 100% of trip unit rating. Long-time delay and instantaneous trip ratings shall also be adjustable. The short time pick-up trip shall have adjustable pick-up settings at definite times and with I₂t delay.
 2. Long time current adjustment shall be possible without the need for a rating plug.
 3. Main and feeder circuit breakers shall be provided with integral ground fault protection in 480 volt distribution panels. Ground fault pick-up shall be adjustable from 20% to 70% of the breakers maximum continuous current rating, but in no case be greater than 1200A. Ground fault time delay shall be adjustable with three (3) I₂t delay settings.
 4. Solid state circuit breakers shall have built-in test ports for testing the long-time delay, instantaneous, and ground fault functions (if equipped) of the breaker by means of a test set.
 5. Provide one (1) test set capable of testing all circuit breakers with a built-in test port.
- I. Service entrance panelboards shall utilize a molded case main circuit breaker (MCB) equipped with individual insulated, braced and protected connectors, and single phase protection. The circuit breaker shall use a solid state trip furnished with a plug-in or panel mounted metering device. This device shall

simultaneously display all three phase currents, as well as average current, ground current, and phase unbalance. In addition it shall display date, time and type (overload, short circuit or ground fault) of trip for the most recent five (5) events. **(ENGINEER TO EDIT OUT THIS PARAGRAPH IF NOT USING THE PANEL FOR SERVICE ENTRANCE.)**

- J. Circuit breaker accessories: Provide shunt trips, bell alarms and auxiliary switches, etc. as may be shown on the Drawings. All accessories shall be UL listed for field installation.
- K. Circuit breakers shall be manufactured by the same manufacturer as the panelboard and factory installed.
- L. Where indicated, circuit breakers shall be UL listed for series application. **(ENGINEER TO EDIT OUT THIS PARAGRAPH IF NOT USING SERIES CONNECTED BREAKERS.)**

2.04 SWITCH AND FUSE UNITS **[ENGINEER, EDIT OUT FUSIBLE SWITCH SECTION IF NOT USING]**

- A. The switch and fuse units shall be quick-make, quick-break type. The units shall be listed by UL for service entrance use where applicable. Each unit shall be enclosed in a separate steel enclosure. The enclosure shall employ a hinged cover for access to the fuses which shall be interlocked with the operating handle to prevent opening the cover when the switch is in the ON position. This interlock shall be constructed so that it can be released with a standard electrician's tool for testing fuses without interrupting service. The units shall have padlocking provisions in the OFF position and the operating handle position shall give switch position indication, i.e., horizontal OFF, diagonal ON. Units 30 ampere through 600 ampere shall be rated not less than 100 kAIC with rejection type clips for Class R type fuses. Fuses shall be furnished and installed by this Contractor.
- B. Switch and fuse units shall be manufactured by the same manufacturer as the panelboard and factory installed.

2.05 MULTIPLE SECTION PANELBOARDS

- A. Panelboards with two (2) or more sections shall have sub-feed lugs or thru-feed lugs in all but one (1) section of the panelboard, unless otherwise shown on the Drawings. Lugs shall have same capacity as incoming mains. Cable interconnections shall be field installed.

2.06 NAMEPLATES

- A. Panelboards shall have nameplates of 1/16-inch thick laminated plastic with 3/16

inch high white letters on a black background. Nameplates shall identify the panelboard and shall be mounted on the front top of the enclosure.

- B. Circuit protective devices shall each have nameplates of 1/16 inch thick laminated plastic with 1/8 inch high white letters on a black background. Nameplates shall be mounted in a manner to that above.

2.07 SURGE PROTECTIVE DEVICE (SPD)

- A. Provide surge protective devices (SPD) as specified in Section 16418.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Before installing panelboards, check all of the Drawings for possible conflict of space and adjust the location of the panelboard to prevent such conflict with other items. Panelboard locations in electrical rooms and other spaces shall closely follow the layouts shown on the Drawings, leaving sufficient space on walls for future installations of panelboards and/or other electrical equipment.
- B. Panelboards shall be securely mounted to steel framing channel at locations shown on Drawings. Construction shall be such that additional conduits can be added for future requirements.
- C. The cabinets and enclosures shall be mounted in accordance with the NEC. This Contractor shall furnish all materials necessary for mounting the panelboards.
- D. Install units plumb, level and rigid without distortion to the distribution panelboard.
- E. Panelboard interiors shall be factory assembled with circuit breakers, wire connectors, etc. Circuit breakers shall be sequence numbered to correspond with the panelboard directory.
- F. Connect the SPD to the appropriate circuit breaker.
- G. Contractor shall install required safety labels.

3.02 START-UP SERVICE AND PERFORMANCE TEST FOR SERVICE ENTRANCE DISTRIBUTION PANELBOARDS **[ENGINEER, EDIT OUT THE SECTION IF NOT USED FOR SERVICE ENTRANCE]**

- A. The manufacturer shall provide factory personnel to completely inspect and test the service entrance panelboard(s) for proper installation and operation of all equipment, at the time of system start-up. Testing shall include, but not be limited to, performance testing of the circuit breakers, fused switches (if equipped), SPDs, metering, single phase protection, and ground fault protection systems and equipment.
- B. All testing and start-up services shall be in the presence of the Engineer and the Contract Owner's Technical Representative (COTR). The tests shall be as stated in the manufacturer's literature. One (1) copy of the tests results shall be submitted to the Engineer and Owner for review.
- C. The completed equipment grounding system shall be subjected to a metered test at the service entrance panelboard ground bar to ensure that the ground resistance, without chemical treatment or other artificial means, does not exceed five (5) ohms. One (1) copy of the test results shall be submitted to the Engineer and Owner for review.

3.03 FIELD TESTS

- A. Check tightness of all accessible mechanical and electrical connections to assure they are torqued to the minimum acceptable manufacturer's recommendations.
- B. Check all panelboards for proper grounding, fastening and alignment.

3.04 FIELD ADJUSTMENTS

- A. This Contractor shall perform field adjustments of the protective devices as required to place the equipment in final operating condition. Necessary field settings of devices and adjustments and minor modifications to equipment shall be carried out by this Contractor at no additional cost to the Owner.
- B. **(ENGINEER, DELETE THIS PARAGRAPH WHEN SECTION 16015 "SHORT-CIRCUIT/COORDINATION STUDY" IS NOT USED)** The settings shall be in accordance with the approved protective device coordination study or as directed by the Engineer.

3.05 TRAINING **[ENGINEER, DELETE THIS SECTION IF PANEL IS NOT USED FOR SERVICE ENTRANCE]**

- A. This Contractor shall provide eight (8) hours of technical service training to the Owner's technical and maintenance staff.
- B. The training session shall be conducted by a manufacturer's qualified

representative. The training program shall consist of instruction on operation of the assembly, circuit breakers, fused switches (if equipped), metering, and major components within the assembly.

3.06 CLEANING

- A. Remove debris from panelboards and wipe dust and dirt from all components.
- B. Repaint marred and scratched surfaces with touch-up paint to match original finish.

3.07 EXISTING DISTRIBUTION PANELBOARDS

- A. This Contractor shall clean, adjust, and tighten all feeder and branch circuit connections (new and existing) and provide new typewritten directories (as described above) in all existing distribution panelboards that is associated with work on this project. Distribution panelboards not associated with work on this project are not subject to the requirement.

END OF SECTION

SECTION 16435

BRANCH CIRCUIT PANELBOARDS

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work covered under this Section shall include furnishing and installing circuit breaker type branch circuit panelboards complete for all systems as shown on the Drawings and herein specified.

1.03 QUALITY ASSURANCE

- A. All equipment, materials, and their installation shall conform to the requirements of the National Electrical Code (NEC), local code requirements, and these Specifications.
- B. All equipment and materials shall be listed by Underwriter's Laboratories, Inc. (UL) for their intended use and shall bear the UL label.
- C. Equipment shall be constructed in accordance with National Electrical Manufacturer's Association (NEMA) standards.
- D. Submittals are required in accordance with SECTION 16010 of these Specifications. The manufacturer shall furnish, but not be limited to the following:
 - 1. Circuit breaker layout with dimensions and nameplate designation.
 - 2. Circuit breaker trip ratings and frame sizes.
 - 3. Component list.
 - 4. Conduit entry/exit locations.
 - 5. Assembly ratings, including short-circuit rating, voltage, and continuous current rating.
 - 6. Bus material, including ground bar.

7. Cable terminal sizes.
8. Product data for each type of panelboard.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Deliver material and products in factory labeled packages. Store and handle in strict compliance with manufacturer's instructions and recommendations.
- B. Each panelboard section shall be delivered in individual shipping cases and individually wrapped for protection.
- C. Store in a clean, dry space. Maintain factory protection and /or provide an additional heavy canvas or heavy plastic cover to protect panelboards from dirt, water, construction debris, and traffic. Where applicable, provide adequate heating within enclosures to prevent condensation.
- D. Handle in accordance with NEMA PB1.1 and manufacturer's written instructions. Handle carefully to avoid damage to panelboards internal components, enclosure and finish.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. The branch circuit panelboards shall be as manufactured by EATON, ABB or SIEMENS.

2.02 PANELBOARDS

- A. This Contractor shall furnish and install where indicated on the Drawings, deadfront branch circuit panelboards incorporating switching and branch circuit protective devices of the number, ratings, and type noted herein or as shown on the Drawings. Branch circuit panelboards shall have NEMA 1 general purpose enclosures and shall be surface or flush mounted as noted. All branch circuit panelboards shall be rated for the intended voltage and shall be in accordance with UL's "Standard for Panelboards" and "Standard for Cabinets and Boxes" and shall be so labeled. Branch circuit panelboards shall also comply with NEMA "Standard PB1 for Panelboards" and the NEC.

B. Ratings: **[ENGINEER, EDIT OUT SHORT-CKT STUDY IF NOT IN PROJECT]**

1. Panelboards rated 240 Vac or less shall have short-circuit ratings as shown on the Drawings **or as determined by the Short-Circuit Coordination Study whichever is higher**, but not less than 10,000-

amperes RMS symmetrical.

2. Panelboards rated 480 Vac shall have short-circuit ratings as shown on the drawings **or as determined by the Short-Circuit Coordination Study whichever is higher**, but not less than 25,000-amperes RMS symmetrical.
3. **(ENGINEER, DELETE THIS PARAGRAPH IF NOT USING SERIES CONNECTED RATINGS)** Panelboards shall have a fully rated or series connected short-circuit rated interrupting ratings as indicated on the Drawings and shall be labeled with a UL short-circuit rating. When series connected ratings are applied with integral or remote upstream devices, a label shall be provided. It shall state the conditions of the UL series connected ratings including:
 - a. Size and type of upstream device.
 - b. Branch devices that can be used.
 - c. UL series short-circuit rating.

C. Interiors:

1. All interiors shall be completely factory assembled with switching and protective devices, wire connectors, etc. All conductor connectors, except screw terminals, shall be of the anti-turn solderless type and all shall be suitable for copper conductors of the sizes indicated on the Drawings.
 2. Interiors shall be designed so that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors and shall be so designed that circuits may be changed without matching, drilling, or tapping.
- D. Branch circuits shall be arranged using double row construction except where a narrow column width panelboard is required or noted on the Drawings. Branch circuits shall be numbered by the manufacturer.
- E. Furnish and install three (3) 3/4 inch and two (2) one inch empty conduits up through the wall and turned out above the ceiling; and three (3) 3/4 inch and two (2) one inch empty conduits down into the ceiling space below the floor for all flush mounted branch circuits panelboards. Where floor slab is on grade, provide only empty conduits to the ceiling.
- F. All surface mounted branch circuit panelboards shall be mounted on twelve (12) gauge formed steel channel having a cross section dimension at least 1-1/2 inches x 1-1/2 inches on walls. The channel and fittings shall have a hot dipped galvanized finish to resist rust formation. Channels shall be installed vertically

and as detailed on the Drawings.

G. Bus Bars:

1. Bus bars for the mains shall be of copper sized in accordance with UL 67 Standards for temperature rise to limit temperature rise on any current carrying part to a maximum of 65 degrees C above an ambient of 40 degrees C maximum. Bus bar taps for branch circuit panelboards with single pole branches shall be arranged for sequence phasing of the branch circuit devices. Busing shall be braced throughout to conform to industry standard practice governing short circuit stresses in panelboards. Phase busing shall be full height without reduction. Cross connectors shall be copper. A non-insulated copper ground bus shall be provided for each panelboard.
2. Phase busing shall be manufactured to accept bolt-on circuit breakers only.
3. Spaces for the addition of future switching and protective devices in branch circuit panelboards shall be bussed for the maximum number of devices possible complete with pre-drilled mounting holes and knockouts in the front cover.
4. A non-insulated copper ground bus shall be provided for each branch circuit panelboard.
5. Full size (100% rated) insulated neutral busing shall be included for panelboards shown with a neutral. Neutral busing shall have a suitable lug for each outgoing feeder or branch circuit requiring a neutral connection.
6. Lugs shall be rated for 75 degrees C terminations and shall bolt in place.

H. Backboxes:

1. Backboxes shall be made from unpainted galvanized (#16) gauge steel having no knockouts.
2. Boxes shall have gutter and wiring space sized as required per NEC but not less than four (4) inches on all sides. Where feeder cables supplying the mains of a panelboard are carried through the box to supply other electrical equipment, the box shall be so sized as to include this wiring space. This wiring space shall be in addition to the minimum gutter space specified above and the limiting width may be increased accordingly.
3. Backboxes shall also have sufficient space to safely attach clamp-on or split-core current transformers to the feeders for future portable or

permanent check metering.

4. Backboxes for multiple (two or more) sections shall be of the same dimensions.
5. Each backbox shall include at least four (4) interior mounting studs.
6. The branch circuit panelboard identification number shall be on the backbox.
7. Branch circuit panelboard backboxes shall be of one (1) piece construction.

I. Trim:

1. Hinged doors shall be the door-in-door type covering all switching device handles and all live parts and shall be included in all branch circuit panelboard trims. The use of door in a hinged cover type panelboard is prohibited.
2. Doors in branch circuit panelboard trims shall conform to the following:
 - a. In making device handles accessible, inboard doors shall not uncover any live parts. Outboard doors shall allow hinged access to the interior panel wiring without removal of the panel door assembly.
 - b. Doors shall have a semi-flush type cylinder lock and catch. Door hinges shall be concealed. Two (2) keys shall be furnished for each panelboard door and all locks shall be keyed as requested by the Owner to match current standard. The outer door shall be keyed separately. Directory frame and card, having a transparent cover, shall be furnished on the inside of each door.
 - c. Directory cards shall be neatly typewritten indicating each branch circuit number and assignment. The assignment designation shall include the final room number(s) assigned by the Owner. Do not use the architectural room numbers shown on the Drawings. The director cards shall also include the source (switchboard, panelboard, etc. with circuit number) feeding the panel.
3. The trims shall be fabricated from (#14) gauge sheet steel.
4. All of the panelboard's steel surfaces, exterior and interior shall be properly cleaned and finished with the manufacturer's standard paint over a rust-inhibiting phosphatized coating. The finish paint shall be of a type to which field applied paint will adhere.

5. Trims for flush mounted branch circuit panelboards shall overlap the box by at least 3/4 inches on all sides. Surface trims shall be mountable by a screwdriver without the need for special tools.
- J. Conduit skirts shall be provided on surface mounted branch circuit panelboards, where shown on the drawings. Skirts shall be the same width and depth as the panelboard backbox. Screw on skirt covers shall be the same code gauge sheet steel as the panelboard trim and painted with the same finish and color as the panelboard. Skirts shall be from the top of the panelboard to the underside of the finished ceiling and/or from the bottom of the panelboard to the finished floor concealing all conduits.

2.03 CIRCUIT BREAKERS

- A. Electrical circuits shall be protected by molded case circuit breakers as indicated on the Drawings.
- B. The circuit breakers shall be operated by a toggle type handle and shall have a quick-make, quick-break over-center switching mechanism that shall be mechanically trip free from the handle so that the contacts cannot be held closed against short circuits and abnormal currents. Tripping due to overload or short circuit shall be clearly indicated by the handle automatically assuming a position midway between the manual "ON" and "OFF" positions. All latch surfaces shall be ground and polished. All poles of a multi-pole breaker shall be so constructed that they open, close, and trip simultaneously.
- C. The circuit breakers shall be completely enclosed in a molded case. Non-interchangeable trip breakers shall have their covers sealed; interchangeable trip breakers shall have the trip unit sealed to prevent tampering. Ampere ratings shall be clearly visible. Contacts shall be non-welding silver alloy. Arc extinction shall be accomplished by means of arc chutes consisting of metal grids mounted in an insulating support. Breakers shall be of the bolt-on type; plug-in, plug-on, blow-on, and clamp-on circuit breakers shall not be acceptable.
- D. Circuit breakers shall be 80% rated unless indicated on the Drawings to be 100% rated.
- E. Circuit breakers shall have a minimum symmetrical interrupting capacity as indicated on the Drawings. The interrupting ratings of the circuit breakers shall be at least equal to, or greater than, the available short circuit at the line terminals and not less than those values shown on the Drawings and specified in this specification section **or as determined by the Short-Circuit Coordination Study whichever is higher. [ENGINEER, EDIT OUT SHORT-CKT STUDY IF NOT IN PROJECT]**

- F. Circuit breakers shall be listed with UL listing and conform to the applicable requirements of the latest issue of NEMA Standards Publication No. AB1.
- G. Circuit breakers shall have thermal-magnetic trip units, with inverse time-current characteristics, unless otherwise noted on the Drawings and/or specified herein.
1. Automatic operation of all circuit breakers shall be obtained by means of thermal-magnetic tripping devices located in each pole providing inverse time delay and instantaneous circuit protection. Instantaneous pick-up settings for each phase shall be adjustable on all frames 250A and above.
 2. Circuit breakers shall be ambient compensating in that, as the ambient temperature increases over 40° C, the circuit breaker automatically derates itself to better protect its associated conductor.
 3. Circuit breakers 250A and above shall have thermal magnetic interchangeable trip units.
- H. Circuit breaker frames 400 ampere and above shall have microprocessor-based RMS sensing trip units on 480 volt systems and on 208 volt systems where indicated on the Drawings.
1. Solid state sensing shall measure true RMS current with capability to measure through to the 13th harmonic. Automatic operation of all circuit breakers shall be obtained by means of solid state tripping elements providing inverse time delay and instantaneous and short-time circuit protection. Continuous current rating shall be adjustable from 40% to 100% of trip unit rating. Long-time delay and instantaneous trip ratings shall also be adjustable. The short time pick-up trip shall have adjustable pick-up settings at definite times and with I²t delay.
 2. Long time current adjustment shall be possible without the need for a rating plug.
 3. Main and feeder circuit breakers shall be provided with integral ground fault protection in 480 volt panels. Ground fault pick-up shall be adjustable from 20% to 70% of the breakers maximum continuous current rating, but in no case be greater than 1200A. Ground fault time delay shall be adjustable with three (3) I²t delay settings.
 4. Solid State circuit breakers shall have built-in test ports for testing the long-time delay, instantaneous, and ground fault functions (if equipped) of the breaker by means of a test set.

5. Provide one test set capable of testing all circuit breakers with a built-in test port, unless previously provided under another section of these Specifications.
 - I. Where a circuit breaker is the disconnecting means for fire alarm equipment, a listed breaker locking device shall be installed.
 - J. Circuit Breaker Accessories: Provide shunt trips, bell alarms and auxiliary switches, etc. as may be shown on the Drawings. All accessories shall be UL listed for field installation.
 - K. Circuit breakers shall be manufactured by the same manufacturer as the panelboard and factory installed.
 - L. Where indicated, circuit breakers shall be UL listed for series application. **(ENGINEER TO EDIT OUT THIS PARAGRAPH IF NOT USING SERIES CONNECTED BREAKERS.)**

2.04 MULTIPLE SECTION PANELBOARDS

- A. Panelboards with two (2) or more panelboard sections, sub-feed lugs or thru-feed lugs shall be used in all but one (1) section of each panelboard, unless otherwise shown on the Drawings. Lugs shall have same capacity as incoming mains. Cable interconnections shall be field installed.

2.05 NAMEPLATES

- A. Branch circuit panelboards shall have nameplates of 1/16 inch thick laminated plastic with 3/16 inch high white letters on a black background. Nameplates shall identify the branch circuit panelboard and shall be mounted on the front top of the enclosure.

2.06 SURGE PROTECTIVE DEVICE (SPD)

- A. Provide surge protective devices (SPD) as specified in Section 16418.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Before installing branch circuit panelboards, this Contractor shall check all of the Drawings for possible conflict of space and adjust the location of the branch circuit panelboard to prevent such conflict with other items. Panelboard locations in electrical rooms and other spaces shall closely follow the layouts shown on the Drawings, leaving sufficient space on walls for future installations of panelboards and/or other electrical equipment.

- B. Surface mounted branch circuit panelboards shall be securely mounted to steel framing channel at locations shown on Drawings. Construction shall be such that additional conduits can be added for future requirements.
- C. The cabinets and enclosures shall be mounted in accordance with the NEC. This Contractor shall furnish all materials necessary for mounting the branch circuit panelboards.
- D. Install units plumb, level and rigid without distortion to the branch circuit panelboard.
- E. Branch circuit panelboard interiors shall be factory assembled with circuit breakers, wire connectors, etc. Circuit breakers shall be sequence numbered to correspond with the panelboard directory.
- F. Connect the SPD to the appropriate circuit breaker.
- G. Contractor shall install required safety labels.
- H. The mounting of junction boxes, wire troughs, and auxiliary gutters to the top, bottom or sides of a branch circuit panelboard is prohibited unless approved by the FCPS technical inspection staff on a case by case basis.

3.02 FIELD TESTS

- A. Check tightness of all accessible mechanical and electrical connections to ensure they are torqued to the minimum acceptable manufacturer's recommendations.
- B. Check all panelboards for proper grounding, fastening and alignment.

3.03 FIELD ADJUSTMENTS

- A. This Contractor shall perform field adjustments of the protective devices as required to place the equipment in final operating condition. Necessary field settings of devices and adjustments and minor modifications to equipment shall be carried out by this Contractor at no additional cost to the Owner.
- B. **(ENGINEER, DELETE THIS PARAGRAPH WHEN SECTION 16015 "SHORT-CIRCUIT/COORDINATION STUDY" IS NOT USED)** The settings shall be in accordance with the approved protective device coordination study or as directed by the Engineer.

3.04 CLEANING

- A. Remove debris from panelboards and wipe dust and dirt from all components.
- B. Repaint marred and scratched surfaces with touch-up paint to match original finish.

3.05 EXISTING BRANCH CIRCUIT PANELBOARDS

- A. This Contractor shall clean, adjust, and tighten all feeder and branch circuit connections (new and existing) and provide new typewritten directories (as described above) in all existing branch circuit panelboards that are associated with work on this project. Panelboards not associated with work on this project are not subject to this requirement.

END OF SECTION

SECTION 16440

DISCONNECT SWITCHES

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work under this Section shall include furnishing and installing safety switches and/or bolted pressure switches as shown on the Drawings and herein specified.

1.03 QUALITY ASSURANCE

- A. All equipment, materials, and their installation shall conform to the requirements of the National Electrical Code (NEC), local code requirements, and these Specifications.
- B. All equipment and materials shall be listed by Underwriter's Laboratories, Inc. (UL) for their intended use and shall bear the UL label.
- C. Equipment shall be constructed in accordance with National Electrical Manufacturer's Association (NEMA) standards.
- D. Submittals are required in accordance with SECTION 16010 of these Specifications.

PART 2 - PRODUCTS

2.01 SAFETY SWITCHES

- A. This Contractor shall furnish and install where shown on the Drawings, heavy-duty type safety switches. Safety switches shall be NEMA heavy-duty type HD only and shall be UL listed. The heavy-duty safety switches shall be manufactured by EATON, ABB or SIEMENS.
- B. Switches shall have a quick-make and quick-break operating handle and mechanism that shall be an integral part of the enclosure. Switches shall be horsepower rated 250 volt for 120/208 volt systems or 600 volt for 277/480 volt systems. The lugs shall be UL listed for copper conductors and be front

removable. Ampere ratings shall be as indicated on the Drawings.

- C. Safety switches required and/or noted on the Drawings to be "four wire" shall be furnished by the manufacturer complete with a solid neutral assembly.
- D. Safety switches shall have defeatable door interlocks that prevent the door from opening when the handle is in the "ON" position. Defeater mechanism shall be front accessible.
- E. Enclosures for the switches shall generally be NEMA 1 or NEMA 3R (rainproof) for exterior locations, or where noted "WP" on the Drawings.
- F. Fusible switches 1200A and higher shall have an Arc Flash Maintenance System that meets NEC 240.87.

2.02 BOLTED PRESSURE SWITCHES

- A. This Contractor shall furnish and install where shown on the Drawings, true bolted contact load-break type switches with provisions for NEMA Class L fuses (fuses shall be furnished and installed by this Contractor). The stored energy deadfront operating mechanism shall include disk springs, compressed and released by the operating handle, to provide quick-positive switching action independent of the speed with which it is operated. The mechanism shall be designed so that the switch can be closed only after the opening spring has been charged, ready for manual opening by mechanical pushbutton.
- B. The switch operating handle shall be mechanically interlocked with the fuse access door and have provisions for padlocking in OPEN position.
- C. The switch shall have an interrupting rating of twelve (12) times the continuous rating and be capable of carrying 100% of rated current and shall have been tested in accordance with UL Subject 977. The switch shall be suitable for use on circuits having available fault currents of 65,000 RMS symmetrical amperes rated (250) (600) VAC and of the ampacity shown on the Drawings. High-pressure contact switches do not meet the intent of these Specifications.
- D. The switch shall be complete with single phase protection to open the main device upon loss of any single phase but not upon simultaneous loss of all three (3) phases.
- E. The switch shall be complete with separate blown fuse protection to open the bolted pressure switch if one or more of the Class L fuses operate. Indicating lights mounted on the front of the switch shall be included as a means of showing that the fuses have operated. Operating lights shall operate only when a fuse has blown.

- F. The switch shall have two (2) sets of auxiliary contacts (2 normally open and 2 normally closed) for switch position monitoring.
- G. A ground fault protection system shall be included for the bolted pressure switch as shown on the Drawings or as required by NEC.
1. The system shall consist of a current sensor enclosing all phase and neutral conductors of the circuit to be monitored, and appropriate relaying equipment to provide the desired ground fault current sensitivity and time-current response characteristics. The switch shall be equipped to function in conjunction with the other elements of the ground fault protection system. Installation of the equipment shall be in all respects in accordance with the manufacturer's recommendations.
 2. A current sensor shall be provided of the size necessary to encircle the phase conductors and the neutral conductor of the circuit to be monitored. Current sensor output shall be coordinated with the required input to the relay. A test winding shall be included to simulate the flow of ground fault current through the current sensor in order to test the operation of the ground fault protection system including sensor pick-up relay, and circuit protective device operation. The frame of the current sensor shall be so constructed that one leg can be opened to allow removal of installation around cable or bus without disturbing the cable or requiring drop-links in the bus.
 3. The ground fault relay shall be of solid state construction, except that a coil operated output relay shall be provided to control 120 volt power to operate the associated fusible bolted pressure switch ground fault trip mechanism. The relay shall require 120 volt power to operate the associated main device. Adjustable pickup current sensitivity for ground currents from 200 amperes to 1200 amperes shall be provided. A calibrated dial shall be provided for setting the current pickup point in the field. Settings for individual relays shall be 1200 amperes **or as determined by the Short-Circuit Coordination Study whichever is lower**. Time delay provided by the relay circuitry shall be nominally 0.2 seconds **or as determined by the Short-Circuit Coordination Study** and shall be permanently calibrated. A self-contained test circuit utilizing the test coil provided in the current sensor shall be incorporated in the system. The test circuit shall be part of the monitor panel that shall be mounted on the front cover of the switch. **[ENGINEER, EDIT OUT SHORT-CIRCUIT STUDY PORTIONS IF NOT IN PROJECT.]**
- H. The switch enclosure shall be NEMA 1, floor or wall mounted as shown on the Drawings.
- I. The switch shall be manufactured by PRINGLE and shall be type CBC or

approved equal.

- J. Fusible switches 1200A and higher shall have an Arc Flash Maintenance System that meets NEC 240.87.

2.03 NAMEPLATE

- A. Disconnect switches, including exterior locations, shall have nameplates of 1/16 inch thick laminated plastic with 3/16 inch high white letters on a black background. Nameplates shall identify each piece of equipment and shall be mounted on the front top of the enclosure. Nameplates shall be screw fastened using stainless steel screws.
- B. Disconnect switches for elevator equipment shall also provide nameplates and signage to identify the location of the supply side overcurrent protective device, including circuit numbers, per NEC Article 620. Nameplates and signage shall be laminated plastic as hereinbefore described.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. The disconnect switches shall be securely mounted in accordance with the NEC, approximately forty eight (48) inches but no less than twelve (12) inches above the finished floor to the bottom unless otherwise noted.
- B. Mounting brackets and hardware exposed to weather shall be galvanized or otherwise suitably protected from corrosion.
 - 1. All NEMA 3R disconnect safety switches mounting openings not used must be permanently sealed to keep rain, moisture, insects, etc. from entering the switch housing. The use of stainless steel screws/nuts with rubber washers and silicone sealant may be used, or another approved method for a completely sealed switch housing.
- C. The fuses (type and size as noted on the Drawings) as specified shall be installed in disconnect switches requiring fuses. Rejection fuse clips shall be installed where called for on the Drawings or in these Specifications.
- D. Contractor shall install required safety labels.

END OF SECTION

SECTION 16445

ELECTRIC EQUIPMENT ENCLOSURES

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE OF WORK

- A. The work covered under this Section shall apply to the design and supply of pad mounted, weatherproof, electric equipment enclosures that are used to house electric equipment in outdoor environments.
- B. The electric equipment enclosures shall be as noted on the Contract Drawings.

1.03 QUALITY ASSURANCE

- A. All equipment, materials, and their installation shall conform to the requirements of the Virginia Uniform Statewide Building Code (VUSBC), National Electrical Code (NEC), local code requirements, and these Specifications.
- B. All equipment and materials shall be listed by Underwriters Laboratories, Inc. (UL) for their intended use and shall bear the UL label.
- C. Equipment shall be constructed in accordance with National Electrical Manufacturer's Association (NEMA) standards.
- D. The supplier shall design and produce the electric equipment enclosures to meet the criteria noted in these Specifications and as shown on the Drawings. The supplier shall be capable of producing a premium grade product, which meets the quality, fit and finish noted herein.
- E. The cabinet shall be designed to meet the approval of the local electrical utility (if applicable) and shall be designed for ease of maintenance.
- F. Submittals are required in accordance with SECTION 16010 of these Specifications. Submittals shall include but not be limited to the following:
 - 1. Detailed cabinet and door shop drawings showing all fabrication and the layout of all internal components and equipment.

2. List of all components (by manufacturer and model number) and product sheets for each item.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturers of electric equipment enclosures are: HOFFMAN ENCLOSURES, INC., NJ SULLIVAN CO. or approved equal.
- B. The listing of the above manufacturers does not constitute automatic approval or final acceptance. It is the Contractor's responsibility to verify and document that any product selected from the above list does meet the requirements of the Contract Documents.

2.02 GENERAL MATERIAL REQUIREMENTS

- A. All materials shall be new.
- B. Unless otherwise noted, the cabinet shall be fabricated from 12 gauge galvanized post-fabrication, electrostatically primed and painted steel; or unpainted 12 gauge Type 304 or 316L stainless steel.
- C. All materials shall be corrosion resistant for extended life.
- D. Enclosures shall be rated NEMA 3R or 4X.

2.03 FABRICATION PROCESS

- A. The cabinet and doors shall be fabricated to plus or minus 10-thousandths of an inch tolerance for proper fit.
- B. All bending shall be done using a suitable break press.

2.04 CONNECTING HARDWARE

- A. All screws, bolts, washers, nuts, etc. shall be stainless steel.
- B. All screws shall be stainless steel pan-head machine screw type.
- C. No sheet metal or self tapping screws shall be used.

2.05 WELDING

- A. All exterior seams shall be of continuously welded construction. All welds shall be free of slag and spatter. All exterior welds shall be ground smooth.

B. The supplier shall have suitable credentials to weld steel and shall adhere to all applicable ANSI standards.

C. The supplier shall use a suitable welding process and materials.

2.06 DOORS AND HINGES

A. Doors shall be designed for maximum strength and snug fit. It is the supplier's responsibility to design and fabricate the doors to the fit and finish required in this specification.

B. Doors shall be fabricated out of a single sheet of steel and have wrap-around return for strength and fit.

C. Doors shall have a one-piece gasket to provide a tight seal against contaminants entering the cabinet.

D. Door handles shall be 3-point contact steel construction. The lever handles shall latch to the cabinet with 16-gauge stainless steel rails and rollers which shall be fabricated to provide a secure and well sealed attachment to the cabinet. Door handles shall be designed to accept a padlock. Bolted door closures or dogs are not allowed.

E. The exterior of the doors shall have continuous welds.

F. All exterior corners shall be rounded to a minimum radius of 1/8 of an inch. All sharp edges shall be de-burred to a minimum radius of 1/64 inch in order to reduce hazards to service personnel.

G. Hinges shall be both corrosion resistant and vandal proof.

2.07 CABINET

A. The cabinet and door shall be constructed to meet NEMA 3R or 4X standards. The cabinet shall be made up of the main body, roof section and inner wall. These components shall be welded together. The cabinet shall be designed for maximum strength and proper fit to the door.

B. It is the supplier's responsibility to design and fabricate the cabinet to the fit and finish required in this specification.

C. The cabinet shall be designed to attach to a concrete pad via suitable drop-in anchors, which shall be supplied with the cabinet.

D. The exterior of the cabinet shall have continuous welds.

E. The cabinet main body shall have a wrap-around return to accept the door.

F. The cabinet shall have a 120V weather-resistant ground fault duplex receptacle.

- G. The cabinet shall be equipped with lifting brackets, which shall be removable after installation.
- H. All exterior corners shall be rounded to a minimum radius of 1/8 of an inch. All sharp edges shall be de-burred to a minimum radius of 1/64 inch in order to reduce hazards to service personnel.

2.08 EQUIPMENT MOUNTING INNER WALL

- A. Equipment shall be mounted on the interior using mounts and fittings supplied with the enclosure. No penetrations of the outer enclosure shall be used to mount equipment.
- B. Equipment mounting panels shall be constructed from minimum 12 gauge sheet steel with a conductive, corrosion-resistant coating. Panels shall have edge flanges on two or four sides and lifting holes.

2.09 FINISH

- A. Upon completion of fabrication the cabinet, door and inner wall shall be finished as follows:
 - 1. Surfaces shall be thoroughly cleaned and degreased.
 - 2. Painted surfaces shall receive a prime coat electrostatically applied. After the prime coat has set, the top coat shall be electrostatically applied. Color shall be ANSI Dark Green or as shown on the Drawings.
 - 3. Stainless steel surfaces are unpainted. Front, sides, top and back shall have a smooth #4 brushed finish.
 - 4. The final product shall be free of dents, scratches, weld burns and abrasions harmful to its strength and general appearance.

2.10 GENERAL ELECTRICAL

- A. All equipment shall be mounted on stand-off back panels.
- B. All equipment shall be labeled using Lamicoid or vinyl adhesive labels with 1/2-inch high black characters on a white background.

2.11 METERING (WHEN REQUIRED)

- A. Metering location shall meet the approval of the local utility company. The metering shall be located for easy reading by the local utility.

- B. CTs and metering cabinets shall be sized and laid out to meet the local utility company's standards.

2.12 GROUNDING

- A. The grounding system shall be designed to meet all NEC standards and any codes and local utility standards.
- B. The grounding system shall be designed as part of the power distribution system.

2.13 EXTERNAL LIGHTING CONTROLS – SPORTS FIELDS **[ENGINEER: EDIT OUT IF NOT USING]**

- A. A weatherproof NEMA 3R pad-lockable box shall be provided and located as shown on the Drawings, for an on/off pushbutton control station furnished as part of the sports field lighting control system. This control station switch will allow users to turn the lights on or off whenever the system is enabled by the remote system, on-site digital key pad, or time clock, see Specification Section 16545. The control station enclosure box shall be suitably located on the exterior of the electrical equipment enclosure.

2.14 LABELING

- A. All products shall be labeled (inside) with the supplier's company name, model number, panel rating and the date of manufacture.
- B. The Contractor or supplier shall also provide adhesive Lamicoid or vinyl labels on the inside of each cabinet for each component. Each incoming feeder and output circuit shall also be labeled per the electrical design Drawings.
- C. All ID labels shall have ¼" to ½" high black characters on a white background.

2.15 PACKAGING

- A. Any product damaged in shipping shall be repaired or replaced at no cost to the Owner.

PART 3 – EXECUTION

3.01 FOUNDATIONS

- A. The Contractor shall provide and install concrete pads for electrical equipment enclosures and utility transformers (if applicable) as shown on the Drawings.

1. Concrete foundations for electrical equipment enclosures shall be as follows:
 - a) Minimum compressive strength at 28 days – 3500PSI
 - b) Maximum nominal aggregate size – 1 inch
 - c) Maximum W/C ratio by mass - 0.45
 - d) Air content - $5 \pm 1\%$
 - e) Slump - $2'' \pm 0.75''$
 2. Top of concrete bases shall be trowel finished smooth and level with beveled edges. Top surface shall not vary by more than 1/8 inch in depth as measured across the widest surface.
 3. All concrete shall be fully vibrated.
 4. Reinforcing steel – reinforcing to meet ASTM requirements. Spacing of bars shall be adjusted to suit conduit spacing.
- B. Excavated material may be used as backfill. All excess excavated material shall be disposed of off-site.

3.02 GROUNDING

- A. Install all grounding and bonding in accordance with NEC and the Contract Documents.

3.03 FIELD QUALITY CONTROL

- A. Inspect each installed unit for damage. Replace damaged components.
- B. Any paint damage shall be repaired by spray applied or other application that matches the factory finish to the maximum extent possible. Brush or roller applied repair painting is not allowed.

END OF SECTION

SECTION 16450

DRY-TYPE TRANSFORMERS

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work under this Section shall include furnishing and installing TP-1 dry-type energy efficient transformers complete as shown on the Drawings and herein specified. Provide all lugs, accessories and mounting hardware necessary for proper installation and operation.

1.03 QUALITY ASSURANCE

- A. All equipment, materials and their installation shall conform to the requirements of the National Electrical Code (NEC), local code requirements, and these Specifications.
- B. Transformers shall meet the requirements of U.S. Department of Energy (DOE) 10 CFR Part 431 "Energy Efficiency Program for Certain Commercial and Industrial Equipment".
- C. The transformer manufacturer shall be ISO 9001 or 9002 certified.
- D. All equipment and material shall be listed by Underwriter's Laboratories, Inc. (UL) for their intended use and shall bear the UL label.
- E. Equipment shall be constructed and tested in accordance with National Electrical Manufacturer's Association (NEMA) standards including D.O.E. 2016 TP-1, TP-2 and TP-3.
- F. Submittals are required in accordance with SECTION 16010 of these Specifications. The following minimum information shall be submitted:
 - 1. Outline dimensions and weights
 - 2. Technical certification sheet
 - 3. Transformer ratings including:

- a. kVA
 - b. Primary and secondary voltage
 - c. Taps
 - d. Design impedance
 - e. Insulation class and temperature rise
 - f. Sound level
4. Product data sheets

1.04 DELIVERY, STORAGE AND HANDLING

- A. Handle transformers in accordance with manufacturer's recommendations. Utilize factory provisions for all lifting, rigging, or hoisting.
- B. Store transformers prior to installation in a temperature and humidity controlled space. If such a space is not available, apply temporary heat in accordance with the manufacturer's instructions within each ventilated type transformer case to exclude moisture and condensation.

PART 2 - PRODUCTS

2.01 MATERIALS AND COMPONENTS

- A. Dry-type energy efficient transformers shall be indoor, dry, ventilated, quiet type and shall be constructed and tested in accordance with the latest applicable standards of ANSI, NEMA and UL.
- B. Ratings:
 1. KVA and voltage ratings shall be as shown on the drawings.
 2. Transformers shall be designed for continuous operation at rated kVA, for 24 hours a day, 365 days a year operation, with normal life expectancy as defined in ANSI C57.96.
 3. Transformer meet NEMA ST20-2014 Sound levels. Table 3.9.
 4. Transformers shall be low loss type with minimum efficiencies as listed in U.S. Department of Energy (DOE) 10 CFR 431 when operated at 35% of full load capacity. Efficiency shall be tested in accordance with NEMA TP-2.
- C. Insulation Systems:
 1. Transformer insulation system shall be Class 220 degrees C insulation system with 150 degree C rise, ventilated design.

2. Required performance shall be obtained without exceeding the above indicated temperature rise in a 40 degrees C maximum ambient, and a 24 hour average ambient of 30 degrees C.
3. All insulation materials shall be flame-retardant and shall not support combustion as defined in ASTM Standard Test Method D635.

D. Core and Coil Assemblies:

1. Three phase core shall be constructed with grain oriented, nonaging, silicon steel with high magnetic permeability, and low hysteresis and eddy current losses. Maximum magnetic flux densities shall be substantially below the saturation point. The transformer core volume shall allow efficient transformer operation at 10% above the nominal tap voltage. The core laminations shall be tightly clamped and compressed. Coils shall be wound of high quality electrical grade aluminum with continuous wound construction.
2. On three-phase units rated 15 kVA and above the core and coil assembly shall be impregnated with non-hydroscopic, thermosetting varnish and cured to reduce hot spots and provide a flame retardant seal and seal out moisture. The assembly shall be installed on vibration-absorbing pads. There shall not be any metal-to-metal contact between the core and coil assembly and the enclosure except for a flexible safety ground strap.

- E. Three-phase transformers rated 15 through 500 kVA shall be provided with six 2-1/2% taps, two above and four below rated primary voltage.

F. Enclosure:

1. The enclosure shall be made of heavy-gauge steel. All transformers shall be equipped with a wiring compartment suitable for conduit entry and large enough to allow convenient wiring. The maximum temperature of the enclosure shall not exceed 90 degrees C. The core of the transformer shall be visibly grounded to the enclosure by means of a flexible grounding conductor sized in accordance with applicable UL and NEC standards.
2. On three-phase transformers rated 15 kVA and above the enclosure construction shall be ventilated, NEMA 2, drip-proof, with lifting holes. All ventilation openings shall be protected against falling dirt. Enclosures shall be finished with ANSI gray color, weather-resistant enamel.
3. On ventilated outdoor units, NEMA 3R, conforming to the requirements of NEMA 250, and provide suitable weathershields over ventilation opening, conforming to the requirements of NEMA 250, Type 3R. Suitable screens

shall be provided to prevent insertion of foreign debris and animals in the ventilation openings.

- G. Dry-type transformers shall be as manufactured by EATON, ABB or SIEMENS.

2.02 NAMEPLATE

- A. Transformers shall have nameplates furnished by the electrical contractor of 1/16 inch thick laminated plastic with 3/16 inch high white letters on a black background. Nameplates shall identify the transformer and shall be mounted on the top front edge of the enclosure. Nameplates shall be screw fastened using stainless steel screws. Nameplates for transformers on emergency power shall have a red background.

PART 3 – EXECUTION

3.01 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 latest version of ANSI and NEMA standards.
 1. Ratio tests at the rated voltage connection and at all tap connections.
 2. Polarity and phase relation tests on the rated voltage connection.
 3. Applied voltage tests.
 4. Induced potential test.
 5. No-load and excitation current at rated voltage on the rated voltage connection.

3.02 INSTALLATION

- A. Transformers, shown on the Drawings to be floor mounted shall have a four (4) inch high by four (4) inch greater all sides concrete base. Connections shall be made with flexible metal conduit.
- B. Transformer manufacturer's nameplates, marked in accordance with NEMA Specifications, shall be permanently attached to the transformer in a readily accessible position.
- C. Transformer secondary neutral shall be grounded as per NEC requirements, and/or hereinafter specified.
- D. This Contractor shall install the transformer to ensure that the minimum

clearances required by the transformer manufacturer are provided. These clearances shall be clearly labeled on the transformer by the manufacturer.

- E. Install units plumb, level and rigid without distortion.

3.03 ADJUSTMENTS AND CLEANING

- A. On completion of installation, inspect components. Remove paint splatters and other spots, dirt and debris. Repair scratches and mars on finish to match original finish. Clean components internally using methods and materials recommended by the manufacturer.
- B. Adjust transformer taps to provide optimum voltage conditions at utilization equipment throughout normal operating cycle of the facility. Measure and record primary and secondary voltages and tap settings and submit with test results.

3.04 FIELD TESTING

- A. Include the following minimum inspections and tests according to manufacturer's written instructions. Comply with IEEE C57.12.91 for test methods and data correction factors.
- B. Inspect accessible components for cleanliness, mechanical and electrical integrity and damage or deterioration. Verify that temporary shipping bracing has been removed. Include internal inspection through access panels and covers.
- C. Inspect bolted electrical connections for tightness according to manufacturer's published torque values or, if not available, those specified in UL 486A and UL 468B.

END OF SECTION

SECTION 16460

GROUNDING

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work under this Section shall consist of furnishing and installing grounding systems as shown on the Drawings and herein specified.

1.03 QUALITY ASSURANCE

- A. All equipment, materials, and their installation shall conform to the requirements of the National Electrical Code (NEC), local code requirements, and these Specifications.
- B. All equipment and material shall be listed by Underwriter's Laboratories, Inc. (UL) for their intended use and shall bear the UL label.
- C. Equipment shall be constructed in accordance with National Electrical Manufacturer's Association (NEMA) standards.

1.04 DESCRIPTION

- A. The equipment grounding system shall be designed so all building steel, metallic structures, raceways, enclosures, cabinets, machine frames, junction boxes, outlet boxes, portable equipment, and all other conductive items in close proximity with electrical circuits operate continuously at ground potential providing a low impedance path for possible ground fault currents.

PART 2 - PRODUCTS

2.01 MATERIALS AND COMPONENTS

- A. MAIN GROUNDING SYSTEM:
 - 1. The ground bus in the main distribution switchboard shall be connected to at least three (3) copper-clad ground rods, not less than 3/4 inches in

diameter, ten (10) feet long, and driven full length into the ground outside in unpaved earth. Where required to meet the requirements of herein specified tests, extra rods shall be installed at no additional cost to the Owner. The rods shall be located a minimum of ten (10) feet from each other, or any other electrode, and shall be loop interconnected with each other by a minimum No. 4/0 AWG bare copper conductor thermal welded, using the proper style mold, to each rod below grade.

2. Provide a minimum No. 4/0 AWG green insulated copper ground conductor from the main distribution switchboard ground bus to the main metallic water service entrance (before the first pipe joint inside the building) and connect to same by means of adequate ground clamps. Where a dielectric main water fitting is installed, this ground conductor shall be connected to the street side of the dielectric water fitting. The conduit shall be bonded to the ground conductor at each end. Furnish and install with ground clamps, a minimum No. 4/0 AWG jumper around the water meter.
3. Provide a secondary building ground bar to serve as part of the building grounding electrode system in each electric room and other utilitarian areas of the building where dry-type transformers will be located, and in each communication room and/or where telecommunications main distribution frames (MDF) and sub-distribution frames (SDF) will be located. A ground bar(s) shall also be located at the telephone and CATV service entrance demarcation point(s). The ground bar(s) shall be electro-tin plated copper, minimum size of 1/4" x 6" x 12" or larger sizes as shown on the Drawings or required, with 3/8" plastic standoff insulators bolted to the wall. These ground bars shall be connected with a continuous No. 4/0 AWG bare copper ground conductor using high compression two (2) hole lugs. The No. 4/0 AWG ground conductor shall originate at the main switchboard ground bus and route through the building corridor ceilings unspliced to each of the ground bars. Provide "low smoke" type exothermic welds in an accessible ceiling using the proper style mold. Where impractical to use an exothermic weld due to space constraints, the Contractor may use an irreversible compression type connection listed for the purpose but only at locations approved by the Owner.
4. **(ENGINEER, USE THIS PARAGRAPH FOR AN ALL STEEL FRAMED BUILDING IN LIEU OF #3 ABOVE.)** Provide a secondary building ground bar to serve as part of the building grounding electrode system in each electric room and other utilitarian areas of the building where dry-type transformers will be located, and in each communication room and/or where telecommunications main distribution frames (MDF) and sub-distribution frames (SDF) will be located. A ground bar(s) shall also be located at the telephone and CATV service entrance demarcation

point(s). The ground bar(s) shall be electro-tin plated copper, minimum size of 1/4" x 6" x 12" or larger sizes as shown on the Drawings or required, with 3/8" plastic standoff insulators bolted to the wall. These ground bars shall be connected with a continuous No. 4/0 AWG bare copper ground conductor using high compression two (2) hole lugs. The No. 4/0 AWG ground conductor shall originate at the nearest accessible building steel beam or column using a "low smoke" type exothermic weld with the proper style mold. Remove the building steel paint completely prior to making grounding connections and repaint with proper galvanized paint when complete.

5. **(ENGINEER, USE THIS PARAGRAPH FOR AN ALL STEEL FRAMED BUILDING.)** Bond the building steel at each building expansion joint with No. 4/0 AWG bare copper using a "low smoke" type exothermic weld using the proper style mold at accessible locations. Remove the building steel paint completely prior to making grounding/bonding connections and repaint with proper galvanized paint when complete.
6. New Buildings, Building Additions and Exterior Electrical Equipment Enclosures:
(ENGINEER TO EDIT PARAGRAPHS BELOW TO SUIT PROJECT)
 - a. Buildings with new concrete foundations and/or footings shall be provided with a minimum No. 4/0 AWG bare copper ground conductor from the main distribution switchboard ground bus to the foundations and/or footings concrete-encased electrode rebar meeting the requirements of NEC 250.52(A)(3). The conductor shall be thermal welded to the concrete-encased electrode (rebar), using the proper style mold. Refer to the detail on the Drawings. **(ENGINEER EDIT OUT THIS PORTION IF NOT USING)** Building additions foundations and/or footings not within a reasonable distance from the switchboard may have the concrete-encased electrode bonded to the buildings secondary building electrode system ground bar.
 - b. Exterior electrical equipment enclosures with new concrete foundations and/or footings shall be provided with a bare copper ground conductor from the ground rods (if provided) and/or from the ground bus of the main panel within the enclosure to the concrete-encased electrode, meeting the requirements of NEC 250.52(A)(3), as shown on the Drawings. The conductor shall be thermal welded to the concrete-encased electrode (rebar), using the proper style mold. The enclosure, if metal, shall be bonded to the grounded electrode.
 - c. **(ENGINEER, USE THIS PARAGRAPH FOR A STEEL FRAMED**

BUILDING.) Steel frame buildings shall also have the steel columns anchor bolt connected to the concrete-encased electrode (rebar) with a No. 4/0 AWG bare copper ground conductor having an exothermic weld at both ends, using the proper style molds. Coordinate the installation of the anchor bolts to the base plate to scrape away paint/rust prior to the installation of the washer and nut to the steel columns anchor bolts. Refer to the detail on the Drawings.

- B. Secondary services shall be grounded on the "line" side in accordance with the NEC. The neutral disconnecting link, or links, shall be located so that the main distribution switchboard neutral bus with all interior secondary neutrals can be isolated from the common ground bus and the service entrance conductors.
- C. The equipment grounding conductors and straps shall be sized in compliance with the NEC. All equipment grounding conductors shall be provided with green insulation equivalent to the insulation on the associated phase conductors. The related feeder and branch circuit grounding conductors shall be connected to the ground bus with pressure connectors. A feeder serving several panelboards shall have a continuous grounding conductor which shall be connected to each related cabinet ground bus.
- D. This Contractor shall furnish and install a separate green insulated equipment grounding conductor for each single or three-phase feeder and each branch circuit with a two-pole or three-pole protective device. The required grounding conductor shall be installed in the same raceway with the related phase and/or neutral conductors. Where there are parallel feeders installed in more than one raceway, each raceway shall have a green insulated equipment ground conductor. Single-phase branch circuits required for 120 and 277 volt lighting, receptacles, and motors shall consist of phase and neutral conductors installed in a common metallic raceway, which shall serve as the grounding conductor. Flexible metallic conduit equipment connections utilized in conjunction with the above single-phase branch circuits shall be provided with suitable green insulated grounding conductors connected to grounding terminals at each end of the flexible conduit.
- E. This Contractor shall furnish and install in the same raceway with the associated phase and/or neutral conductors, a green colored equipment ground conductor having the same type insulation and connected as described below:
 - 1. Where electrical devices, such as heaters, are installed in air ducts, provide a green insulated equipment ground conductor sized in accordance with the NEC based on the rating of the overcurrent device supplying the unit. This conductor shall be bonded to the ground bus in the associated panelboard.

2. From the equipment ground bus in panelboards through raceways and flexible metallic conduit to ground terminal in a connection box mounted on three-phase motors, furnish and install a ground conductor sized as herein specified. Where the motor has a separate starter and disconnecting device, the ground conductor shall originate at the ground bus in the panelboard. Motors shall be bonded to each starter and disconnecting device enclosure.

PART 3 - EXECUTION

3.01 POWER SYSTEM GROUNDING

- A. This Contractor shall furnish and install green insulated ground conductor(s) in a raceway to the main ground and domestic metallic water main with ground clamps designed specifically for that purpose.
- B. Main distribution system: From the ground electrodes, this Contractor shall furnish and install an insulated ground conductor to the ground bus within the switchgear, to the neutral of the switchgear, and to all non-current carrying parts.
- C. Secondary building grounding: Furnish and install secondary building ground bars where indicated and as detailed on the drawings. Connect the ground bars with No. 4/0 AWG bare copper ground conductors originating from the (switchgear ground bus) (building steel). Provide green tags on the ground conductors every fifty (50) feet or less. The tags shall identify the ground conductor as the building secondary grounding electrode system. Laminate tags and secure with tie wraps.
- D. Branch circuit grounding: This Contractor shall furnish and install grounding bushings, ground terminal blocks, and grounding jumpers at distribution centers, pullboxes, panelboards, and the like.
- E. Bonding jumpers: This Contractor shall furnish and install a green insulated bonding conductor (size shall correlated with the over-current device protecting the conductor) attached to grounding bushings on the raceway, to lugs on boxes, and other enclosures.
- F. Bonding conductors: This Contractor shall furnish and install a bonding conductor in all flexible conduits connected at each end to a grounding bushing.
- G. Pole mounting luminaire (lighting fixture) grounding: This Contractor shall furnish and install a ground conductor with green insulation to the lighting standard (pole). Connect to a corrosion-resistant ground stud or ground clamp furnished as part of the standard. The ground conductor shall originate and be run with the branch circuit wiring.

- H. All electrical outlets shall be connected from the device grounding terminal to the outlet box with No. 12 AWG green insulated conductor. This Contractor shall furnish and install a green screw terminal in the outlet box and a continuous green ground conductor from the green terminal screw to the grounding systems as indicated on the Drawings.

3.02 COMMUNICATION GROUNDING

- A. Communications
 - 1. This Contractor shall furnish and install one (1) No. 2 AWG green ground conductor in a $\frac{3}{4}$ inch raceway from the Communication equipment demarcation space to the main service ground or building secondary grounding electrode system.
 - 2. This Contractor shall furnish and install one (1) No. 2 AWG type green ground loop between each raceway terminating at the communication equipment demarcation backboard by means of a grounding bushing.
- B. Fire detection and alarm systems: This Contractor shall furnish and install one (1) No. 8 AWG green ground conductor in a $\frac{3}{4}$ inch raceway from system equipment enclosures to the main service ground or building secondary grounding electrode system.
- C. Ancillary communication systems: Provide additional grounding of other building systems as described elsewhere in these specifications.

3.03 TESTS

- A. The completed grounding system shall be subjected to a ground resistance test with an earth test megger to ensure that the ground resistance, without chemical treatment or other artificial means, does not exceed five (5) ohms at the service entrance equipment's ground bus. The Contractor shall furnish and install additional ground rods and conductors from the exterior ground grid to achieve the required resistance to ground. Testing equipment must be calibrated to the manufacturer's requirements. Upon request, the Contractor shall provide documentation of the testing equipment's most recent calibration.
- B. **(ENGINEER, USE THIS PARAGRAPH FOR AN ALL STEEL FRAMED BUILDING.)** In addition to the above, steel framed buildings shall be subjected to a ground resistance test with an earth test megger for the adequacy of the steel framing of the building as a grounding electrode system for five (5) ohms or less. Testing shall be at all of the secondary building ground bar connection points. If testing results do not meet the required resistance, the engineer must be notified.

END OF SECTION

SECTION 16470

ENCLOSED CIRCUIT BREAKERS

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work under this Section shall include furnishing and installing enclosed circuit breakers and/or molded case switches as shown on the Drawings and as herein specified.

1.03 QUALITY ASSURANCE

- A. All equipment, materials, and their installation shall conform to the requirements of the National Electrical Code (NEC), local code requirements, and these Specifications.
- B. All equipment and materials shall be listed by Underwriter's Laboratories, Inc. (UL) for their intended use and shall bear the UL label.
- C. Equipment shall be constructed in accordance with National Electrical Manufacturer's Association (NEMA) standards.
- D. Submittals are required in accordance with SECTION 16010 of these Specifications. The manufacturer shall furnish, but not be limited to the following:
 - 1. Circuit breaker enclosure with dimensions and nameplate designation.
 - 2. Circuit breaker trip ratings and frame sizes.
 - 3. Conduit entry/exit locations.
 - 4. Assembly ratings, including short-circuit rating, voltage, and continuous current rating.
 - 5. Cable terminal sizes.
 - 6. Product data.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Deliver material and products in factory labeled packages. Store and handle in strict compliance with manufacturer's instructions and recommendations.
- B. Each unit shall be delivered in individual shipping cases and individually wrapped for protection.
- C. Store in a clean, dry space. Maintain factory protection and/or provide an additional heavy canvas or heavy plastic cover to protect equipment from dirt, water, construction debris, and traffic. Where applicable, provide adequate heating within enclosures to prevent condensation.
- D. Handle carefully to avoid damage to panelboards internal components, enclosure and finish.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. The enclosed circuit breaker(s) shall be as manufactured by EATON, ABB or SIEMENS.

2.02 MATERIAL AND COMPONENTS

- A. Enclosed circuit breakers shall be furnished and installed by this Contractor as shown on the Drawings. Enclosed circuit breakers shall be UL listed.
- B. Enclosed circuit breakers required and/or noted on the Drawings to be "four wire" shall be furnished by the manufacturer complete with a solid neutral assembly.
- C. Enclosed circuit breaker enclosures shall generally be NEMA 1 or NEMA 3R (rainproof) for exterior locations, or where noted "WP" on the Drawings.

2.03 CIRCUIT BREAKERS

- A. Electrical circuits shall be protected by molded case circuit breakers as indicated on the Drawings.
- B. The circuit breakers shall be operated by a toggle type handle and shall have a quick-make, quick-break over-center switching mechanism that shall be

mechanically trip free from the handle so that the contacts cannot be held closed against short circuits and abnormal currents. Tripping due to overload or short circuit shall be clearly indicated by the handle automatically assuming a position midway between the manual "ON" and "OFF" positions. All latch surfaces shall be ground and polished. All poles of a multi-pole breaker shall be so constructed that they open, close, and trip simultaneously.

- C. The circuit breakers shall be completely enclosed in a molded case. Non-interchangeable trip breakers shall have their covers sealed; interchangeable trip breakers shall have the trip unit sealed to prevent tampering. Ampere ratings shall be clearly visible. Contacts shall be non-welding silver alloy. Arc extinction shall be accomplished by means of arc chutes consisting of metal grids mounted in an insulating support. Breakers shall be of the bolt-on type; plug-in, plug-on, blow-on, and clamp-on circuit breakers shall not be acceptable.
- D. Circuit breakers shall be 80% rated unless indicated on the Drawings to be 100% rated.
- E. Circuit breakers shall have a minimum symmetrical interrupting capacity as indicated on the Drawings. The interrupting ratings of the circuit breakers shall be at least equal to, or greater than, the available short circuit at the line terminals and not less than those values shown on the Drawings and specified in this specification section **or as determined by the Short-Circuit Coordination Study whichever is higher. [ENGINEER, EDIT OUT SHORT-CKT STUDY IF NOT IN PROJECT]**
- F. Circuit breakers shall be listed with UL, conform to the applicable requirements of the latest issue of NEMA Standards Publication No. AB1.
- G. Circuit breakers shall have thermal-magnetic trip units, with inverse time-current characteristics, unless otherwise noted on the Drawings.
 - 1. Automatic operation of all circuit breakers shall be obtained by means of thermal-magnetic tripping devices located in each pole providing inverse time delay and instantaneous circuit protection. Instantaneous pick-up settings for each phase shall be adjustable on all frames 250A and above.
 - 2. Circuit breakers shall be ambient compensating in that, as the ambient temperature increases over 40° C, the circuit breaker automatically derates itself to better protect its associated conductor.
 - 3. Circuit breakers 250A and above shall have thermal magnetic interchangeable trip units.

- H. Circuit breaker frames 400 ampere and above shall have microprocessor-based RMS sensing trip units on 480 volt systems and on 208 volt systems where indicated on the Drawings.
1. Solid state sensing shall measure true RMS current with capability to measure through to the 13th harmonic. Automatic operation of all circuit breakers shall be obtained by means of solid state tripping elements providing inverse time delay and instantaneous and short-time circuit protection. Continuous current rating shall be adjustable from 40% to 100% of trip unit rating. Long-time delay and instantaneous trip ratings shall also be adjustable. The short time pick-up trip shall have adjustable pick-up settings at definite times and with I2t delay.
 2. Long time current adjustment shall be possible without the need for a rating plug.
 3. Where specifically indicated on the Drawings, enclosed circuit breakers shall be provided with integral ground fault protection. Ground fault pick-up shall be adjustable from 20% to 70% of the breakers maximum continuous current rating, but in no case be greater than 1200A. Ground fault time delay shall be adjustable with three (3) I2t delay settings.
 4. Solid state circuit breakers shall have built-in test ports for testing the long-time delay, instantaneous, and ground fault functions (if equipped) of the breaker by means of a test set.
 5. Provide one test set capable of testing all circuit breakers with a built-in test port, unless previously provided under another section of these Specifications.
 6. Circuit breakers 1200A and higher shall have an ARC Flash Maintenance System that meets NEC 240.87.
- I. Circuit Breaker Accessories:
1. Provide shunt-trips, bell alarms and auxiliary switches, etc. as may be shown on the Drawings. All accessories shall be UL listed for field installation.
 2. Coils for the shunt-trip circuit breakers associated with the elevator shut-down system, activated by the fire alarm and detection system shall be coordinated with the Fire Alarm and Detection System for the proper coil voltage of the shunt-trip device.
- J. Circuit breakers shall be manufactured by the same manufacturer as the panelboards and the circuit breaker enclosure and be factory installed.

- K. Lugs shall be rated for 75 degrees C terminations and shall bolt in place.
- L. Where indicated, circuit breakers shall be UL listed for series application.
(ENGINEER TO EDIT OUT THIS PARAGRAPH IF NOT USING SERIES CONNECTED BREAKERS.)

2.04 MOLDED CASE SWITCHES

- A. Where indicated on the Drawings provide enclosed molded case switches. Molded case switches shall employ the same operating mechanism as the thermal magnetic and magnetic only circuit breaker units described above. The molded case switch shall have a factory preset instantaneous function to allow the switch to trip and protect itself at a high fault current, without thermal overload protection.

2.05 NAMEPLATES

- A. Enclosed circuit breakers and or molded case switches, including exterior locations, shall have nameplates of 1/16 inch thick laminated plastic with 3/16 inch high white letters on a black background. Nameplates shall identify each piece of equipment and shall be mounted on the front top of the enclosure. Nameplates shall be screw fastened using stainless steel screws.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. The enclosed circuit breakers shall be securely mounted in accordance with the NEC, approximately forty eight (48) inches but no less than twelve (12) inches above the finished floor to the bottom unless otherwise noted.
- B. Mounting brackets and hardware exposed to weather shall be galvanized or otherwise suitably protected from corrosion.
- C. Install units plumb, level and rigid without distortion to the units.
- D. Contractor shall install required safety labels.

3.02 FIELD TESTS

- A. Check tightness of all accessible mechanical and electrical connections to ensure they are torqued to the minimum acceptable manufacturer's recommendations.

- B. Check all enclosed circuit breakers and enclosures for proper grounding, fastening and alignment.

3.03 FIELD ADJUSTMENTS

- A. This Contractor shall perform field adjustments of the protective devices as required to place the equipment in final operating condition. Necessary field settings of devices and adjustments and minor modifications to equipment shall be carried out by this Contractor at no additional cost to the Owner.
- B. **(ENGINEER, DELETE THIS PARAGRAPH WHEN SECTION 16015 “SHORT-CIRCUIT/COORDINATION STUDY” IS NOT USED)** The settings shall be in accordance with the approved protective device coordination study or as directed by the Engineer.

3.04 CLEANING

- A. Remove debris from enclosed circuit breaker enclosures and wipe dust and dirt from all components.
- B. Repaint marred and scratched surfaces with touch-up paint to match original finish.

END OF SECTION

SECTION 16480
FEEDER BUSWAY

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work under this Section shall include furnishing and installing prefabricated feeder busway distribution system(s) including all necessary fittings, hangers, and accessories as shown on the Drawings and herein specified.

1.03 QUALITY ASSURANCE

- A. All equipment, materials, and their installation shall conform to the requirements of the National Electrical Code (NEC), local code requirements, and these Specifications.
- B. All equipment and materials shall be listed by Underwriter's Laboratories, Inc. (UL) for their intended use and shall bear the UL label.
- C. Equipment shall be constructed in accordance with National Electrical Manufacturer's Association (NEMA) standards.
- D. All of the busway components shall be of the same manufacturer as the switchboard, see SECTION 16420.
- E. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.
- F. Submittals are required in accordance with SECTION 16010 of these Specifications. Submittals shall include, but not be limited to the following:
 - 1. Product data to include all dimensions, weights, electrical ratings, wiring diagrams, required clearances, fittings, hangers and accessories.
 - 2. A dimensioned isometric drawing, prepared by the manufacturer, for each feeder busway system showing the layout for and identification of all required components, including hanger spacing.
 - 3. Cable terminal sizes and ratings.

PART 2 - PRODUCTS

2.01 MATERIALS AND COMPONENTS

- A. This Contractor shall furnish and install prefabricated feeder busway distribution system(s) as shown on the Drawings and as specified herein including all necessary fittings, hangers, and accessories. The feeder busway distribution system(s) shall consist of standard ten (10) foot sections with special sections and fittings provided to suit the installation. Horizontal runs shall be suitable for hanging on ten (10) foot maximum support centers. On vertical runs, one (1) adjustable vertical hanger per floor shall be furnished and installed. The feeder busway shall meet the latest applicable standards of NEMA, ANSI, and UL 857.
- B. Busway shall be 277/480 volt, 120/208 volt three phase, four wire with 100% neutral and 50% capacity integral (housing) and/or internal ground bus as manufactured by EATON, ABB or SIEMENS. Feeder busway ampere rating shall be as noted on the Drawings.
- C. The busway shall be of the low impedance type, totally enclosed and non-ventilated for protection against mechanical damage and dust accumulation. The housing shall meet NEC requirements and shall be a 2-piece design fabricated from extruded aluminum. The 2-piece housing shall be bolted together along with bottom flange using grade 5, 1/4 x 20 zinc-plated fasteners on 3-inch centers for maximum mechanical strength. The busway enclosure finish shall be ANSI 61 gray baked epoxy powder paint applied by an electrostatic process.
- D. Each busway section shall be furnished complete with joint hardware and covers. The joints shall be a single-bolt, non-rotating, removable bridge design. All bridge joints shall be furnished with torque-indicating double head joint bolts and Belleville washers. The bridge joint shall ensure proper installation without the use of a torque wrench. Each joint shall allow for a minimum length adjustment of +/- 0.5 inches. De-energization of busway shall not be required for safe testing of joint tightness. Access to only one side of the busway shall be required for tightening or inspection of the joint. Joint covers shall be provided with captive hardware. It shall be possible to remove any joint connection assembly to allow electrical isolation or physical removal of a busway length without disturbing adjacent busway lengths.
- E. Bus bars shall be fabricated from high strength **[ENGINEER TO EDIT]** [58% conductivity aluminum] [98% conductivity copper] and suitably plated at all electrical contact surfaces. Bus bars shall be insulated over their entire length, except at joints and contact surfaces, with an UL listed insulating material consisting of epoxy applied by fluidized bed process or electrostatically applied Class B (130 degree C. certified) epoxy insulation. Busway shall be of sandwich construction meaning no air gap shall exist between bus bars except at the joints. Bus bars shall be tin plated at all contact surfaces.

- F. Busway shall be braced to withstand **[ENGINEER TO SELECT]** [_____] maximum RMS symmetrical amperes. The short circuit rating must be based upon actual tests at the rated short-circuit current for six (6) cycles. The busway shall be so designed and tested that at rating no part shall exceed a fifty five (55) degree C. rise based on a forty (40) degree C. maximum ambient temperature.
- G. Three-phase line-to-line voltage drop shall not exceed 4.0 volts per hundred feet at 70% power factor concentrated load, which condition may exist during motor starting. The voltage drop (input voltage minus output voltage) specified shall be based on the busway operating at full rated current and at stabilized operating temperature in 35 degree C. ambient temperature.
- H. The busway shall be UL listed to meet two-hour fire ratings for gypsum wallboard construction and three-hour fire rating for poured concrete or concrete block construction.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. The feeder busway shall be installed in accordance with the manufacturer's recommendations/instructions, NEMA publication BU1.1 (which shall be shipped with the busway) and the NEC.
- B. Busway shall be run as tight as possible to the underside of the building structure and shall be carefully coordinated with all piping, ductwork, other trades and the building structure. Install busway expansion fittings at each location where busway crosses a building expansion joint. Extra care shall be taken to ensure that all components of each busway system remain dry and free from foreign matter during the construction period. Final field measurements shall be made by this Contractor prior to release of the busway for fabrication.
- C. Busway supports shall not terminate or be fastened directly to the roof decking except where specifically approved by the Owner. Busway shall not be supported from the bottom cord of joists unless specifically approved, in writing, by the Structural Engineer of Record.

3.02 TESTING

- A. Standard factory tests shall be performed on the equipment provided under this specification section. All tests shall be in accordance with the latest version of ANSI and NEMA standards. The manufacturer shall provide three (3) copies of factory test reports.
- B. After completion of each busway system, and prior to energizing, the entire

system shall be tested by an independent testing laboratory to ensure that phasing is correct and that there are no electrical faults present. This Contractor shall notify the Architect/Engineer and the Owner two (2) weeks prior to the date the test will be performed. Costs associated with this test shall be the responsibility of this Contractor.

END OF SECTION

SECTION 16485

TRACK BUSWAY SYSTEM

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work under this Section shall include furnishing and installing prefabricated track busway distribution system(s) including all necessary fittings, hangers, and accessories as shown on the Drawings and herein specified.
- B. The system is primarily for overhead distribution of electrical power to support designated work areas and equipment. Once installed, the busway will provide a simple, versatile, fast and economic means of distributing power. Loads fed from a variety of plug-in units can be easily added or removed without shutting power down to the busway.

1.03 QUALITY ASSURANCE

- A. All equipment, materials, and their installation shall conform to the requirements of the National Electrical Code (NEC), local code requirements, and these Specifications.
- B. All equipment and materials shall be listed by Underwriter's Laboratories, Inc. (UL) for their intended use and shall bear the UL label.
- C. Equipment shall be constructed in accordance with National Electrical Manufacturer's Association (NEMA) standards.
- D. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.
- E. Submittals are required in accordance with SECTION 16010 of these Specifications. Submittals shall include, but not be limited to the following:
 - 1. Product data to include all dimensions, weights, electrical ratings (to include short-circuit rating, voltage and continuous current), wiring diagrams, power details, required clearances, fittings, hangers and accessories.

2. Circuit breaker and cable schedule include cable lengths, plug-in unit schedules with type and quantity of devices (if applicable).
3. A dimensioned drawing, prepared by the manufacturer, for each track busway system showing the layout for and identification of all required components, including hanger spacing.
4. Cable terminal sizes and ratings.
5. Component list.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Refer to NEMA Publication BU1.1, which is a guide for proper installation, operation and maintenance of busway products.
- B. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.
- C. Utilize factor provisions for all lifting, rigging, or hoisting.
- D. Prior to installation, busway and busway equipment shall be stored in a temperature and humidity controlled dry environment.

1.05 WARRANTY

- A. This Contractor shall deliver the work in first-class operating condition in every respect. This Contractor shall also warrant that the material, equipment, and workmanship furnished shall be entirely free from defects. Any materials, equipment, or workmanship in which defects may develop before or during the warranty period shall be repaired or replaced at the Contractor's own expense. Refer to SECTION 01740 for the start of the warranty period. This Contractor shall further warrant that all material, equipment, and workmanship used in the installation, but not specifically mentioned in the Drawings and Specifications, is the best of their respective kinds and that the construction and installation was performed in accordance with the best accepted standard practices in all details.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. The track busway shall be STARLINE Track Busway manufactured by Starline Holdings, LLC or approved equal. Such firms shall be regularly engaged in the

manufacture of track busway system equipment and ancillary equipment, of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years. Any product other than those listed in this specification must be pre-approved in accordance with these Specifications as hereinbefore described in SECTION 16010.

2.02 RATINGS

- A. The track busway shall be rated for 120/208 volt, three phase, four wire with 100% neutral and 100% capacity integral (housing) ground.
- B. The track busway shall have a minimum of 3-cycle short-circuit rating of 22 kA RMS symmetrical rating.
- C. Three-phase line-to-line voltage drop shall not exceed 1.0 volt per forty-seven (47) feet at 80% power factor for a distributed load at 225 amperes.

2.03 MATERIALS AND COMPONENTS

- A. This Contractor shall furnish and install prefabricated track busway distribution system(s) as shown on the Drawings and as specified herein including all necessary plug-in units, cables, fittings, hangers, accessories, etc.
- B. The track busway sections shall have an extruded aluminum housing containing solid copper busbars. Aluminum busbars are not permitted. The housing shall act as a 100% ground and shall provide a polarizing feature to avoid incorrect installation of plug-in units. Busbars shall be enclosed in a continuous insulator, with openings sufficient for the plug-in units to make contact. Busbars shall be sized to handle 100% of its rating continuously with ambient temperatures below 40° C / 104° F.
- C. Track busway housing sections shall be five (5), ten (10), or twenty (20) feet standard lengths. The housing shall be extruded with slots to receive rod mount hangers to hang from the building structure. The housing shall have a continuous access slot opening on the bottom to accept plug-in units anywhere along its length. This opening shall pass the UL hypothetical finger probe test.
- D. The ampere ratings, approximate footage, fittings, plug-in units, etc. shall be as shown on the Drawings.
- E. Track busway housing sections shall be joined together by a 'press fit' that requires no bolted connection and no future maintenance.
- F. Busbar connections shall be provided, consisting of copper stabs protruding from one end of each busway section. The stabs shall insert into the opposite end of the next section, and use a tool provided by the manufacturer to make a compression fit into the busbar channel for a reliable connection.

- G. Housing couplers shall be provided with adequate mechanical strength so that busway and couplers will support up to 100 pounds per 10 foot interval, with 10 foot hanger spacing. Housing couplers shall be secured in place with bolts provided by the manufacturer.
- H. End caps shall be provided and installed at the ends of each track busway run.
- I. Closure strips shall be provided, field cut and fitted to cover the continuous access slot bottom opening of the track busway housing to prevent dust and debris from gathering in the track busway.
- J. Power feed connections with junction boxes, end caps, ells, tees and special fittings shall be provided as necessary and as shown on the Drawings to complete the system.
- K. Plug-in units shall be of the types and electrical ratings indicated in the Drawings, with UL listing where applicable. Units shall consist of a plug head assembly designed to fit into the access slot of the busway sections, and rotate 90 degrees to make the electrical connection. Units shall be polarized, to avoid incorrect installation. Each plug stab shall have wire color coding indicated on the unit. A grounded junction box shall be provided on the plug-in unit. Direct wire connections, fusing, circuit breakers or other circuit protection devices, shall be provided as required. The units shall have locking clips or bolt-on tabs to secure units to the busway. Circuit breakers and fuses in plug-in units shall have a minimum interrupting rating of 22 kA.
- L. Cord grips and fittings, drop cord assemblies, and other electrical devices shall be furnished as indicated on the Drawings and specified herein. Plug-in units that include drop cords shall be manufactured with cord grips and receptacles.
- M. Busway whole run metering:
 - 1. An electronic power meter equivalent to STARLINE model no. M41P3 Critical Power Monitor shall be mounted in busway end power feed units to monitor power utilization for each busway run, where shown on the Drawings.
 - 2. Electronic power meter shall have a digital display showing real-time information about critical power parameters for each phase. Each phase shall be visible on the display simultaneously.
 - 3. The electronic power meter shall comply with ANSI C12.20 for power utilization and quality with an accuracy of 0.5 percent.
 - 4. The electronic power meter shall be capable of monitoring the following parameters: input voltages (L-L/L-N); current per phase (max/min);

voltage per phase (max/min); neutral current; power factor; frequency; active (real), reactive and apparent power; demand (kWh); current demand; and current peak demand.

5. The electronic power meter shall communicate in RS-485 or Ethernet or wireless mesh network or web interface, Modbus RTU or SNMP. Provide all necessary communication hubs, modules, software, etc. for complete remote monitoring capabilities.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. The track busway and accessories shall be installed in accordance with the manufacturer's recommendations/instructions, NEMA publication BU1.1 and the National Electrical Code.
- B. Track busway shall be hung using manufacturer's hangers and Contractor furnished all thread rods secured to the building structure. The rod mount hangers shall connect the track busway to the all thread. The maximum spacing is ten (10) feet on center for the hangers. The height of the track busway shall be as shown on the Drawings. The busway runs shall be routed as shown on the Drawings and carefully coordinated with all piping, ductwork, other trades and the building structure. Final field measurements and coordination shall be made by this Contractor prior to release of the busway for fabrication.
- C. Busway supports shall not terminate or be fastened directly to roof decking. Busway shall not be supported from the bottom cord of joists unless specifically approved, in writing, by the Structural Engineer of Record.
- D. Extra care shall be taken to ensure that all components of each busway system remain dry and free from foreign matter during the construction period.

3.02 ADJUSTMENTS AND CLEANING

- A. Set field-adjustable trip devices per coordination study. **[Engineer, edit out if short-circuit study is not part of this project]**
- B. Clean exposed surfaces using manufacturer recommended materials and methods. Touch-up damaged coating and finishes using non-abrasive material and methods recommended by the manufacturer. Eliminate all visible evidence of repair.

3.03 TESTING

- A. Perform testing on all busway runs per NEMA publication BU1.1 and manufacturer's recommendations prior to energizing.

3.04 STARTUP SERVICES

- A. A factory authorized service representative shall perform all startup services.

3.05 TRAINING

- A. This Contractor shall provide four (4) hours of technical service training to the Owner's technical and maintenance staff.
- B. This Contractor shall provide six (6) hours of operating, programming and software training to the Owner's operating staff. Training shall be scheduled at the Owner's convenience during the warranty period.
- C. All training specified herein shall be performed by a factory certified technician.

END OF SECTION

SECTION 16500

LIGHTING CONTROL SYSTEMS

PART 1 – GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work covered in this section shall include furnishing and installing complete lighting control systems for the control of selected interior and exterior lighting and other equipment as indicated on the Drawings, detailed in the manufacturer submittal and as further defined herein. Contractor is solely responsible to verify quantity, installation locations and wiring requirements for this project. Specific manufacturers' catalog numbers, when listed in this section are for reference only. It is the responsibility of this Contractor to verify with the lighting control manufacturer all catalog information and specific product acceptability.
- B. The systems shall include but not be limited by the following: intelligent lighting control devices with individually addressable network communication capability and consist of one or more basic lighting control components such as occupancy sensor, photocell sensor, relay, dimming output, contact closure input, analog 0-10V input, and manual wall station capable of indicating switching, dimming, and/or scene control. Combining one or more of these components into a single device enclosure shall be permissible so as to minimize overall device count of system.
- C. Requirements are indicated elsewhere in these specifications for work including, but not limited to, raceways and electrical boxes and fittings required for installation of control equipment and wiring.
- D. It is the intent of this specification that the entire lighting control system, as specified herein, be available to all bidders and not "Packaged or Bundled" with any other lighting systems or equipment. Therefore the lighting control system shall be provided as a separate price, to all bidders, at bid time.

1.03 QUALITY ASSURANCE

- A. The lighting control systems shall meet the requirements of the National Electrical Code (NEC), state and local codes, and these Specifications.
- B. The network lighting control systems shall be UL/CUL listed. The Contractor is responsible for verifying compliance.

- C. All components and the manufacturing facility where product was manufactured must be RoHS compliant.
- D. All components shall be subjected to 100% end of line testing prior to shipment to the project site to ensure proper device operation.

1.04 SUBMITTALS

- A. This Contractor shall furnish submittals for all components of the lighting control systems in accordance with SECTION 16010 of these Specifications. Submittals shall include the following for review. Submittals not containing all of the information listed below will be rejected.
 - 1. Shop Drawings: Submit device layout drawings of complete lighting control systems and accessories including, but not necessarily limited to, relay panels, switches, power packs, system head end, photocells and other interfaces. Shop drawings shall indicate exact location of each device. Plans shall be diagrammatical. "Cut Sheet" submittals are not acceptable. This Contractor shall furnish to the lighting control system manufacturer a copy of the project construction phasing plan for design of the bus system.
 - 2. Product Data: Submit for approval manufacturer's data on the specific lighting control systems and components. Submittal shall be in both electronic and hard copy formats. To prevent departures from approved system operation, electronic file submitted shall be able to be directly downloaded to the specified system at the manufacturer's facility. Submit a complete bill of materials with part numbers, description and voltage specifications.
 - 3. One Line Diagram: Submit riser diagram showing device wiring connections, size and number of conductors between each component, and each communication buss provided for the project. Submittals that show typical riser diagrams are not acceptable.
 - 4. Programming Forms: Submit programming forms with complete information describing the operation of the lighting control system and all other information necessary to show proper operation of the system.

1.05 SPARE PARTS

- A. Provide 10% spare relays, if relay panels are provided, up to the maximum capacity of the LCP. If the LCP is fully populated with active relays, provide a minimum of two spare relays per relay panel.

- B. Provide ten (10) spare classroom lighting control switches plus one (1) spare digital switch for each additional type of digital switch shown.
- C. Provide ten (10) spare classroom lighting control power packs.
- D. Manufacturer's software shall be available online for download at no charge. If software is not available online, it shall be provided in CD form with the most up to date software.
- E. Provide 2 extra sets of as-built and operating manuals.
- F. Provide 10 spare keys for each key operated switch.

1.06 SYSTEM DESCRIPTION

A. System Architecture

1. System shall have an architecture that is based up on networkable intelligent lighting control devices, standalone lighting control zones using distributed intelligence, and optional system backbone for remote, time based and global operation between control zones.
2. The system shall be capable of providing individually addressable switching and dimming control of the following: control zones to include multiple switch legs or circuits, relays, and dimming outputs from centralized panels and networked luminaires. System shall be capable of integrating indoor and outdoor lighting controls.
3. Lighting control zones shall be capable of being networked with a higher level system backbone to provide time based control, remote control from inputs and/or systems external to the control zone, and remote configuration and monitoring through software.
4. System shall be capable of 'out of box' sequence of operation for each control zone. Standard sequence is:
 - a. All switches control all power packs in a zone.
 - b. All occupancy sensors automatically control all power packs in the control zone with a default time out.

B. Wired Network Control Zone Characteristics

1. Following proper installation and provisions of power, all networked devices connected together with low voltage network cable shall automatically form a functional lighting control zone without requiring any

type of programming. The 'out of box' default sequence of operation is intended to provide typical sequence of operation so as to minimize the system start up and programming requirements and to also have functional lighting control operation prior to system startup and programming.

2. System shall be able to automatically discover all connected devices without requiring any provisioning of system or zone addresses.

C. System Integration Capabilities

1. The system shall be capable of interface with third party building management systems to support two-way communication using the industry standard BACnet/IP or BACnet/MSTP protocols.

1.07 SYSTEM TEST AND ACCEPTANCE

- A. Prior to the Architect/Engineer's final site visitation and acceptance of each construction phase, this Contractor shall conduct a complete operating test of each system including each device. The systems shall test free from grounds, shorts, and other faults. All connections shall be thoroughly checked for mechanical and electrical connection. All equipment shall be demonstrated to operate in accordance with the requirements set forth in these Specifications and as shown on the Drawings.
- B. This Contractor shall perform all tests in the presence of the Owner. This Contractor shall furnish all personnel for use in the tests.
- C. When the work on the system has been completed and is ready for final review, a visit shall be made by the Owner at which time the Contractor shall demonstrate that the requirements of the Contract as it applies to this system have been carried out and that the system has been adjusted and operated in accordance herewith.

1.08 DOCUMENTATION

- A. This Contractor shall furnish to the Owner point-to-point "As Built" wiring diagrams for the lighting control systems. Diagrams must indicate exact mounting location of each system and their devices. This accurate "as built" shall indicate the loads controlled by each relay and the identification number for that relay, placement of switches and location of photocell. Original shall be given to Owner, copies placed inside the door of each LCP.
- B. This Contractor shall furnish to the Owner, four (4) sets of factory operation and maintenance manuals. These manuals shall include factory service manuals with complete parts lists, wiring and component schematics including circuit

diagrams, programming forms with complete information and all other information necessary for the proper operation, service, and maintenance of the lighting control systems.

1.09 TRAINING

- A. This Contractor shall furnish four (4) hours of technical service training to the Owner's technical staff using the factory operation manuals previously specified.
- B. This Contractor shall furnish four (4) hours of operating and programming training to the Owner's operating staff to be scheduled at the Owner's convenience during the warranty period.
- C. All training specified herein shall be performed by a factory certified technician.

1.10 WARRANTY

- A. This Contractor shall deliver the work in first-class operating condition in every respect. This Contractor shall also warrant that the material, equipment, and workmanship furnished shall be entirely free from defects. Any materials, equipment, or workmanship in which defects may develop before or during the warranty period shall be repaired or replaced at the Contractor's own expense. Refer to SECTION 01740 for the start of the warranty period. This Contractor shall further warrant that all material, equipment, and workmanship used in the installation, but not specifically mentioned in the Drawings and Specifications, is the best of their respective kinds and that the construction and installation was performed in accordance with the best accepted standard practices in all details.

PART 2 - PRODUCTS

2.01 MANUFACTURER

- A. Lighting control systems products shall be manufactured by Acuity Brands Controls (nLight), or as listed herein. Such firms shall be regularly engaged in the manufacture of lighting control equipment and ancillary equipment, of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years. Any product or manufacturer other than those listed in this Specification must be pre-approved in accordance with these Specifications as hereinto described in SECTION 16010.

2.02 SYSTEM ARCHITECTURE

- A. System Architecture

1. System shall have an architecture that is based upon three main

concepts: (a) networkable intelligent lighting control devices, (b) standalone lighting control zones using distributed intelligence, (c) optional system backbone for remote, time based and global operation between control zones.

2. Lighting control zones consisting of one or more networked luminaires and intelligent lighting control devices and shall be capable of providing automatic control from sensors (occupancy and/or photocell) and manual control from local wallstations without requiring connection to a higher level system backbone; this capability is referred to as "distributed intelligence."
3. Lighting control zones shall be capable of being networked with a higher level system backbone to provide time based control, remote control from inputs and/or systems external to the control zone, and remote configuration and monitoring through a software.
4. All system devices shall support remote firmware update, such that physical access to each device is not necessary, for purposes of upgrading functionality at a later date.

B. Distributed System Power, Switching and Dimming Controls

1. Devices shall incorporate one optional Class 1 relay, optional 0-10 VDC dimming output, and contribute low voltage Class 2 power to the rest of the system.
2. Device programming parameters shall be available and configurable remotely from the software and locally via the device push-button.
3. Power packs shall accept 120 or 277 volt VAC and shall be plenum rated.
4. Devices shall be UL listed for load and load types as specified on the plans.

C. Wired Network Relay and Dimming Panel

1. Relays and dimming panels shall be capable of providing the required amount of relay capacity indicated as 4-relay, 8-relay, or 16-relay, as required per panel schedules shown on Drawings, with an equal number of individually 0-10V dimming outputs.
2. Standard relays used shall have the following required properties:
 - a. Configurable in the field to operate with normally closed or normally open behavior.

- b. Provide visual status of current state and manual override control of each relay.
 - c. Be individually programmable.
3. 0-10 VDC dimming outputs shall support a minimum of 100 mA sink current per output.
 4. Panel shall be UL924 listed for control of emergency lighting circuits.
 5. Panel shall provide a contact closure input that acts as a panel override to activate the normally configured state of all relays in the panel.
- D. Wired Networked Wall Switches, Dimmers, Scene Controllers
1. Wall switches & dimmers shall support the following device options:
 - a. Number of control zones: 1, 2 or 4
 - b. Control types supported: On/Off or On/Off/Dimming
 2. Scene controllers shall support the following device options:
 - a. Number of scenes: 1, 2 or 4
 - b. Control types supported:
 - 1) On/Off or On/Off/Dimming
 - 2) Preset level scene type
 - 3) Reprogrammed other devices within daisy-chained zone so as to implement user selected lighting scene.
 - 4) Selecting a lighting profile to be run by the system's upstream controller so as to implement a selected lighting profile across multiple zones.
- E. Wired Networked Occupancy and Photosensors
1. Sensors shall utilize passive infrared (PIR) or massive dual technology (PDT) to detect both the major and minor motion as defined by NEMA WD-7 standards.
 2. Sensing technologies that are acoustically passive, meaning they do not transmit sound waves to any frequency and do not require additional commissioning. Ultrasonic or microwave based sensing technologies may require commissioning due to the active nature of their technology, if factory required.
 3. Sensor coverage shall be coordinated with the floor plans. Sensors shall

be available in standard and extended range, as well as being available with option for High Bay mounting. All occupancy sensors installed in ceilings above 10 ft. in height shall be the High Bay type.

4. Sensor programming parameter shall be available and configurable remotely from the software and locally via the device.
5. Sensor mounting type shall match project design requirements as shown on the plans.
 - a. Sensors shall have optional features for photosensor/daylight override, dimming control and low temperature/high humidity operations.
6. The system shall support the following types of photocell-based control:
 - a. On/Off: The control zone is automatically turned off if the photocell reading exceeds the defined setpoint and automatically turned on if the photocell reading is below the defined setpoint. A time delay or adaptive setpoint adjustable behavior may be used to prevent the system from exhibiting nuisance on/off switching.
 - b. Continuous Dimming: The control zone automatically adjusts its dimming output in response to photocell readings, such that a minimum light level consisting of both electric light and daylight sources is maintained at the task. The photocell response shall be configurable to adjust the photocell setpoint and dimming rates.

F. Wired Networked Auxiliary Input / Output (I/O) Devices

1. Auxiliary Input/Output Devices shall be specified as an input or output device with the following options:
 - a. Contact Closure Input
 - i. Input shall be programmable to support maintained or momentary inputs that can activate local or global scenes and profiles, ramp light level up or down, or toggle lights on/off.
 - b. 0-10V Analog Input
 - i. Input shall be programmable to function as a daylight sensor.
 - c. RS-232/RS-485 Digital Input

- i. Input supports activation of up to 4 local or global scenes and profiles, and on/off/dimming control of up to 16 local control zones.
 - d. 0-10V Dimming Control Output, Capable of Sinking a Minimum of 20 mA of Current
 - i. Output shall be programmable to support all standard sequence of operations supported by system.
- G. Wired Networked Wall Switch Sensors
 - 1. Wall switches sensors shall support the following device options:
 - a. User input control types supported: On/Off or On/Off/Dimming
 - b. Occupancy sensing technology: PIR or Dual Technology
 - c. Daylight sensing option: Inhibit Photosensor
- H. System Controller
 - 1. System controller shall be a multi-tasking, real-time digital control processor consisting of modular hardware with plug-in enclosed processors, communication controllers, and power supplies.
 - 2. System controller shall perform the following functions:
 - a. Facilitation of global network communication between different areas and control zones.
 - b. Time-based control of downstream wired and wireless network devices.
 - c. Linking to an Ethernet network
 - d. Integration with building management system (BMS) and heating, ventilation and air conditioning (HVAC) equipment.
 - e. Connection to various software interfaces, including management interface, historical database and analytics interface, visualization interface, and personal control applications.
 - 3. System controller shall not require a dedicated PC or a dedicated cloud connection.

4. Device shall automatically detect all networked devices connected to it, including those connected to wired and wireless communication bridges.
 5. Devices shall have a standard and astronomical internal time clock.
 6. Shall be capable of connecting to the customers Local Area Network (LAN) via IEEE 802.11.x wireless and IEEE 802.3 wired connection.
 7. System controllers shall support BACnet/IP and BACnet/MSTP protocols to directly interface with BMS and HVAC equipment without the need for additional protocol translation gateways.
 - a. BACnet/MSTP shall support a minimum of 50 additional BACnet MS/TP controllers in addition to the expansion I/O modules.
 - b. BACnet/MSTOP shall support 9600 to 115200 baud.
 - c. System controllers shall be BACnet Testing Laboratory (BTL listed) using Device Profile BACnet Building (B-BC) with outlined enhanced features.
 - d. System controllers must support BACnet/IP Broadcast Management Device (BBMS) and Foreign Device Registration (FDR).
- I. System Software Interfaces
1. Management Interface
 - a. System shall provide a web-based management interface that provides remote system control, live status monitoring, and configuration capabilities of lighting control settings and schedules.
 - b. Management interface must be compatible with industry-standard web browser clients.
 - c. All system software updates must be available for automatic download and installation via the internet.
 2. Historical Database and Analytics Interface
 - a. System shall be capable of providing a browser-based trending and monitoring interface that stores historical data for all occupancy/daylight sensors and lighting loads. Additionally, the system shall optionally upload that data to a cloud based server.
 3. Visualization Interfaces
 - a. System shall be capable of providing an optional web-based

visualization interface that displays a graphical floorplan. System data, to include status of occupancy sensors, daylight sensors and light output, shall be overlaid to the floorplan to provide a graphical status page's.

4. Portable Programming Interface for Standalone Control Zones

- a. System shall have option for a portable handheld application interface for standalone control zones.
- b. Programming capabilities through the application shall include, but not be limited to, the following:
 - 1) Switch/occupancy/photosensor group configuration
 - 2) Manual/automatic on modes
 - 3) Turn-on dim level
 - 4) Occupancy sensor time delays
 - 5) Dual technology occupancy sensors sensitivity
 - 6) Photosensor calibration adjustment and auto-setpoint
 - 7) Trim level settings.

J. Low Voltage Cable

1. This Contractor shall furnish and install the required low voltage cable with RJ45 connectors between all switches and panels. The cable shall be UL listed, plenum rated, unshielded, four (4) twisted pairs, No. 24 AWG, Category 6, extended distance, high speed data type with a flame retardant polyvinyl chloride jacket and a temperature range for dry locations of minus ten (10) degrees C to sixty (60) degrees C. A Category 6 cable which meets this specification is BERK-TEK cat. no. 10177147 (pink) or equal as manufactured by AMP, AT&T, BELDEN, THE CABLE COMPANY, GENISIS, HITACHI, MOHAWK, NORTHERN TELECOM, OPTICAL CABLE CORP., PAIGE, or SUPERIOR.
2. Refer to Specification Section 16506 for low voltage three (3) conductor, No. 18 AWG, plenum rated wiring between lighting control panels and occupancy sensors.
3. Low voltage wiring for connections to photocells and contact closure switches to micro relay panels shall be three (3) conductors, No. 18 AWG, plenum rated with a temperature range for dry locations of minus ten (-10) degrees C to sixty (60) degrees C. A cable that will meet this specification is WEST PENN Cat. No. 25234B or equal by CONSULATED WIRE, GENERAL CABLE, PAIGE or TAPPAN.

PART 3 – EXECUTION

3.01 EQUIPMENT INSTALLATION

A. Control Module(s) – Gateway and Communication Bridges

1. Control module and associated communications bridges shall be securely mounted within the network lighting control enclosure at locations shown on Drawings.
2. The enclosure shall be mounted and grounded in accordance with the NEC. The Contractor shall furnish all materials necessary for mounting the enclosure(s).
3. During the construction process, protect all interior components of each network lighting control enclosure and each digital switch from dust and debris. Any damage done to electronic components due to non-protection shall be the sole responsibility of the Contractor.

B. Relay Panels

1. Before installing the Lighting Control Panels and relay control cabinets, check all of the Drawings for possible conflict of space and adjust the location of the relay control cabinet to prevent such conflict with other items. Relay control cabinet locations in electrical rooms and other spaces shall closely follow the layouts shown on the Drawings, leaving sufficient space on walls for future installations of panelboards and/or other electrical equipment.
2. Relay control cabinet shall be securely mounted to steel framing channels, by at least four (4) points, at locations shown on the Drawings. Construction shall be such that additional conduits can be added for future requirements.
3. The cabinets and enclosures shall be mounted and grounded in accordance with the NEC. This Contractor shall furnish all materials necessary for mounting the cabinets.
4. Relay control cabinets will generally be located adjacent to respective lighting panelboards unless otherwise shown on the Drawings. During the construction process, protect all interior components of each relay panel and each digital switch from dust and debris. Any damage done to electronic components due to non-protection shall be the sole responsibility of this Contractor.

C. Digital Switches

1. Provide outlet boxes, single or multi-gang as shown on the Drawings for the low voltage digital switches. All digital switches shall be ivory in color. Provide type 302 stainless steel coverplate for all switches. Provide labeling as indicated on the Drawings.

D. Digital Daylight Sensor

1. Photocell shall maintain an even light level of 50fc average across the task plane, unless otherwise noted in the sequence of operation. Photocell shall dim (2) zones of lights, the primary zone and secondary zone, if shown in classrooms. All other photocells shall be single zone. The primary zone shall be the closest to the window, and the secondary zone shall be the zone in the center of the room.

E. Digital Occupancy Sensor

1. It shall be the Contractor's responsibility to provide the quantity of occupancy sensors required for complete and proper volumetric coverage to completely cover the controlled areas. Rooms shall have ninety (90) to one hundred (100) percent volumetric coverage to completely cover the controlled areas to accommodate tall occupancy habits of single or multiple occupants at any location within the rooms. Proper judgement must be exercised in executing the work so as to ensure the best possible installation in the available space and to overcome local difficulties due to space limitations, interference of structural components, or furnishings in the room or spaces. The locations and quantities of sensors shown on the Drawings are based on coverage patterns of nLight (Acuity) sensors. Sensors of other approved manufacturers may require different quantities of sensors for full coverage of spaces being controlled. The sensors shown on the Drawings are diagrammatic and do not necessarily show the exact locations of the sensors. This Contractor shall confirm with the occupancy sensor's manufacturer the exact quantities of sensors and power packs at time of bid. This Contractor shall provide additional sensors if required to properly and completely cover the respective rooms at no additional cost to the Owner.
2. Digital wall switch type occupancy sensors shall be installed in a suitable wall outlet box in a method recommended by the equipment manufacturer similar to a standard line voltage light switch.
3. Low voltage occupancy sensors shall be securely mounted to a ceiling or wall mounted junction box in a method recommended by the sensor manufacturer. Ceiling mounted junction boxes shall be supported from the building structure with no less than one (1) ¼" threaded rod. Sensors

shall be wired as detailed on the Drawings and as recommended by the equipment manufacturer.

4. Power packs shall be located in accessible ceiling spaces and securely mounted to a standard electrical enclosure (junction box) through a standard ½" chase nipple. Each power pack shall be mounted to individual junction box. Power pack/junction box shall be labelled for easy identification. Plastic clips into the junction box shall not be acceptable. Junction box shall be supported from the building structure with no less than one (1) ¼" threaded rod. All Class 1 wiring shall pass through the chase nipple into the junction box without any exposure of wire leads. Low voltage Class 2 wiring to the sensors shall not be exposed in finishing spaces. Power packs shall be wired as detailed on the Drawings and as recommended by the equipment manufacturer.
5. Location of power packs shall be identified on the ceiling grid.
6. Supports shall not terminate or be fastened directly to the roof decking except where specifically approved by the Owner.

F. Wiring

1. All vertical wiring for the network Lighting Control Systems shall be installed by this contractor in conduit and/or surface metal raceway as shown on the Drawings.
2. All horizontal wiring for the network lighting control systems to be installed in areas without a ceiling or in areas without an accessible ceiling shall be installed by the Contractor in conduit sized for maximum 40% fill, but not less than ½" trade size.
3. All horizontal wiring for the network lighting control systems to be installed in areas with accessible ceilings shall be installed by this Contractor and run exposed above the ceiling. Cables shall be supported by 'J' hooks to be dedicated to the wiring specified in this Specification section.
4. All horizontal wiring for the network lighting control systems shall be run at right angles to the building structure.
5. All horizontal wiring for the network lighting control systems shall be installed below the roof/floor structural supports (joist, beams, girders, etc). Wiring installed between the structural supports mentioned above and the roof or floor deck will not be acceptable.
6. All horizontal wiring penetrations for the network lighting control systems

through new and/or existing walls shall be sleeved. Minimum sleeve size shall be $\frac{3}{4}$ inch. All sleeves shall be bushed on both sides. Cables pulled through sleeves without bushings, cut bushings, or wrapped with tape will not be accepted and shall be replaced by the Contractor.

7. All wiring for the network lighting control systems in millwork or casework only shall be installed in flexible metal conduit, complete with an additional 200-pound pull string.
8. All wiring for the network lighting control systems shall be furnished and installed by this Contractor as hereinbefore specified and as shown on the Drawings. All junction box covers shall be stenciled for distinct identification.
9. All low voltage RJ45 wiring connections shall be made by this Contractor as detailed on the Drawings using the 568A data only configuration. Cables shall be run free of splices from the equipment enclosures to the outlets.
10. All wiring shall be checked and tested by this contractor to ensure the system is free from grounds, opens and shorts. This Contractor shall provide test results for low voltage cables associated with lighting control systems.
11. Do not mix low voltage and high voltage conductors in the same conduits.
12. Ensure low voltage conductors, conduits or control wires do not run within four (4) inches parallel to current carrying conduits or cables.
13. Place manufacturer supplied 'terminators' at each end of the system bus per manufacturer's instructions.
14. Netaly lace and rack wiring in cabinets.
15. Plug Category 5e cable in all the indicated RJ45 port provided at each network lighting control device, per manufacturer's instructions.
16. Do not exceed 300 ft-wire length for the system bus.
17. All items on the bus shall be connected in sequence (daisy chained). Star and spur topologies are not acceptable.

3.02 INSTALLATION AND SET-UP

- A. Contractor shall test all low voltage cable for integrity and proper operation.
- B. Unused openings in the cabinets shall be effectively closed.

- C. Lugs shall be suitable and listed for installation with the conductor being connected.
- D. Neatly lace and rack wiring in cabinets. Conductor lengths shall be maintained to a minimum within the wiring gutter space. Conductors shall be long enough to reach the terminal location in a manner that avoids strain on the connecting lugs and maintain the required bending radius of conductors inside cabinets.
- E. Follow the manufacturer's torque values to tighten lugs.
- F. Before energizing the panel, the following steps shall be taken:
 - 1. Retighten connections to the manufacturer's torque specifications. Verify that required connections have been furnished.
 - 2. Remove shipping blocks from component devices and the panel interior.
 - 3. Remove debris from panel interior.
- G. Follow manufacturer's instructions for installation and for all low voltage wiring.
- H. This Contractor shall tag the cable at either end at the connection point. Label with the lighting control panel designation and room number designation. Labeling shall be done with a BROTHER® model no. PT-1400 (P-touch) professional label maker, or approved equal, using a laminated type extra strength adhesive tape. Letters/numerals shall be black with a white background.
- I. Power relay packs shall be securely mounted to a junction box through a threaded ½" chase nipple. Plastic clips into the junction box shall not be accepted. All Class 1 wiring shall pass through the chase nipple into the adjacent junction box without exposing of wire leads.

3.03 SERVICE, SUPPORT AND COMMISSIONING

- A. Preconstruction: Factory technician or factory trained rep shall meet with FCPS representative and Electrical Contractor to review project submittals, system requirements, and wiring best practices. Contractor shall coordinate meeting between all parties prior to start of construction.
- B. Start Up: This Contractor shall contact the system manufacturer at least 7 days before activation of the system. System gateway shall be connected to the school's Intranet network switch for connection to building LAN. This Contractor shall contact FCPS IT 14 days prior to startup for a dedicated IP address for each system gateway that will be assigned to the device during start up. Dedicated IP address shall be provided to factory technician, by this Contractor,

upon request.

- C. Upon completion of the installation of the entire lighting control system and prior to the substantial completion of the project, this Contractor shall have the system commissioned by an authorized system manufacturer's representative. This Contractor shall be responsible for participation and coordination within the commissioning process including but not limited to:
1. Verify proper installation and performance of the lighting control system.
 2. Provide a factory trained lighting control system technician/programmer for use during system verification and functional performance testing.
 3. Manipulate the lighting control systems to facilitate verification and performance testing.
 4. Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the Owner.
 5. Address current A/E punchlist items before functional testing.
 6. Correct deficiencies (differences between specified and observed performance) as interpreted by the CA, Owner and A/E and retest the equipment.
 7. On multi-phased projects, each phase shall have a separate startup by a factory trained lighting control system technician. Contractor to contact factory a minimum of 7 business days prior to technician being required to be onsite.
- D. Final Walkthrough: Factory technician or factory trained representative will be present for final systems walkthrough with Contractor and FCPS representative. Factory technician will be responsible for demonstrating that all spaces have been programmed according to the sequence of operation in the design documents. Contractor shall coordinate walkthrough at a time when the space can be unoccupied and both FCPS and factory technician can be present.
- E. System Database: At completion of system walkthrough, factory technician shall make available the programming database to FCPS.

3.04 CLEANING

- A. Remove debris from the lighting control panels, wipe dust and dirt from all components, and repaint marred surfaces with touch-up paint to match the original finish.

- B. Clean photocell lens as recommended by manufacturer.
- C. Clean all switch faceplates.

3.05 ON-SITE AS-BUILT DRAWINGS

- A. The Contractor shall provide one (1) set of the as-built lighting floor plans (including site lighting plans associated with this lighting control system) and one (1) set of the lighting control system supplier's point-to-point as-built wiring diagrams and supporting drawings as hereinbefore described for permanent use on-site. The Contractor shall: laminate each page of these drawings; provide a rigid means for mounting such as 1/4 inch thick x two (2) inch wide x width of the drawings through-bolted wood along the left edge of the drawings; furnish and install hanging hooks on the back of the main communication room door; and hang the bound set of drawings.

END OF SECTION

SECTION 16506

LIGHTING OCCUPANCY SENSORS

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work covered under this Section shall include furnishing and installing a complete operational occupancy sensor based lighting control system as shown on the Drawings, as detailed in the manufacturer's submittal and as herein specified.
- B. Work described in this section shall be coordinated with all applicable plans and specifications, including but not limited to, interfacing with microprocessor based lighting control systems, wiring, raceways, boxes and fittings, luminaires, and HVAC systems.

1.03 QUALITY ASSURANCE

- A. Occupancy sensors shall conform to the requirements of the National Electrical Code (NEC), state and local codes, and these Specifications.
- B. All components shall be listed by Underwriter's Laboratories, Inc. (UL) for their intended use and shall bear the UL label.
- C. Products supplied shall be from a single manufacturer that has been continuously involved in manufacturing of occupancy sensors for a minimum of five (5) years. Mixing of manufacturers shall not be allowed.
- D. Products shall be manufactured by an ISO 9002 certified manufacturing facility and shall have a defect rating of less than 1/3 of 1%.
- E. Wall switch products must be capable of withstanding the effects of inrush current. Submittals shall clearly indicate the method used.

1.04 SUBMITTALS

- A. Submittals are required in accordance with SECTION 16010 of these specifications. Submittals shall include, but not be limited to (comma) the following for review. Submittals not containing all of the information listed below

will be rejected.

1. Manufacturers shall substantiate conformance to this specification by providing the necessary documents, performance data and wiring diagrams. Any deviations to the specifications must be clearly stated by letter and submitted.
2. Submit a scaled building lighting plan (minimum size of 1/16" = 1'-0") clearly marked by the manufacturer showing proper product, location and orientation of each sensor and power pack (switch pack). Plans shall show detection coverage patterns. If necessary for clarity, provide a 1/8" = 1'-0" scaled plan or one plan with coverage areas shown and another plan with the other information shown. Illegible drawings will be rejected.
3. Submit interconnections diagrams per major subsystem and interfacing with lighting control panels (LCP) [Refer to SECTION 16500, showing proper wiring].
4. Submit standard catalog literature which includes performance specifications indicating compliance to the specification.
5. Catalog sheets must clearly state any load restrictions when used with electronic ballasts.

1.05 SYSTEM DESCRIPTION

- A. The objective of this specification section is to ensure the proper installation of the occupancy sensor based lighting control system so that lighting is turned off automatically after reasonable time delay when a room or area is vacated by the last person to occupy said room or area.
- B. The occupancy sensor based lighting control shall accommodate all conditions of space utilization and irregular work hours and habits.

1.06 SYSTEM TEST AND ACCEPTANCE

- A. Prior to the Architect/Engineer's final site visitation and acceptance of each construction phase, this Contractor shall conduct a complete operation test of each system including each device. The systems shall test free from grounds, shorts, and other faults. All connections shall be thoroughly checked for mechanical and electrical connection. All equipment shall be demonstrated to operate in accordance with the requirements set forth in these Specifications and as shown on the Drawings.
- B. This Contractor shall perform all tests in the presence of the Owner. This Contractor shall furnish all personnel for use in the tests.

- C. When the work on the system has been completed and is ready for final review, a visit shall be made by the Owner at which time the Contractor shall demonstrate that the requirements of the Contract as it applies to this system have been carried out and that the system has been adjusted and operated in accordance herewith.

1.07 Training

- A. Upon completion of the project, the Contractor and manufacturer's factory authorized representative shall provide a minimum of four (4) hours of training to familiarize the Owner with the operation, use, adjustment, and problem solving diagnosis of the occupancy sensing devices and systems.

1.08 WARRANTY

- A. This Contractor shall warrant all equipment furnished in accordance with this specification to be undamaged, free of defects in materials and workmanship, and in conformance with these Specifications. The warranty shall include repair or replacement, and testing without charge to the Owner on all or any parts of equipment which are found to be damaged, defective or non-conforming. There shall be no deductibles applied to such warranty. Satisfactory warranty documents shall be furnished. Refer to SECTION 01740 WARRANTIES AND BONDS.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. The lighting occupancy sensors shall be manufactured by SENSORSWITCH, as listed or equal by GREENGATE (COOPER CONTROLS), HUBBELL, or WATTSTOPPER.
- B. The listing of any manufacturer as "equal" does not imply automatic approval. This Contractor shall ensure submittals made are for sensors and associated equipment which meet or exceed the specifications included herein.

2.02 LIGHTING OCCUPANCY SENSORS

- A. Occupancy sensors shall consist of, but not be limited to the following:
 - 1. Sensing technology shall be passive infrared (PIR), MicroPhonics (or ultrasonic), dual technology having both PIR and MicroPhonics (or ultrasonic).
 - 2. Passive infrared sensors shall provide high immunity to false triggering

from RFI (hand-held radios) and EMI (electrical noise in the line). The PIR sensors shall have a multiple segmented Fresnel lens, in multi-tier configuration, with grooves-in to eliminate dust and residue build-up.

3. MicroPhonics shall be used in conjunction with PIR (passive infrared) sensing technology to enable a sensor to provide dual-technology sensing that is completely passive. MicroPhonics shall detect an occupant by detecting leading edge noises typical of human activity while filtering out building noises. The MicroPhonic sensing circuitry shall have automatic gain control to dynamically adapt to the sensor to its environment allowing it to filter out background noise.
 4. Ultrasonic sensors shall be able to adjust the detection threshold dynamically to compensate for constantly changing levels of activity and air flow throughout controlled spaces. Ultrasonic operating frequency shall be crystal controlled at 32 kHz within $\pm 0.002\%$ tolerance, or 40 kHz within $\pm 0.002\%$ tolerance to assure reliable performance and eliminate sensor cross-talk. Sensors using multiple frequencies are not acceptable.
 5. Dual technology sensors shall consist of PIR and MicroPhonics (or ultrasonic) technologies for occupancy detection.
 6. All sensors shall be capable of operating normally with electronic ballasts, PL lamp systems and rated motor loads.
 7. Coverage of sensors shall remain constant after sensitivity control has been set. No automatic reduction shall occur in coverage due to the cycling of air conditioner or heating fans.
 8. All sensors shall have readily accessible, user adjustable settings for time delay and sensitivity. Settings shall be located on the sensor (not the control unit) and shall be recessed to limit tampering. Time delay shall be set to 10 minutes for all sensors.
 9. In the event of failure, a bypass manual override shall be provided on each sensor. When bypass is utilized, lighting shall remain on constantly or control shall divert to a wall switch or lighting control panel until the sensor is replaced. This control shall be recessed to prevent tampering.
 10. All sensors shall provide an LED as a visual means of indication at all times to verify that motion is being detected during both testing and normal operation.
- B. Ceiling mounted room occupancy sensors shall be low voltage dual technology type consisting of passive infrared (PIR) and MicroPhonic (or ultrasonic) technologies with 360° coverage for large classrooms, open office spaces or areas up to 1600 square feet; SENSORSWITCH Model CM PDT 10. High

Humidity sensor called for in the drawings shall be SENSORSWITCH Model CM PDT LT. Sensors shall operate on 12 to 24 VAC or VDC and NEC Class 2 wiring. Each sensor shall be complete with one (1) power pack or two (2) power packs for rooms requiring two (2) lighting branch circuits. Rooms requiring multiple sensors may only require one (1) power pack for multiple sensors, where shown on the Drawings. Sensors shall also be equipped with an additional isolated relay.

1. Occupancy sensors shown on the Drawings to be powered from a lighting control panel generally will not require a power pack.
- C. Ceiling mounted (or wall mounted where shown on the Drawings) room occupancy sensors shall be low voltage dual technology type consisting of passive infrared (PIR) and MicroPhonics (or ultrasonic) technologies for directional one-way coverage for classrooms, offices or areas up to 1000 square feet; SENSORSWITCH Model WV PDT 16. High humidity sensor called for in the drawings shall be SENSORSWITCH Model WV PDT 16 LT. Sensors shall operate on 12 to 24 VAC or VDC and NEC Class 2 wiring. Each sensor shall be complete with one (1) power pack or two (2) power packs for rooms requiring two (2) lighting branch circuits. Rooms requiring multiple sensors may only require one (1) power pack for multiple sensors, where shown on the Drawings. Sensors shall also be equipped with an additional isolated relay.
1. Occupancy sensors shown on the Drawings to be powered from a lighting control panel generally will not require a power pack.
- D. Corridor and corridor lobby ceiling mounted occupancy sensors, refer to lighting control specification section 16500.
- E. Wall switch occupancy sensors shall be line voltage dual-technology passive infrared (PIR) and MicroPhonic (or ultrasonic) technology type with coverage of approximately 30 to 40 square feet for use in small utility/storage rooms, small toilet rooms, etc. as shown on the Drawings; SENSORSWITCH Model WSX PDT-IV. Sensors shall operate on 120 or 277 volts. Load rating shall be 0 to 800 watts ballast or tungsten at 120 volts and 0 to 1200 watts ballast at 277 volts. Sensor shall use zero-cross circuitry to detect when the sine wave crosses at the "zero-point" so as to minimize wear on the switching contact.
1. Contractor shall supply stainless steel cover plates, not the plastic cover plates that may be included in the switch packaging. See Specification Section 16130 for type.
- F. Wall switch occupancy sensors, with dual ON/OFF button switches and dual relays for controlling two lighting loads or circuits, shall be line voltage dual-technology passive infrared (PIR) and MicroPhonic (or ultrasonic) technology type with coverage of approximately 30 to 40 square feet for use in small utility/storage rooms, small toilet rooms, etc. as shown on the Drawings;

SENSORSWITCH Model WSX PDT 2P-IV. Sensors shall operate on 120 or 277 volts. Load rating shall be 0 to 800 watts ballast or tungsten at 120 volts and 0 to 1200 watts ballast at 277 volts.

1. Contractor shall supply stainless steel cover plates, not the plastic cover plates that may be included in the switch packaging. See Specification Section 16130 for type.

2.03 POWER PACKS AND AUXILIARY RELAY PACKS CONTROL UNITS

- A. Power packs shall accept 120 or 277 volts, be plenum rated, and provide Class 2 power to a minimum of two (2) occupancy sensors. Power packs shall be able to externally mount through a 1/2" knock-out on a standard electrical enclosure (junction box) and be an integrated, self-contained unit consisting internally of an isolated load switching control relay (load rated 20 amperes at 120 or 277 volts) and a transformer to provide low voltage power; SENSORSWITCH Model PP 20. Power pack shall provide a minimum of 150mA at 15 VDC to drive occupancy sensors and auxiliary relay packs.
- B. Power packs shall use zero-cross circuitry to detect when the sine wave crosses at the "zero-point" so as to minimize wear on the switching contact.
- C. Auxiliary relay packs shall be the same self-contained type unit as the power pack hereinbefore described, except shall not include a transformer; SENSORSWITCH Model SP 20. The auxiliary relay pack shall be used to control another lighting load with a different line voltage than the power pack. Auxiliary relay packs shall be powered from a power pack with 15 VDC.

2.04 ISOLATED RELAY

- A. Sensors hereinbefore described to include an isolated relay shall have the relay be internal with Normally Open, Normally Closed and Common outputs for use with lighting control panels (LCP), HVAC control, and other control options as shown on the Drawings. Sensors utilizing separate components or specially modified units to achieve this function shall not be acceptable.
- B. Corridor and other location occupancy sensors indicated on the Drawings to interface with a lighting control panel (LCP) shall have the isolated relay send a contact closure signal to the lighting control system. These sensors shall be powered from the LCP and not by a power pack. Operation of sensors in corridors and other areas where sensors are interfaced with the lighting control system shall operate in a manner such the lighting in the controlled areas is "held-on" during normal school operating hours. After normal schools hours, these controlled areas shall respond to the occupancy sensors for lighting control. See the Drawings and details for the sequence of operations via the LCP.

2.05 WIRING

- A. Low voltage wiring between occupancy sensors and power packs shall be three (3) conductor, No. 18 AWG, unshielded, plenum rated with a temperature range for dry locations of minus ten (10) degrees C to sixty (60) degrees C. A cable that will meet this specification is WEST PENN Cat. No. 25234B.
- B. Low voltage wiring between occupancy sensors and lighting control panels (LCP) shall be three (3) conductor, No. 18 AWG, unshielded, plenum rated with a temperature range for dry locations of minus ten (10) degrees C to sixty (60) degrees C. A cable that will meet this specification is WEST PENN Cat. No. 25234B.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. It shall be the Contractor's responsibility to provide the quantity of occupancy sensors required for complete and proper volumetric coverage to completely cover the controlled areas. Rooms shall have ninety (90) to one hundred (100) percent volumetric coverage to completely cover the controlled areas to accommodate all occupancy habits of single or multiple occupants at any location within the rooms. Proper judgment must be exercised in executing the work so as to ensure the best possible installation in the available space and to overcome local difficulties due to space limitations, interference of structural components, or furnishings in the rooms or spaces. The locations and quantities of sensors shown on the Drawings are based on coverage patterns of SENSORSWITCH sensors. Sensors of other approved manufacturers may require different quantities of sensors for full coverage of spaces being controlled. The sensors shown on the drawings are diagrammatic and do not necessarily show the exact locations of the sensors. This Contractor shall confirm with the occupancy sensors' manufacturer the exact quantities of sensors and power packs at time of bid. This Contractor shall provide additional sensors if required to properly and completely cover the respective rooms at no additional cost to the Owner.
- B. Line voltage wall switch type occupancy sensors shall be installed in a suitable wall outlet box in a method recommended by the equipment manufacturer similar to a standard line voltage light switch.
- C. Low voltage occupancy sensors shall be securely mounted to a ceiling or wall mounted junction box in a method recommended by the sensor manufacturer. Ceiling mounted junction boxes shall be supported from the building structure

with no less than one (1) 1/4" threaded rod. Sensors shall be wired as detailed on the Drawings and as recommended by the equipment manufacturer.

- D. Power packs shall be located in accessible ceiling spaces and securely mounted to a standard electrical enclosure (junction box) through a standard 1/2" chase nipple. Plastic clips into the junction box shall not be acceptable. Junction box shall be supported from the building structure with no less than one (1) 1/4" threaded rod. All Class 1 wiring shall pass through the chase nipple into the junction box without any exposure of wire leads. Low voltage Class 2 wiring to the sensors shall not be exposed in finished spaces. Power packs shall be wired as detailed on the Drawings and as recommended by the equipment manufacturer.
- E. Supports shall not terminate or be fastened directly to the roof decking except where specifically approved by the Owner.
- F. Wiring:
1. All low voltage field wiring in finished and unfinished spaces shall be installed by this Contractor in 1/2-inch conduit and/or surface metal raceway as shown on the Drawings or hereinbefore specified elsewhere. Conduit fill shall not exceed the conduit space capacity.
 2. All low voltage field wiring to be installed in areas without a ceiling or in areas without an accessible ceiling shall be installed by this Contractor in 1/2-inch conduit.
 3. All low voltage field wiring to be installed in areas with accessible ceilings shall be installed by this Contractor bundled together and run exposed above the ceilings. Bundles shall be supported by "J" hooks mounted not more than four (4) feet on center. "J" hooks shall be dedicated to the wiring specified in this specification section.
 4. All low voltage field wiring shall be run at right angles to the building structure.
 5. All low voltage field wiring shall be installed below the roof/floor structural supports (joists, beams, girders, etc.). Wiring installed between the structural supports mentioned above the roof or floor deck will not be acceptable.
 6. All low voltage field wiring penetrations through new and/or existing walls shall be sleeved. Minimum sleeve size shall be one (1) inch. All sleeves shall be bushed both sides.
 7. All low voltage field wiring for the occupancy sensor systems shall be furnished and installed by this Contractor. All junction box covers shall be

stenciled for distinct identification.

8. All wiring connections shall be made by this Contractor as shown on the Drawings and as recommended by the equipment manufacturer. Splices shall be made only in junction boxes.
 9. All occupancy sensor system wiring shall be checked and tested by this Contractor to ensure the system is free from grounds, opens, and shorts.
 10. Contractor shall test all low voltage cable for integrity and proper operation of the system.
- G. The Contractor shall arrange a pre-installation meeting with the occupancy sensors manufacturer's factory authorized representative, at the project facility to verify proper placement of sensors and installation criteria.

3.02 TESTING

A. Sensor Testing and Adjustment:

1. At the time of installation, the Contractor shall be responsible for testing and adjusting each sensor for proper detection of motion appropriate to room usage. The Contractor shall follow the testing and adjustment procedures as written in the installation instructions for each sensor model. **Note: Due to room conditions it may be necessary for the Contractor to make adjustments, change the location or type of sensor to obtain proper operation and coverage of the system in each room and should therefore make labor and material allowances for such changes and adjustments.**

END OF SECTION

SECTION 16512

INTERIOR L.E.D. AND EXIT LIGHTING

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work covered under this Section shall include furnishing and installing light-emitting diode (L.E.D.) luminaires (lighting fixtures) complete as shown on the Drawings, as described in the "Luminaire (Lighting Fixture) Schedule", and as herein specified.

1.03 QUALITY ASSURANCE

- A. This Contractor shall provide luminaires that are of a manufacturer engaged in the production of luminaires that are equal in material, design and workmanship. The manufacturer's luminaire shall have been in satisfactory commercial or industrial use for a minimum of three (3) years. The manufacturer's luminaire shall have been available on the commercial market during the three (3) year period.
- B. L.E.D. luminaires shall conform to the requirements of the National Electrical Code (NEC), state and local codes, and these Specifications.
- C. The luminaires shall be listed by Underwriters Laboratories, Inc. (UL) or listed by a nationally recognized testing laboratory acceptable to Fairfax County DPWES.
- D. Submittals are required in accordance with SECTION 16010 of these Specifications.

1.04 DESCRIPTION

- A. This Contractor shall furnish, assemble, and install L.E.D. luminaires complete with sockets, louvers, lenses, internal wiring, leads, trims, rings, frames, hangers, straps, reflectors, light engine, and power supply unit (driver) as applicable and required for a complete installation.
- B. Luminaires that require remote mounting of any components needed for its operation, such as drivers, or light engine electronics are not permitted. All components needed to make the luminaire operational shall be integral to the

luminaire housing.

1.05 WARRANTY

- A. This Contractor shall deliver the work described herein in a first class operating condition in every respect. This Contractor shall also warrant that the material and workmanship shall be entirely free from defects. Any materials, equipment, or workmanship in which defects may develop before or during the warranty period shall be repaired or replaced at the Contractor's own expense. Refer to SECTION 01740 for the start of the warranty period. The Contractor shall further warrant that all material, equipment, and workmanship used in the installation, but not specifically mentioned in the Drawings and Specifications, is the best of their respective kinds and that the construction and installation was performed in accordance with the best accepted standard practices in all details.

PART 2 - PRODUCTS

2.01 MATERIALS AND COMPONENTS

- A. The L.E.D. luminaires supplied shall have the proper trim, frames, mounting devices, configuration, and accessories necessary to be properly installed in the building construction. Catalog numbers of luminaires in the "Luminaire Schedule" or "Lighting Fixture Schedule" on the Drawings are to establish a type of luminaire and not to determine a method of mounting.
1. Catalog numbers scheduled on the Drawings may indicate luminaire compatibility with certain types of ceiling construction. The Contractor shall determine exact type of ceilings actually to be furnished in each area and shall obtain luminaires to suit, deviating from specified catalog numbers or descriptions only where necessary, and only to the extent necessary to ensure luminaire-ceiling compatibility. The Contractor shall notify the Architect/Engineer and Owner in writing where such changes are to be made.
- B. Where L.E.D. luminaires are specified on the Drawings to be complete with a flat diffusing lens, the lens shall be virgin acrylic Type 19 pattern with a minimum thickness of 0.156 inches unless otherwise shown on the Drawings.
- C. When L.E.D. luminaires are specified on the Drawings to be complete with a curved or rounded lens refractor/diffuser, the lens shall be impact resistant 100% virgin acrylic type with diffusing optical film.
- D. Double lock nuts shall be used at the load bearing ends of threaded pipe used as part of a stem mounting assembly.

2.02 POWER SUPPLY UNIT (DRIVERS)

- A. Luminaires shall be equipped with an L.E.D. driver(s) that accepts the voltage as indicated on the "Luminaire (Lighting Fixture) Schedule". Individual driver(s) shall be replaceable.
- B. Driver(s) shall be UL8750 class 2 compliant for their intended purpose.
- C. Total harmonic distortion (THD) for current: $\leq 20\%$
- D. Driver(s) shall be rated to operate between -30°C to 50°C minimum.
- E. Individual driver(s) shall be equipped with surge protection (2kV minimum) in accordance with IEEE/ANSI C62.4.1. Driver shall be protected against damage due to either an open circuit or short circuit fault condition on the driver output.
- F. Driver(s) shall have a minimum efficiency of 85%.
- G. Drivers shall deliver dimming to 1% light output from 0-10V control signal.

2.03 L.E.D. LIGHT SOURCE (LIGHT ENGINE)

- A. Individual light engine(s) shall be replaceable.
- B. L.E.D. light engine(s) shall have a minimum lifetime of 50,000+ hours at 25°C and shall have a minimum efficiency of 80 lumens per watt.
- C. L.E.D. dies shall be tested in accordance with I.E.S.N.A. LM-80-08 standards.
- D. Thermal management shall be passive by design and shall consist of heat sinks with no fans, pumps, or liquids.

2.04 SPARE PARTS

- A. The Contractor shall furnish to the Owner at the completion of the project, a minimum of 5% spare L.E.D. driver assemblies. LED drivers shall be turned over to the Owner representative in their manufacturer's protective packaging. LED drivers not in their protective packaging will not be acceptable.
- B. The Contractor shall furnish to the Owner at the completion of the project, a minimum of 5% spare L.E.D. light engine assemblies. LED light engines shall be turned over to the Owner representative in their manufacturer's protective packaging. L.E.D. light engines not in their protective packaging will not be acceptable.

2.05 EXIT LIGHTS

- A. Exit lights (signs) shall be universal mount and complete with factory installed light-emitting diodes (L.E.D.s) mounted behind a red diffusing panel and with direction arrows as shown on the Drawings.
- B. Exit lights shall have wire guards where shown on the Drawings.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. L.E.D. luminaires (lighting fixtures) shall be installed as shown on the Drawings and in accordance with the manufacturer's recommendations.
- B. Wall washer type L.E.D. surface mounted track light luminaires for illumination of white (marker) boards shall be located at a distance away from the wall to achieve the best illumination for the marker board. This Contractor shall refer to the luminaire manufacturer's published product literature to determine the optimum distances from the wall. Various ceiling heights may vary the distances.
- C. Recessed lay-in type linear L.E.D. luminaires shall be supported from the building structure independently of the ceiling grids with a minimum of four (4) steel tie wires per luminaire or as detailed on the Drawings.
- D. Recessed lay-in type linear L.E.D. luminaires installed in lay-in type ceiling tile shall be securely fastened from the building structure and be installed in the lay-in type ceiling in such a manner that the louver/lens housing may be easily opened and so that the luminaires may be removed and relocated without forcing the luminaires or changing the grid system tie wires. This Contractor shall coordinate with the ceiling installer before the ceiling grid is installed to ensure a mutually satisfactory installation of ceiling and luminaires.
- E. Recessed L.E.D. luminaires installed in "hard" ceiling systems (i.e. drywall, metal pan, etc.) shall be securely fastened from the building structure and be installed in such a manner that the louver/lens housing may be easily opened and so that the luminaires may be removed and relocated without forcing the luminaires or changing the ceiling support system. This Contractor shall coordinate with the ceiling installer before the ceiling is installed to assure a mutually satisfactory installation of ceiling and luminaires.
- F. Surface mounted linear L.E.D. luminaires shall be supported from the building

structure with a minimum of two (2) 1/4 inch threaded rods per each one (1) foot wide by four (4) foot long and a minimum of four (4) 1/4 inch threaded rods per each two (2) foot wide by four (4) foot long luminaire as detailed on the Drawings.

- G. Pendant/suspended luminaires shall be supported from the building structure with 1/4 inch threaded rods at each of the luminaires suspension points. Hardware connections to the threaded rods shall be listed components from the luminaire manufacturer and be specifically designed for the type of suspension called for on the Drawings. Installation shall be in accordance with the manufacturer's instructions.
- H. Recessed non-linear L.E.D. luminaires (i.e. downlights) located in lay-in type ceiling tile shall be mounted in the center of the tile or as shown on the Drawings and shall be supported by means of bar hangers extended across the main ceiling support members and also supported from the building structure with no less than one (1) 1/4 inch threaded rod per luminaire. Where luminaires are installed in slopped ceilings the luminaires shall be complete with appropriate slopped ceiling adapters.
- I. Surface mounted non-linear L.E.D. luminaires, track and exit lights shall be supported from the building structure with a minimum of two (2) 1/4 inch threaded rods per luminaire or exit light.
- J. 1-1/2 inch x 1-1/2 inch steel framing channel shall be used where required to span bar joists and otherwise facilitate structural support for luminaires and exit lights.
- K. Ceiling grid layouts when indicated on the electrical Drawings are for convenience only. This Contractor shall coordinate the luminaires layout with the Architect/Engineer and all other trades before the ceiling grid, air outlets, and luminaires are installed.
- L. L.E.D. luminaires installed in mechanical room and other similar equipment rooms shall be located in the field to clear all obstructions such as ducts, piping, bracing, and supports. Where the location of luminaires shown on the Drawings must be radically changed, approval from the Architect/Engineer shall be obtained before the luminaire is placed.
- M. Pendant mounted luminaires and exit lights shall be located to avoid mechanical systems, ductwork, piping, structural members, and the like.
- N. Supports shall not terminate or be fastened directly to the roof decking.

3.02 GENERAL CONFORMANCE

- A. Surface mounted luminaires shall not have gaps between the luminaire and attaching surface, except where required by code regulations or manufacturer's

instructions.

- B. Recessed luminaires shall not have gaps between the luminaire trim and the adjacent surface. Where light leaks occur, suitable gaskets shall be furnished and installed.
- C. Install luminaires level, plumb and true. Align rows accurately in three (3) dimensions.
- D. Where luminaires are to be installed in areas without ceilings, this Contractor shall furnish supports consisting of threaded rods and steel channels as required to have a finished mounting height of 8'-0" to bottom of the luminaire (or other mounting height as shown on the Drawings), unless pendant or chain mounting is indicated on the Drawings or Luminaire Schedule.
- E. Recessed luminaires shall be connected with flexible metal conduit or MC Cable (maximum 6'-0" length) from outlet boxes mounted above or alongside of luminaire. Luminaires shall be wired in such a way that removal of one shall not disrupt the continuity of power to the others.
- F. All luminaires designated for wet locations shall have sealed conduit entries. Any luminaire leaking water before or during the warranty period shall be repaired or replaced by this Contractor at no additional expense to the Owner.
- G. Prior to final inspection, this Contractor shall check all L.E.D. luminaires for damages during construction and replace the damaged luminaires where necessary at no additional expense to the Owner. All luminaires shall be cleaned at the time of final acceptance of the building.

END OF SECTION

SECTION 16542

EXTERIOR/SECURITY LED LIGHTING

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work covered under this Section shall include furnishing and installing exterior/security light-emitting diode (LED) luminaires complete as shown on Drawings, as described in the "Luminaires (Lighting Fixture) Schedule", and as herein specified.

1.03 QUALITY ASSURANCE

- A. This Contractor shall provide luminaires that are of a manufacturer engaged in the production of luminaires that are equal in material, design and workmanship. The manufacturer's luminaire shall have been in satisfactory commercial or industrial use for a minimum of three (3) years. The manufacturer's luminaire shall have been available on the commercial market during the three (3) year period.
- B. Exterior/security LED luminaires shall meet requirements of the National Electrical Code (NEC), state and local codes including Fairfax County's Outdoor Lighting Standards and these Specifications.
- C. The luminaires shall be listed by Underwriters Laboratories, Inc. (UL) or listed by a nationally recognized testing laboratory acceptable to Fairfax County DPWES.
- D. Submittals are required in accordance with SECTION 16010 of these specifications.
- E. In addition to the submittal requirements of Section 16010, submittals shall include but not be limited to the following:
 - 1. Complete point-by-point photometric footcandle calculations of the parking lots on a scaled plan(s) (scaled to match the electrical site plan). The scaled plan must include points thirty (30) feet beyond the property lines. The calculations must include contributions from the building mounted luminaires and the pole mounted site luminaires.
 - 2. Calculations must be based on "one (1) footcandle minimum maintained"

with no more than 0.5 footcandles at the property line with a maximum of 0.01 footcandles ten (10) feet beyond the property line and a "light loss factor" (LLF) of 0.85. Luminaire photometry shall be designed using the I.E.S.N.A. LM-79-08 absolute photometric principles for LED lighting. The 0.5 footcandles maximum at the property line(s) and 0.01 footcandles ten (10) feet beyond the property line(s) must not be compromised.

3. The exact quantities, locations, and I.E.S.N.A. photometric distribution types of pole mounted luminaires, may differ from the original basis of design layout, but the required footcandle levels must be maintained. Should the luminaire manufacturer require additional luminaires to achieve the stated footcandle levels and/or require additional branch circuit wiring, supports, poles, etc., in conjunction with these additional luminaires, this shall not cause additional expense to the Owner.
4. The Architect/Engineer may require changes to the submitted point-by-point photometric plans, if in their opinion the plans do not meet the requirements of this project or due to conflicts with other site issues not addressed in the submittal.

1.04 DESCRIPTION

- A. This Contractor shall furnish and install LED luminaires complete with proper reflectors, diffusers, louvers, glassware, concrete bases, gaskets, shims, wiring, control, conduit, hardware, photocontrols, and other appropriate devices and parts for a complete exterior weatherproof lighting installation. Adjustable luminaires shall be aimed as directed by the Architect/Engineer. Each luminaire shall be complete with prewired integral drivers and optical (LED) assemblies.
- B. Luminaires that require remote mounting of any components needed for its operation, such as drivers, or light engine electronics are not permitted. All components needed to make the luminaire operational shall be integral to the fixture housing.
- C. Luminaires shall have a minimum IP rating of IP65 or IP66.

1.05 WARRANTY

- A. This Contractor shall deliver the work described herein in a first class operating condition in every respect. This Contractor shall also warrant that the material and workmanship shall be entirely free from defects. Any materials, equipment, or workmanship in which defects may develop before or during the warranty period shall be repaired or replaced at the Contractor's own expense. Refer to SECTION 01740 for the start of the warranty period. The Contractor shall further warrant that all material, equipment, and workmanship used in the installation, but not specifically mentioned in the Drawings and Specifications, is the best of their respective kinds and that the construction and installation was performed in accordance with the best accepted standard practices in all details.

- B. All luminaires shall have a minimum five (5) year factory warranty for defective or non-starting power supply units (driver), and LED source assemblies, which includes, but not limited to: LED package, LED arrays, LED modules, LED die, encapsulate, and phosphor.

PART 2 - PRODUCTS

2.01 MATERIALS AND COMPONENTS

- A. Exterior/security LED luminaires supplied shall be complete with the proper reflectors, diffusers, house side shields, louvers, glassware, gaskets, pole arms, collars, shims, wiring, control, conduit, hardware, drivers, photocontrols, and other appropriate devices, parts and accessories to be properly installed for an exterior weatherproof lighting installation.

2.02 POLES AND STANDARDS

- A. Poles for LED luminaires shall be aluminum or as indicated on the Drawings with factory finish as shown in the "Luminaire (Lighting Fixture) Schedule". Aluminum poles shall be factory wrapped with heavy weatherproof paper for protection during handling and shipping.
- B. This Contractor shall furnish hot-dipped galvanized anchor bolts, templates, ground rods, conduit elbows, and base information, etc., for the installation of concrete bases as detailed on the Drawings.
- C. Poles shall be of the height and with brackets, etc. as indicated in the "Luminaire (Lighting Fixture) Schedule".
- D. All aluminum poles shall be seamless with all edges and parts factory polished and ground to a smooth congruous finish.
- E. Poles greater than twenty (20) feet in length shall be complete with vibration dampers installed.

2.03 POWER SUPPLY UNIT (DRIVERS)

- A. Luminaires shall be equipped with an LED driver(s) that accepts the voltage as indicated on the "Luminaire (Lighting Fixture) Schedule". Individual driver(s) shall be replaceable.
- B. Driver(s) shall be UL8750 class 2 listed for their intended purpose.
- C. Individual driver(s) shall be equipped with surge protection (6kV minimum for building mounted units and 10kV minimum for pole mounted units) in

accordance with IEEE/ANSI C62.4.1 and shall be rated for a category "C" environment.

- D. Driver(s) shall have a minimum efficiency of 85%.
- E. Driver(s) shall reliably start at minimum ambient temperatures from -40 deg. C to 40 deg. C with THD of $\leq 20\%$.
- F. Drivers shall deliver dimming to 10% light output from 0-10V control signal.

2.04 LED LIGHT SOURCE (LIGHT ENGINE)

- A. All LED light engine(s) shall be set to achieve IES, Type III, Type IV or Type V distribution as shown on the "Luminaire (Lighting Fixture) Schedule". Individual light engine(s) shall be replaceable
- B. LED light engine(s) shall have a minimum lifetime of 50,000+ hours at 40 deg. C and shall have a minimum efficacy of 80 lumens per watt.
- C. All LEDs shall be installed with 0 lumens above 90° up from nadir (full cut-off) performance.
- D. LED dies shall be tested in accordance with I.E.S.N.A. LM-80-08 standards.
- E. Thermal management shall be passive by design and shall consist of heat sinks with no fans, pumps, or liquids.

2.05 DIMMING CONTROLS

- A. Provide, in addition to the lighting control system, after hours dimming controls which reduces light levels to approximately 30% of full lumen output at a predetermined time. Controls shall be designed to fail to the "OFF" position. Dimming controls shall be compatible with the lighting control system. Refer to specification section 16505 or 16505A and details for lighting control system information.

2.06 SPARE PARTS

- A. The Contractor shall furnish to the Owner at the completion of the project, a minimum of 20% (minimum of 4) spare LED driver assemblies. LED drivers shall be turned over to the Owner's representative in their manufacturer's protective packaging. LED drivers not in their protective packaging will not be acceptable.
- B. The Contractor shall furnish to the Owner at the completion of the project, a minimum of 20% (minimum of 4) spare LED light engine assemblies. LED light engines shall be turned over to the Owner's representative in their manufacturer's protective packaging. LED light engines not in their protective packaging will not be acceptable.

2.07 FOUNDATIONS

- A. Pole base foundations shall be cast-in-place as detailed on the Drawings and as specified herein.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. The exterior/security LED luminaires shall be installed as shown on the Drawings and in accordance with the manufacturer's recommendations.

3.02 POLE LAYOUT

- A. This Contractor shall lay out all equipment and review locations with the Architect/Engineer and/or Owner prior to construction. Pole locations shall be set by using a metal tape to the exact locations shown on the Drawings.

3.03 POLE HANDLING AND ERECTION

- A. Transportation, site handling and erection shall be performed by qualified personnel with equipment and methods that are in accordance with standard industry practices.
- B. Prior to unloading the pole, shop drawings shall be reviewed to identify proper pick-up points for unloading, storage and erection procedures. A thru-hole shall be provided at the proper pick-up point for the purpose of inserting a steel bar to act as a stop to the cable choker when erecting the pole.
- C. Web fabric slings (not chain or cable) shall be used to raise and set structural members. Protect equipment during installation to prevent corrosion.
- D. Install poles and other structural units level, plumb and square. Orientation of the cast-in-place foundation anchor bolts in relation to the direction of the lighting must be checked carefully using the manufacturer's drawings, contract drawings and specifications.
- E. Pole steel base plates shall not be installed until concrete has reached the specified 28 day strength.
- F. After installation is complete, the Contractor shall plug with suitable semi-permanent material any alignment or installation aid or other unused holes or cavities in the poles to prevent them serving to harbor insects and to prevent

tampering. Material used shall be the same color as the pole.

3.04 SITE PROTECTION AND RESTORATION

- A. Protect existing site, plantings, trees, pavements, facilities, structures, grounds, playing fields, and all other site amenities designated or intended to remain, temporarily or permanently, from damage during demolition or construction activities, including delivery of poles and equipment. Repair items damaged during demolition or construction activities to their original condition, or replace with new, by qualified personnel and technicians, at no additional cost to the Owner. Repairs, reinforcement or structural replacement shall be approved by the Architect and/or Owner.
- B. Refer to Specification Section 02100 for additional requirements. **[Engineer, edit out if 02100 is not included in this project.]**

3.05 STORAGE

- A. Poles may be stored on-site (for a short time period) if they do not impact the day-to-day operations of the facility. Poles shall be placed on suitable supports.
- B. Luminaires, wiring, control equipment, etc. shall be stored off-site until they are ready for assembly and erection. On-site storage is permitted provided all items are stored in secure and DRY locations.
- C. This Contractor is responsible for any damage or theft to any materials left on-site.

3.06 FOUNDATIONS – CAST-IN-PLACE CONCRETE

- A. Foundations shall be poured in place concrete. Concrete foundations shall be constructed of not less than 3,000 psi.
 - 1. The steel reinforcement within the concrete shall be protected from slippage and exposure to oxidation through voids in the concrete or exposure of the steel through porous concrete material. Provide cover as specified in ACI-318.
- B. All exposed areas of concrete bases shall be trowel finished smooth and level with beveled edges. Top surface shall not vary by more than 1/8 inch in depth as measured across the widest surface. Concrete base forms leaving any imperfections shall be ground down to have a smooth finish. Concrete bases shall be finished to remove all concrete form imperfections. Refer to Specification Section 16010.

- C. All concrete shall be fully vibrated.
- D. Reinforcing steel shall meet ASTM A615 and Grade 60.
- E. Cast-in-place foundations anchor bolt projections must allow for the thickness of the base plate, nuts (including leveling nuts), and raking if required. Adjust leveling nuts before installing the pole. They should be in a horizontal plane.
- F. Reinforcing steel in cast-in-place foundations must not be welded to the anchor bolts. Care must be taken not to disturb the position of the anchor bolts while pouring concrete.
- G. Orientation of the foundation anchor bolts in relation to the direction of the lighting must be checked carefully using the manufacturer's drawings, contract drawings and specifications.

3.07 POLE/FOUNDATION EXCAVATION

- A. The Contractor may excavate by any means he prefers, insofar as these methods conform to these specifications. Holes shall be excavated with diameters not less than 8 inches greater than the largest dimension of the pole foundations being installed. Depth of pole holes shall be as detailed on the Drawings for cast-in-place foundations or as required for precast direct embedment units.
- B. The bottom of the pole holes shall be on undisturbed earth. If a pole hole is excavated to a depth greater than required, it shall be backfilled with specified crushed stone, placed in 6 inch layers, and thoroughly machine tamped to an approximate compaction of 95%.
- C. Backfill
 - 1. The backfill for poles and foundations shall be Virginia Department of Transportation (VDOT) specification 21-A bluestone placed from the bottom of the pole hole to a distance of 18 inches below the top of the hole and topped with excavated soil. All backfill shall be placed in 6 inch layers and each layer shall be thoroughly tamped to an approximate compaction of 95%.
 - 2. Subject to the Owner's approval, surplus material shall be uniformly spread at the site or removed and disposed of at this Contractor's expense. Care shall be taken that the spreading of surplus material does not result in the channeling of run-off water past pole locations.
 - 3. Follow up inspections for settlements are required. Should settlement occur, the Contractor shall be responsible for all necessary repairs.

3.08 LIGHTING CONTROL

- A. The exterior/security LED luminaires shall be controlled through the building lighting control system as shown on the plans. If the exterior/security LED luminaires are installed and energized prior to the lighting control system and/or prior to the lighting control system being properly programmed, this Contractor shall install **TEMPORARY** photo control sensor(s) for the lighting fixtures circuit(s) so that the exterior/security LED luminaires operate dusk till dawn. At no time shall the exterior/security LED luminaires operate 24 hours a day. Once the lighting control system is installed and properly programmed the **TEMPORARY** photo control sensors shall be removed.

3.09 FIELD QUALITY CONTROL

- A. Prior to final inspection, this Contractor shall check all exterior/security LED luminaires, poles and concrete bases for damage during construction and replace the damaged luminaires or poles and repair or replace the concrete bases where necessary at no additional expense to the Owner. All exterior/security LED luminaires shall be cleaned and complete with all light engines and drivers at the time of final acceptance of the building.
- B. Luminaires shall be checked for proper orientation on pole, proper reflector orientation, and proper IES distribution type.

END OF SECTION

SECTION 16545

SPORTS FIELD LIGHTING SYSTEM AND LIGHTING CONTROL SYSTEM

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work covered under this Section shall include furnishing and installing sports field lighting system(s), and sports field lighting control and monitoring system(s) complete as shown on Drawings and as herein specified.
- B. The sports field lighting systems shall include field lighting luminaires, egress/entry luminaires, and support structures to include: poles; foundations; crossarms; and other appurtenances, complete as shown on Drawings and as herein specified.
- C. The sports field lighting control and monitoring system shall be for the control of sports field lighting system(s) and other equipment as shown or indicated on the Drawings, detailed in the manufacturer submittal and as further defined herein. Contractor is solely responsible to verify quantity, installation locations and wiring requirements for this project.
 - 1. The systems shall include but not be limited to microprocessor controlled relay panels controlled via wireless communication based equipment, switches, and Digital Time Clock (DTC), and other devices to provide the required functionality of the system. The system shall also include contactors, cabinets, interface cards, and other devices or equipment as shown on the Drawings. Requirements are indicated elsewhere in these specifications for work including, but not limited to, raceways and electrical boxes and fittings required for installation of control equipment and wiring.
- D. Specific manufacturers' catalog numbers, when listed in this section are for reference only. It is the responsibility of this Contractor to verify with the lighting control manufacturer all catalog information and specific product acceptability.

1.03 DEFINITIONS

- A. Coefficient of Utilization (CU):

SPORTS FIELD LIGHTING SYSTEM AND LIGHTING CONTROL SYSTEM SECTION 16545

1. A measurement of the efficiency of a luminaire in transferring luminous energy to the field surface.
- B. Coefficient of Variation (CV):
 1. A measure of the weighted average of all relevant illuminance values. Defined by IESNA Lighting Handbook, Ninth Edition, Chapter 20.
- C. Design Documents:
 1. Documents, including drawings, calculations, and material and product specifications prepared to obtain acceptance by Owner and authorities having jurisdiction.
- D. Horizontal Illuminance:
 1. Illuminance measured in footcandles (FC), on a horizontal surface three (3) feet above the playing surface (ground), unless otherwise indicated.
- E. Illuminance:
 1. Concentration of incident light falling on a surface.
- F. LLD:
 1. Lamp lumen depreciation. The fractional loss of lamp lumens at rated operating conditions that progressively occurs during lamp operation.
- G. LLF:
 1. Light loss factor. Factor used to adjust lighting calculations from initial values obtained in a controlled laboratory environment to maintained values in actual field conditions.
- H. Support Assembly:
 1. Includes poles or other support structures, brackets, arms, appurtenances, base, anchorage, and foundation.
- I. Target Illuminance:
 1. Illuminance level used for calculations during system design to determine if the system meets a desired performance standard.
- J. Vertical Illuminance:

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1. Illuminance, measured in footcandles, in two (2) directions on a vertical surface, at an elevation coinciding with plane height of horizontal measurements, unless otherwise indicated.

1.04 LIGHTING PERFORMANCE

A. Illumination Criteria: **(ENGINEER; EDIT THE FOLLOWING TO SUIT PROJECT)**

1. BASEBALL/SOFTBALL

- a. Minimum Average Target Illumination: 50 FC infield and 30 FC outfield.
- b. Maximum-to-Minimum Uniformity Ratio: 2:1 infield or less and 2.5:1 outfield or less.
- c. CV: 0.17 or less infield and 0.21 or less outfield.

2. FOOTBALL/STADIUM*

- a. Minimum Average Target Illumination: 30 FC
- b. Maximum-to-Minimum Uniformity Ratio: 3:1 or less.
- c. CV: 0.25 or less.

3. TRACK AND FIELD*

- a. Minimum Average Target Illumination: 20 FC track (at surface of track) and 30 FC for field event areas and all areas inside the track.
- b. Maximum-to-Minimum Uniformity Ratio: 4:1 or less.
- c. CV: 0.3 or less.

*The football/stadium includes the track and field playing surfaces as well as other sports such as soccer and lacrosse. Stadiums shall have the entire area inside the track lighted to a minimum average target illumination of 30 FC and the track lit to a minimum average target illumination of 20 FC. FIELD EVENT areas (such as pole vaults, broad jumps, etc.) located outside of the track shall have these areas lit to a minimum average target illumination of 30 FC. This criterion is the same for standalone TRACK and FIELDS.

- B. Illumination Levels and Design Factors: Playing surfaces shall be lit to an average target illumination level and uniformity as specified in the chart below.

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Lighting calculations shall be developed and field measurements taken on the grid spacing with the minimum number of grid points specified below. Appropriate light loss factors shall be applied and submitted for the basis of design. Average illumination level shall be measured in accordance with the IESNA LM-5-04 (IESNA Guide for Photometric Measurements of Area and Sports Lighting Installations). Illumination levels shall not to drop below desired target values in accordance to IES RP-6-15, Page 2, Maintained Average Illuminance and shall be guaranteed for the full warranty period.

- C. Computer-analyzed illumination calculations shall include, but not limited to, the following:
1. Grid Pattern Dimensions: For playing areas of each sport and areas of concern for spill-light control, correlate and reference calculated parameters to the grid areas. Each grid point represents the center of the grid area defined by the length and width of the grid spacing. The grid pattern dimensions shall generally be 30 feet by 30 feet, unless indicated otherwise. Each grid point shall be considered a field test station for purposes of field testing described later in these specifications.
 2. Spill-Light Control: Minimize spill light for each playing area on adjacent and nearby areas. These levels shall be initial footcandles and shall be measured at a maximum distance of 150 **<edit distance if necessary>** feet from the boundary of the playing field(s).
 - a. Prevent light trespass on properties near the playing field(s) as defined by Fairfax County Lighting Ordinance 14-904, Fairfax County's Outdoor Lighting Standards and these Specifications.
 - b. For areas indicated on the Drawings as "Spill-Light Critical", limit the level of luminance directed into the area from any luminaire or group of luminaires, and measured 36 inches above finished grade to the following:
 - 1) Maximum Horizontal Illuminance: 0.5 FC.
 - 2) Maximum Vertical Illuminance from the direction of the greatest contribution of light: 0.3 FC.
 - c. Calculate the horizontal and vertical illuminance due to spill light for points spaced 20 feet apart in areas indicated on the Drawings as "spill-light critical" and 30 feet apart in other "non-critical" areas, to ensure that design meets above limits. Each spill-light point shall be considered a field test station for purposes of field testing described later in these specifications.

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3. Glare Control: Minimize direct glare in adjacent and nearby areas and properties. These levels shall be measured at a maximum distance of 200 **<edit distance if necessary>** feet from the boundary of the playing field(s).
 - a. The intensity of luminaires that may be observed at an elevation of 60 inches above finished grade from nearby areas and properties shall be less than 7,000 candelas when so observed.
 - b. The intensity of luminaires that may be observed at an elevation of 60 inches above finished grade from designated "spill-light critical" areas at nearby properties shall be less than 4,000 candelas when so observed.
 - c. Calculate and measure the glare points spaced 20 feet apart in areas indicated on the Drawings as "spill-light critical" and 30 feet apart in other "non-critical" areas, to ensure that design meets above limits. Each glare point shall be considered a field test station for purposes of field testing described later in these Specifications.
4. Luminaire Mounting Height: Comply with IESNA RP-6 with consideration for requirements to minimize spill light and glare. Luminaire mounting heights are to the lowest sports lighting luminaire measured above the playing field elevation.
5. Luminaire clusters shall be located outside of the playing field glare zones defined by IESNA RP-6-15.
6. Egress/Entry Lighting: Provide LED luminaires to provide a minimum of 1.0 FC illumination measured at grade in spectator and spectator egress/entry areas. These luminaires shall operate upon initial activation of the sports field lights and upon deactivation of the sports field lights. Momentary power interruptions shall activate the egress/entry lighting immediately following restoration of power to the lighting circuits. The duration of these lights illumination shall not be less than 15 minutes, for each occurrence stated above, and then automatically extinguished.

1.05 QUALITY ASSURANCE

- A. Sports field lighting systems and the control systems shall meet the requirements of the National Electrical Code (NEC), state and local codes, including Fairfax County's Outdoor Lighting Standards, and these Specifications.
- B. The entire sports field lighting system, which includes the support assemblies, shall be listed by Underwriters Laboratories, Inc. (UL) as a system as well as

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each individual component having its own UL listing or classification.

- C. The sports field lighting controls and monitoring system lighting control panels (LCP) shall be UL 916 Listed. LCP's controlling emergency operation by a relay panel shall fully comply with NEC 700.9(B). This Contractor is responsible for verifying compliance.
 - 1. Control wiring shall be in accordance with the NEC requirements for Class 2 remote control systems, Article 725 and manufacturer's specification and requirements.
- D. All materials used shall be new and of good quality conforming to these specifications and the successfully reviewed submittals. Any material not successfully reviewed by the Architect/Engineer that is incorporated in the work, used or delivered to the site, shall be immediately removed upon the order of the Owner or Architect/Engineer and replaced to the satisfaction of the Owner and Architect/Engineer at this Contractor's expense.

1.06 SUBMITTALS

- A. This Contractor shall furnish submittals for the **sports field lighting system(s)** in accordance with SECTION 16010 of these Specifications. Submittals for review shall include but not be limited to the following:
 - 1. Design Calculations for the following:
 - a. Target Illuminance(s).
 - b. Complete computer-generated point-by-point photometric calculations of horizontal and vertical illuminance, at minimum grid size and area for each sports field(s).
 - 1) The exact quantities of luminaires may differ from the original design, but the required footcandle levels, CV, uniformity ratios, spill-light and glare control must be maintained using the same design criterion shown on the drawings and/or specified herein. Should the luminaire manufacturer require additional luminaires to achieve the stated footcandle levels, uniformity and/or require additional branch circuit wiring, supports, support assembly, etc., in conjunction with these additional luminaires, shall not cause additional expense to the Owner.
 - c. Computer-generated spill/glare analysis in accordance with the lighting performance specifications.

- d. Total electrical load, in kilowatts, of lighting system and for each individual pole.
 2. Provide an aiming plan for each sports luminaire.
 3. Manufacturers must provide the first page of a photometric report for all luminaire types proposed showing horizontal and vertical axial candle power shall be provided to demonstrate the capability of achieving the specified performance. Reports shall be certified by a qualified independent testing laboratory with a minimum of five years experience or by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products. A summary of the horizontal and vertical aiming angles for each luminaire shall be included with the photometric report.
 4. Provide pole and foundation design drawings signed and sealed by a Professional Engineer registered in the Commonwealth of Virginia. Pole drawings shall indicate the design criteria, assumptions, codes, standards, and all foundation reaction forces and moments. Foundation drawings shall indicate the design criteria allowable soils bearing pressures, codes, standards, all foundation reaction forces and moments, construction specifications, materials, and specific installation requirements such as shoring or de-watering. For the purpose of this bid, the Contractor shall assume the following type of sub-grade material specified in the current adopted edition of the International Building Code, Section 1804, Table 1804-2 – Allowable Foundation and Lateral Pressure:
 1. Soils – Class 5 (clay and sandy clay)
 5. Provide data and drawings for all lighting system equipment, service platforms, crossarms and other accessories specified herein and as shown on the Drawings.
- B. This Contractor shall furnish submittals for all components of the **sports field lighting control and monitoring system(s)** in accordance with SECTION 16010 of these Specifications. Submittals for review shall include but not be limited to the following:
1. Shop Drawings: Submit dimensioned drawings of complete lighting control systems and accessories including, but not necessarily limited to, relay panels, switches, DTC, contactors, cabinets, and other interfaces. Shop drawings shall indicate exact location of each device. Plans shall be diagrammatical. "Cut Sheet" submittals not acceptable.

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2. Product Data: Submit for approval manufacturer's data on the specific lighting control and monitoring systems and components. Submittal shall be in both electronic and hard copy formats. To prevent departures from approved system operation, electronic file submitted shall be able to be directly downloaded to the specified system at the manufacturer's facility. Submit a complete bill of materials with part numbers, description and voltage specifications.
3. One Line Diagram: Submit a project specific one-line diagram of the system configuration indicating the type, size and number of conductors between each component. Submittals that show typical one-line or riser diagrams are not acceptable.
4. Schematics: Submit wiring schematics for switches and remote control system including all relays and contactors.
5. Programming Forms: Submit programming forms with complete information describing the operation of the lighting control system and all other information necessary to show proper operation of the system.

1.07 DESCRIPTION – SPORTS FIELD LIGHTING SYSTEM

- A. This Contractor shall furnish and install sports field luminaires complete with diffusers, louvers, glassware, gaskets, shims, wiring, control, conduit, hardware, driver, and other appropriate devices and parts for a complete exterior weatherproof sports field lighting system installation. Adjustable fixtures shall be aimed in accordance with the luminaire manufacturer's recommendations. Each luminaire shall be installed by this Contractor complete with the proper type of new lamp(s).
- B. Poles and support assemblies shall be designed and constructed so that all wiring and grounding facilities are concealed. All handholes, wire inlets/outlets, inserts for pole steps, thru-bolt holes and ground wire shall be cast or fitted into the pole during the manufacturing process.

1.08 DESCRIPTION – SPORTS FIELD LIGHTING CONTROL AND MONITORING SYSTEM

- A. The sports field lighting control and monitoring system shall be a microprocessor controlled wireless control system that controls and monitors the operation of sports field lighting. The system shall be comprised of lighting control panel(s), suitable cabinet enclosures, contactors, relays, TCP/IP communication link and control software to provide the required functionality.
 1. The system shall monitor lighting performance and notify the manufacturer if individual luminaire outage is detected so that appropriate maintenance can be scheduled. The manufacturer shall notify the Owner of outages within 24 hours, or the next business day. The controller shall

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determine switch position (Manual or Auto) and contactor status (open or closed).

2. The system shall allow the Owner and users with a security code to schedule on/off system operation via a web site, telephone, fax or email up to ten (10) years in advance. Manufacturer shall provide and maintain a two-way TCP/IP communication link. Trained staff shall be available 24/7 to provide scheduling support and assist with reporting needs. The Owner may assign various security levels to schedulers by function and/or fields. This function must be flexible to allow a range of privileges such as full scheduling and capabilities for sports fields, to only having permission to execute "early off" commands by telephone. The controller shall accept and store 7-day schedules, be protected against memory loss during power outages, and shall reboot once power is restored and execute any commands that would have occurred during said power outage.
3. Manufacturer of the systems shall include communications costs for the operation of the controls and monitoring systems for the length of the warranty and maintenance period.
4. Manufacturer shall provide a web-based database of actual field usage and provide reports by facility and user group.

1.09 ALTERNATIVE SYSTEMS

- A. Compliance to Specifications: Acceptance of alternative (substitution) systems or equipment does not negate the Contractor and the lighting and control manufacturer's responsibility to comply fully with the requirements of these specifications. Any exceptions to the specifications must be clearly stated in the 10-day Prior Approval submittal documents. Refer to specification sections 16010 and 01630.
- B. Lighting Performance Requirements: Manufacturer shall provide computer models guaranteeing the lighting performance, hereinbefore described under LIGHTING PERFORMANCE, for a period of 25 years. For alternative systems, scans for both initial and maintained light levels shall be submitted. All computer generated models shall also include the spill-light control and glare control criterion.
- C. Revised Electrical Distribution: Manufacturer shall provide revised electrical distribution plans to include any changes to the electrical service entrance, panelboards, branch circuits, wire sizing, etc. associated with an alternative system or equipment.
- D. Associated Costs: Contractor and the lighting system and controls manufacturer

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shall be responsible for any additional costs associated with an alternative system or equipment, including engineering costs from the Engineer of Record.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. It is the intent of these Specifications that the sports field lighting system and the sports field lighting control and monitoring system manufacturer be the same manufacturer in order to have a complete sports field lighting system and control system from a single manufacturer. Such firms shall be regularly engaged in the manufacture of sports lighting equipment and lighting control equipment and ancillary equipment, of types and capacities necessary to provide the required functionality, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Acceptable sports field lighting system manufacturers shall be: MUSCO LIGHTING, LLC (Light-Structure with TLC for LED) or approved equal.
- C. Acceptable egress/entry luminaire manufacturers shall be MUSCO LIGHTING, LLC (Light-Structure with TLC for LED) or approved equal or as shown on the Drawings.
- D. Acceptable hybrid steel pole with pre-stressed concrete foundation base manufacturers shall be MUSCO LIGHTING, LLC, or approved equal.
- E. Acceptable service platforms and crossarm brackets manufacturers shall be MUSCO LIGHTING, LLC or approved equal (if required).
- F. Acceptable sports field lighting controls and monitoring system manufacturers shall be MUSCO LIGHTING, LLC [Basis of Design] or approved equal.
- G. The listing of the above products and manufacturers does not constitute automatic approval or final acceptance. Products must meet the lighting performance and control requirements. It is the Contractor's responsibility to verify and document that any product selected from the above list does meet the requirements of these specifications.

2.02 LUMINAIRES

A. SPORTS LUMINAIRES

- 1. Light Control Luminaires: All LED luminaires shall utilize spill light and glare control devices including, but not limited to, internal shields, louvers and external shields. No symmetrical beam patterns are accepted. Color:

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The lighting system shall have a minimum color temperature of <5700K and a CRI of 75.

2. Manufacturer will supply all drivers and supporting electrical equipment
 - Remote drivers and supporting electrical equipment shall be mounted approximately 10 feet above grade in aluminum enclosures. The enclosures shall be touch-safe and include drivers and fusing with indicator lights on fuses to notify when a fuse is to be replaced for each luminaire. Disconnect per circuit for each pole structure will be located in the enclosure.
3. The mounting hardware shall be heavy-gauge steel protected by a weather-resistant coating. The mounting hardware shall be capable of allowing the floodlight to be moveable in all directions, containing degree markers and a repositioning stop. Each luminaire shall be pre-aimed. Each luminaire aiming location shall be verified in order to comply with IESNA recommendations. Each luminaire shall have a memory positioning device for automatic repositioning after re-lamping. To ensure added durability, luminaire visors/glare shields and platform/crossarm shall withstand 150 mph winds and maintain luminaire aiming alignment.

B. EGRESS/ENTRY WALK-WAY LUMINAIRES

1. Walkway luminaires shall be a heavy-duty, weather-resistant floodlight for operation of one (1) 400-1150 watt LED. The floodlight shall contain a complete optical assembly with 6x5 NEMA type beam spread (horizontal X vertical), prewired with leads for connection to the power source. The floodlight shall have a NEMA lamp identification decal. The floodlight shall be UL 1572 listed and labeled SUITABLE FOR WET LOCATIONS. Standard construction shall be IP55.
2. The floodlight shall include die-cast aluminum housing with an electrocoat paint finish, hinged front door frame, built-in aiming sight and ½-inch standard tapered pipe tread swivel mount. All external hardware shall be of a corrosion-resistant material or protected by a corrosion-resistant finish.
3. The optical assembly shall include a tempered, clear, heat and shock resistant door glass, a one-piece aluminum reflector and twin compressible sockets.

2.03 POLES

A. POLE STRUCTURES

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1. Pole structures shall be multi-sectional and shall consist of one of two types, but only one type may be selected for use on this project. The types of pole structures are as follows:
 - a. Hybrid steel and prestressed concrete multi-section pole with the prestressed concrete base foundation designed for direct embedment.
 - b. Steel multi-section pole with a cast-in-place concrete anchor bolt foundation.
2. Steel poles direct embedded and precast concrete poles are not acceptable.
3. Poles shall be designed considering the application of both dead load and wind load. The moment at any point along the length of the pole is to be the sum of moments resulting from dead loads and forces from wind loads. The wind force is to be computed by multiplying the specified wind pressure by the effective projected area (EPA) of the individual components.
4. The P-Delta secondary moments due to the deflected unbalance of the structure must be accounted for in the design and shown in the calculations submitted.
5. Poles shall be designed to meet AASHTO requirements for wind loading and shall be designed such that the deflection does not exceed 1.1% of the free height of the pole at its maximum EPA under a wind loading equivalent to $\frac{1}{2}$ the designated ultimate wind speed, including a 1.3 gust factor.
6. The natural frequency of the pole shall be limited to 0.8 cycles/sec. The manufacturer shall provide calculations verifying the above requirements.
7. Pole heights shall be determined to provide a mounting height above the playing field sufficient to meet the specified lighting requirements. Luminaire mounting heights are to the lowest mounted sports lighting luminaire(s) measured above the playing field, not the grade location of the pole(s).

Mounting Heights: To ensure proper aiming angles for reduced glare and to provide better playability, minimum mounting heights shall be as described below. Higher mounting heights may be required based on photometric report and ability to ensure the top of the field angle is a minimum of 10 degrees below horizontal.

# of Poles	Pole Designation	Pole Height
# of Poles	Pole Designation(s)	Pole Height
# of Poles	Pole Designation(s)	Pole Height

B. POLE MATERIALS for PRESTRESSED CONCRETE POLE BASES

1. The specification contained herein shall be for the prestressed concrete foundation portion of hybrid steel and concrete multi-sectional pole.
2. The concrete mix shall be designed to achieve a minimum 28-day compressive strength of 9,500 psi. Concrete test reports shall be kept per ASTM C-39. Cement shall conform to the latest requirements of Type I or III Portland Cement in accordance with ASTM-C150. Maximum size aggregate may be $\frac{3}{4}$ inch or 75% of the clear spacing between main reinforcing steel and surface of pole. Any water reducers, retarders, or accelerating admixtures shall conform to ASTM-C494. Water shall be free from foreign materials in amounts harmful to concrete and embedded steel.
3. Reinforcing Steel – Deformed steel reinforcement shall conform to requirements of ASTM A615 for Grade 60 Rebar.
4. Pre-stressing Steel – Pre-stressing steel reinforcement shall conform to uncoated 7-wire, stress relieved strand (including low relaxation) per ASTM-A416.
5. Spiral Reinforcement – Steel spiral reinforcement shall conform to the requirements of ASTM-A82 and shall not be less than .150 inch diameter. The pitch of the spiral steel shall not be greater than 4 inches or the radius of the pole, whichever is less.
6. Hardware – All structural steel shall conform to ASTM-A36 and be hot-dipped galvanized in accordance with ASTM-A123 or ASTM-A153 as applicable. Zinc alloy AC41A for inserts, handhole frames and covers, shall conform to ASTM-B240. All bolts, nuts, washers and other fasteners must be either stainless steel or hot-dipped galvanized to resist corrosion.
7. Manufacture of Pre-stressed Concrete Poles:
 - a. All manufacturing tolerances, details of reinforcement and finishes shall be in accordance with “Guide Specification for Prestressed Concrete Poles”, as published in the May-June, 1982 issue of the Journal of the Prestressed Concrete Institute.

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- b. Poles bases shall be prestressed concrete poles, manufactured by the centrifugal spinning process. Pole bases shall be round in cross section with a hollow center.
- c. Forms shall be designed to provide a continuous taper of +/- 0.16 inches per foot of length and provide a minimum of $\frac{3}{4}$ " of concrete coverage over the longitudinal steel.
- d. Pole bases shall have a smooth natural form finish, soft gray in color.
- e. The manufacturer shall have 10 years experience in the design and production of centrifugally spun concrete poles and be a "PCI-Certified Facility."
- f. All cable entry holes shall be free from sharp edges for passage of electrical wiring. All handhole frames shall be composed of rugged high density cast zinc.

8. Pole Accessories:

- a. A nameplate shall be cast into the wall of the pole approximately 5 feet above the ground line identifying the name of the manufacturer, overall length, weight, manufacturer date, class and fabrication number.
- b. A 3" x 12" or 4" x 10" conduit entrance opening shall be centered 18" below grade (depending on pole size).
- c. A 3.5" x 10.5" handhole frame with flush cover shall be centered approximately 36" above grade.
- d. A 2.5" x 8.5" handhole frame with flush cover shall be located 180 degrees from disconnect switches and/or electrical equipment cabinets that are pole mounted.
- e. All pole bases shall be provided with pull cordage to facilitate cable installation.
- f. Provisions shall be made for attaching and wiring any disconnect switches or other electrical components not covered herein but required to complete the project.

C. POLE MATERIALS for MULTI-SECTION STEEL POLES

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1. The specification contained herein shall be for full length multi-sectional steel poles or for the steel portion(s) of the hybrid steel and prestressed concrete foundation multi-sectional pole.
2. The pole shaft shall be constructed of low carbon, tapered tubular steel conforming to ASTM A595 Grade A or ASTM A572 Grade 65. A non-tapered section of pole conforming to ASTM A513 may be used at the top of the pole for luminaire crossarms and/or platforms. The overlap telescoping joint of pole sections shall be by slip fitting the top section over the lower section by a length that is the larger of 2 feet or 1.5 times the diameter of the inside of the female tube. All sections shall maintain a uniform taper from top to bottom.
3. There shall be at least one longitudinal seam weld in the tapered section of the shaft. The longitudinal seam weld shall have at least 60% penetration, except in the areas where the shaft section telescopes over another. In overlapping areas, the weld penetration shall be 100%. No circumferential weld splices may be used in fabricating the shafts.
4. The pole shaft shall be hot dip galvanized after fabrication to conform to ASTM A123. To ensure a high quality galvanized coating with good adherence, all steel components used for the pole shaft, luminaire crossarm, and other attachments must be of a steel content that conforms to ASTM A385.
5. All exposed steel components of the pole shall be at least 18 inches above the surface of the ground to avoid exposure of the steel to the heavily moisture and oxygen laden air, both above and below the surface. There shall be a cap to cover the top of the pole and covers for all access openings in the pole wall so that rain will not enter the interior of the pole. To avoid stress corrosion of the pole, there shall be no critical stress points of the steel portion of the pole within 18 inches of the ground.
6. All fasteners and attaching hardware shall either be stainless steel or be hot dip galvanized to conform to ASTM A153.
7. Hand holes shall be peripherally reinforced with flat bar which shall be integrally welded to the plate shaft. Hand holes shall be minimum 4" x 6" and located at each platform/crossarm level for use during installation and maintenance of electrical wiring. Hand holes shall also be located 180 degrees from each disconnect switch and/or electrical equipment cabinet that are mounted to the pole. One 4" x 10.5" hand hole shall be located two to six feet above finished grade with a ground lug welded inside the pole opposite this hand hole. Cover plates shall be included with each hand hole and attached to the pole with a black bar and screw.

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8. Top wiring shall be through a threaded coupling suitable for the diameter of the pole, with access by the way of a hand hole. A suitable wire hanger(s) shall be provided at top coupling locations for use with a wire mesh grip.
9. Pole assemblies which exceed 50 feet in height shall have an internal cable guide and strain relief mechanism, which is typically attached at the mid-height of the pole assembly. The cable guide assembly shall consist of an offset bar, steel pipe sleeve with internal PVC sheathing to reduce wear, and a handhole opposite the offset bar access.
10. Steel poles using a cast-in-place concrete anchor bolt foundation design shall have a base plate. The base plate shall be a structural quality hot rolled carbon steel plate that meets or exceeds ASTM A36 with a minimum yield of strength of 42,000 psi. The base plate shall telescope the pole shaft and have a circumferential weld on the top and bottom or shall have a full penetration butt weld with a back up bar. The anchor bolt holes shall be slotted and be a minimum $\frac{1}{4}$ " larger than the diameter of the anchor bolts used on the pole.
11. Anchor bolts shall be fabricated from a commercial quality hot rolled carbon steel bar that meets or exceeds minimum yield strength of 55,000 psi. Anchor bolts shall be sized according to each pole design and furnished with two (2) galvanized flat washers. Anchor bolts shall be galvanized a minimum of 6" on the threaded end in accordance with ASTM A153. Typically, the anchor bolts will ship with the poles.

C. POLE FIELD APPLIED LABELS

1. Labels shall be attached to each sports field lighting pole identifying each poles designation, as shown on the Drawings. Labels shall be pressure-sensitive type, suitable for exterior use. Labels shall have bright contrasting colors with letters minimum 2" high or greater. Locate labels at 10'-0" above finished grade on two sides of the poles, with one side visible from the field side. Poles located behind stadium bleachers or other structures shall have the labels located at a height visible from the field.
2. Labels shall be UV sunlight resistant.

2.04 FOUNDATIONS

- A. The sports field lighting system manufacturer shall provide foundation designs to suit their lighting system. Geotechnical information (boring logs) have been provided on the Boring Location Plan to assist in foundation design. **[Engineer to edit out last sentence if borings not taken]**

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- B. For purposes of this Bid, or in the absence of geotechnical information, the Contractor shall assume the following type of sub-grade material specified in the current adopted edition of the International Building Code, Section 1804, Table 1804.2 "Allowable Foundation and Lateral Pressure":
1. Soils – Class 5 (Clay and Sandy Clay).
- C. Foundation size, shape, depth of embedment, and backfill material shall be determined by the manufacturer's structural engineer. Manufacturer shall provide suitable concrete foundations to support anticipated pole loading based on load carrying capacity of existing soil conditions as hereinbefore described. The design of the support structure and foundation shall be signed and sealed by a licensed Professional Engineer registered in the Commonwealth of Virginia. The design shall include the following minimum requirements:
1. Use Broms safety factor of three (or IBC) in the foundation design.
 2. Foundation strength shall allow the concrete to harden on any concrete portions of the pole in which steel components that provide tension strength are contained, for a minimum of 28 days before design loads of pole attachment are applied.
 3. Concrete material:
 - a. Cast-in-place concrete foundations shall be constructed of not less than 3,000 psi.
 - b. Pre-stressed concrete poles as hereinbefore described.
 - c. The steel reinforcement within the concrete shall be protected from slippage and exposure to oxidation through voids in the concrete or exposure of the steel through porous concrete material. Provide cover as specified in ACI-318.
- D. Excavation is unclassified soil and includes excavation to sub-grade elevations indicated regardless of character of materials and obstructions.

2.05 SERVICE PLATFORM CAGE ASSEMBLY (If Required)

- A. Platform cages shall be provided on all sports field lighting poles, unless specifically shown on the Drawings as not requiring a platform cage. Poles that may be shown as not requiring a platform cage are based on a maximum of twelve (12) sports luminaires on stacked crossarms as described under CROSSARM ASSEMBLY below.
- B. Platform cages shall be OSHA APPROVED and shall be constructed from either

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tubing or angle iron members, which meets the minimum requirements of ASTM A53 Grade B and ASTM A36 respectively. Tubular members shall have silicone gasketed end caps.

- C. Top mounted platform cages shall be mechanically attached to the pole with plates meeting the requirements of ASTM A36 and connecting hardware meeting the requirements of ASTM A325.
- D. Side mounted platform cages shall be mechanically fastened to the pole with plates conforming to ASTM A36 and U-bolts fabricated from round stock conforming to ASTM A36. Additional side mounted assemblies may be permitted to establish correct quantity of luminaires.
- E. The platform floor shall consist of expanded aluminum grating and shall incorporate a hinged door for access to the platform. The hinged door shall be capable of closing prior to unlatching any safety climbing devices. Cage railings shall be constructed of flat bar stock or angle iron. Railings constructed of cable or steel rope materials will not be accepted. Cages shall also incorporate a bottom "kick-plate."
- F. The platform cage sections shall be powder coated aluminum in accordance with the requirements of ASTM A123 specifications. Each cage assembly must be completely coated, inside and out, in a single dip. Double dipping will not be permitted to prevent acid entrapment in compliance with USGA recommended practices. All miscellaneous connecting hardware shall be galvanized in accordance with ASTM A153 specifications.
- G. All wiring shall be factory pre-wired enclosed within the system assembly when required by the luminaire manufacturer's lighting system.
- H. For ease of maintenance, the system must be capable of re-lamping the luminaires from the front or rear of the assembly.

2.06 CROSSARM ASSEMBLY

- A. The crossarm assembly shall be hot dip galvanized in accordance with the requirements of ASTM A123 specifications. Each assembly must be completely coated, inside and out, in a single dip. Double dipping will not be permitted to prevent acid entrapment in compliance with USGA recommended practices. All miscellaneous connecting hardware shall be galvanized in accordance with ASTM A153 specifications.
- B. Crossarms shall be tubular type and shall meet the requirements above and shall be 4" x 2" x 1/8" tubular steel (FTY-46 KSI, ASTM A500 GRADE B) and welded to a 6" C-channel support structure. Crossarms using steel less than 1/8" are unacceptable and length shall not exceed 155". Crossarms shall be hot dip

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galvanized after fabrication. Angle iron crossarms or any kind will not be accepted.

- C. All wiring shall be factory pre-wired enclosed within the system assembly. No external wiring shall be accepted.

2.07 WELDING

- A. Welding shall be in accordance with AWS (American Welding Society) Structural Welding Code's most recent edition. Welders certified in accordance with the AWS Code shall perform welding. Welds shall be free of cracks and undercutting, and shall be 100% visually inspected with questionable areas inspected by the magnetic particle non-destructive process.

2.08 CLIMBING SYSTEM (If Required)

- A. Each pole shall have a climbing system, whether or not the pole includes a platform cage assembly. The climbing system shall incorporate pole steps, safety climbing cable, and harness.
 1. Pole step bolts shall be field installed. Each step shall utilize a minimum 5/8 inch diameter x 6.5 inch long carriage bolt. Each bolt shall attach by means of a "nut-holder" cast or welded into the pole. Steps shall start 12 feet from the finished grade and continue to within 18 inches of the platform/crossarm. The steps shall be alternately spaced staggered on 15 inch intervals, 90-120 degrees apart. The first set of steps and last two sets of steps shall be "doubled" without staggering.
 2. Safety climbing cable shall be 5/16 inch diameter, galvanized steel or stainless steel cable. The cable system shall incorporate a tension spring and intermediate cable guides(s) to insure the cable remains "tight" and offset from the pole shaft. Poles with a platform cage assembly shall have the cable transition into the caged platform assembly in a manner that does not require the climber to disengage the safety belt from the cable prior to entering the caged platform and closing the door.
 3. The safety harness assembly shall be OSHA approved for climbing sports lighting support structures. The belt, lanyard, and respective attachment hardware shall be appropriate for the safety cable and step system. One (1) safety harness assembly shall be provided for each sports field lighted system.

2.09 WIRING HARNESS

- A. Strain Relief – The wiring harness shall be supported at the top of the pole by a stainless steel wire mesh grip matched to the size of the harness. There shall be not more than 13 conductors supported by a single wire mesh grip. An interim

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wire mesh grip support shall be located approximately halfway down the pole.

- B. Strain Relief Slippage – There shall be protection around the conductors, in addition to the insulation, to protect from damage from the wire mesh grip and also to avoid slippage of the grip on the wire harness. The wire mesh grip shall also be clamped to the harness with a cable tie at the bottom of the grip to avoid loosening.
- C. Pole Attachment – The wire mesh grip shall be mechanically attached to the pole with an enclosed mounting loop so that it cannot be accidentally removed in any direction.
- D. Spiral Winding – The harness being supported by the wire mesh grip shall consist of multiple #14 A.W.G. (minimum) conductors rated at 600V with 90°C insulation and shall be continuously spiral wound and bound with Mylar wrap to prevent slippage of individual conductors within the wiring harness. Additionally, a cable tie shall be tightly wrapped around the harness at not more than 10-foot increments.
- E. Abrasion Bumper – There shall be provided at 2 feet below the wire mesh grip and then at not more than 10-foot intervals along the entire length of the wire harness an abrasion protective bumper device of soft, durable abrasive resistant material not less than 2 inches in diameter attached around the wiring harness to protect the harness from striking and being abraded by the interior surface of the pole.
- F. Labeling – All wiring harness conductors shall be color-coded and clearly labeled.
- G. Plug-ins – Each end of the wire harness shall be terminated into a plug-in device with conductors sequenced consistent with the pattern of the wiring schematic provided by the Manufacturer.
- H. Testing – All conductors and plug-in devices shall be tested for resistance under load for continuity, schematic sequence, and for insulation integrity. Manufacturer shall ship a copy of the test results with the wire harness.
- I. Grounding – There shall be included, within the wiring harness, one conductor for use as a grounding conductor. The grounding conductor shall be equal in size to the load carrying conductors.

2.10 ELECTRICAL COMPONENT ENCLOSURE (ECE)

- A. The ECE shall be a NEMA 3R rated, gasketed enclosure to house the drivers, fuses, terminal strips, disconnect switch and distribution lugs.

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- B. The ECE shall be divided into two (2) compartments. The upper compartment shall house the drivers and fuses. The lower compartment shall provide for the thermal magnetic circuit breaker, distribution lugs, and connection of all circuits coming into and out of the ECE.
- C. NEMA 3R rated aluminum enclosure powder coated.
- D. All latches, hinges and non-current carrying fasteners, outside or inside the enclosure, shall be stainless steel and shall further be coated with a clear thermoset polymer coating such as Empigard to prevent galvanic interaction.
- E. The access door of the ECE shall be attached by a full-length stainless steel hinge and shall be secured, when closed, by lockable stainless steel latches.
- F. The ECE shall attach to the pole by means of a device, which is sufficient to align the ECE and support its weight. There shall be a sealed joint with a non-threaded connection to provide wiring access from the pole to the ECE for both the primary and secondary circuits. The connection shall be gasketed for watertight protection. All wire passages shall be protected to prevent wire abrasion or damage.
- G. There shall be provided, within the ECE, a UL listed disconnect switch such that electrical power to all equipment on the pole served by the three-phase feeder circuit shall be disengaged by the operation of one switch. The disconnect switch shall be located in a compartment separated from any capacitors or drivers.
- H. The circuit breaker shall provide landing lugs for the conductors that provide power to the pole.
- I. There shall be provided by the Manufacturer a set of distribution terminal blocks, which shall be factory wired from the breaker to the blocks. These blocks shall provide for termination of all driver connection wiring.
- J. There shall be provided an individual fuse for each driver conductor except neutral conductors which shall not be fused or switched. Fusing must be UL listed. In-line fusing will NOT be acceptable.
- K. All luminaire circuits in the ECE shall be color-coded and labeled and shall be terminated into a UL recognized plug-in device in the lower compartment of the ECE in a manner suitable for plug-in to the wiring harness.
- L. The wiring harness circuits from the luminaires shall be attached to the ECE circuits by UL recognized plug-in connectors.
- M. There shall be provided, in the ECE located in the lower compartment of the

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enclosure, one equipment-grounding lug rigidly fastened to the enclosure, sized to accept up to a 1/0 conductor. There shall also be provision in the upper compartment for a ground terminal of sufficient size to permit connection of the grounding conductors from the capacitors and the ground wire from the wiring harness.

- N. There shall be an individual driver for each luminaire. The drivers shall be located remote from the luminaire cross arm and shall be placed approximately 10 feet above ground level. The driver box must be a NEMA 3R enclosure and must be manufactured by the luminaire assembly manufacturer and all hardware shall be included with the driver box assembly. The remote driver system described above shall be located on the same pole as the luminaire assembly in the NEMA 3R enclosure. The assembly design shall be adaptable to various standard ballasts and must retain its U.L. listing.
- O. The manufacturer shall provide an electrical schematic of the ECE circuits, which schematic shall be of a durable material and affixed to the inside of the ECE door for use by maintenance personnel.
- P. The ECE shall be attached to the pole with the lower end approximately 10 feet above grade.
- Q. The ECE shall be listed by UL both for use with 90°C-rated supply conductors and as suitable for use in wet locations.
- R. Comply with ANSI C82.4 and be capable of starting at a temperature of minus 30 degrees Celsius.

2.11 IN-GROUND CAST HANDHOLES

- A. Provide open bottom in-ground cast handhole at each pole location and at location(s) shown on the drawings.
- B. Each in-ground cast handhole shall be approximately 18 inches (length) x 11 inches (width) x 18 inches (depth) with a skid resistant cover.
- C. The bases and covers for the handholes shall have a load of 22,568 lbs. minimum over a 10 inch square with a minimum test load of 33,852 lbs. The top of the box shall fit flush with the finished grade.
- D. The base and covers shall be as manufactured by QUAZITE series "PG" or approved equal.

2.12 LIGHTING CONTROL SYSTEM – MATERIALS and COMPONENTS

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- A. The sports field lighting control and monitoring equipment shall include cabinets to house all lighting control panels (LCP), contactors, switches, terminals, digital cellular communications equipment and lighting controls required to control the sports field lighting system(s) as shown on the Drawings and as specified herein.
- B. Off-On-Auto switches shall be utilized to manually over-ride the lighting control system. One switch shall be required for each lighting zone or system. Switches shall be supplied with on, off, and auto nameplates and labels clearly identifying the zone by field or location.
- C. The lighting system shall be controlled via remote system. In addition to the remote system, On/Off pushbutton control stations (user switch) shall be provided to allow users to turn the sports field lighting system(s) on and off from the field. These on/off controls shall be provided in a weatherproof NEMA 3R pad-lockable box and located as shown on the Drawings. This user switch will allow the users to turn the lights on or off whenever the system is enabled by the remote system, on-site digital keypad, or time clock. The digital keypad enabling switch shall be located within the same weatherproof box as the On/Off control station, unless otherwise noted.
- D. The remote lighting system shall include Digital Cellular Communication equipment using wireless technology avoiding both the ongoing and installation costs of utilizing telephone land lines at remote sites. The system shall utilize publicly available wireless communication infrastructure avoiding the cost associated with installing and maintaining a private wireless infrastructure.
 - 1. Digital Cellular Communication equipment shall have a main power switch for servicing convenience and safety.
- E. The remote lighting control system shall also meet the following:
 - 1. A security-code based, 24-hour, remote control system that enables Owner and/or authorized user to remotely enable the system on or off, control the sports field lighting schedule, and monitor the system, using telephone and web based or software driven computer.
 - 2. The remote control system shall be protected against power outages and memory loss, shall reboot to real-time once power is restored, and execute any commands issued prior to the power outage.
 - 3. The remote control system shall monitor and provide reports of actual lighting system luminaire usage.
 - 4. On-site equipment shall include manual Off-On-Auto switches to allow for maintenance and manual operation.

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5. System shall be capable of operating any given field from multiple computers via the Internet.
 6. Zones shall have one or more outputs assigned to them, with the ability to have any outputs assigned to any zone. Outputs shall have the ability to be assigned to multiple zones.
 7. System shall have delay-off capability on a per zone basis whereby some of the lighting for a given zone is turned off at the end of the lighting schedule time or the local user switch is turned to the off position, and the balance of the lights are turned off a number of minutes later (user definable), for safety and convenience.
 8. LCPs shall allow for user settable overrides on an independent basis for each zone whereby the override is set for either duration of time or set to be cancelled at a specific time decided by the user. If the override is canceled for any reason, the underlying schedule shall run as normal. The override capabilities shall be available to the user remotely or manually at the field.
- F. Manual Off-On-Auto Selector Switches
1. For on-site manual control, three position selector switches (Off-On-Auto) shall be factory-mounted in the Lighting Contactor Cabinet.
 2. The OFF-ON-AUTO switches shall operate as follows: The three position switch shall control each lighting zone. In the OFF position all contactors are open and the local user switch is locked out. In the ON position all contactors are closed independent of or in conjunction with the position of the local user switch. In the AUTO position, the system is under control of the remote control signal or the time clock and the local user switch is active. The contacts on the OFF-ON-AUTO switch shall be make-before-break so that the switch may be moved between ON and AUTO without de-energizing the circuit.
- G. An adequate number of lighting control panels (LCP) shall be supplied to control the required number of zones of control for this project.
- H. LCP's shall utilize dry-contact type outputs for switching the control voltage to the lighting contactors.
- I. LCP's shall incorporate the appropriate control mechanism to control the type of lighting contactors; regardless of whether the lighting contactors are continuous electrically held, mechanically held latching and unlatching (continuous power OK), mechanically held latching and unlatching (requiring momentary power), etc; all combined within the same LCP if required.

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- J. LCP's shall permit the downloading of all data within the unit for analysis via laptop computer or PDA.
- K. Override control may be achieved either via the remote manual control switches at the LCP's, or computer; none of which shall be mutually exclusive of the other (e.g., the user may set an override via Web Access, then cancel later at the keypad at the LCP's); all available 24 hours per day, 7 days per week, and all without the user having to contact manufacturer.
- L. In *addition* to utilizing Web Access for scheduling, the user shall be able to contact Manufacturer support team 24/7 to enter schedules and request last minute changes.
- M. The lighting control system shall automatically adjust for changes in Daylight Savings Time and changes in sunset and sunrise times, on a stand-alone basis not reliant upon a computer or some other system transmitting the information to the units.
- N. UL listed power supply shall be non-linear switching-type power supply.

2.13 LIGHTING CONTROL SYSTEM CABINETS

- A. The Lighting Control and Monitor Systems equipment shall be housed in suitable cabinets, including lighting contactors. The manufacturer shall determine the quantity of cabinets needed for this project.
 - 1. Lighting contactors shall be housed in a separate cabinet. The contactor cabinet shall contain custom configured contactor modules for 20, 30, 60, and 100 amps, labeled to match field diagrams and electrical design. Manual On-Off-Auto selector switches shall be provided as hereinbefore described. Refer to the Drawings for specific contactor sizes.
 - 2. As an option, the contactors may be located within the Lighting Control and Monitoring Cabinet provided there is adequate space. However, all the contactors per system must be located in a single cabinet.
- B. The final complete cabinet(s) with all electrical components shall bear the UL label.
- C. The cabinet(s) shall be designed and produced to meet the criteria noted in this document. The supplier shall be capable of producing a premium grade product, which meets the quality, fit and finish noted in this document. The use of CNC (Computer Numerical Control) equipment is preferred. The supplier's shop shall be approved to produce UL listed products.

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- D. The cabinet(s) and doors shall be constructed to meet NEMA 1 standards. The cabinets shall have ventilation as required for the lighting controls and monitoring equipment and contactors.
- E. All materials shall be new.
- F. Unless otherwise noted, cabinet(s) shall be fabricated from 5052-H32 sheet aluminum of at least 1/8-inch thick. Alternate materials may be considered.
- G. All materials shall be corrosion resistant for extended life.
- H. The cabinet(s) and doors shall be fabricated to plus or minus 10-thousandths of an inch tolerance for proper fit. All bending shall be done using a suitable break press.
- I. Connecting hardware screws, bolts, washers, nuts, etc. shall be stainless steel. The screws shall be stainless steel pan-head machine screw type. No sheet metal or self tapping screws shall be permitted.
- J. Welding:
 - 1. All exterior seams shall be of continuously welded construction. All welds shall be free of slag and spatter. All exterior welds shall be ground smooth.
 - 2. The supplier shall have suitable credentials to weld aluminum and shall adhere to all applicable ANSI standards.
 - 3. The supplier shall use a suitable welding process and materials.
- K. Doors shall be designed for maximum strength and snug fit. It is the supplier's responsibility to design and fabricate the doors to the fit and finish required in this specification. Doors shall be fabricated out of a single sheet of aluminum and have wrap-around return for strength and fit.
- L. All equipment mounted in the cabinet shall be mounted on an inner wall.

2.14 LIGHTING CONTROL SYSTEM EQUIPMENT LABELING

- A. All products shall be labeled (inside) with the supplier's company name, model number, panel rating and the date of manufacture.
- B. The supplier shall also provide adhesive Lamicoid or vinyl labels on the inside of each cabinet for each component. Each contactor and output circuit shall also be labeled in accordance with the lighting design.

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- C. All ID labels shall have ¼" to ½" high black characters on a white background.
- D. All wiring shall be labeled with computer generated sleeve type wire markers.

PART 3 - EXECUTION

3.01 LAYOUT

- A. This Contractor shall layout all equipment and review locations with the Architect/Engineer and/or Owner prior to construction. Poles shall be laid out based on pole locations on the suppliers lighting layout drawing. Pole locations shall be set by using a metal tape to the exact locations shown on the drawings (+/- 2 feet).

3.02 POLE HANDLING AND ERECTION

- A. Transportation, site handling and erection shall be performed by qualified personnel with equipment and methods that are in accordance with standard industry practices.
- B. Prior to unloading the pole, shop drawings shall be reviewed to identify proper pick-up points for unloading, storage and erection procedures. A thru-hole shall be provided at the proper pick-up point for the purpose of inserting a steel bar to act as a stop to the cable choker when erecting the pole.
- C. Web fabric slings (not chain or cable) shall be used to raise and set structural members. Protect equipment during installation to prevent corrosion.
- D. Step bolts, safety cable and internal wiring may be installed while the pole is in a horizontal position on the ground. If the service platform/crossarms are to be attached prior to erection, the pole tip must be supported to prevent undesirable deflection.
- E. Install poles and other structural units level, plumb and square. Orientation of the prestressed concrete pole base or the cast-in-place foundation anchor bolts in relation to the direction of the lighting must be checked carefully using the Manufacturer's drawings, contract drawings and specifications.
- F. For base plate style poles, the steel shall not be installed until concrete has reached the specified 28 day strength. For direct bury prestressed concrete foundations the steel pole portion shall not be installed until backfill has reached 98% of the specified compaction all around the prestressed foundation as per ASTM D698.
- G. After installation is complete, the Contractor shall plug with suitable semi-

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permanent material any alignment or installation aid or other unused holes or cavities in the poles to prevent them serving as harboring for insects and to prevent tampering. Material used shall be the same color as the pole.

3.03 SITE PROTECTION AND RESTORATION

- A. Protect existing site, plantings, trees, pavements, facilities, structures, grounds, playing fields, and all other site amenities designated or intended to remain, temporarily or permanently, from damage during demolition or construction activities, including delivery of poles and equipment. Repair items damaged during demolition or construction activities to their original condition, or replace with new, by qualified personnel and technicians, at no additional cost to the Owner. Repairs, reinforcement or structural replacement shall be approved by the Architect and/or Owner.
- B. Refer to Specification Section 02100 for additional requirements. **[Engineer, edit out if 02100 is not included in this project.]**

3.04 STORAGE

- A. Poles and foundations may be stored on-site (for a short time period) if they do not impact the day-to-day operations of the facility. Poles and bases shall be placed on suitable supports.
- B. Luminaires, platforms, crossarms, wiring, electrical enclosures and control equipment shall be stored off-site until they are ready for assembly and erection. On-site storage is permitted provided all items are stored in secure and DRY locations.
- C. This Contractor is responsible for any damage or theft to any materials left on-site.

3.05 FOUNDATIONS

- A. Foundations shall be the directly embedded pre-stressed concrete or cast-in-place concrete (directly embedded steel in ground is not acceptable). The foundation shall have suitable conduit entrance holes and wiring access hand holes and shall have a suitable wire way into the pole.
- B. Top of cast-in-place concrete bases shall be trowel finished smooth and level with beveled edges. Top surface shall not vary by more than 1/8 inch in depth as measured across the widest surface.
- C. All concrete shall be fully vibrated.
- D. Reinforcing steel shall meet ASTM A615 and Grade 60.

- E. Cast-in-place foundations anchor bolt projections must allow for the thickness of the base plate, nuts (including leveling nuts), and raking if required. Adjust leveling nuts before installing the pole. They should be in a horizontal plane.
- F. Reinforcing steel in cast-in-place foundations must not be welded to the anchor bolts. Care must be taken not to disturb the position of the anchor bolts while pouring concrete.
- G. Steel poles shall have grout in the void between pole base and foundation. Use approved non-shrinking or expanding concrete grout firmly packed in entire void space. Use a short piece of ½ inch diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

3.06 POLE/FOUNDATION EXCAVATION

- A. The Contractor may excavate by any means he prefers, insofar as these methods conform to these specifications. Holes shall be excavated with diameters not less than 8 inches greater than the largest dimension of the pole foundations being installed. Required depth of pole holes shall be as recommended by the pole manufacturer and the support assemblies Professional Engineer.
- B. The bottom of the pole holes shall be on undisturbed earth. If a pole hole is excavated to a depth greater than required, it shall be backfilled with specified crushed stone, placed in 6 inch layers, and thoroughly machine tamped to an approximate compaction of 95%.
- C. All excavations must be free of loose soil and debris prior to foundation installation and concrete pour and backfill placement.
- D. Backfill:
 - 1. Prestressed concrete foundations shall include poured concrete backfill. Temporary casings or drillers slurry may be used to stabilize the excavation during installation. Casings must be removed during concrete backfill placement. Concrete backfill must be placed with a tremie when slurry or water is present within the excavation or when the free drop exceeds 6'-0".
 - 2. Cast-in-place foundations backfill shall be Virginia Department of Transportation (VDOT) specification 21-A bluestone placed from the bottom of the pole hole to a distance of 18 inches below the top of the hole and topped with excavated soil. All backfill shall be placed in 6 inch layers and each layer shall be thoroughly tamped to an approximate compaction of 95%. The soil backfill shall be banked and tamped around

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the poles/foundations to a height of 12 inches above the finished grade.

- E. Subject to the Owner's approval, excavated surplus material shall be uniformly spread at the site or removed and disposed of at this Contractor's expense. Care shall be taken that the spreading of surplus material does not result in the channeling of run-off water past pole locations.

3.07 LIGHTNING PROTECTION/GROUNDING

- A. Manufacturer shall provide lightning grounding as defined by NFPA 780 and be UL listed per UL 96 and YL96A.
 - 1. Integrated grounding via concrete encased electrode grounding system.
 - 2. If grounding is not integrated into the structure, the manufacturer shall supply grounding electrodes, copper down conductors, and exothermic weld kits. Electrodes and conductors shall be sized as required by NFPA 780. The grounding electrode shall be minimum size of 5/8 inch diameter and 8 feet long, with a minimum of 10 feet embedment. Grounding electrode shall be connected to the structure by a grounding electrode conductor with a minimum size of 2 AWG for poles with 75 feet mounting height or less, and 2/0 AWG for poles with more than 75 feet mounting height.

3.08 IN-GROUND HANDHOLES

- A. Excavation
 - 1. Excavation for the handhole shall be approximately eight inches deeper than the depth of the handhole box. The bottom of the hole shall be on undisturbed earth. Provide eight to ten inches of gravel for drainage.
 - 2. Box shall be placed in the excavated hole with the top level with the finished grade.
- B. Backfill
 - 1. Backfill around the box shall be with excavated soil placed in six-inch layers and each layer thoroughly tamped to approximate compaction of 95%.

3.09 LIGHTING CONTROL SYSTEMS EQUIPMENT INSTALLATION

- A. Lighting Control Panels

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1. Before installing the sports field lighting control and monitoring systems equipment check all of the Drawings for possible conflict of space and adjust the location of the system's equipment to prevent such conflict with other items. Equipment locations shall closely follow the layouts shown on the Drawings, leaving sufficient space for installations of panelboards and/or other electrical equipment.
 2. Equipment shall be securely mounted at locations shown on the Drawings. Construction shall be such that additional conduits can be added for future requirements.
 3. The cabinets and enclosures shall be mounted and grounded in accordance with the NEC. This Contractor shall furnish all materials necessary for mounting the cabinets.
 4. Lighting control equipment will generally be located adjacent to respective lighting panelboards. During the construction process, protect all interior components of each relay panel and each digital switch from dust and debris. Any damage done to electronic components due to non-protection shall be the sole responsibility of this Contractor.
- B. Pull boxes and wireways may be used for ease of field wiring and trouble shooting. All wireways shall have removable covers.
- C. Switches: Provide outlet boxes, single or multi-gang, as shown on the Drawings for the control switches. Provide coverplates for all switches.
- D. Wiring:
1. All vertical wiring for the lighting control systems shall be installed by this Contractor in conduit and/or surface metal raceway as shown on the Drawings.
 2. All horizontal wiring for the lighting control systems to be installed in areas without a ceiling or in areas without an accessible ceiling shall be installed by this Contractor in minimum ½ inch conduit.
 3. All horizontal wiring for the lighting control systems shall be run at right angles to the building structure.
 4. All wiring for the lighting control systems shall be furnished and installed by this Contractor as hereinbefore specified and as shown on the Drawings. All junction box covers shall be stenciled for distinct identification.

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5. All low voltage wiring connections shall be made by this Contractor accordance to manufacturer recommendations. Cables shall be run free of splices from the equipment enclosures to the outlets.
6. All wiring shall be checked and tested by this Contractor to insure the system is free from grounds, opens, and shorts.
7. Do not mix low voltage and high voltage conductors; power limited and non-power limited in the same conduit.
8. Ensure low voltage conductors, conduits or control wires do not run parallel to current carrying conduits.
9. All control wiring shall be labeled in accordance with the schematic diagram.

E. Terminal Blocks:

1. Terminal blocks, fuses, relays, etc. shall be din-rail mounted.
2. Output wiring shall be connected via terminal blocks to accept field wiring.
3. Terminals for bonding conductors shall also be provided.

F. Installation and Set-up

1. Verify that conduit for line voltage wires enters the panel in line voltage areas and conduit for low voltage control wires enters the panel on low-voltage areas. Refer to manufacturer's plans and approved shop drawings for location of line and low-voltage areas. It is the responsibility of this Contractor to verify with the lighting control manufacturer all catalog information and specific product acceptability.
2. Unused openings in cabinets shall be effectively closed.
3. Lugs shall be suitable and listed for installation with the conductor being connected.
4. Neatly group, lace and rack wiring in cabinets. Conductor lengths shall be maintained to a minimum within the wiring gutter space, but long enough to allow for future changes within the cabinet without splicing. Conductors shall be arranged in a manner that avoids strain on the connecting lugs and maintain the required bending radius of conductors inside cabinets.

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5. Follow the manufacturer's torque values to tighten lugs.
6. Follow manufacturer's instructions for installation and for all low voltage wiring.

G. Service and Support

1. Start Up: This Contractor shall contact the manufacturer at least 7 days before activation of the system. Manufacturer shall remotely connect into the lighting control system, run diagnostics and confirm system programming. This Contractor shall be available at the time to perform any corrections required by the manufacturer.
2. Telephone factory support shall be available at no additional cost to the Contractor or Owner both during and after the warranty period. Factory shall pre-program the lighting control system per plans and approved submittal, to the extent data is available. The specified manufacturer, at no added cost, shall provide additional remote programming via Web Access as required by the Contractor or Owner for the operational life of the system.

3.10 FIELD QUALITY CONTROL

- A. Inspect each installation for damage. Replace damaged luminaires and components. All luminaires shall be cleaned and completely lamped and wired.
- B. Before energizing the system, the following steps shall be taken:
 1. Retighten connections to the manufacturer's torque specifications. Verify that required connections have been furnished.
 2. Remove shipping blocks from component devices and panel interiors.
 3. Inspect each installed unit for damage. Replace damaged components.
 4. Remove debris from the panels and cabinets, wipe dust and dirt from all components, and repaint marred surfaces with touch-up paint to match the original finish.
- C. After installation and connection of sports field lights to their permanent power supply, the Contractor shall verify supply voltages and currents at the disconnecting device in the electrical enclosure and at the main circuit breaker. Branch circuit and feeder voltage drop shall not exceed three (3) percent. Ensure that the three phases are balanced between phases at each support structure to minimize flicker. Measurements shall be taken phase to phase.

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- D. Prior to the Architect/Engineer's and/or Owner's final site visitation, and acceptance of each construction phase, this Contractor shall conduct a complete operating test of each system, including each device. The system shall test free from grounds, shorts, and other faults. All connections shall be thoroughly checked for mechanical and electrical connections. Replace or repair damaged and malfunctioning units, make necessary adjustments, and retest. Repeat procedure until all units operate properly.
- E. This Contractor shall perform all tests in the presence of the Architect/Engineer and/or Owner. This Contractor shall furnish all personnel and test instruments for use in the tests. Give advance notice of dates and times for field tests to the Architect/Engineer and Owner and coordinate a mutually agreed time and date. All equipment shall be demonstrated to operate in accordance with the requirements set forth in these Specifications and as shown on the Drawings.
- F. Testing and Measuring of Field Illuminance
 - 1. Contractor shall perform proof-of-performance field measurements and analysis for compliance with lighting requirements hereinbefore described in Part 1.04 LIGHTING PERFORMANCE. Initial footcandle readings for the sports lighting luminaires shall be taken after 100 hours of operation.
 - 2. Field measurements shall be taken on appropriate grid spacing test stations and at the appropriate spill-light and glare points test stations. Test stations shall be the points hereinbefore specified in the "Lighting Performance" section.
 - 3. Ambient light levels shall be measured at the specified test stations with the facility luminaires turned off. Once the maximum spill-light readings have been recorded, subtract the ambient light readings from the respective footcandle readings at each test station to determine spill-light due to facility luminaires only.
 - 4. Testing equipment for measuring footcandle levels shall be a Gossen Panlux meter or equal. Meter must show proof of calibration as required by its manufacturer.
 - 5. After all photometric testing has been completed, a final report shall be provided to the Architect/Engineer and the Owner. This report should indicate footcandle levels taken on the playing field, spill-light locations (including and deducting ambient light levels at spill-light locations), candela levels for glare measurements at the spill-light locations, total number of hours on the system, average initial illumination as tested, CV and uniformity ratios. Report shall also include computer-generated values. Computer-generated values shall use Manufacturer's lamp lumens that are adjusted to lamp age at time of field testing.
 - 6. Correcting Non-Conformance – If, in the opinion of the Architect/Engineer

SPORTS FIELD LIGHTING SYSTEM AND LIGHTING CONTROL SYSTEM SECTION 16545

and/or Owner, the actual performance levels and uniformity do not meet the requirements of the performance specifications and submitted information, the Contractor shall be liable to any of the following:

- a. Contractor shall, at his expense, provide and install any necessary additional luminaires and/or re-aim luminaires so that specified levels are achieved. If additional luminaires are installed the Contractor shall also either replace the existing poles to meet the new wind load (EPA) requirements or verify by certification by a licensed Professional Engineer registered in the Commonwealth of Virginia that the existing poles will withstand the additional wind loading.
- b. Contractor shall remove the entire unacceptable lighting system and install a new lighting system to meet the specifications.

3.11 WARRANTY AND MAINTENANCE REQUIREMENTS

- A. This Contractor shall deliver the work in a first-class operating condition in every respect.
- B. The Contractor/lighting system and controls system manufacturer shall warrant that the material, equipment, and workmanship furnished shall be entirely free from defects for a minimum 25-year warranty period. Any material, equipment, or workmanship in which defects may develop before or during the warranty period shall be repaired or replaced at the Contractor/Manufacturer's own expense. Refer to SECTION 01740 for the start of the warranty period.
- C. In addition to the Warranty Provisions, the sports field lighting and controls system manufacturer shall provide a signed maintenance agreement covering the entire lighting and control systems for a minimum period of 25 years. The maintenance agreement shall guarantee light levels; luminaire replacements; monitoring; communications; maintenance and control services; spill-light control, and structural integrity. During the maintenance period the manufacturer shall:
 1. Maintain lighting levels for the entire field(s) being lit.
 2. All repairs shall be completed within seventy-two (72) hours of notification, unless otherwise approved by the Owner.
- D. Manufacturer shall maintain specifically-funded financial reserves for this project to assure fulfillment of the warranty and maintenance for the full term. Warranty may exclude fuses, storm damage, vandalism, abuse and unauthorized repairs or alterations. Warranty may not exclude means and methods to access any part of the lighting and controls systems.

3.12 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. At the completion of the installation, this Contractor shall furnish four (4) final sets of “as-built” drawings as well as manuals of instruction as to the proper operation and maintenance of the sports field lighting system and control system.
- B. The “As-Built” documentation shall include wiring diagrams for the lighting control and monitoring systems. Diagrams must indicate exact mounting location of each system and their devices. This accurate “as built” shall indicate the loads controlled by each relay and contactor and the identification number for that relay and contactor, and placement of switches. Original shall be given to Owner, copies placed inside the door of each lighting control cabinet.
- C. This Contractor shall also furnish the Architect/Engineer four (4) bound copies of complete operating and maintenance instruction manuals of the complete sports field lighting system and the sports field lighting control and monitoring system. These manuals shall include factory service manuals with complete parts lists, wiring and component schematics including circuit diagrams, programming forms with complete information and all other information necessary for proper operation, service, and maintenance of the systems.

3.13 TRAINING

- A. This Contractor shall furnish the Owner’s officially designed representative(s) with a minimum of four (4) hours of on-the-job instructions in the operation, maintenance, and testing of the systems, using the factory operation manuals previously specified, for proper operation, maintenance and testing of the systems. The lighting controls supplier shall undertake all required set-up, programming, testing, commissioning and training of the Owner’s Representative as required for the proper operation of the lighting control and monitoring system.
- B. This Contractor shall furnish four (4) hours of operating and programming training to the Owner’s operating staff to be scheduled at the Owner’s convenience during the warranty period.
- C. All training specified herein shall be performed by a factory certified technician.

END OF SECTION

SECTION 16550

AUDITORIUM LIGHTING CONTROLS AND PERFORMANCE LIGHTING SYSTEMS

PART 1 – GENERAL

1.01 REQUIREMENT

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work covered under this Section shall include the materials and equipment necessary for this Contractor to furnish and install the house and stage lighting control system, emergency lighting transfer system, stage theatrical lighting instruments, and stage lighting equipment herein specified. It shall also include the services of qualified field engineer/technicians regularly employed by the manufacturer of the system who shall review the installation to ensure its proper operation and provide Owner training.
- B. The auditorium lighting controls and performance lighting systems shall be furnished by a factory authorized theatrical contractor/distributor (TC/D) certified to design, program and service the systems. The theatrical contractor shall be responsible for coordination between the electrical installation and other trades installing theatrical equipment and for control terminations, system startup, system training, and warranty repair. A TC/D is defined as a dealer who regularly engages in the sale and installation of theatrical supplies and equipment. The TC/D must show evidence of successfully furnishing theatrical systems specified for at least five (5) years.
- C. The TC/D shall furnish all necessary equipment as hereinafter detailed for a complete and functional house and stage lighting control system including the stage theatrical lighting instruments. Although not every component is called out in every detail, it shall be the responsibility of the manufacturer providing the system to assure that the intended function is furnished.
- D. The system specified herein shall consist of a relay-per-circuit high density dimming system equipment rack, performance lighting control console, E1.31 ANSI based network signal distribution system, distribution equipment, stage theatrical lighting instruments, and all required interconnecting wiring.
- E. The TC/D shall furnish and install in accordance with the lighting control manufacturer's instructions, all conduits, wiring, and outlet boxes required for the erection and operation of the complete system(s) as herein specified and as

shown on the Drawings.

- F. The house and stage lighting control system shall be supplied as a single integral unit with all dimmer modules, control circuits, circuit breakers, and the like factory wired. Field wiring shall consist of connecting input feeders, dimmer circuits, and remote control wiring to the distribution devices and control console.
- G. It is the intention of this specification section that the entire house and stage lighting control system be available to all bidders and not "Packaged or Bundled" with any other lighting systems or equipment.

1.03 QUALITY ASSURANCE

- A. The TC/D shall furnish submittals for all components of the house and stage lighting and lighting control system in accordance with SECTION 16010 of these Specifications. The submittals should include, but not be limited to the following:
 - 1. Manufacturer's catalog data for all lighting instruments, equipment, and components that shall include all technical data to demonstrate conformance with these Specifications.
 - 2. Complete physical drawings of all items of equipment showing dimensions, metal gauges, etc.
 - 3. Complete load schedules which shall clearly indicate actual connected loads and control channel assignment (where applicable), cross-reference of internal equipment identifications to circuit numbers shown on the Drawings, and all other scheduled information which shall relate the equipment to the project requirements. The schedules shall also clearly identify those circuits that are on the emergency lighting transfer system.
 - 4. Complete internal and interconnection wiring diagrams showing number, size, and types of conductors between equipment and from equipment to loads, and feeder quantity and sizes.
- B. All materials used shall be new and of good quality conforming to these specifications and the successfully reviewed submittals. Any material not successfully reviewed by the Architect/Engineer that is incorporated in the work, used or delivered to the site, shall be immediately removed upon the order of the Owner or Architect/Engineer and replaced to the satisfaction of the Owner and Architect/Engineer at this Contractor's expense.
 - 1. It shall be this Contractor's responsibility to include costs incurred in other trades for any work disarranged by such replacements described above. This will include replacement of work and damaged equipment during the progress of construction.

- C. The lighting control system equipment specified herein shall be the sole responsibility of a single manufacturer. The manufacturer shall have been producing theatrical lighting and SCR type lighting control systems for at least fifteen (15) years without changes in ownership.
- D. All work shall be in accordance with good engineering practices. All equipment for this system shall be listed by Underwriter's Laboratories, Inc. (UL), bear the UL label, and shall be installed in accordance with all requirements of the National Electrical Code (NEC), state and local codes, and these Specifications.
- E. The entire house and stage lighting control system shall be completely factory assembled and tested under load conditions prior to shipment of the system.
- F. All equipment provided within this specification shall have a minimum five year warranty from date of turn on.
- G. **(ENGINEER, USE THIS ONLY WHEN ADDING TO OR MODIFYING AN EXISTING SYSTEM)** Prior to any work being performed on the existing system, the entire house and stage lighting control systems shall be completely tested under load conditions. The test shall include each device on the existing system. The Contractor shall certify the operating condition and report any abnormal conditions to the Owner.

1.04 QUALIFICATIONS

- A. The Contractor and the theatrical contractor/distributor shall be required to furnish satisfactory proof of their competence as evidenced by successfully completed previous contracts where control equipment of this nature has been specified.
- B. The Contractor shall visit the site, and be familiar with the Drawings outlining this work. The Contractor shall be completely familiar with the various items of equipment being furnished under other Divisions of these Specifications related to this work. This Contractor shall make all necessary investigations relative to the conditions that may be encountered on this project.

1.05 SPARE PARTS

- A. Spare parts shall be furnished to the Owner prior to the installation of the system.
- B. The Contractor shall furnish spare parts for the system as follows:
 - 1. One (1) switch

2. One (1) P-TS7 7" LCD touchscreens.
 3. Two (2) spare motorized relays for motorized breaker panels (Sensor)
 4. Two (2) spare relays and two spare breakers for commercial relay panel. (Echo)
 5. One (1) spare power supply for architectural processor.
 6. One (1) spare fuse kit for each type of processor. Kit shall include three (3) fuses, miscellaneous nuts, screws and hardware.
- C. The Contractor shall furnish spare parts for the theatrical lighting instruments as follows:
1. 10% spare engines for each type of theatrical lighting instrument where the LED array warranty is less than 10 years. 5% spare engines shall be provided if LED array warranty is met.
 2. 10% spare cables for each type and length of jumper cable.
 3. 5% spare lenses for each type of lens degree.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. The house and stage lighting control system as shown on the Drawings and herein specified shall be as manufactured by ELECTRONIC THEATRE CONTROLS, INC. (ETC) [Sensor IQ System and Echo ERP System] as listed or the equivalent as manufactured by STRAND LIGHTING, INC. [Motorized Breaker System with relays] which must meet all of the requirements of these Specifications. The system shall utilize the manufacturer's standard products and components with modifications as required meeting the construction and performance requirements of this section.
- B. The theatrical lighting instruments as shown on the drawings and herein specified shall be as manufactured by ELECTRONIC THEATER CONTROLS INC. (ETC). Listed equivalents by ALTMAN with full accessories and additional quantities as outlined in specification may be acceptable.
- C. The followspots as shown on the drawings and herein specified shall be as manufactured by CANTO USA. Acceptable equivalents shall include LYCIAN,

and must meet all of the construction and performance requirements of the basis of design.

2.02 DIMMING SYSTEM EQUIPMENT RACK

A. This Contractor shall furnish and install where shown on the Drawings, a house and stage lighting dimming system equipment rack(s). The racks shall be the ETC Sensor IQ48 (48 relay) wall mounted intelligent breaker rack.

1. Breaker panels shall be UL508, UL67, and UL924 listed, and shall be so labeled when delivered. Breakers shall be UL489 listed and shall be labeled when delivered.
2. Breaker panels shall consist of a main enclosure with 48 pole breaker subpanels, integral control electronics for low voltage terminations, and provision for accessory cards.

B. Mechanical

1. The panel shall be constructed of 16-gauge galvanized steel. All panel components shall be properly treated or finished in fine-textured, scratch resistant paint.
2. Breaker panels shall be capable of being mounted on the surface of a wall or recessed mounted.
3. Breaker panels shall support a main breaker and up to forty-eight single pole 20A branch circuits capable of holding full rated load for a minimum of three hours continuously. Panels shall measure 64 inches high, 20" wide and 5.25" deep (with front panel attached).
4. Panel cover shall be suitable for a surface mounted application. This outer panel shall ship complete with a locking door to limit access to electronics and breakers.
5. The unit shall provide interior cover over the control electronics and accessory cards to allow access only to class 2 wiring and prevent direct access to class 1 line voltage components.
6. Breakers shall provide manual switching control while power is unavailable to the panel such that critical lighting can be set to an on state, without the need for power to the panel. Breaker output lugs shall accept 10-14 AWG dual conductor wire and shall support solid or stranded 6-14 AWG class B, C, or K copper wire.
7. Control wiring for DMX, station bus, and emergency input terminations shall land on a removable headers for contractor installation.

C. User Interface

1. The user interface shall contain an LCD display with button pad to include 0-9 number entry, up, down back arrow navigation and enter. A Test shortcut button shall be available for local activation of preset, sequence and set level overrides. The control interface shall support a USB memory stick interface for uploads of configurations and software updates.
2. The user interface shall have a power status LED indicator (blue), a DMX status LED indicator (green), a network status LED indicator (green) and an LED indicator (red) for errors. Interface shall allow the backlight to timeout and shall provide user editable options to shut off backlight completely as well as adjust screen contrast.
3. Ethernet interface (when installed) shall default to automatic IP through link local and DHCP. Upon receiving IP address, the address of the Network Interface Card (NIC) shall display in the about menu. Static address and settings shall also be possible.

D. Functional

1. Panel setup shall be user programmable. The control interface shall provide the following breaker setup features (per circuit):
 - a. Type (1 pole)
 - b. Name
 - c. Circuit and space number
 - d. DMX address
 - e. sACN address (network enabled panels only)
 - f. Circuit Modes
 - 1) Normal (priority and HTP based activation and dimming)
 - 2) Latch-lock
 - 3) Fluorescent
 - 4) DALI

- g. On and Off threshold level
 - h. Include in UL924 emergency activation
 - i. Allow Manual
 2. Breaker panels shall support discrete addressing of each breaker. Panels that are restricted to use of start address with sequential addressing shall not be acceptable.
 3. The panel shall be capable of switching 6 poles on or off at once, or in a user-selectable delay per breaker using a period of 0.1 to 60 seconds, in 0.1 second increments.
 4. Control electronics shall report the following information per branch circuit:
 - a. Breaker state (On/Off)
 - b. Breaker state (Open/Closed)
 - c. Current draw (in amps)
 - d. Voltage
 - e. Energy usage
 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. 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 breaker state on each breaker, 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. Up to 8 spaces in a single rack for total of up to 16 spaces shall be supported per system or system subnet.
 - b. Indication of an active preset shall be visible on the control panel display.
 - c. One 16-step sequence per space for power up and power down routines.

- d. The panel shall have a UL924-listed contact input for use in emergency lighting systems and shall respond to the contact input by setting included breakers to “on”, while setting non-emergency breakers “off”. Each breaker can be selected for activation upon contact input.
 - e. 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. 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 breaker change state.
 - f. 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.
6. The breaker 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 time clock, programmed via the control panel. The time clock shall support event override from the face panel of the time clock.
- a. 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.
 - b. Time clock events shall be activated based on sunrise, sunset, time of day or periodic event.
 - c. System shall automatically compensate for regions using a fully configurable daylight saving time.
 - d. Presets shall be assigned to events at the time clock.
 - e. The time clock shall support timed event hold. It shall be possible to hold a timed event from the face panel of the processor. 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 circuit 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 breakers 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 breaker in a single action from the face panel.
 - d. DMX data loss shall allow for levels/breakers to be held for ever or for a specified time before switching to a lower priority source.
 - e. Initial Panel setup
 - 1) The breaker panel shall automatically detect the type of breaker 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. Electrical
1. Breaker Panels shall support power input from: 120/208V three phase 4-wire plus ground, or 120/240V single phase 3-wire plus ground.
 2. Conduit entry shall support feeds from top or upper 6" of either side, or, bottom or lower 6" of either side. Feeders shall enter through the top or bottom according to the orientation of the enclosure, and feeder entry shall be nearest to the location of the feeder lugs or main breaker.
 3. Load wiring shall enter through the top or bottom of the enclosure through the surface nearest to the breaker sub panel. Load wiring may also enter through left and/or right side provided a low voltage chase is not required through the same area. If class 2 chase is required, a field installable barrier panel shall be provided upon request. The side of the panel where the barrier has been installed shall not permit load wiring.

4. Low voltage wiring shall enter through the top of bottom of the enclosure. For low voltage conduit entry at the breaker end of the cabinet, conduits shall be located at the outer 3" of the top/bottom panel.
5. Breaker
 - a. Bus connection type: Stab on
 - b. 20A, single pole
 - c. UL489 listed
 - d. 22,000 SCCR; 65,000A series rated with main breaker
 - e. High inrush trip curve (matches all sensor breakers)
 - f. Maintains trip curve through entire thermal range
 - g. Guaranteed not to trip at full load
 - h. Load lugs accept 6-14awg load wiring
 - i. Multi-conductor listed output terminal
 - j. Integral mechanically held air gap relay
 - k. Manual control of relay state using breaker handle w/o power
 - l. Integral current sensing
 - m. Integral position and trip sensing
 - n. Control and status provided by contact pads directly at bottom of the breaker case
 - o. No external wires or connections required for control or feedback
 - p. The breaker shall be capable of switching up to 30A
6. The breaker panel shall support a maximum feed size of 400 Amps at 48 circuits.
7. Breaker panels shall support a field installable main circuit breaker options available in up to 400 amps for 48 circuit panels. Series SCCR ratings apply as follows with appropriate main breaker:
 - a. 22,000A or 64,000 at 120/208V

- b. Main breakers shall allow the following wire size: up to 2x250kcmil at 400A
 - c. Main lug input shall support up to 2x250kcmil
 - d. Breaker panel shall support a 500kcmil main lug option for 48-circuit panels.
- F. Breaker remote switching ratings
- 1. Mechanical 1,000,000 cycles
 - 2. 24A resistive 100,000 cycles
 - 3. 16A ballast (HID) 75,000 cycles
 - 4. Electronic (LED) 100,000 cycles
 - 5. 15A tungsten 45,000 cycles
 - 6. 30FLA; 180 LRA motor load 50,000 cycles
 - 7. Tested duty cycle: 12 operations (6 cycles) per minute. Decreasing duty cycle significantly increases switch life.
 - 8. Isolation: 4000V RMS
 - 9. Current reporting accuracy: 5%
 - 10. Latching state mechanical relay
- G. Breaker Panel Accessories
- 1. An Ethernet card shall provide advanced control of relays over streaming ACN (sACN) and transmit status, control override, and measured energy usage per branch circuit to a web browser based or central monitoring interface.
 - 2. A UPS Kit shall allow the power control processor to be powered via external UPS (by others) and enable load shedding.
 - 3. Main breaker per Section E.5
- H. 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 32°F (0°C) and 104°F (40°C), and humidity between 5-95% (non-condensing).
- I. Provide two (2) Sensor IQ 48 Intelligent Breaker System Panel with IQ-NET Option Card, IQ-UPS KIT, main breaker, and surface mount door.
- J. Provide an engraved nameplate on the front face of the relay rack in a suitable location. The nameplate shall be lettered HOUSE AND STAGE LIGHTING RELAY PANEL #1/#2.

2.03 HOUSE LIGHTING RELAY PANEL

- A. Relay panel shall be UL508, UL67 and UL924 listed, and shall be so labeled when delivered.
 1. Relay panels shall consist of a main enclosure with 30 pole breaker panel, relay/dimmer sub panel, integral control electronics, and a low voltage subpanel for data terminations and provision for accessory cards.
 2. Up to two accessory cards shall be supported per relay panel.
- B. Mechanical
 1. The panel shall be constructed of 16 -gauge steel. All panel components shall be properly treated and finished in fine textured, scratch resistant paint.
 2. Relay Panels shall be available in 120V AC configurations.
 - a. 120V enclosures shall be 67.5" high by 14.36" wide and 4" deep with a weight not more than 80 pounds.
 3. The panel shall be capable of being mounted on the surface of a wall or recessed mounted.
 - a. 120V AC panels shall support mounting between standard wall stud framing (16 inch on center spacing).
 4. Choice of panel covers shall be available for surface or recess mount applications. The outer panel shall ship complete with a locking door to limit access to limit electronics and breakers.

- a. Optional center pin reject security screws shall be available for all accessible screws.
 - b. Recess mount doors shall extend 1" beyond all panel edges to hide wall cut out.
 5. The unit shall provide interior cover over breaker panel to allow access to class 2 wiring and prevent direct access to class 1 line voltage components.
 6. The relay panel shall support up to twelve 20A single pole circuits made up of relays.
 - a. Two and three pole relay circuits shall be supported at decreased density where each pole constitutes one of the available single pole circuits. Mixing of circuits in any combination shall be supported.
 - b. Panels that do not support an integral dimmer module shall not be acceptable.
 7. Relays shall include integral switches to manual control while power is unavailable to the panel such as critical lighting can be set to an on state, without the need for power to the panel.
 8. Relay output lugs shall accept 6-14AWG copper wire.
 9. Breaker subpanel may include up to twenty-nine 20A single pole, up to fourteen 20A double pole or nine three pole breakers as required in any combination up to capacity.
 10. Control wiring for DMX, station bus and emergency input terminations shall land on removable headers for contractor installation.
- C. User Interface
1. The user interface shall contain a graphical display with button pad to include 0-9 number entry, up, down back arrow navigation and enter.
 2. Tet shortcut button shall be available for local activation of preset sequence and set level overrides.
 3. The user interface shall have a power status LED indicator (blue), a DMX status LED indicator (green), a network status LED indicator (green) and an LED indicator (red) for errors.

4. Interface shall allow the backup to timeout and shall provide user editable options to shutoff backlight completely as well as adjust screen contrast.
5. Ethernet interface shall default to automatic IP though link local and DHCP. Upon receiving IP address, the address of the network interface card (NIC) shall display in the about menu. Static address and settings shall also be possible.
6. The control interface shall support a USB memory stick interface for uploads of configurations and software updates.

D. Functional

1. Panel setup shall be user programmable. The control interface shall provide the following breaker setup features (per circuit):
 - a. Type (1 pole, 2 pole or 3 pole)
 - b. Name
 - c. Circuit and space 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 CAN (sCAN) and transmit status, control override, and measured energy usage per branch circuit via an internal web UI or central monitoring interface.
 - a. Control electronics shall report the following information per branch circuit:
 - 1) Breaker state (On/Off)
 - 2) Breaker state (Open/Closed)
 - 3) Current draw (In amps)
 - 4) Voltage
 - 5) Energy usage
 - 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 and 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. 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 breaker change state.
6. The control of lighting and associated systems via real time and astronomical clock controls
- a. The relay panels 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 clocks 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 from the face panel of 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 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. Electrical
1. Relay panels shall support power input from: 120/208V three phase 4-wire plus ground.
 2. Conduit Entry

- a. Feeders
 - 1) Top or top side (upper 6" of either side)
 - 2) Bottom or bottom side 6" of either side
 - 3) Feeders shall enter through the top or bottom according to the orientation of the enclosure.
 - 4) Feeder entry shall be nearest to the location of the feeder lugs or main breaker.
- b. Load
 - 1) Load wiring shall enter through the top or bottom of the enclosure.
 - 2) Load wiring shall enter through the top or/bottom surface nearest to the breaker sub panel.
 - 3) Load wiring may also enter through left and/or right side provided a low voltage chase is not required through the same area. If class 2 chase is required, a field installable barrier panel shall be provided upon request. When installed, the left or right side of the panel, where the barrier has been installed, shall not permit load wiring.
- c. Low Voltage
 - 1) Top or top side (Upper 6" of either side)
 - 2) Bottom or bottom side (bottom 6" of either side)
 - 3) For low conduit entry at the relay end of the cabinet., conduit shall be located at the outer 3" of the top/bottom panel.
 - 4) Field installed low voltage channel shall be provided separately for installation on the left or right side of the panel to allow class 2 wiring to traverse the panel from top to bottom or bottom to top.
3. All relays shall be mechanically latched.
4. The relay shall be capable of switching 20A at up to 300V.

5. The relay panel shall support a maximum feed size of 200 Amps.
6. The relay panel shall support main circuit breaker options
 - a. Main breaker options shall be optional and available for purchase on request.
 - b. Main breakers shall be field installable.
 - c. Main breaker shall be available in 200 Amps for 120V systems.
 - d. Series rated SCCR ratings apply as follow with appropriate main breaker
 - 1) 22,000A at 120/240V.
 - 2) 10,000A at 100A;120/208V
 - 3) 10,000A, 22,000A or 42,000A at 200A, 120/208V.
 - e. Main breaker shall allow the following range of wire sizes:
 - 1) 1AWG-300Kcmil at 120/240V
 - 2) 3/0 to 300kcmil at 120/208V

F. Relay

1. Each relay shall have a manual override switch with on/off status indication.
2. Relays shall be rated for use with
 - a. 16A electronic ballast loads at 120V
 - b. 20A tungsten loads at 120V
 - c. Motor loads with ratings of 20A at 120V, 100,000A symmetrical SCCR.
3. Isolation shall be 4000V RMS.
4. Relays shall be latching state.
 - a. 1,000,000 mechanical activations.
 - b. 100,000 cycles at full resistive load.
 - c. 30,000 cycles full motor, inductive, tungsten and electronic (LED).
 - d. Decreasing loading shall increase the rated life of the relay inversely proportional the square of the load.
5. Rated Life:

- a. 1,000,000 mechanical activations.
 - b. 100,000 cycles at full resistive load.
 - c. 30,000 cycles full motor, inductive, tungsten and electronic (LED).
 - d. Decreasing loading shall increase the rated life of the relay inversely proportional the square of the load.
6. Relay shall support reporting of current usage with an accuracy of five percent of the connected load.
- G. Relay Panel Accessories
1. A Ride Thru option shall provide short term power back up of control electronics by automatically engaging when power is lost, and recharging when power is present.
- H. Main breaker options shall be available as specified in Section E.6
- a. 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 32°F (0°C) and 104°F (40°C), and humidity between 5-95% (non-condensing).
 - I. Provide one (1) ERP Echo Relay Panel with (12) 20A relays, main breaker and surface mount door.
 - J. Provide an engraved nameplate on the front face of the relay rack in a suitable location. The nameplate shall be lettered HOUSE LIGHTS RELAY PANEL

2.04 CONTROL ENCLOSURES

- A. The control enclosure shall be the Unison ERn Series Control Enclosure as manufactured by Electronic Theatre Controls, Inc., or equal.
- B. Mechanical:
 1. The ERn Control Enclosure shall be a surface mounted panel, suitable for rack mounting, constructed of 18 gauge formed steel panels with a hinged, lockable full-height door containing an integral electrostatic air filter.

- a. The enclosure door shall have an opening to allow limited access to the control module face panel.
 - b. Enclosures shall be convection cooled without the use of fans.
 - c. Enclosure shall have rack mounting brackets.
 2. Control enclosures shall be sized to accept one control processor and one Station Power Module, as needed for a complete system, including various options and accessories.
 - a. The two-space Control Enclosure (ERn2) shall support a single Station Power Supply module.
 3. All enclosure components shall be properly treated and finished.
 - a. Exterior surfaces shall be finished in fine textured, scratch resistant, powder based epoxy paint.
 4. Enclosure(s) shall be the 19" rack mounted (RM) version.
 - a. Rack-mounted version shall have an independent enclosure suspension kit, with a full height, locking door/cover attached to the kit.
 - b. Rack-mounted version shall have an opening to access the control module face panel, and openings to view indicators on option modules.
 - c. Rack-mounted version enclosure dimensions and weights (without modules) shall not exceed ERn2-RM - 19" W 11"H 10" D, 20 lb.
 5. Top, bottom, and side knockouts shall facilitate conduit entry.
 6. Enclosures shall be designed to allow easy insertion and removal of all control and option modules without the use of tools.
 - a. Supports shall be provided for precise alignment of modules into power and signal connector blocks.
 - b. With modules removed, enclosures shall provide clear front access to all power and control wire terminations.
- C. Electrical:
1. Control enclosures shall have 120 volt, single-phase configurations.

2. Control enclosures shall be completely pre-wired by the manufacturer. This contractor shall provide input and control wiring.
 3. Control enclosures shall be designed to support the following wire terminations:
 - a. AC (single phase)
 - b. Echelon link power (Belden 8471 or equivalent)
 - c. 24Vdc (2- 16AWG Wire)
 - d. DMX512A Port A (In or Out) (Belden 9729 or equivalent)
 - e. DMX512A Port B (In or Out) (Belden 9729 or equivalent)
 - f. RS232 Serial In/Out (Belden 9729 or equivalent)
 - g. Unshielded Twisted Pair (UTP) Category 5 Ethernet
 - h. Contact Closure In (14AWG to 26AWG Wire)
 - i. Contact Closure Out (14AWG to 26AWG Wire)
 - 1) Contact Closure Out shall provide 1A @ 30vDC
 4. Station Power Modules
 - a. Station power supply modules shall provide LinkPower for at 32 stations and 1.5A@24VDC of Auxiliary (AUX) power.
 - b. Station power module shall support over-current/short protection for LinkPower and Aux. LinkPower shall support fault detection on each leg of the balanced data bus.
 5. All control wire connections shall be terminated via factory provided connectors.
- D. Thermal
1. Ambient room temperature: 0-40°C / 32-104°F
 2. Ambient humidity: 30-90% non-condensing
- E. Provide one (1) Unison Ern2 Rack Mounted Series Control Enclosure.

2.05 CONTROL PROCESSOR MODULES

- A. The Architectural Control Processor shall be the Unison Paradigm P-ACP Series Control Processor as manufactured by Electronic Theatre Controls, Inc., or equal.
- B. The Architectural Control Processor (ACP) assembly shall be designed for use in ERn Series Control Enclosures.
- C. The processor shall utilize microprocessor based, solid state technology to provide multi-scene lighting and building control.
 1. ACP shall support functions such as station programming, macro sequencing, electronic lockout, room combine and astronomical time clock events. ACP station processor shall allow configuration of the control system via the menus.
 2. When used in a dimming enclosure, the ACP shall allow access to dimming control menus including the status screen, dimming configuration screen, backup menu, test menu and configuration menu.
- D. One ACP shall be rated to drive 1024 channels of control, 1024 zones, 64 rooms, 512 presets, 62 button stations and 6 Touchscreen stations.
- E. ACP module electronics shall be convection cooled.
- F. The ACP shall provide front-panel RJ45 jack, Secure Digital (SD) card slot, and Universal Serial Bus (USB) Port for configuration and data exchange.
- G. Architectural Lighting System configuration and program information shall be stored in flash memory, which does not require battery backup.
- H. The ACP shall be contained in a plug-in assembly and require no discrete wiring connections; all wiring shall be terminated into Dimming or Control Enclosure.
 1. The ACP shall support the following communications:
 - a. Echelon LinkPower
 - b. 10/100BaseTX, auto MDI/MDIX, 802.3af compliant Ethernet networking with TCP/IP, ESTA BSR E1.17 Advanced Control Networks (ACN) and ESTA BSR E1.31 (sACN) Protocols
 - c. EIA-232 serial protocol

- d. ESTA DMX512A, configurable as input or output ports
 - e. Dry contact closure inputs
 - f. Dry contact closure outputs, rated at 1A@30VDC
- I. Provide one (1) Paradigm Architectural Control Processor and one (1) spare.

2.06 P-SPM STATION POWER MODULES

- A. The Station Power Module shall be the Unison Paradigm P-SPM-E Series Station Power Module as manufactured by Electronic Theatre Controls, Inc., or equal.
- 1. The Station Power Module (SPM) assembly shall be designed for use in ERn Rack Enclosures.
- B. The SPM shall convert input power into low-voltage (Class II) power with data line and a secondary auxiliary low-voltage line to energize button, Touchscreen, and interface devices for multi-scene lighting and building control.
- C. The SPM, in conjunction with a matching Architectural Control Processor (ACP), shall support Echelon LinkPower communications with remote devices, including button, and Touchscreen stations, and shall interoperate with LonMARK-approved third-party devices.
- 1. 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.
 - 2. The LinkPower network shall be topology free. Network wiring may be bus, loop, home run, star or any combination of these.
 - 3. Link power wiring shall permit a total wire run of 1640 ft. (500m)
 - 4. Link power wiring between stations shall not exceed 1313 ft. (400m).
 - 5. The SPM shall support auxiliary power for certain remote devices, including touchscreen stations, as required by the device.
 - a. The auxiliary power network shall utilize polarity-dependent, low-voltage Class II wiring, consisting of two # 16 AWG wires.
 - b. Auxiliary wiring shall permit a total wire run of 1640 ft. (500m)

- c. The SPM shall supply 1.25 amps at 24v DC continuously.
- D. ACP module electronics shall be convection cooled.
- E. Each SPM shall supply power for up to 63 button and button/fader stations
 - 1. Shall supply auxiliary power for up to four Touchscreen stations, when a like number of other stations are deducted from the total.
- F. Provide one (1) Paradigm Station Power Module plus one spare.

2.07 GENERAL NETWORK

- A. The Electronic Theatre Controls (ETC) Net3 network shall provide data distribution over TCP/IP Ethernet networks. Data shall be layer 3 routable. Systems using proprietary formats or formats other than 10/100/100Mbit wired Ethernet or non-layer 3 routable networks shall not be accepted.
 - 1. Connections shall be made between consoles, face panels, architectural processors, dimmers, Net3 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.
 - 2. The Lighting Control system must be supplied by a single manufacturer and must have seamless integration over Ethernet between the performance and architectural lighting control.
 - 3. Network data, DMX associated equipment, and theatrical control devices shall be housed in a separate wall mounted equipment rack.
- B. Capacities:
 - 1. The network shall support DMX routing, patching, and prioritization for up to 63,399 universes (32,767,488 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 Net3 Gateway Configuration Editor (GCE) 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 must support the above mentioned address patching capabilities.
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 must 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 must support configuration backup as described above.

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 Net3 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 63,999 DMX universes (32,747,488 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.

E. Provide one (1) general network.

2.08 NETWORK/DMX EQUIPMENT RACK

A. A wall mounted network/DMX equipment rack shall be provided to house Network data, DMX associated equipment, and theatrical control devices in a fully functional, EIA compliant 19" panel mount assembly. The rack shall be MIDDLE ATLANTIC PRODUCTS (MAP) model no. DWR Series or equal with an overall width of 24.4", depth of 26.3" and height as needed to house all the equipment required and recommended by the theatrical system manufacturer. The rack's center section and back panel shall be 16-gauge steel, phosphate pre-treated and finished in a black textured powder coat. Rack rails shall be constructed of 11-gauge steel with tapped 10-32 mounting holes in universal EIA spacing with black e-coat finish and marked rack spaces. Rack shall be constructed to swing open for component cabling access, center section shall pivot for either left or right opening. Rack shall be provided with suitable cable management modules.

B. The rack shall contain all of the rack mounted equipment set forth in these specifications, as shown on the Drawings and required by the system manufacturer. The rack shall also contain, but not be limited to the following:

1. Plexi-glass locking door
2. Lockable sliding shelf to allow a 15.6" laptop computer to fit (laptop provided by others).
3. Blank brushed panels for equipment mounting not designed for rack mounting but necessary for the operation of the system.
4. Blank brushed panels for future applications and to enclose all unused spaces.
5. One (1) theatrical system wireless access point (Airport).
6. One (1) custom engraved rack ID label, nomenclature as specified.
7. One (1) 24 Port PoE switch and one (1) spare PoE switch.
8. One (1) port patch panel with one (1) spare
9. Two (2) locking drawers

10. Four (4) rack spaces with four (4) individual blank panels for future devices or equipment.
 11. One (1) BlueBeam DMX power supply
 - a. Frosted BlueDome running lights with cowl
 - b. Cue light
 12. Three (3) 4-Port Gateways with rack mount kit
 13. One (1) Net3 Conductor
 14. One (1) 1-In, 16-Out with rack mount kits,
 15. One (1) UPS
 16. One (1) 20A Power Invertor with three outputs.
 17. Vertical mounted, slim, high density, internal power distribution strip sufficiently sized to power all equipment rack with 20% spare outlets.
- C. Provide one (1) network/DMX rack. The rack shall have an engraved nameplate on the front face of the network/DMX rack in a suitable location. The nameplate shall be lettered THEATRICAL LIGHTING SYSTEM NETWORK/DMX EQUIPMENT RACK.

2.09 NETWORK SERVICES GATEWAY

A. General

1. The lighting network service gateway shall be a microprocessor-based unit specifically designed to provide network services and storage for lighting control systems. The gateway shall provide all necessary network services for automatic network configuration over an Ethernet network. The unit shall be a Net3 Conductor as provided by ETC, Inc.
2. The gateway shall communicate over Ethernet directly with ETC, Inc.'s entertainment and architectural lighting control products and other Ethernet interfaces.
3. Connections shall be made between gateways, consoles, architectural systems, and PCs over standard Ethernet distribution systems using 10/100BaseT.

4. The gateway shall support multiple protocols including:
 - a. Dynamic Host Control Protocol (DHCP) for automatic assignment of IP address.
 - b. Dynamic Name Service (DNS)
 - c. Simple Network Time Protocol (sNTP) for automatic time assignment and synchronization.
 - d. File Transfer Protocol (FTP) for configuration storage and backup
 - e. Windows File Sharing (SMB) for configuration and file storage and backup.
5. The gateway shall support real-time logging and notification of system errors.
 - a. Logging shall utilize a standard Syslog database. Databases that do not utilize Syslog shall not be acceptable.
 - b. Notifications shall utilize an email system.
6. The gateway shall support storage of system device configurations and complete stem configurations. Configuration storage for the following device types is required:
 - a. Power panels including relays and dimmers
7. User definable reports that detail historical errors and power usage shall be supported. Reports shall be generated using the gateway database and queried from Net3 Concert software or another 3rd party application.
8. The gateway shall have a backlit graphic LCD display for identification and status reporting.
 - a. The LCD display shall show the full software version number.
 - b. The LCD display shall show current date, current time (12/24 hour options), time zone, +/- time offset, and DST.
 - c. The LCD display shall show unit IP address and total unit uptime.

B. Mechanical

1. The gateway shall be fabricated of 16-gauge steel, finished in fine-texture, scratch-resistant, black powder coat.

2. The gateway shall have front panel, backlit power button.
3. The gateway shall provide rear panel connections for low voltage power supply input.
4. The gateway shall provide two rear panel Ethernet connections:
 - a. One shall be dedicated to the local lighting control network.
 - b. The second shall support connection to a building network or secured internet connection for remote monitoring and reporting.
5. Dimensions shall be 8.5" (22 cm) wide x 13.30.55" (33.8cm) deep x 1.75" (5 cm) high.
6. Mounting holes shall be provided for installation of a 19" one E.I.A unit rack mount accessory kit.

C. Electrical

1. Power for the gateway shall be provided via an isolated in-line power supply rated for 5A at 12vDC provided by the gateway manufacturer.
2. All Ethernet connections and communications shall be compliant with IEEE 802.3i for 10BASE-T, 802.3u for 100BASE-TX and utilize standard Ethernet switches.
3. The gateway shall be tested to UL standards and labeled ETL listed.
4. The gateway shall be RoHS compliant (lead-free).
5. The gateway shall be CE compliant.

D. Configuration

1. The gateway on the network shall be individually configurable using:
 - a. Integrated web interface
 - b. Net3 Concert configuration software
2. The gateway shall support automatic assignment of IP addresses to the entire lighting control system when DHCP is enabled.
3. The gateway shall support time assignment and synchronization of the

lighting system using sNTP to ensure reliable playback from all devices.

4. All information shall be stored in non-volatile memory at each gateway. The system shall recover from a power outage without requiring user interaction. Gateways that do not support non-volatile storage shall not be accepted.

E. Network

1. All network cabling shall be Category 5 (or better), conforming to TIA-568A/B, and shall be installed by a qualified network installer.
2. ANSI E1.17 Architecture for Control Networks (ACN) shall be supported. Gateways that do not support ANSI E1.17 shall not be acceptable.

F. 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.

G. Accessories

1. One E.I.A. rack space mounting bracket kit shall support mounting of up to two complete gateways, including DMX gateways.
2. A universal power supply with international plug-set shall be available. Multiple power supplies shall be able to fit in a vertically stacked power strip.
3. Net3 Concert configuration software

H. System Requirements

1. Gateways and software shall be as manufactured by Electronic Theatre Controls Inc. of Middleton, WI.
2. Provide Ethernet switches and power supplies as scheduled and as shown on drawings.
3. Provide a current generation PC with Windows operating system equipped with a 10/100 Ethernet card.

- I. Systems that do not provide the above capabilities shall not be acceptable.

J. Provide one (1) Net3 Conductor Network Services Gateway.

2.10 DMX ETHERNET GATEWAY – FOUR PORT

A. General

1. The lighting control gateway shall be a microprocessor-based unit specifically designed to provide DMX-512 control of lighting systems and transport of RDM configuration and status messages. The gateway shall permit DMX-512 data to be encoded, routed over an Ethernet network and decoded back to DMX-512. The unit shall be a Response Mk2 4-port DMX Gateway as provided by ETC, Inc.
2. Gateways shall communicate over Ethernet directly with at least ETC, Inc.'s entertainment and architectural lighting control products and other Ethernet interfaces.
3. Connections shall be made between gateways, consoles, architectural systems, and PCs over standard Ethernet distribution systems using 10/100BaseT.
4. The gateway shall support multiple protocols including:
 - a. ANSI E1.17 Architecture for Control Networks (ACN)
 - b. ANSI E1.31 Streaming ACN (sACN)
 - c. ANSI E1.11 USITT DMX512-A
 - d. ANSI E1.20 Remote Device Management (RDM)
5. The gateway shall be tested to UL standards and labeled ETL listed.
6. The gateway shall be RoHS compliant (lead-free).
7. The gateway shall be CE compliant.
8. The gateway shall have a graphic OLED display and four buttons for identification (soft-labeling), configuration, status reporting and troubleshooting.
 - a. Labeling shall be user configurable using ANSI E1.17 Architecture for Control Network (ACN), or a purpose built software configuration tool.
 - b. The OLED display shall show DMX port configuration indication

as well as indicate the presence of valid signal.

- c. Gateways that do not indicate port configuration (input/output) and valid data shall not be acceptable.
9. Each gateway shall have power and data activity LEDs on the front of the gateway.

B. DMX Ports

1. DMX ports shall comply with the requirements of ANSI E1.11 USITT DMX512-A standards.
2. Each DMX port shall be software or locally-configurable for either input or output functionality.
3. DMX input shall be optically-isolated from the gateway electronics.
4. DMX port shall provide at least 500V isolation to ground and the rest of the electronics.
5. Each port shall incorporate one DMX512-A connection.
 - a. Gateways shall be available with the following connection options: 5-pin male XLR, 5-pin female XLR, Ethercon RJ-45, or terminal strip for DMX wiring.
6. Network gateways that do not indicate input/ output port configuration or presence of valid data shall not be accepted.

C. Processor

1. Each gateway shall have sufficient processing power to manage up to 63,999 universes (32,767,488 addresses).
2. Maximum delay time from input to output shall not be greater than one packet time (approximately 22 mSec.).
3. A minimum DMX update rate of 40Hz shall be sustained under all conditions unless specifically configured for a slower rate for the sake of compatibility with 3rd party DMX devices.

D. Mechanical

1. The gateway shall be rack-mounted.
 - a. The gateway shall be fabricated of 16-gauge steel, finished in

fine-texture, scratch-resistant, black powder coat (RAL 9004).

- b. The gateway shall support field configuration allowing the Ethernet port to be either on the front or the rear of the unit.

E. Power

- 1. Power for the gateway shall be provided over the Category 5 (or better) cable, utilizing IEEE 802.3af compliant Power over Ethernet (PoE). Power consumption using shall not be greater than 7 watts.
- 2. An optional low-voltage DC power input shall be available utilizing an isolated in-line power supply capable of an operating range of 12-24VDC. The power supply shall be provided by the gateway manufacturer.
- 3. The gateway electronics shall be electrically isolated from the power supplied over the Category 5 (or better) cable.

F. Configuration

- 1. The gateway must support local or remote configuration.
- 2. Each gateway on the network shall be individually configurable using freely available software configuration tools. The primary configuration tool shall be Net3 Concert configuration software running on a network connected PC. The PC shall only be required for configuration, and shall not be required for normal operation of the system.
- 3. Each port of the DMX gateway shall control up to 512 DMX addresses, within the confines of 63,999 universes.
- 4. The specific DMX data input or output by the gateway shall be freely configurable by the user.
- 5. Duplicate outputs of DMX lines (DMX splitter) and discrete outputs shall be fully supported.
- 6. Multiple DMX universes may be configured with any length up to 512 total addresses. Any range of DMX input addresses shall support selection and routing to the specified sACN output.
- 7. Multiple sACN sources may be combined with a priority may be assigned to each source sending data to the gateway.
- 8. All relevant routing information shall be stored in non-volatile memory at each gateway. The system shall recover from a power outage without requiring the PC to be online. Gateways that do not support non-volatile

storage of data routing shall not be accepted.

G. Network

1. Communications physical layer shall comply with IEEE 802.3i for 10BASE-T, 802.3u for 100BASE-TX and 802.3af for Power over Ethernet specifications.
2. All network cabling shall be Category 5 (or better), conforming to TIA-568A/B, and shall be installed by a qualified network installer.
3. Data transport shall utilize the TCP/IP suite of protocols to transfer the DMX data.
4. ANSI E1.17 Architecture for Control Networks (ACN) and streaming ACN (sACN) shall be supported. Gateways that do not support ANSI E1.17 shall not be acceptable.
5. Each DMX gateway shall control up to 512 DMX addresses, per DMX port within the confines of up to 63,999 universes (32,767,488 addresses) using Streaming ACN (sACN).
 - a. Any range of DMX addresses may be selected for each universe.
 - b. Multiple sources shall be supported by prioritized Highest Takes Precedence (HTP with priority). Each source shall support assignment of priority to allow override of default HTP behavior.
 - c. Each DMX port shall support its own universe and start address.
6. Gateways shall have built in DMX merger capability on a universe or channel-by-channel basis.
7. Gateways shall support have built in priority on a per-universe or channel-by-channel basis. Gateways that do not support prioritized merging of multiple network sources at independent priorities shall not be accepted.

H. 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.

I. Accessories

1. One E.I.A. rack space mounting bracket kit shall support either one or two complete units and allow for up to eight ports of DMX.
2. Front access panel kit shall allow the connectors on the rear of the gateway to be accessed from the front of an equipment rack. Options for 5-pin XLR style connectors that support DMX input or output shall be available.
3. A universal power supply with international plug-set shall be available. Multiple power supplies shall be able to fit in a vertically stacked power strip.
4. ETC Net3 Concert configuration and monitoring software

J. Provide three (3) 4-Port Rack Mounted Gateway

2.11 TWO PORT DMX ISOLATED OPTO-SPLITTER

A. General

1. The DMX/RDM splitter shall be a solid state device specifically designed as an optically isolated DMX512 Opto-Splitter. The Opto-Splitter shall permit DMX512 data to be received and operated out to multiple ports. The unit shall be a Response Opto-Splitter as provided by ETC Inc. of Middleton, WI.
2. The splitter shall support multiple protocols including:
 - a. ANSI E1.11 USITT DMX512-A
 - b. ANSI E1.20 Remote Device Management (RDM)
3. The splitter shall be tested to UL Standards and labeled ETL listed.
4. The splitter shall be RoHS compliant (lead-free)
5. The splitter shall be CE compliant.
6. The gateway shall be visual indicators on the splitter showing status of the DMX Opto-Splitter and its interface.

B. DMX Ports

1. DMX ports shall comply with the requirements of ANSI E1.11 USITT DMX512-A standards.

2. The Opto-Splitter shall have DMX input and thru ports that are optically isolated from the output ports.
 3. All trans receiver chips shall be socketed allowing for field replacement. A space trans receiver chip shall be provide with each unit.
 4. DMX port shall provide at least 500V isolation to ground and the rest of the electronics.
 5. Opto-Splitters shall be available with the following connection options.
 - a. Terminal strip for DMX wiring (16 ports).
- C. Mechanical
1. Opto Splitter shall be fabricated of sheet steel aluminum, finished in fine texture, scratch resistant, black powder coat (RAL9004).
 2. The Opto-Splitter shall support field configuration allowing the connectors to be either on the front or rear of the unit.
- D. Power
1. Power for the rack mount Opto-Splitters shall be 100-230V AC at 50 or 60Hz., supplied via a detachable power cord. Power consumption shall not be greater than 35 watts.
 2. Power for the DIN rail Opto-Splitters be 12-48V DC. Power consumption shall not be greater than 8 watts. Wiring connections use pluggable rising clamp terminations.
- E. 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.
- F. Provide one (1) Rack Mounted 1-In 16 Out DMX/RDM Opto Splitter with terminal strip.

2.12 TOUCHSCREEN CONTROL STATIONS

- A. The Touchscreen control stations shall be the Unison Paradigm Touchscreen P-TS7 Series Control Stations as manufactured by ETC, Inc., or equal.

B. General

1. Touchscreen stations shall support default and 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 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. Standard RAL colors include: Cream (RAL 9001), Ivory (RAL 1015), Gray (RAL 7001), Black (RAL 9004), and Signal White (RAL 9003).
 - a. The bezel shall have no visible means of attachment.
 - b. The bezel shall allow the touchscreen to be installed and removed without the use of tools.
 - c. The bezel shall provide two working positions for the Touchscreen: service and normal operation.
3. 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.

D. 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.
- E. Functional
- 1. System
 - a. The Touchscreen shall support configuration firmware upload from a Paradigm 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.
4. Operation
- a. The Unison Paradigm 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 LightDesigner 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 LightDesigner 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 LightDesigner software.
- 3) System time clock events shall be programmable via the Touchscreen, LightDesigner system software, the processor user interface, or the internal web server.
- a) Time clock events shall be assigned to system day types. Standard day types include: 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.
- b. Touchscreen stations shall be designed to operate standard default or custom system functions. Components shall operate default functions unless re-assigned via LightDesigner, the Windows-based configuration program.

- 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.
 - c. Touchscreen stations shall allow programming of station and component electronic lockout levels via LightDesigner.
 - d. It shall be possible to adjust LCD contrast and brightness.
 - e. It shall be possible to program the station to dim during periods of inactivity.
- F. Provide two (2) P-TS7 Paradigm 7" Touchscreen stations plus spare.

2.13 DIGITAL BUTTON AND FADER STATIONS

A. General

1. The control station shall be the Paradigm Inspire Station Series as manufactured by ETC, Inc., or equal.
2. It shall be a remote station on a LinkConnect network that can recall presets, provide direct zone control, play macros and provide room combine actions for a control system.
3. The station shall consist of a dual function (control/ record) push-button with an integral tri-color backlight for each corresponding button.

B. Mechanical

1. Control stations shall operate using four buttons.
2. All button stations shall be available with cream, grey, black or white decorator style faceplates. Manufacturer's standard colors shall conform to the RAL CLASSIC standard.
3. Stations shall have tri-color backlights for each button.
 - a. Indicators shall utilize a configurable color backlight for active status.

- b. Indicators shall utilize a configurable color backlight for inactive status to assist in locating stations in dark environments. Stations that do not support a lit inactive or deactivated state shall not be accepted.
 - c. Stations shall support an off backlight state of inactive status when required.
4. All faceplates shall be designed for flush or surface mounting and have no visible means of attachment.
- a. Station faceplates shall be constructed of ABS plastic and designed based on a standard decorator style faceplate.
 - b. Buttons shall be indelibly laser marked for each button function.
 - c. Control station electronics shall mount directly behind the faceplate. The entire assembly shall mount into a single gang back box. Back boxes for flush mounted stations shall be industry standard back boxes. The manufacturer shall supply back boxes for surface mounted stations.
- C. Electrical
- 1. Control station wiring shall be LinkConnect control wiring utilizing 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. The station shall operate on class 2 voltage provided by the control system via the LinkConnect network.
 - a. Station wiring must be topology free. It may be point-to-point, bus, loop, home run or any combination of these.
 - b. Wiring termination connectors shall be provided with all stations.
 - c. Control stations shall be UL/ cUL listed and CE marked and meet WEEE compliance.
- D. Functional
- 1. The control system shall be designed to allow control of lighting and associated systems via Button and Fader controls.
 - 2. System presets shall be programmable via LightDesigner configuration

software. Presets shall have a discrete fade time, programmable from zero to 1,000 hours with a resolution of one millisecond.

3. System macros and sequences shall be programmable via LightDesigner configuration software. Macro and sequence steps shall provide user selectable steps, and allow the application of conditional logic. Macro and sequences shall be activated by button, time clock event or LightDesigner software.
 4. Control components shall be designed to operate default or custom system functions. Components shall operate default functions unless re-assigned via LightDesigner, the software-based configuration program.
 5. Optional button functions include: preset selection, manual mode activation, record mode activation, station lockout, raise, lower, macro activation, or room join/separate.
 6. Stations shall allow programming of station and component electronic lockout levels via LightDesigner.
- E. Provide four (4) PI1004 Paradigm Inspire 4 Button Stations labeled as follows: "100%", "50%", "25%", "Off"

2.14 DATA PLUG-IN STATIONS

- A. Data plug-in stations shall consist of the appropriate connectors required for the functional intent of the system. These stations shall be available with DMX input or output, Remote Focus Unit, Network, or architectural control connectors as shown on the Drawings or as required.
- B. Connector Options:
 1. The following standard components shall be available for plug-in stations:
 - a. RJ45 connectors for network connections - twisted pair
- C. Physical:
 1. Station faceplates shall be .80" aluminum, finished in fine texture, scratch-resistant black powder coat. Silk-screened graphics shall be white.
 2. The station panel shall mount into an industry standard back box, depending on size and quantity of connectors. A terminal block shall be supplied for contractor terminations.

D. Provide data plug-in stations of the types and quantities as follows:

1. Three (3) ECPB NET/NET
2. One (1) ECPB NET

2.15 BRANCH CIRCUIT EMERGENCY LIGHTING TRANSFER SWITCH

A. General

1. The Branch Circuit Emergency Lighting Transfer Switch (BCELTS) shall be the SC1008 as manufactured by ETC, Inc.
2. The BCELTS shall provide automatic transfer of a single branch circuit from normal to emergency power source, when normal power fails.
3. The BCELTS shall transfer a lighting load branch circuit from a dimmer/relay or secondary control output to a second power source in the event of a loss of power to the primary power source, a normal system failure, or activation of a fire alarm.
4. The system shall be listed under ANSI / UL1008 Transfer Switch Equipment and comply with ANSI / NFPA 110 Standard for Emergency and Standby Power Systems, and ANSI / NFPA 70 (NEC), including Article 700, 701 and 702 safety standards. Emergency transfer systems that do not comply with the below stated NEC articles and sections shall not be permitted.
 - a. Satisfies requirements of the National Electrical Code (NFPA 70):
 - 1) Article 700 – Emergency Systems
 - 2) Article 701 – Legally Required Standby System
 - 3) Article 702 – Optional Standby Systems
 - 4) Section 518.3(C) – Assembly Occupancies
 - 5) Section 520.7 – Theatres and Similar Locations
 - 6) Section 540.11(C) – Motion Picture Projection Rooms
5. The BCELTS shall transfer a single circuit at 120V or 277V up to 20 amperes in capacity.

B. Transfer Switch

1. The BCELTS shall be a UL1008 transfer switch listed for Emergency Systems (NEC Articles 700 and 701; UL CCN WPWR).
 - a. Transfer switches not listed under UL1008 shall not be acceptable.
 - b. Transfer switches listed under UL1008 for Optional Standby (NEC Article 702; UL CCN WPXT) applications only shall not be acceptable.
 - c. Automatic Load Control Relays (ALCR) listed under UL924 shall not be acceptable.
 2. The switch shall be positively latched and unaffected by voltage variations or momentary outages so that constant contact pressure is maintained and temperature rise at the contacts is minimized.
 3. The switch shall be electrically interlocked to ensure only one position, either Normal or Emergency, is engaged at any time.
 4. The switch shall be break-before-make to ensure that normal and emergency sources are never interconnected within the unit.
 5. Built-in fuses shall provide 10,000 ampere Short Circuit Current Rating (SCCR) on the connected emergency circuit.
 6. Switch contacts shall withstand transfer without welding, with 180° phase displacement between normal and emergency power sources if both sources are energized.
 7. Transfer switch contacts shall be rated for mixed loads, including electric discharge lamps and tungsten filament lamps.
 8. Transfer switch shall be rated for a minimum of 6,000 cycles at full tungsten load.
- C. Control Circuitry
1. The control circuitry shall direct the operation of the transfer switch.
 2. A field-configurable normally closed (NC) or normally open (NO) dry contact closure input shall be provided.
 - a. Up to (10) BCELTS devices may be connected to a single remote loop.

3. The BCELTS shall support transfer of a 0-10V or DALI controlled circuit.
 - a. Upon activation of emergency transfer the BCELTS shall break the 0-10V or DALI control circuit, driving connected 0-10V circuits to full output and DALI circuits to their default level.
- D. Operation
 1. Transfer to alternate emergency supply will occur when normal supply sense voltage drops below 80V when used at 120V or 277V.
- E. Enclosure
 1. The BCELTS shall be mounted in a NEMA 1 interior type enclosure finished in fine- textured epoxy paint.
 2. The enclosure shall be 8.5"H x 10.5"W x 2.75"D.
 3. The system shall be provided with an approved overlay mounted on the front of the enclosure, stating, "BRANCH CIRCUIT EMERGENCY LIGHTING TRANSFER SWITCH".
 4. The enclosure shall be provided with an approved label indicating that the system is UL1008 LISTED for Emergency Systems.
- F. Provide two (2) BCLETS SC1008 Branch Circuit Emergency Lighting Transfer Switches.

2.16 EMERGENCY BYPASS DETECTION KIT

- A. The bypass detection kit shall be the Emergency Bypass Detection Kit as manufactured by Electronic Theatre Controls, Inc., or equal.
- B. The enclosure shall be a surface mounted, constructed of 16-gauge formed steel panels removable front cover finished in fine textured, scratch-resistant, powder coat paint.
- C. Accessories for installation, including tap kits and manual reset switch kits shall be available from a single manufacturer.
- D. Emergency Bypass Detection enclosures shall support 100 to 277 volt configurations.
 - 1) EBDK enclosures shall be field configurable for single-phase, bi-phase, and three-phase operation without the need for additional components.
- E. The Emergency Bypass Detection Kit shall be completely pre-wired by the

manufacturer. The contractor shall provide input feed and control wiring.

- F. All control wire connections shall be terminated via factory provided connectors.
- G. The Bypass Detection Kit shall be UL and cUL Section 924 listed for interaction with similarly listed dimming and switching panels.
- H. Provide one (1) Emergency Bypass Detection Kit.

2.17 DMX EMERGENCY BYPASS CONTROL

- A. Where required to trigger special-purpose lighting presets and bypass normal lighting controls during emergency or panic situations, the bypass means shall be the DMX Emergency Bypass Controller (DEBC) as manufactured by Electronic Theatre Controls, Inc., or equal.
- 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 up to optically-isolated DMX outputs.
 - b. The DMX Emergency Bypass Controller shall poll the bypass trigger input after a power loss and react upon startup.
 - c. The default or recorded sequence 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 second (default)
 - 2) 10 second wait
 - 3) 30 second wait
 - 4) 10 minute wait
4. The DMX Emergency Bypass Controller (DEBC) 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 triggering system. 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 mount enclosure, constructed of 16-gauge, formed steel panels 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.
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.
 - 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. 8 lb. (single output); 14.5 lbs (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 24-10AWG solid or stranded ground wire.
4. DEBC shall support one grounding lug for 24-14AWG 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. Terminations shall support two, 30-12AWG low voltage wires.
 - b. The bypass input shall support a maintained open (N.O.) or normally closed (N.C.) dry contact input.
 - c. A +12VDc wet contact input shall be available for interface to fire alarm system.
 - d. DEBX shall support socketed transceiver chips. 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 DMX output using electromechanical relay when triggered.
 - a. The DEBC shall have non - volatile memory for storage of as ingle 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 pockets per second) for increased compatibility during bypass DMX output.
 8. The DMX shall be capable of outputting to 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: 10-90% non-condensing
- F. Provide one (1) DEBC DMX-6 Emergency Bypass Controller with six (6) outputs.

2.18 LIGHTING CONSOLE AND ACCESSORIES

- A. General
1. The lighting control console shall be a microprocessor-based system specifically designed to provide complete control of stage, studio, and entertainment lighting systems. The console shall be the Gio @5 as manufactured by Electronic Theatre Controls, Inc., or equal.
 2. The control system shall be Net3 and ETCNet 2 native, with both protocols output simultaneously over the network. The system shall also be able to control third party ANSI e1.31 sACN/ACN devices directly. Artnet and Avab UDP protocols shall also be available. The system shall provide control of from 2048 to 32,768 parameters on a maximum of 16,000 control channels. The base system shall be 2048 outputs, upgradable in 1024 increments pre- or post- installation.
 3. A maximum of 10,000 cues, 1000 groups, 1000 presets, 4 x 1000 palettes (Intensity, Focus, Color and Beam), 99,999 macros, 1000 effects, 1000 curves and 1000 snapshots may be contained in non-volatile electronic memory and stored to an onboard solid-state hard drive or to any USB storage device.
 4. Recorded cue lists may be played back simultaneously on a maximum of 200 faders. Channels shall respond to cue information by last instruction

with discrete rate control provided for all cues. The console may be placed in Tracking or Cue Only mode by the user as a system default and overridden on individual record actions as required. HTP/LTP intensity flags, assert, proportional, intensity master or manual master fade control. Priority and Background Priority may be placed on each cue list. It shall also be possible for a cue list to contribute to playback background states or to withhold such contributions.

5. A master playback fader pair shall be provided. The 60 mm motorized fader pair may execute crossfades or all-fades, with IFCB cue level timing.
6. Five 60mm motorized faders shall be user configurable across 100 pages and provide additional playback faders (up to 200), additive or inhibitive submasters (up to 999), and grand master control. Presets and IFCB palettes may be loaded to faders for playback control, either individually or in user-defined lists. Virtual fader control is also provided.
7. The system shall have one 17.1" integral articulating multi-touch display. Content posted to this display shall be user definable. The display shall support multiple interpreted simultaneous touches.
8. A high-resolution level wheel shall be provided to control intensity for selected channels and scrolling within selected displays. Four pageable high-resolution encoders shall be provided for control of other non-intensity parameters. Non-intensity encoders toggle between coarse and fine control, with tactile feedback for full frame (color or image) settings. The expand function for frame table devices shall provide a graphic representation of all images and colors in the associated device for instant selection. A graphic shutter representation shall provide additional control of shutter parameters. The display shall also provide an indication of the current value for the associated parameter, based on channel selection. A high-resolution rate wheel, which may also be used for fader paging shall be provided.
9. Control surface buttons shall be backlit. This backlighting provides indication of functional states. Backlight intensity shall be user controllable, and shall automatically dim after a defined period of inactivity.
10. Control and programming features for automated fixtures shall also include: a standard library of fixture profiles, the ability to copy and edit existing profiles and create new profiles, patch displays including channel and output addressing, 16-bit fade resolution, color characterization allowing color mixing and storing in Hue and Saturation or native device values.

11. System information, including playback status, live output and blind values for all record targets shall be displayed on a maximum of two external high resolution monitors, which may also be multi-touch touch-screens. All displays may also be routed to the integral touch screen. Any Windows 7 compatible display may be used.
12. A context sensitive on-line Help feature shall explain and provide an example of the operation of each feature of the system.
13. A fully integrated Virtual Media Server feature shall allow user to map images and animations to a rig array. 40 such maps may be created, each with 12 layers. System that rely on external hardware or software for this functionality shall not be acceptable.
14. A back-lit detachable alphanumeric keyboard shall be provided in a keyboard drawer under the main programming keypad. The keyboard shall allow labeling of channels, cues, presets, groups, palettes, effects, macros, curves, snapshots and the show. The central touch screen shall also repoint to access an integrated virtual alphanumeric keyboard.
15. Console software upgrades shall be made by the user via flash drive; changing internal components shall not be required. It shall be possible to install software updates in all consoles, processor units and remotes from one device over the network.
16. The console operating software shall be loaded into program execution memory from the internal hard drive when the console is powered. In the event of an uncontrolled shutdown, the console shall return to its last output state when power is restored.
17. Integrated dimmer monitoring features shall be provided to allow indication of dimming system status, error states and dimmer load monitoring. Adjustment of dimmer configuration shall also be supported. Communications with the dimming system shall utilize ANSI E1.17 2006 - Entertainment Technology - Architecture for Control Networks.
18. Integrated RDM device features shall be provided. The console shall discover and patch RDM devices. The console shall monitor RDM devices to allow indication of RDM device online/offline status error states. The console shall be capable of changing settings of RDM devices such as the DMX start address. Communications with the RDM devices shall utilize ANSI E1.20 2006 – Remote Device Management.
19. Network configuration tools shall be provided from within the desk.

20. Show data may be created and modified on a personal computer, using either Windows XP or Windows7, or a Macintosh platform running OS X, via a free offline editing application. The program shall run natively on Apple operating systems. Applications requiring PC emulation programs shall not be acceptable.
21. A PC, using either Windows XP or Windows 7, or a Macintosh (Intel only) running OS X using the offline software application shall be able to connect to a control system via the network and view or modify current show data in an independent display environment, using an ETCnomad dongle. When connected without the dongle, the computer shall operate in Mirror Mode, with the device to be mirrored selectable by the user.
22. Synchronized backup shall be provided via another full console on the network, an ETCnomad, or by use of a remote processor unit. The backup console/RPU shall maintain synchronized playback with the master and shall take over control of the lighting system upon loss of communication with the master. Use of two RPUs to service and backup system output is also supported.
23. A maximum of twelve users may access and interact with show data simultaneously. Each user shall have an individual workspace. User identification may be assigned to more than one control device, allowing users to work in tandem, or allowing a designer/ALD to mirror the current display format, mode and command line of the associated programmer. Partitioned control allows discrete control of channel/parameter groupings by user. Partitioned control may be easily enabled and disabled with no need to merge show data from multiple users.
24. The system shall support up to 32 individual simultaneous Time Code inputs or Event lists.
25. Systems that do not provide the above capabilities shall not be acceptable.

B. Controls and Playback

1. Manual Control and Programming Section

- a. The console keyboard shall be grouped by function. Major groupings shall be record target functions, numeric keys, level assignment functions, display navigation functions and controls, as well as non-intensity parameter controls.
- b. The command keypad shall be fully interactive with direct selects and other virtual controls, which provide "one touch" selection of

channels, groups, palettes, presets, effects, snapshots and macros.

- c. Non-intensity parameters may be set numerically via an extensible keypad on the central LCD. This control shall be fully interactive with the moving light encoder controls and the virtual controls. The LCD touch screen associated with the encoders shall display the current encoder function. The touch screen shall also access available modes for each parameter type, min and max values for each parameter as applicable, as well as home position on a parameter basis. Each encoder shall support push button control for coarse and fine. Tactile feedback shall indicate full and half frame positioning of certain controls.
- d. Only those parameters available for control in the active lighting system shall be displayed for control. Displays shall condense or lowlight parameters not available to selected channels. Alternatively, the encoders may be placed in a state allowing parameters not applicable to the current selection to be suppressed.
- e. Lamp controls provide direct access to luminaire functions such as striking and dousing arc lamps and calibrating entire fixtures or individual mechanisms of fixtures, as provided by the luminaire manufacturer. User access to these features is normalized across all manufacturers for ease of use. Use of a "control channel" for accessing these functions shall not be required and systems requiring use of control channels for these functions shall not be acceptable.
- f. Fan functions shall be provided both via command line operation and through encoder controls.
- g. Highlight shall be supported, with user definable highlight values. Lowlight conditions may be defined for selected, but not specified channels. Rem Dim commands, at specific levels by channel, may be optionally and automatically called with the highlight command.
- h. Advanced color control function provide color mixing in any of six different color spaces. Gel matches are provided via gel picker or by command line control. Tinting tools allow adjusting the color mix irrespective of the native mixing system. Spectrum tools support adjusting the output of additive color systems with more than three emitter types, allowing the X/Y coordinate to be held while adjusting the recipe that achieves that mix. Color Path

tools allow the user to control the live fade of fixtures through the color space.

- i. The Virtual Media Server function shall allow the user to create layouts of devices, identified as pixel maps. Media content (images, movies, text and procedurally generated effects) may then be applied, manipulated and stored. Stock content is provided and the user may import his own imagery and animations.
- j. Macros may be set to run as default. Default macros called manually shall post to the command line, but executed via cue lists shall run in the background. The user may override this behavior by defining the macro to always execute in the foreground or background, regardless of the recall method.

2. Playback Section

- a. The playback faders shall consist of a motorized 60mm master fader pair with three definable playback buttons and a 5 pageable playbacks.
- b. Up to 200 cue playback faders may be defined on the fader array. Each playback shall have an associated 60mm motorized potentiometer and definable buttons.
- c. Faders may be grouped for playback, with sliders and button action defined by the user.
- d. It shall be possible to instantaneously halt an active cue, back to the previous cue, manually override the intensity fade or manually override the entire fade.
- e. It shall be possible for a cue list to contribute to the background state or for the contents of each cue list to be withheld from such.
- f. Playback faders shall have the following associated controls:
 - 1) Freeze, which halts the output of the fader.
 - 2) Stop Effect, which stops the action of an effect.
 - 3) Filter, to assign filter states to a fader.
 - 4) Go To Cue 0, to reset a cue list.

- 5) Off, to turn off the contents of a playback, releasing control to the background state or to set to null.
- 6) Assert, to replay an active cue.
- 7) Release, to release control to the background and reset the cue list.
- 8) Timing disable, channel filters, parameter filters, priority and background priority status may also be defined.
- 9) The potentiometer shall be configurable as a proportional master, an intensity master, or manual master. Support for rate, effect rate, effect size and Master Only controls is also provided.
- 10) Rate override and fader paging are supported with a wheel encoder and associated controls.

3. Submasters

- a. Up to 999 proportional, fully overlapping additive or inhibitive submasters may be defined. Submasters shall have colored LEDs to indicate submaster status. Each submaster may have fade up, dwell and down fade times. Submasters may be set to priority and background priority status.
- b. Submasters may be set to HTP or LTP intensity. Non-intensity parameters on submasters shall be LTP only.
- c. Exclusive mode for a submaster shall prohibit the live contribution of that submaster from storing to cues or other submasters. Shield mode prohibits access of associated channels from any other playback or manual control operations.
- d. A submaster potentiometer may be defined as proportional, master only or intensity master. When set as an intensity master, a mark and unmark feature is supplied.
- e. Motorized faders shall set submasters to required positions as fader pages are changed.
- f. The submaster blind buffer shall be linked directly to live playback.
- g. It shall be possible to set submaster values directly from the command line.

- h. Submasters may be set to fade to background or to minimum value when the fader is returned toward zero.
 - i. Submaster values may contribute to the background state or withheld from such.
- 4. Grand Master Faders
 - a. The location of the Grand Master shall be user definable. The Grand Master shall have associated blackout and blackout enable buttons.
 - b. Blackout shall send all associated intensity outputs to zero. Non-intensity outputs shall not be affected.
 - c. Motorized faders shall set Grand Masters to required positions as fader pages are changed.
- 5. Display Controls
 - a. Format shall change the view of selected displays.
 - b. It shall be possible for the user to choose which parameter categories or parameters (s)he wishes to display.
 - c. Flexichannel shall change which channels are viewed in selected displays, as follows:
 - 1. All channels
 - 2. Patched channels
 - 3. Show channels
 - 4. Active/Moved channels
 - 5. Selected channels
 - 6. Manual Channels
 - 7. View channels (user identified list)
 - 8. Channels with discrete timing.
 - d. Expand shall extend the selected view sequentially across connected displays, vertically or horizontally.

- e. [Time] depressed shall display discrete timing data. [Data] suppressed shall display absolute values of referenced data. These functions may be latched.
- f. Displays may also be toggled to show stored data currently manually overridden, the source of the current parameter data and referenced marking data.
- g. Playback status displays are provided with a variety of different formats. Indications are provided per cue for live moves (lights fading from zero and also moving non-intensity parameters) and dark moves (inactive lights which have stored non-intensity parameter moves).

C. Operating Modes

1. Live Mode

- a. Channel lists may be constructed using the +, -, and Thru keys as well as the direct selects. Channel selection and deselection is fully interactive, regardless of the method used.
- b. Levels may also be set with the keypad, level wheel and non-intensity encoders. "Selected" channels shall be those last addressed and under keypad control. Controls are provided for single button access to the last selected channel list, all channels with manual levels and all active channels.
- c. Channels may be set at a user defined default level using the Level key. +% and -% keys adjust channels quickly by user definable values.
- d. Channels and/or channel parameters may be captured. Capture mode shall allow the user to selectively capture channel data at specific levels. Captured data shall be indicated on the Live display.
- e. Sneak shall be used to restore specified channels to background states, default values, or to send them to specified values, in user specified times.
- f. Selected channels may be set at a level or held to current values while all other channels are set to zero using Rem Dim. Toggling Rem Dim shall restore all unselected channels to original levels. The Rem Dim level shall be user definable via the command line

or with a default setup value.

- g. Channels may be recorded into groups for fast recall of commonly used channels. 1000 groups shall be available. Groups shall store selection order. The Offset function supports rapid creation of ordered groups, including reverse and random order.
- h. Parameter settings may be stored to Intensity, Focus, Color and Beam Palettes and to Presets. All referenced data may be stored to whole numbers or to up to 99 decimal places between each whole number.
- i. The following conditions may be placed on a channel or channel parameter to be included with a cue record action.
 - 1) Discrete fade time and/or delay
 - 2) Block flag
 - 3) Assert flag
 - 4) IFCB Filters, which may be set at a parameter level.
 - 5) Release and Restore
- j. 999 cue lists may be stored. Cues may be recorded in any order. Up to 99 decimal cues may be inserted between any two whole number cues. Each cue may contain a maximum of twenty parts. Parameters may be automatically assigned to specific parts or assigned when the part is created.
- k. It shall be possible to record cues and cue parts with the following information:
 - 1) Any collection of channel data, as determined by the use of "Record", "Record Only" or selective store commands, combined with parameter filters.
 - 2) Cue Level timing and delays for Intensity Up, Intensity Down, Focus, Color and Beam.
 - 3) Follow or hang time
 - 4) Link instruction
 - 5) Loop value

- 6) Block, Assert, Preheat, and/or Mark Flag
 - 7) Curve
 - 8) Allfade
 - 9) Label and note
 - 10) Execute list to trigger other activity
- i. Non-intensity channel parameters may be marked (preset), in two ways. Automark presets any parameters transitions in the cue just prior to intensity becoming active. Automark may be disabled on a cue or cue part basis, enabling a “live” move. Alternatively, non-intensity parameters may be marked to a specific cue with a single command instruction. It shall not be necessary to store these parameters directly into the cue in which the movement is to occur.
 - m. Any channel parameter may be stored with an effect instruction. These effects may contain relative offsets from current value, or absolute instructions. Effects may be progressive action or on/off states. Entry and exit behaviors shall modify the channel parameters activity when beginning and ending the effect.
 - n. Update may be used to selectively add modified parameter data quickly to that parameter’s current source. Update may be specified to modify referenced data content or break the link to that content. A dialogue informs the user of the content that will be updated. A trace command may be used to modify the data to the original source of its move instruction. It shall be possible to update inactive record targets.
 - o. Recall From quickly pulls specified data from record targets or other channels into the current view.
 - p. Copy To quickly copies selected data to specified channels or other record targets.
 - q. Address and channel check functions shall be provided.
 - r. Channel parameters may be “parked” at levels. Those levels are not added to any live record operations, nor may they be changed until the parked element is “unparked”. Scaled park provides real time proportional adjustment of stored intensity values. Address

Park shall also be provided.

- s. About shall provide detailed status of selected channels or specified record targets. This shall include current source, current value, discrete timing, parked value, marked to and for indications. Background levels and current DMX output are also displayed. Channel usage indicates submaster and cue information and also provide a "dark moves" report on a per channel basis.
 - t. 1000 snapshots may be stored which instantly recall specified front panel and display configurations.
 - u. Live data may be displayed in a summary view or detailed table orientation.
 - v. Query shall allow selection of channels by their current or possible state. Keywords and fixture types shall allow quick access to fixtures.
 - w. User definable home positions, on a per channel basis, may be defined.
 - x. Channel level offset commands provide channel ordering and sub-grouping functions.
 - y. Undo shall be used to sequentially step back through manual operations or to undo record and delete actions. It shall be possible to undo multiple commands in one action.
2. Blind
- a. The Blind display allows viewing and modification of all record targets without affecting stage levels.
 - b. Record target data may be displayed in a summary view, a detailed table orientation or a spreadsheet view, which allows quick data comparisons, move and replace functions.
 - c. Changes to blind data shall be automatically stored. Range selection of both record targets and channels shall be supported.
3. Fader Displays
- a. Fader displays isolate the stage view to the contributions of the specified playback. Live modifications to channel levels may be

made and re-recorded in this mode.

4. Patch Display
 - a. Patch shall be used to display and modify the system control channels with their associated library data.
 - b. Each channel may be provided with a proportional patch level, curve, label, swap and invert functions, as well as keywords to service Query.
 - c. Accessing library data to patch multiple parameter fixtures may be accomplished entirely from the command line. Use of a pointing device to patch to moving lights shall not be required.
 - d. Offset functions in patch shall allow selection of channel ranges and shall allow the user to establish a "custom" footprint for any device output.
 - e. Custom color wheels, color scrolls and gobo wheels shall be defined in patch. These devices shall be created with a simple table and graphical user interface supported by images of major manufacturers.
 - f. RDM discovery and device monitoring shall be supported.
 - g. Copy to and Move functions shall be supported in patch.
 5. Setup/Browser
 - a. Setup shall access system, show and desk configurations.
 - b. It shall be possible to partially import Eos/lon show files. Users shall be able to select as much or as little of the show file as required, with renumber tools.
 - c. It shall be possible to import ASCII and Lightwright data files. It shall be possible to export as ASCII or .csv.
 - d. Setup shall also access show data storage, import, export, print to .pdf and clear functions, as well as show data utilities.
- D. Interface Options
1. The console shall support a variety of local interfaces.

- a. AC input
 - b. USB (eleven ports for items such as alpha-numeric keyboard, mouse, touch screens, USB flash drive...)
 - c. Ethernet (two ports)
 - d. Two Display Port output connectors, supporting Windows 7 compliant monitors as 1280x1024 resolution minimum. Touchscreen/multi-touch support of any/all of these monitors is provided.
 - e. Contact Closure trigger via D-Sub connector
 - f. 4 DMX/RDM ports
 - g. Alternative Contact Closure trigger through Gateway
 - h. OSC Transmit/Receive
 - i. MIDI In/Out, MSC and MIDI Notes through Gateway
 - j. SMPTE Timecode through Gateway
- E. Accessories Required
1. iRFR and iRFR Preview (applications for iPhone, iPod Touch and iPad units)
 2. aRFR (application for Android devices)
 3. 2x10 universal fader wings
 4. One (1) 50'-0 Net cable
 5. One (1) 10'-0 Net cable
 6. Two (2) Dell P2418HT LCD Touchscreen monitor with DVI cable
- F. Synchronized Backup
1. An optional Backup system shall consist of one of the following combinations of devices:
 - a. Two networked consoles.
 - b. One (or more) console with one Remote Processor Unit (RPU)

- c. One (or more) consoles with two Remote Processor Units (RPUs)
- d. ETCnomad with matching output capacity
- G. Physical
 - 1. All operator controls and console electronics for a standard system shall be housed in a single desktop console, not to exceed 25.25" wide, 26.25" deep, 14.33" high, weighing 52 pounds. Console power shall be 90 – 240V AC at 50 or 60Hz, supplied via a detachable locking power cord.
- H. Provide one (1) Gi0@5-8K, 192 outputs (16 universe) Lighting Console with required accessories (per section E) -OR-- provide one (1) Strand NEO Lighting Control Console (4 Universes of DMX) 91001, with twelve (12) one NEO console universe of DMX (512 channels each) 91002, two (2) 24-inch touchscreen monitors (multi- touch), and one (1) Ethernet cable 25'-0".

2.19 MOTORIZED FADER WINGS

A. General

- 1. The motorized fader wings shall provide extended playback control for the lighting control system.
- 2. The motorized fader wings shall be compatible with the ETC Gio @5k. Hosting hardware must be USB 2.0 on Windows 7 or higher or Mac native 10.11 (El Capitan) or later.
- 3. Up to three wings may be connected to any host hardware. These may be combined with non-motorized fader wings.
- 4. The motorized faders shall automatically preset to the required positions when changing pages, or using size and rate controls.
- 5. The motorized wings shall be available in the following configuration:
 - a. The x10 fader wing shall have 10 60mm motorized faders, three controls keys and two integral high-resolution, full-color displays.

B. Mechanical and Electrical

- 1. The fader wings shall connect to compatible products via external USB 2.0 cables and provide 2 additional external USB multi-function ports.
- 2. Provide auto power sensing when both USB data and external power are connected.

3. VESA 100x100mm mountable and provides a Kensington Lock compatible locking point.
 4. The x10 fader wing shall be 12.10" (307mm) wide, 3.93" (100mm) high and 14.24" (362mm) deep, weighing 6.2 pounds (2.8 kgs).
- C. Provide one (1) EOS Motorized Fader Wing 10 OR provide one (1) NEO Console Submaster Wing 91004.

2.20 ELECTRICAL DISTRIBUTION EQUIPMENT

- A. All distribution equipment shall be furnished by the manufacturer of the dimming equipment. Hanging and supporting hardware shall be furnished and installed under SECTION 11065 "THEATRE AND STAGE EQUIPMENT - RIGGING SYSTEMS".

B. PANTOGRAPH CABLE MANAGEMENT FOR ELECTRICS

1. The load circuits and data wiring shall be fed to the distribution trough by one or more UL listed pantograph cable management systems that are specifically designed to interface with traditional stage distribution raceways. The pantograph shall allow the cable trays, feeder cable and data wiring to fold and store along the top of the connector strip without imposing a direct physical load on the connector strip.
2. The pantograph shall consist of a series of 18 ga. ventilated steel trays hinged to each other to allow the entire distance of travel required by the batten, up to 50'. The hinges and hinge attachment points shall be stiffened to prevent distortion of the pantograph.
3. The trays shall be connected to a moving trolley at the compression tube that allows relief as the system moves slightly from side to side during ascent/descent of the batten. At the bottom, the pantograph shall be attached to a hinge point above the houselight or distribution trough in a manner that imposes no additional physical load on those assemblies. The flat cable in the trays shall exit the pantograph and enter a termination box on the distro strip where all electrical connections shall be made.
4. The flat cable shall be UL LISTED.
5. The pantograph shall support a double-high/double wide stack of flat cable and shall allow the flat cable to bend at each joint within required NEC bending radii.

6. The trays shall hinge open/closed as the batten is lowered/raised and shall not impede the movement of the line set.
 7. The trays shall be sufficiently stiff to support themselves and the flat cable they carry. At no time shall the trays bow, warp, sag or twist whether or not under load of the flat cable.
 8. Flat cable in the pantograph tray shall never heat in excess of the rated temperature maximum of the flat cable when all circuits within the tray are loaded at maximum electrical capacity.
 9. It shall be possible to provide power for up to sixteen 20 amp circuits plus ground and data via each pantograph.
 10. These cable management systems shall interface with the circuit distribution trough with standard mechanical and electrical hardware purpose designed for this assembly.
 11. Hoisting systems utilizing cable management systems from third-party vendors shall be fully integrated into the hoisting system without additional custom hardware, changes to any part of the pantograph or changes to the QuickTouch controller.
 12. Hoisting systems that do not fully integrate cable management in the hoisting system and controller shall not be acceptable for this installation.
- C. Connector Strips shall be furnished and installed for the stage and catwalk where shown on the Drawings.
1. Each connector strip shall be complete with three-pole, 20A grounded stage pin connector type female receptacles.
 2. Internal wiring shall be sized to circuit ampacity and shall be rated at 125°C.
 3. Terminations shall be at one end using feed-through terminals individually labeled with corresponding circuit numbers.
 - a. 20 amp circuits shall use screwless tension clamp terminals listed for 20 – 8 gauge wire.
 - b. Terminals that place a screw directly on the wire are not acceptable.

4. Connector strips shall be supplied with appropriate brackets and hardware for mounting as shown on the Drawings.
 - a. Connector strips shall have junction brackets on 5' centers.
 - b. Brackets shall be 1 ½" x .188" ASTM A 36 steel.
 - c. Hardware shall be ASTM A307 grade 5.
5. A low voltage distribution system shall be available to incorporate DMX, Ethernet or other protocols as specified in the connector strip. Connector strips shall utilize a voltage barrier to accommodate these systems. Low Voltage signals shall enter the connector strip via a strain relief or connector mounted in a separate low voltage terminal box at the specified end of the connector strip. Up to four low voltage cables shall be supported for each connector strip.
6. Physical:
 - a. Connector strips shall be 6.25" H x 3.3" D and fabricated from 18-gauge galvanized steel and finished in black fine-texture powder coat paint.
 - b. Covers shall be fabricated from 16-gauge galvanized steel.
 - c. Connector strips shall be available in any length specified in increments of 6" and shipped fully wired with all splicing hardware.
 - d. Connector outlets shall be spaced on 18" centers, or as otherwise specified or shown on the Drawings.
 - e. Outlets shall be mounted on individual 3" panels.
 - f. No external terminal boxes shall be required for connector strips with 28 or fewer circuits unless otherwise specified.
 - g. Circuits shall be labeled on the connector strip with 2" high lettering. Circuit labeling shall be located on the front side of the connector strip with white lettering on black background.
7. Connector strips shall support and include optional LED indicators to indicate the presence of power at each local circuit. The LED indicator shall be red in color and mounted in the connector strip directly below the outlet panel.
8. Connector strips shall be Underwriter Laboratories (UL) LISTED. The

- connector strips shall be the Electronic Theatre Controls, Inc. 99 series or equal.
- a. Two outlets per circuit shall be provided for each strip. Each circuit shall repeat from left to right, with labels reflecting the circuit repetition as follows: ABCD, ABCD.
 - b. Data shall be provided via portable or built in gateways as per the drawings.
- D. Plug-in outlet boxes shall be furnished and installed where shown on the Drawings.
1. Plug-in outlet boxes shall be complete with three-pole, 20A grounded stage pin connector type female receptacles attached to twenty four (24) inch pigtails.
 2. Pigtails shall be three-wire type "SOW" rubber jacketed cable sized for the maximum circuit ampacity.
 3. Pigtails with 20 amp stage pin connectors shall be terminated using 12 gauge 4 way indent crimp (with inspection window) type where the wire is inserted and crimped directly in the socket.
 4. Terminations for pigtail connectors shall utilize feed-through terminals individually labeled with corresponding circuit numbers. 20 amp circuits shall use screwless tension clamp terminals listed for 20 – 8 gauge wire. Terminals that place a screw directly on the wire are not acceptable.
 5. Pigtail outlet boxes shall be supplied with appropriate brackets and hardware for mounting as shown on the Drawings.
 - a. Standard mounting options shall include pipe or wall mounting.
 - b. Brackets shall be made from ASTM A 36 steel.
 - c. Hardware shall be ASTM A307 grade 5.
 6. A low voltage distribution system shall be available to incorporate DMX, Ethernet or other protocols as specified in the plug-in outlet box where shown on the Drawings.
 - a. A voltage barrier shall be used to separate the low voltage wiring for the electrical circuits.
 7. Physical:

- a. Plug-in outlet boxes shall be 6.25" H x 3.3" D and fabricated from 18 gauge galvanized steel and finished in black fine-texture powder coat paint.
 - b. Covers shall be fabricated from 16-gauge galvanized steel.
 - c. Plug-in outlet boxes shall be available in any length specified in increments of 3-inches with a maximum length of up to 3-feet.
 - d. Pigtails and outlets shall be spaced on 4" centers, or as otherwise specified.
 - e. Pigtail outlets shall be mounted on individual 3" panels.
 - f. Circuits shall be labeled with 1.25" lettering. Circuit labeling shall be located on the front side of the plug-in outbox with white lettering on black background.
 - g. Pigtail boxes shall support and include optional LED indicators to indicate the presence of power at each local circuit. The LED indicator shall be red in color and mounted in the cover plate directly below the circuit label for pigtail circuits.
8. Plug-in outlet boxes power distribution equipment shall be Underwriter Laboratories (UL) LISTED. Plug-in pigtail outlet boxes shall be the Electronic Theatre Controls, Inc. 9300 Series or equal (for surface or pipe mounting).
- E. CONNECTOR STRIP—DISTRO shall be furnished and installed where shown on drawings.
1. Circuit wiring shall be supplied to the trough via an ETC Pantograph Cable Management system.
 2. Cable management shall utilize an ETC Prodigy Pantograph that allows up to sixteen line-voltage circuits or a combination of line-voltage and up to two emergency circuits. Knockouts located 6" on-center are built into the raceway. The knockouts permit installation of houselights with canopy or stem mounts to attach directly to the raceway. Up to 50 pounds may be suspended between raceway supports.
 3. Pantograph cable management and houselight distribution is UL LISTED for use with flat cable circuit distribution and fixture mounting as described above.

4. The load circuits and data wiring shall be fed to the distribution trough by one or more UL listed Pantograph cable management systems that are specifically designed to interface with traditional stage distribution raceways. The pantograph shall allow the cable trays, feeder cable and data wiring to fold and store along the top of the connector strip without imposing a direct physical load on the connector strip.
5. The Pantograph shall consist of a series of 18 ga. ventilated steel trays hinged to each other to allow the entire distance of travel required by the batten, up to 50'. The hinges and hinge attachment points shall be stiffened to prevent distortion of the pantograph.
6. The trays shall be connected to a moving trolley at the compression tube that allows relief as the system moves slightly from side to side during ascent/descent of the batten. At the bottom, the pantograph shall be attached to a hinge point above the houselight or distribution trough in a manner that imposes no additional physical load on those assemblies. The flat cable in the trays shall exit the pantograph and enter a termination box on the distro strip where all electrical connections shall be made.
7. The flat cable shall be UL listed.
8. The pantograph shall support a double-high/double wide stack of flat cable and shall allow the flat cable to bend at each joint within required NEC bending radii.
9. The trays shall hinge open/closed as the batten is lowered/raised and shall not impede the movement of the line set.
10. The trays shall be sufficiently stiff to support themselves and the flat cable they carry. At no time shall the trays bow, warp, sag or twist whether or not under load of the flat cable.
11. Flat cable in the Pantograph tray shall never heat in excess of the rated temperature maximum of the flat cable when all circuits within the tray are loaded at maximum electrical capacity.
12. It shall be possible to provide power for up to sixteen 20 amp circuits plus ground and data via each Pantograph.
13. These cable management systems shall interface with the circuit distribution trough with standard mechanical and electrical hardware purpose designed for this assembly.
14. Hoisting systems utilizing cable management systems from third-party

vendors shall be fully integrated into the hoisting system without additional custom hardware, changes to any part of the Pantograph or changes to the QuickTouch controller.

15. Hoisting systems that do not fully integrate cable management in the hoisting system and controller shall not be acceptable for this installation.

2.21 ARCHITECTURAL LED RUNNING LIGHTS

A. General

1. The instrument shall be a BluesSystem luminaire as manufactured by ETC, Inc., or approved equal.
2. The product shall be controlled via an external, proprietary power supply from the BluesSystem range of products (see Section E below).
3. The product shall be provided with a minimum warranty of 5 years full fixture coverage and 10 years LED array coverage.

B. Physical

1. The product shall be constructed of an injection molded poly-carbonate material with enclosed LED emitter and electronics sealed in place using an epoxy resin to form one complete fixture.
2. The luminaire:
 - a. Shall have pre-installed factory fitted reflectors or lenses for different beam angles as specified below.
 - b. Shall have 3 factory installed screw terminals accepting allowing low voltage connection to the separate power supply.
3. The luminaire shall be as follows:
 - a. Dome:
 - 1) Round form factor with shallow profile no greater than 1.5" in height housing integrated dome optical lens providing 2 options of diffusion as follows:
 - a) Frosted lens
 - 2) Testing to UL1598 and CSA22.2 (No. 250) standard and listed with a 3rd-party laboratory.

- 3) 2 x holes at 2" (51mm) spacing for mechanical securement.

C. Optical

1. The luminaire shall contain integral optics to provide beam option as detailed in section 3.
2. The luminaire shall contain a single color Blue LED. Other single color LED's shall be available by custom order.

D. LED

1. The luminaire shall utilize a single Blue LED emitter.
2. The LED shall be rated for an average of 70% output after 50,000 hours of use.
3. The luminaire shall have an expected average power consumption of less than 4W.
4. The luminaire shall have a minimum output of
 - a. BlueDome Frosted Lens: 3 field lumens

E. Power Supply

1. The BluesSystem luminaire shall require the use of a separate, rack mounted, BluesSystem power supply.
2. The BluesSystem power supply shall be manufactured from a cold rolled steel enclosure finished in a fine texture, high temperature black powder coat paint and be available as follows:
 - a. 6-Zone power supply capable of providing power and control for up to 60 BluesSystem luminaires across 6 circuits. The 6-Zone power supply shall be a 19" rack mount product (listed to UL2108/CS22.2 No.9)
3. The power supply shall have the following electrical properties:
 - a. 100-240V AC 50/60Hz Input
 - b. 36V DC Output
4. The BluesSystem power supply shall have the following control option:

- a. DMX512-A (ANSI E1.11-2008) in and through via internal terminal blocks
- F. Provide one (1) BS-PS-6-D Rack Mounted BluesSystem Power Supply 6-Zone DMX Controller.
- G. Provide twelve (12) BSDF BluesSystem Dome, Frosted running lights around stage perimeter.

2.22 THEATRICAL LIGHTING INSTRUMENT PACKAGE

- A. Theatrical lighting instruments manufactured by ELECTRONIC THEATER CONTROLS, INC. (ETC), are specified herein to provide a basis of quality. Other acceptable manufacturers are ALTMAN.
 - 1. System Integrator shall provide a Multiverse Transmitter as manufactured by City Theatrical.
- B. Follow spot lighting instruments shall be manufactured by CANTO USA. Other acceptable manufacturers are LYCIAN.
- C. Theatrical lighting instruments shall be capable of performing with light emitting diodes (LED) as indicated herein with proper heat sink cooling. Phenolic materials shall be employed on the fixtures in order to protect the operator from potential burns.
- D. Each theatrical lighting instrument shall be supplied with a safety cable, malleable iron clamp (c-clamp) to grip up to a two (2) inch ID pipe, fixture yoke with locking clutch handle, and power cable (Powercon to Stagepin or Powercon to Powercon).
 - 1. System Integrator shall provide 18" DMX jumper cables when providing theatrical lighting fixture package by Altman.
 - 2. System Integrator shall provide a cable package to include
 - a. Twenty- five (25) 10'-0" DMX jumper cables.
 - b. Five (5) 25'-0" DMX jumper cables
 - c. Sixty (6) 10'-0" PowerCon to PowerCon jumper cables
 - d. Thirty (30) PowerCon to Stage Pin power cables.
- E. Minimum performance criterion for all theatrical lighting instruments shall be as herein specified. Each instrument shall be furnished with a three pole, grounded stage-pin male connector and safety cable. UL listing shall be required on all theatrical lighting instruments.

- F. COLOR MIXING LIGHT OR WHITE LIGHT EMITTING EMITTING DIODE PROFILE FIXTURE
1. The fixture shall be UL 1573 listed for stage and studio use, be rated for IP-20 dry location use, and comply with the USITT DMX-512A standard. The fixture shall be ETL and cETL listed and/ or CE rated, and shall be so labeled when delivered to the job site.
 2. The following shall be provided:
 - a. Shutter assembly shall allow for +/- 25° rotation.
 - b. 25 gauge stainless steel shutters (XDLT barrel)
 - c. Interchangeable lens tubes for different angles with Ryton BR42B guides (in XDLT barrel) for smooth tube movements,
 - d. Sturdy integral die cast gel frame holders with two accessory slots, and a top-mounted, quick release gel frame retainer.
 - e. Rugged steel yoke with two mounting positions allowing 300°+ rotation of the fixture within the yoke.
 - f. Positive locking, hand operated yoke clutch.
 - g. Slot with sliding cover for motorized pattern devices or optional iris.
 3. The housing shall have a rugged black powder coat finish.
 4. The unit shall be constructed of rugged, die cast aluminum, free of burns and pits, finished in black.
 5. The light beam should have a 2 to 1 center to edge drop off ratio.
 6. Power supply, cooling and electronics shall be integral to each unit.
 7. The unit shall provide, but not be limited to low gate and beam temperature, and sharp imaging through a three-pane shutter design:
 - a. High quality pattern imaging.
 - b. Sharp shutter cuts without halation
 - c. Shutter warping and burnout in normal use shall be unacceptable.

- d. Adjustable hard and soft beam edges.
8. The unit shall provide, but not be limited to: XDLT (5-70) lenses.
 - a. 14,96,36 and 50 degree unit shall have XDLT lens tubes available for precision, high contrast imaging and color correction.
 9. Fixture shall be equipped with a cooling fan. Fan speed control via a DMX channel shall be possible. Fixture shall honor DMX fan settings but may power budget output to prevent damage if necessary.
 10. The fixture shall utilize advanced thermal management systems to maintain LED life to average of 70% intensity, after 54,000 hours of use. The fixture shall operate in an ambient temperature range of 0°C (32°F) minimum, to 40°C (104°F) maximum ambient temperature. Thermal management shall include multiple temperature sensors within the housing to include:
 - a. LED array circuit board temperatures. Temperature sensors are placed on each individual circuit.
 - b. Control Temperature. Fixture user shall permit monitoring temperature sensors via a full color.
 - c. Fixtures that do not provide active thermal monitoring of LED circuits and other temperature readings shall not be acceptable.
 11. The fixture shall be equipped with a 100V to 240V 50/60Hz internal power supply.
 12. The fixture shall support power In and Thru operation. Power in shall be via Neutrik True 1 TOP input connector. Power thru shall be via Neutrik TRUE 1 TOP output connector. Fixture power wiring and accessory power cables shall be rated to support linking of multiple fixtures up to the capacity of 15A breaker.
 13. The fixture requires power from a non- dim source. Power supply outputs shall have self- resetting current- limiting protection. Power supply shall have power factor correction.
 14. The fixture shall contain a minimum of six different LED colors to provide color characteristics as described in the color selection below. All LEDs used in the fixture shall be high brightness and proven quality from established and reputable LED manufacturer.

- a. Fixtures shall utilize Luxeon C LED emitters. Manufacturer of LED emitters shall utilize an advanced production. LED binning process to maintain color consistency.
 - b. All LED fixtures (100% of each lot) shall undergo a burn in test during manufacturing.
 - c. LED system shall comply with all relevant patents.
15. Fixtures shall have a PWM frequency of up to 20,000 Hz to avoid flicker on camera.
 16. L70 rating shall not be less than 54,000 hours.
 17. All fixtures shall be provided with the minimum warranty: 5 years full fixture coverage, 10 years LED coverage.
 18. Fixtures shall be calibrated at factory to achieve consistent color and intensity output between fixtures built at different times and/or from different LED lots or bins. Calibration data shall be stored on the LED array as a permanent part of on-board operating system. All arrays including replacement arrays shall be calibrated to the same standard to insure consistency. Fixtures not offering LED calibration shall not be acceptable.
 19. The fixture shall utilize a minimum of 90 LED emitters. Fixture shall have a color temperature range of 1900K -10,450K.
 20. The fixture shall be the Lustr X8 LED array:
 - a. Deep Red, Red, Amber, Lime, Green, Cyan, Blue and Indigo LEDs in an array designed for broad spectrum color, light tints and variable whites.
 21. The LED system shall use 15-bit nonlinear scaling techniques for high resolution dimming. Dimming curves shall be optimized for smooth dimming over longer time fades.
 22. The LED system shall be digitally driven using high speed pulse width modulation (PWM). PWM shall allow for settings to eliminate or reduce flicker when lighting for camera.
 23. The fixture shall be UITT DMX-512A compatible via In and Thru 5-pin XLR connectors.
 24. The fixture shall be compatible with the ANSI RDM E1.20 standard. All

- fixture connections shall be accessible via RDM protocol for modification from suitably equipped control console. Temperature sensors within the luminaire shall be viewable in real time via RDM. Fixtures not offering RDM compatibility, feature set access or temperature monitoring via RDM shall not be acceptable.
25. The fixture shall have integrated radios for City Theatrical Multiverse technologies. The fixtures shall have integrated Near Field Communication (NFC) hardware for configuration from mobile devices.
 26. The fixture shall be equipped with: color LCD display for easy to read status reports and configuration saving and loading, a two button, RGB backlit 4 encoder user interface, and a hard lockout switch to prevent nuisance bumping of the UI.
 27. The fixture shall offer multiple DMX input profile options to include: RGB (control of all individual LED colors via a three- channel profile), Single Channel (control of intensity of prerecorded presets), Expanded (full control of all attributes-Intensity, CCT, Tint, Tuning, Mix, RGB color Control, Strobe, Curve, Fan), Direct (control of each individual color channel via an independent channel- Intensity, Direct Color Control, Strobe , Curve, Fan), and Studio (control of fixture in a white-light profile- Intensity, CCT, Tint, Tuning, Strobe, Curve, Fan).
 28. All fixtures shall have drop compensation to prevent intensity and color shifts as fixtures reach thermal stability.
 29. The fixture shall offer additional user-definable options including but not limited to: display time out options, loss of data behavior options, and red-shift option for tungsten dimming emulation.
 30. Fixtures shall have the following local control modes: Studio (for white light operations), Color (HSI color picker for quick access to selecting and storing user defined colors), Presets (for quick access to default or user defined colors), Effects (for playback of built-in-sequences), and DMX (for setup of DMX parameters.)
 31. All fixtures shall offer stand-alone functionality eliminating the need for a console.
 32. Fixture shall ship with 24- preset colors accessible as a stand-alone feature. Fixtures in a stand- alone state shall restore to the settings present prior to power cycling, eliminating the need for reprogramming. Fixtures without stand-alone operation features described above shall not be acceptable.
 33. Fixtures can be linked together with standard DMX cables and controlled

from designated primary fixture. Up to 32 fixtures may be linked.

34. The fixture shall be capable of copying all performance settings to other fixtures of the same type via a 5 pin XLR DMX cable.
35. Provide nine (9) Source Four LED Series 3 with Cyc Adapters, safety cables, c-clamps, 3 PowerCon to StagePin Power Cables, and 6 PowerCon to PowerCon Jumper Cables – OR- provide seven (7) Altman Spectra Cyc 200W RGBW yoke mounted SSCYC200-RGBW-SC-510-YOKE with DMX Wireless Receiver, plus seven (7) Ground Row ALTMAN Spectra Cyc 200W RGBW Ground Row units SSCY200-RGBWLINK with DMX Wireless Receiver. Provide 18” DMX jumper cables and PowerCon jumper cables for each Altman Spectra. Provide Showbaby multicast receiver for each Altman Spectra.
36. Provide seventy-two (72) Source Four LED Series 3 with forty (40) 26 degree XDLT26 Lens Tubes, twenty (20) 36 degree XDLT36 Lens Tubes, six (6) 50 degree XDLT50 Lens Tubes, six (6) 19 degree XDLT19 Lens Tubes, safety cables, c-clamps, 40 PowerCon to StagePin Power Cables, and 32 PowerCon to PowerCon Jumper Cables -OR- provide eighty-six (86) Altman Phoenix 3 PHX4 RGBL-XX-B with DMX jumper cables for each ALTMAN Phoenix3. Provide Showbaby multicast receiver for each Altman Phoenix.

G. SOURCE FOUR LED CYC ADAPTER

1. General
 - a. The adapter shall work with all Source Four LED light engines.
 - b. The adapter shall provide an evenly distributed light output when used in combination across large, flat surfaces.
2. Physical
 - a. The unit shall be constructed of rugged, die cast aluminum, free of burrs and pits, as well as injection molded ABS components; finished in black.
 - b. Any exposed optics (excludes mirrors) shall be constructed out of heat and impact resistant poly-carbonate material.
 - c. The unit shall attach securely to all Source Four LED light engines.
3. Optical

- a. Unit should be able to be placed as close as 2 Ft. from the illuminated surface.
 - b. Unit should be able to be top or bottom mounted.
 - c. Unit should be able to achieve a 2:1 spacing.
 - d. Unit should be able to light a 40 Ft. cyclorama with a top and bottom hang.
 - e. Unit should maintain approximately 30% efficiency from source lumens to total field lumen output.
4. Provide nine (9) Source Four LED Cyc Adapters.

H. COLOR MIXING LIGHT EMITTING DIODE FRESNEL FIXTURE

1. The fixture shall be a color-mixing high-intensity LED illuminator with DMX control of intensity and color. The fixture shall be a Desire Fresnel as manufactured by Electronic Theatre Controls, Inc. or approved equal.
2. The fixture shall be UL 1573 listed for stage and studio use, and shall comply with the USITT DMX-512A standard.
3. The unit shall be constructed of rugged, die cast and extruded aluminum free of burrs and pits, finished in black. Units shall be provided with rugged aluminum yoke allowing 360° rotation of the fixture within the yoke, regional mounting hardware, 5' Neutrik powerCON True 1 power cable with power input connector, Stage-Pin type equipped power leads, and powerCON True 1 to True1 cables for fixture power linking.
4. Fixture shall have integrated zoom with mechanical adjustment on the front and rear, and an adjustable yoke position to allow for weight balancing.
5. Fixture shall have two (2) accessory slots on the front accessible from the top and bottom of fixture.
6. Power supply, cooling and electronics shall be integral to each unit.
7. Fixtures shall have an aperture of 7"/18 cm.
8. Fixture beam shall allow barn door accessories that shape the beam with a single, soft edge.
9. Fixture shall have an integrated zoom, with a range of 13-55 degrees.

10. The fixture shall be ETL and cETL listed and/or CE rated, and shall be so labeled when delivered to the job site. The fixture shall be rated for IP20 dry location use.
11. The fixture shall be equipped with a cooling fan. Fan speed control via a DMX channel shall be possible. Fan speed software shall permit the fixture to override DMX fan speed setting or reduce output to prevent heat damage to the fixture. The fixture shall utilize advanced thermal management systems to maintain LED life to an average of 70% intensity after 54,000 hours of use. Thermal management shall include multiple temperature sensors within the housing to include:
 - a. LED array circuit board temperature
 - b. Temperature sensors placed on each individual LED color circuit
 - c. Control temperature
12. Fixtures that do not provide active thermal monitoring of LED circuits and other temperature readings shall not be acceptable. The fixture operate in an ambient temperature range of 0°C (32°F) minimum, to 40° C (104°F) maximum ambient temperature.
13. The fixture shall be equipped with a 100V to 240V 50/60Hz internal power supply.
14. The fixture shall support power in thru operation. Power in shall be via Neutrik True 1 input connector. Power thru shall be via Neutrik True 1 output connector. Fixture power wiring and accessory power cables shall be rated to support linking of multiple fixtures up to the capacity of 15A breaker
15. The fixture requires power from a non- dim source. Power supply outputs shall have self- resetting current-limiting protection. Power supply shall have power factor correction.
16. The fixture shall contain a minimum of eight different LED colors to provide color characteristics as described in color selection below. All LEDs used in the fixture shall be high brightness and proven quality from established and reputable LED manufacturers.
17. Fixture shall utilize Luxeon C LED emitters. Manufacturer of LED emitters shall utilize an advanced production LED binning process to maintain color consistency. All LED manufacturers (100% of each lot) shall undergo a burn-in-test during manufacturing. LED system shall comply with all relevant patents.

18. Fixtures shall have a PWM frequency of up to 25,000Hz to avoid flicker on camera.
19. L70 rating shall be no less than 54,000 hours.
20. All fixtures shall be provided with the minimum warranty: 5years full fixture coverage, and 10 years LED coverage.
21. Fixture shall be calibrated at factory to achieve a consistent color and intensity output between fixtures built at different times and/or from different LED lots or bins. Calibration data shall be stored on LED array as permanent part of on-board operating system. All arrays including replacement arrays shall be calibrated to the same standard to ensure consistency. Fixtures not offering calibration shall not be acceptable.
22. The fixture shall utilize a minimum of 60 LED emitters.
23. Fixture shall have color temperature range of 1900K-10,450K. The fixture array shall be LustrX8: Deep Red, Red, Amber, Lime, Green, Cyan, Blue and Indigo LEDs in an array designed for broad spectrum color, light tints, and variable whites.
24. The LED system shall use 15-bit nonlinear scaling techniques for high-resolution dimming. Dimming curves shall be optimized for smooth dimming over longer timed fades.
25. The LED system shall be digitally driven using high speed pulse width modulation (PWM). PWM shall allow for settings to eliminate or reduce flicker when lighting for camera.
26. The fixture shall be USITT DMX 512A – compatible via In and Thru 5-pin XLR connectors. The fixture shall be compatible with the ANSI RDM E1.20 standard. All fixture functions shall be accessible via RDM protocol for modification from suitably equipped control console. Temperature sensors within the luminaire shall be viewed in real time via RDM. Fixtures not offering RDM compatibility, feature set access or temperature monitoring via RDM shall not be compatible.
27. The fixture shall have integrated radios for City Theatrical Multiverse technologies.
28. The fixtures shall have integrated Near Field Communication (NFC) hardware for configuration from mobile devices.
29. The fixtures shall be equipped with: a color LCD display for easy-to-read status reports and configuration changes, a USB port for software

updates, diagnostic reports and configuration saving and loading, a two-button, RGB backlit 4 encoder user-interface, and a hard lockout switch to prevent nuisance bumping of the UI.

30. The fixture shall offer multiple DMX input profile options to include: RGB (control of all individual LED colors via a three-channel profile Red, Green Blue), Single Channel (control of intensity of prerecorded preset Intensity), Expanded (full control of all attributes – Intensity, CCT, Tint, Tuning, Mix, RGB color control, Strobe, Curve, Fan), Direct (control of each individual color channel via an independent channel – Intensity, Direct color control, Mix, Strobe, Curve, Fan) and Studio (control of the fixture in a white-light profile-Intensity, CCT, Tint, Tuning, Strobe, Curve, Fan).
31. All fixtures shall have droop compensation to prevent intensity and color shifts as fixture reach thermal stability.
32. The fixture shall offer user-definable options including but not limited to: display time out options, loss of data behavior options, White point settings, and Red- shift option for tungsten dimming emulation.
33. Fixtures shall have the following local control modes: Studio- for white light operations, Color – HIS color picker for quick access to selecting and storing user defined colors, Presets- for quick access to default or user defined colors, Effects – for playback sequences, and DMX- for set up of DMX parameters.
34. The fixtures shall offer stand-alone functionality eliminating the need for a console Fixture in a stand-alone state shall restore to the settings present prior to power cycling, eliminating the need for reprogramming. Fixtures without stand-alone operation features described above shall not be acceptable.
35. Fixture shall ship with 24 preset colors accessible as a stand-alone feature.
36. Up to 32 fixtures can be linked together with standard DMX cables and controlled from designated primary fixture. The fixture shall be capable of copying all performance settings to other fixtures of the same type via a 5-pin XLR DMX cable.
37. Provide forty four (44) Desire Fresnel with X8 array, 4-leaf barn doors, safety cables, c-clamps, 24 PowerCon to StagePin Power Cables, and 20 PowerCon to PowerCon jumper Cables -OR- provide sixty two (62) Altman AP150PAR. Provide 18” DMX jumper cables and PowerCon jumper cables for each Altman AP150. Provide Showbaby multicast

receiver for each Altman AP150.

I. Followspots: AURORA 1200

1. The basis of this design shall be the Aurora 1200 LED follow spotlight, as manufactured by CantoUSA.
2. Physical
 - a. The unit frame and enclosure shall be constructed of formed cold rolled steel and sturdy aluminum extrusions, free of burrs, and protected by a black powder coat finish.
 - b. Handles shall be provided to facilitate smooth operation and to lift the unit.
 - c. The unit shall be mounted on a stable, folding three-point floor stand, with:
 - 1) Easy height adjustments,
 - 2) Horizontal Swing Control Lever, and
 - 3) Vertical Tilt Control Lever
 - d. The Power Supply shall be integral to the followspot.
 - e. Weight of Head, including power supply, shall not exceed 50 pounds.
 - f. Length of head unit with color changing boomerang shall not exceed 48".
 - g. A sliding panel shall provide access to lenses without the use of tools.
 - h. LED lamp house head must be of a modular design for servicing and be fully upgradeable to a higher output LED engine by the removal of screws. Any alternate fixture that does not comply with this requirement must be rejected.
3. Controls
 - a. The Lamphouse shall, as a minimum, incorporate the following:
 - 1) Fan cooling system, under 30db;

- b. LED mounted to a thermal transfer device, i.e. heatsink.
 - c. The body of the unit shall, as minimum, incorporate the following:
 - 1) Optical dimmer iris mechanism for smooth manual dimming;
 - 2) Drop-in Nichrome steel iris;
 - 3) Drop-in Gobo Holder;
 - 4) Zoom focus controls with calibrations silk screened on followspot body.
 - a) With the iris fully open, this followspot shall be capable of producing a continuous range of field angles from 10.6 degrees in spot to 19.2 degrees in flood.
 - b) At any field angle, the beam shall be adjustable between soft and sharp edges.
 - d. The front of the unit shall house a five-color, self-canceling boomerang with color filters.
4. Optical
- a. The unit's optical train shall consist of a modular mounted LED 220 watt or higher LED engine, with the following features:
 - 1) 5700K color temperature;
 - 2) CRI greater than 90 in 5700K
 - 3) 50,000 hour average life on LED engine;
 - 4) Upgradeable LED light engine.
 - 5) Fixed optical quality glass reflector and double condenser lens;
 - 6) Variable focus lens system utilizing optical-quality glass;
 - 7) Iris/Gobo Holder;
 - 8) Optical dimmer iris;

- 9) Five-color boomerang
 - b. The zoom focus shall increase light intensity as it decreases the spot diameter.
 - c. Any LED Followspot that exceeds 220 watts of power consumption will not be acceptable.
2. Electrical
 - a. Lamp system input shall be 90-265 V.AC, 50/60 hertz, single phase.
3. Performance
 - a. Adjusted for flat field (approximately 70%) the unit shall produce a continuous range of illumination from 600,000 beam candlepower in Flood focus to 2,370,000 beam candlepower in Spot focus.
 - b. The Field diameter at a 60 foot throw shall be continuously adjustable from 20.3 feet in Flood focus to 11.2 feet in Spot focus. With full iris, the Field diameter in spot focus shall be less than 15".
4. Provide two (2) Aurora 1200 LED followspots, complete with Iris, Gobo Holder, Color Changer, Stand, and all necessary accessories.

2.23 Multiverse Transmitter

A. General

1. The transmitter shall be Multiverse Transmitter as designed by City Theatrical, or equal.
2. The transmitter shall input Streaming CAN (sACN) or Art-NET and transmit up to nine universes of DMX.
3. The transmitter shall be FCC, IC, RoHs, and ETL compliant.
4. The following protocols shall be supported: RDMX ANSI E1.20 via Art-NET/DMX cat. Streaming CAN, Art-Net 1, 2 and 3.
5. Wireless DMX broadcasts shall be transmitted on the 2.4 GHz range.

B. Physical

1. The transmitter shall be die cast aluminum and measure no more than 1.85" (47mm) high by 4.0" (101.5mm) and 7.75" (196.9mm) long and weighing no more than 1.25 pounds (0.57kg).
2. User interface shall be possible via DMXcat app for Iphone, android or amazon Fire. Firmware updates shall be available on the product page of CTI website.
3. Transmitter shall be configurable over RDM and feature RDM Proxy and RDM Responder.
4. Transmitter shall be IP50 rated for use in indoor environments with an ambient temperature range of 32°F to 104 °F

C. Electrical

1. AC power connections shall be powerCON TRUE1 In/Thru. DC Power connections shall be via locking DC jack, 5.5mm x 2.1mm, center positive, 12.1mm mating depth; EtherCON.
 - a. High voltage input 100-240V Ac 50/60Hz.
 - b. Low voltage input 5-30V DC
 - c. Power over Ethernet class 0
 - d. Maximum wattage 0.5W
2. The antenna shall be RP-SMA Female.
3. Transmitter wi-fi capability 802.11b/g/n.

D. Radio Technology

1. Transmitter latency shall have an average of 4ms.
2. Radio frequency sensitivity shall be -95dBm, and output stops with loss of data.
3. Transmitter shall have a broadcast power of 3.2mW, 10mW, 32mW or 100mW, and broadcast mods shall include:
 - a. Low
 - b. Mid

- c. High
 - d. Max
 - 4. DMX burst mode shall be auto dynamic.
 - E. Provide one (1) Multiverse Transmitter.
- 2.24 RACK MOUNT EMERGENCY LIGHTING INVERTER
 - A. The Rack Mount Emergency Lighting Inverter shall be the Majorsine2000 Series as manufactured by Major Power, or equal.
 - B. Input
 - 1. Inverter shall accept 100-150 VDC, with a rated current of 20 amps.
 - 2. Fuse and DC breaker shall provide protection.
 - 3. Efficiency: >85% (full linear load), 125 VDC I/P, 120 VAC O/P
 - C. Load Output
 - 1. Inverter shall output 2KVA / 1600W. Output voltages available shall be 100, 110, 115, and 120 VAC, 50/60Hz \pm 0.2Hz. Unit shall have a \pm 2% voltage regulation.
 - 2. Unit shall utilize pure sinewave outputs.
 - a. THD (Linear Load): <3% 120 V/100%; (SPS Load) <5% 120 V/100%. Crest Factor 3:1
 - D. Physical
 - 1. Inverter shall fit a standard 19" rack, and utilize 2 rack units and measure as follows: 17.32"W x 11.81"D x 3.46"H (440x300x88mm). Mounting brackets shall be provided standard.
 - 2. Unit shall support (4) NEMA 5-20 R outlets.
 - 3. Rack mount inverter shall weigh 8kg / 17.6 lbs.
 - E. Interface
 - 1. Unit shall communicate via SNMP / Dry-Contact.

2. An LED display shall report the following status:
 - a. Inverter on
 - b. Overload
 - c. DC Abnormal
 - d. Fault
 3. An LCD display shall report the following:
 - a. Inverter on
 - b. Output voltage & frequency
 - c. Input voltage
 - d. Load percentage
 - e. DC voltage
 - f. System model
 - g. Internal environment temp.
 - h. Utility status
 - i. Short circuit
 - j. Over temp
- F. Protection
1. Short – For 1 second, switch to bypass and shutdown
 2. Overload
 - a. 105-125% for 3 minutes
 - b. 126-150% for 3 seconds
 - c. >150% for 1 second
 - d. switch to bypass

3. Internal Over-Temp Protection. Internal operating temperature shall not exceed $55\pm 5^{\circ}$ (inside the case)
- G. Environmental
1. Inverter shall have an operating temperature of 0° to 50° C, and shortage temperature of -20° to 70° C.
 2. Acceptable humidity levels shall range between 0° - 90° C relative humidity (non-condensing).
 3. Unit shall output acoustical noise at a level of 46 dBA @ 1 M.
- H. Safety
1. Unit shall be approved IEC-60960 Safety (UL / cUL Certified), and meet FCC Class A regulations for low EMI/RFI emissions.
- I. Provide one (1) Majorsine2000-125-2U Rack Mount Inverter.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. All wiring for the house and stage lighting control system shall be run in conduit and flexible multi-conductor cables as hereinbefore specified.
1. Data wiring for DMX controlled house lights shall be Belden 9729 or equal. Data wiring for house lights must be run in conduit.
- B. All junction box covers shall be identified as hereinbefore specified. All conduit, device mounting boxes, junction boxes, and enclosures shall be securely fastened with appropriate fittings to ensure positive ground throughout the entire system.
- C. This Contractor shall furnish and install all wiring and make all final connections as indicated in the system manufacturer's shop drawings and standard installation documents. Splices for dimming circuits shall be made only in junction boxes.
- D. All wiring shall be checked and tested by this Contractor to ensure the system is free from grounds, opens, and shorts.
- E. It shall be the responsibility of the Contractor performing the work in this section

to coordinate with the stage rigging system Contractor for the proper installation and operation of the stage lighting, wiring devices, cables, supports, etc.

- F. All work shall be under the supervision of a field engineering technician, accredited by the system manufacturer. It shall be the responsibility of this technician to check and inspect the installation to the Owner's and Architect/Engineer's satisfaction. This technician shall perform the initial programming of the system with direction and coordination with the Owner.

3.02 SYSTEMS INTERFACE AND PROGRAMMING MODIFICATIONS

- A. A Fire Alarm Interface module shall be furnished and installed by this Contractor. Upon activation of the building's fire alarm and detection system, the auditorium house lights, including emergency lights controlled by the dimmer system, shall be programmed to automatically be restored to full brightness. Refer to Specification Section 16610, Fire Alarm and Detection System.

3.03 PERSONNEL TRAINING

- A. A field engineering technician, accredited by the system manufacturer shall provide a minimum of eight (8) hours of training for the Owner's operating personnel on the proper operation and trouble shooting of the lighting control system equipment.

3.04 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. At the completion of the installation, the manufacturer shall furnish four (4) final sets of "as-built" drawings as well as manuals of instruction as to the proper operation and maintenance of the lighting control system. Formal turn-on and instruction shall be provided to the Owner's officially designated representative within fourteen (14) days of a written request by the Owner.
- B. This Contractor shall furnish the Owner's officially designated representative(s) with a minimum of eight (8) hours of on-the-job instructions in the operation, maintenance, and diagnostic testing of the system. (This shall not be part of the system turn-on specified above.) This Contractor shall also furnish the Architect/Engineer four (4) bound copies of complete operating and maintenance instruction manuals of the lighting control system including circuit diagrams and all other information necessary for proper operation and service maintenance.

3.05 SYSTEM TEST

- A. This Contractor shall conduct an operating test of the complete system. The system shall test free from grounds, shorts, and other faults. All connections shall be thoroughly checked for mechanical and electrical connections. All lighting control system equipment shall be demonstrated to operate in

accordance with the requirements set forth in these Specifications and as shown on the Drawings.

- B. This Contractor shall perform all tests in the presence of the Architect/Engineer. This Contractor shall furnish all personnel and test instruments for use in the tests.

3.06 WARRANTY

- A. This Contractor shall deliver the work in a first-class operating condition in every respect.
- B. The manufacturer shall warrant for a minimum of five years that the material, equipment, and workmanship furnished shall be entirely free from defects. Any material, equipment, or workmanship in which defects may develop before or during the warranty period shall be repaired or replaced at the Contractor's own expense. The Contractor shall further warrant that all material, equipment, and workmanship used in the installation, but not specifically mentioned in the Drawings and Specifications, is the best of their respective kinds and that the construction and installation was performed in accordance with the best accepted standard practices in all details.
- C. A signed System Startup Sign Off shall initiate system warranty period.
- D. Warranty Start Date for fixtures and "boxed goods" shall start upon date of shipment. LED Fixtures shall be warranted for a period of 5 years (entire fixture). LED array shall be warranted for a period of 10 years.
- E. Optional extended warranty shall be available upon request.
- F. The manufacturer shall offer a service contract for the maintenance of the system after the warranty period.

END OF SECTION

SECTION 16555

BLACK BOX THEATER PERFORMANCE LIGHTING AND CONTROLS

PART 1 – GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work covered under this Section shall include the materials and equipment necessary for this Contractor to furnish and install a performance lighting control system(s), wiring devices and performance lighting instruments herein specified for the black box theater. It shall also include the services of qualified field engineer/technicians regularly employed by the manufacturer of the system(s) who shall review the installation(s) to ensure its proper operation and provide Owner training.
- B. The black box theater performance lighting systems and controls (shall be furnished by a factory authorized Theatrical Contractor/Distributor certified to design, program and service the systems. The Theatrical Contractor shall be responsible for coordination between the electrical installation and other trades installing theatrical equipment and for control terminations, system startup, system training, and warranty repair. A Theatrical Contractor is defined as a dealer who regularly engages in the sale and installation of theatrical supplies and equipment. The Theatrical Contractor/Distributor must show evidence of successfully furnishing theatrical systems specified for at least five (5) years.
- C. The TC/D shall furnish all necessary equipment as hereinafter detailed for a complete and functional performance lighting control system(s) including the theatrical lighting instruments. Although not every component is called out in every detail, it shall be the responsibility of the manufacturer providing the system to ensure that the intended function is furnished.
- D. The system specified herein shall consist of a relay high density system equipment panel, performance lighting control console, network-based signal distribution system, distribution equipment, performance lighting instruments, and all required interconnecting wiring.
- E. Electrical Contractor shall furnish and install in accordance with the lighting control manufacturer's instructions, all conduits, wiring, and outlet boxes required for the erection and operation of the complete system(s) as herein specified and as shown on the Drawings.

- F. The black box theater performance lighting control system shall be supplied as a single integral unit with all relay modules, control circuits, circuit breakers, and the like factory wired. Field wiring shall consist of connecting input feeders, dimmer circuits, and remote control wiring to the distribution devices and control console.
- G. It is the intention of this specification section that the entire black box theater performance lighting control system be available to all bidders and not "Packaged or Bundled" with any other lighting systems or equipment.

1.03 QUALITY ASSURANCE

- A. The Contractor shall furnish submittals for all components of the performance lighting and lighting control system(s) in accordance with SECTION 16010 of these Specifications. The submittals should include the manufacturer's working drawings and shall include, but not be limited to the following:
 - 1. Manufacturer's catalog data for all lighting instruments, equipment, and components that shall include all technical data to demonstrate conformance with these Specifications.
 - 2. Complete physical drawings of all items of equipment showing dimensions, metal gauges, etc.
 - 3. Complete load schedules which shall clearly indicate actual connected loads and control channel assignment (where applicable), cross-reference of internal equipment identifications to circuit numbers shown on the Drawings, and all other scheduled information which shall relate the equipment to the project requirements.
 - 4. Complete internal and interconnection wiring diagrams showing number, size, and types of conductors between equipment and from equipment to loads, and feeder quantity and sizes.
- B. All materials used shall be new and of good quality conforming to these specifications and the successfully reviewed submittals. Any material not successfully reviewed by the Architect/Engineer that is incorporated in the work, used or delivered to the site, shall be immediately removed upon the order of the Owner or Architect/Engineer and replaced to the satisfaction of the Owner and Architect/Engineer at this Contractor's expense.
 - 1. It shall be this Contractor's responsibility to include costs incurred in other trades for any work disarranged by such replacements described above. This will include replacement of work and damaged equipment during the progress of construction.

- C. The lighting control system equipment specified herein shall be the sole responsibility of a single manufacturer. The manufacturer shall have been producing theatrical lighting and SCR type lighting control systems for at least fifteen (15) years without changes in ownership.
- D. All work shall be in accordance with good engineering practices. All equipment for this system shall be listed by Underwriter's Laboratories, Inc. (UL), bear the UL label, and shall be installed in accordance with all requirements of the National Electrical Code (NEC), state and local codes, and these Specifications.
- E. The entire performance lighting control system shall be completely factory assembled and tested under load conditions prior to shipment of the system.
- F. All equipment provided within this specification shall have a minimum five-year warranty from date of turn on.
- G. **(ENGINEER, USE THIS ONLY WHEN ADDING TO OR MODIFYING AN EXISTING SYSTEM)** Prior to any work being performed on the existing system, the entire performance lighting control system shall be completely tested under load conditions. The test shall include each device on the existing system. The Contractor shall certify the operating condition and report any abnormal conditions to the Owner.

1.04 QUALIFICATIONS

- A. The Contractor and the Theatrical Contractor/Distributor shall be required to furnish satisfactory proof of their competence as evidenced by successfully completed previous contracts where control equipment of this nature has been specified.
- B. The Contractor shall visit the site, and be familiar with the Drawings outlining this work. Contractor shall become completely familiar with the various items of equipment being furnished under other Divisions of these Specifications related to this work. The Contractor shall make all necessary investigations relative to the conditions that may be encountered on this project.

1.05 SPARE PARTS

- A. Spare parts shall be furnished prior to the installation of the system.
- B. This Contractor shall furnish to the Owner spare parts as follows.
 - 1. Three (3) spare relays for relay panel
 - 2. Three (3) spare breakers for relay panel

3. One (1) spare fuse kit for relay panel kit shall include 3 fuses, miscellaneous nuts, screws and hardware.
- C. This Contractor shall furnish to the Owner spare parts for the theatrical lighting instruments as follows:
1. 10% spare engines for each type of theatrical lighting instrument where the LED array warranty is less than 10 years, 5% spare engines shall be supplied if LED array warranty is met.
 2. 10% spare cables for each type and length of jumper cable.
 3. 5% spare lenses for each degree of lens.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. The house and stage lighting control system as shown on the Drawings and herein specified shall be as manufactured by ELECTRONIC THEATRE CONTROLS, INC. (ETC) [Echo Relay Panel system] as listed or the equivalent as manufactured by STRAND LIGHTING, INC. [A21 System with relays] which must meet all of the requirements of these Specifications. The system shall utilize the manufacturer's standard products and components with modifications as required meeting the construction and performance requirements of this section.
- B. The theatrical lighting instruments as shown on the drawings and herein specified shall be as manufactured by ELECTRONIC THEATER CONTROLS INC. (ETC), as listed or the equivalents as manufactured by ALTMAN, which must meet all of the construction and performance requirements of these specifications.

2.02 DIMMING SYSTEM RELAY RACK

- A. This Contractor shall furnish and install where shown on the Drawings, a stage lighting dimming relay rack(s). The rack shall be ETC Sensor ERP24 (24 relay) wall mounted.
1. Relay panels shall be UL508, UL67, and UL924 listed, and shall be so labeled when delivered.
 2. Relay panels shall consist of a main enclosure with 30 pole breaker subpanels, relay/dimmer sub panel, integral control electronics, and a low voltage subpanel for data terminations and provision for accessory cards.

- a. Up to two accessory cards shall be supported per relay panel.
- B. Mechanical
1. The panel shall be constructed of 16-gauge steel. All panel components shall be properly treated and finished in fine-textured, scratch resistant paint.
 2. Relay panels shall be available in 120V AC configuration.
 - a. 120V enclosures shall be 67.5" high by 14.36" wide and 4" deep with a weight not more than 80 pounds.
 3. The panel shall be capable of being mounted on the surface of a wall or recessed mounted.
 - a. 120V AC panels shall support mounting between standard wall stud framing (16 inch on center spacing).
 4. Choice of panel covers shall be available for surface or recess mount applications. This outer panel shall ship with a locking door to limit access to electronics and breakers.
 - a. Optional center pin reject security screws shall be available for all accessible screws.
 - b. Recess mount doors shall extend 1" beyond all panel edges to hide wall cut-out.
 5. The unit shall provide interior cover over the breaker panel to allow access only to Class 2 wiring and prevent direct access to Class 1 line voltage components.
 6. The relay panel shall support up to twenty four (24), 20A single pole circuits made up of relays.
 - a. Two and three pole relays circuits shall be supported at decreased density where each pole constitutes one of the available single pole circuits. Mixing of circuit in any combination shall be supported.
 - b. Panels that do not support an integral dimmer module shall not be acceptable.

7. Relays shall include integral switches for manual control while power is unavailable to the panel such that critical lighting can be set to an on state, without the need for power to the panel.
8. Relays output lugs shall accept 6-14AWG copper wire.
9. Breaker subpanel may include up to twenty nine (29) 20A single pole, up to fourteen (14) 20A double pole or nine three pole breakers as required in any combination up to capacity.
10. Control wiring for DMX, station bus, and emergency input terminations shall land on removable headers for contractor installation.

C. User Interface

1. The user interface shall contain a graphical display with button pad to include 0-9 number entry, up, down back arrow navigation and enter.
2. Test shortcut button shall be available for local activation of preset sequence and set level overrides.
3. The user interface shall have a power source LED indicator (blue), a DMX status LED indicator (green), a network status LED indicator (green) and a LED indicator (red) for errors.
4. Interface shall allow the backlight to timeout and shall provide user editable options to shut off backlight completely as well as adjust screen contrast.
5. Ethernet interface shall default to automatic IP through link local and DHCP. Upon receiving IP address, the address of the Network Interface Card (NIC) shall display in the about menu. Static address and settings shall also be possible.
6. The control interface shall support a USB memory stick interface for uploads configurations and software updates.

D. Functional

1. Panel setup shall be user programmable. The control interface shall provide the following breaker 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 connection shall provide advanced control of relays over streaming ACN (sCAN) and transmit status, control override, and measured energy usage per branch circuit via an internal Web UI or central monitoring interface.

Control electronics shall report the following information per branch circuit:

- a. Breaker state (On/Off)
- b. Breaker state (Open/Closed)

- c. Current draw (In Amps)
 - d. Voltage
 - e. Energy usage
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. Up to 8 spaces in a single rack for total of up to 16 spaces shall be supported per system or system subnet.
 - c. Indication of an active preset shall be visible on the control panel display.
 - d. One 16-step sequence per space for power up and power down routines.
 - e. The panel shall have a UL924-listed contact input for use in emergency lighting systems and shall respond to the contact input by setting included relay to "on", while setting non-emergency breakers "off". Each relay can be selected for activation upon contact input.
 - f. 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.
 - g. 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.
 - h. After power loss, electronics shall be capable of holding the system in 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 events shall be programmable via the control panel.
 - 1) Time clock events shall be assigned to system day types. Standard day types shall 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 from 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 time clock.
 - 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 circuit 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 forever 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. Electrical
- 1. Relay panels shall support power input from: 120/208V three phase 4-wire plus ground.
 - 2. Conduit Entry
 - a. Feeders
 - 1) Top or top-side (upper 6" of either side).
 - 2) Bottom or bottom-side 6" of either side.
 - 3) Feeders shall enter through the top or bottom according to the orientation of the enclosure.
 - 4) Feeder entry shall be nearest to the location of the feeder lugs or main breaker.
 - b. Load
 - 1) Load wiring shall enter through the top or bottom of the enclosure.

- 2) Load wiring shall enter through the top/bottom surface nearest to the breaker sub panel.
 - 3) Load wiring may also enter through left and/or right side provided a low voltage chase is not required through the same area. If Class 2 chase is required, a field installable barrier panel shall be provided upon request. When installed, the left or right side of the panel, where the barrier panel has been installed, shall not permit load wiring.
- c. Low Voltage
- 1) Top or top side (upper 6" of either side)
 - 2) Bottom or bottom side (bottom 6" of either side)
 - 3) For low voltage conduit entry at the relay end of the cabinet, conduits shall be located at the outer 3" of the top/bottom panel.
 - 4) Field installed low voltage channel shall be provided separately for installation on the left or right side of the panel to allow Class 2 wiring to traverse the panel from top to bottom or bottom to top
3. All relays shall be mechanically latching.
 4. The relay shall be capable of switching 20A at up to 300V.
 5. The relay panel shall support a maximum feed size of 200 amps.
 6. Relay panels shall support a main circuit breaker options:
 - a. Main breaker options shall be optional and available for purchase on request.
 - b. Main breakers shall be field installable.
 - c. Main breakers shall be available in 200 amps for 120V systems.
 - d. Series rated SCCR ratings apply as follows with appropriate main breaker.
 - 1) 22,000A at 120/240V
 - 2) 10,00A at 100A, 120/208V

- 3) 10,000A, 2200A or 42000A at 200A: 120/208V
- e. Main breakers shall allow the following range of wire sizes.
 - 1) 14AWG-300kcmil at 120/240V
 - 2) 3/0 to 300kcmil at 120/208V
- F. Relay
 1. Each relay shall have annual override switch with on/off status indicator.
 2. Relays shall be rated for use with
 - a. 16A Electronic Ballast loads @120V
 - b. 20A tungsten loads at 120V
 - c. Motor loads with ratings of 20FLA @ 120V, 100,000A symmetrical SCCR.
 3. Isolation shall be 4000V RMS
 4. Relays shall be latching state.
 5. Rated Life:
 - a. 1,000,000 mechanical activations
 - b. 100,000 cycles at full resistive load
 - c. 30,000 cycles full motor, inductive, tungsten and electronic (LED)
 - d. Decreasing loading shall increase the rated life of the relay inversely proportional the square of the load.
 6. Relays shall support reporting of current usage with an accuracy of five percent of the connected load.
 7. Tested duty cycle: 12 operations (6 cycles) per minute. Decreasing duty cycle significantly increases switch life
 8. Isolation: 4000V RMS}
 9. Current reporting accuracy: 5%
 10. Latching state mechanical relay
- G. Relay Panel Accessories

1. 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.
 2. Main Breaker option per Section E.6.
- H. 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 32°F (0°C) and 104°F (40°C), and humidity between 5-95% (non-condensing).
- I. Provide one (1) Echo Relay Panel with (24) 20A relays, Ride Thru option card, Main Breaker and surface mounted door.
- J. Provide an engraved nameplate on the front face of the relay rack in a suitable location. The nameplate shall be lettered BLACK BOX THEATER LIGHTING RELAY PANEL.

2.03 DIN RAIL ENCLOSURE WITH NETWORK HARDWARE

- A. The DIN rail enclosure will be sized to hold all of the specified equipment with 20% spare capacity.
1. The units shall be wall mounted with removable front panel for access.
 2. The unit shall be constructed of 16-gauge cold-rolled steel and finished in a fine-textured, black powder coat. Conduit punch guide holes shall be provided on all sides.
 3. The enclosure shall include two aligned rails, and a re-positionable voltage divider allowing re-configuration to meet the needs of the installation.
 - a. Two vertically-aligned DIN rails shall be provided.
 - b. DIN rail compliance: DIN43880 (35/7.5 rail)
 4. The unit shall be a large enclosure: 27" (686mm) long (14" x 28"), with a depth of 12" (304.8mm).
 5. DIN Rail Enclosure shall be ETL listed, conform to ANSI/UL Standard 50/50E, and certified to CAN/CSA Standard C22.2 No. 94.1/94.2.

- B. Provide one (1) DIN28 wall mounted DIN Rail Enclosure with the following components:
 - 1. One (1) DIN mounted dual power supply (24V/48V)
 - 2. One (1) DIN mounted 5 Port PoE Switch
 - 3. One (1) E-SPS-DIN Station Power Supply
 - 4. One (1) E-DMXC DMX Scene Controller
 - 5. One (1) ISP-6R-DC-TERM RDM/DMX Opto Splitter
 - 6. One (1) RSN-DMX4-DIN Gateway
 - 7. One (1) APC DIN Panel Mount UPS with Standard Battery, 120V

2.04 STATION POWER SUPPLY

- A. The DIN Rail Mount Station Power Supply with 24V Aux shall be the Unison Echo E-SPS-DIN as manufactured by Electronic Theatre Controls, Inc., or equal.
- B. Mechanical
 - 1. The Station Power Supply (SPS) assembly shall be designed for use in DIN rail enclosures.
 - 2. The SPS shall convert input power into low-voltage (Class II) power with data line to energize control stations, zone controllers, time clock, and other devices for multi-scene lighting control.
 - 3. The SPS shall be convection cooled.
- C. User Interface
 - 1. The SPS shall utilize light emitting diodes (LEDs) to indicate function, status and fault.
- D. Electrical
 - 1. The SPS shall require no discrete wiring connections when used in a power control enclosure; all wiring shall be terminated into the dimming enclosure.
 - 2. The SPS shall utilize line-voltage power supplied by the contractor, terminated inside the power supply.

3. The SPS shall support EchoConnect communications with remote devices, including control stations and other devices.
4. The EchoConnect network shall utilize 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.
 - a. The network shall be topology free. Network wiring may be bus, loop, home run, star or any combination of these.
 - b. The control bus wiring shall permit a total wire run of 1640 ft. (500m).
 - c. Wiring between stations shall not exceed 1313 ft. (400m).

E. Functional

1. Capacity

- a. Each SPS shall supply power for up to 16 control station, zone controllers, time clock stations and other devices.

2. Operation

- a. The SPS shall not require configuration or programming.
- b. The SPS shall automatically detect faults in the wiring, indicate the fault, including the fault polarity, and shut down the output power.
- c. The SPS shall automatically reset when the fault is clear, and can be manually reset by removing and re-inserting the module.

- F. Provide one (1) E-SPS-DIN DIN mounted Echo Station Power Supply.

2.05 DIGITAL INTERFACE STATIONS (DMX Playback Controllers)

A. General

1. The DMX playback controller be the Echo DMX Scene Controller by ETC, Inc., or equal. The scene controller shall allow for control of DMX lighting through:
 - a. DMX input for snapshot capture of lighting presets.

- b. Live control of intensity, hue and saturation of patch DMX Zones from connected stations and mobile apps.
 2. The scene controller shall support 32 presets of 512 DMX addresses and control of 16 patched DMX zones.
- B. Mechanical
 1. The DMX Scene Controllers shall be DIN-rail mounted on DIN 43880 (35/7.5) rail and shall be constructed of injection-molded black ABS plastic that fully encloses all electrical components.
 2. The DMX Scene Controllers shall support onboard mode and termination configuration using toggle switches.
 3. The DMX Scene Controllers shall have LED indicators for status of
 - a. Blue colored indicator for power.
 - b. Bi-color DMX activity indicator
- C. Electrical
 1. Control station wiring shall be EchoConnect control wiring utilizing 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. The station shall use (2) #16 AWG stranded wires for 24vDC operating power.
 3. Station wiring shall be topology free. It may be point-to-point, bus, loop, home run or any combination of these. Stations that require daisy-chain wiring shall not be acceptable.
 4. DMX Port shall comply with the requirements of ANSI E1.11 USITT DMX512-A standards.
 5. DMX input shall be optically-isolated from the gateway electronics.
 6. DMX output shall be earth-ground referenced.
 7. DMX Port shall be capable of withstanding fault voltages of up to 250vAC without damage.

8. DMX Ports shall be eight-position removable connectors supporting Belden 9729 (or equivalent) or Category 5 Ethernet wiring.
9. Stations shall support a MicroSD card slot for firmware maintenance.
10. Stations shall be UL/ cUL LISTED and CE marked.

D. Functional

1. The scene controller shall support recall of prerecorded scenes for playback using DMX.
2. There shall be support for 32 presets.
3. The scene controller shall support preset playback as activated by any connected control station.
4. The scene controller shall support DMX pass-through for real-time output of incoming DMX levels.
5. The scene controller shall support live control and recording for multiple DMX fixture profiles.

E. Provide one (1) EDMXSC Echo DMX Scene Controller

2.06 DMX ETHERNET GATEWAY – FOUR PORT

A. General

1. The lighting control gateway shall be a microprocessor-based unit specifically designed to provide DMX-512 control of lighting systems and transport of RDM configuration and status messages. The gateway shall permit DMX-512 data to be encoded, routed over an Ethernet network and decoded back to DMX-512. The unit shall be a Response Mk2 4-port DMX Gateway as provided by ETC, Inc.
2. Gateways shall communicate over Ethernet directly with at least ETC, Inc.'s entertainment and architectural lighting control products and other Ethernet interfaces.
3. Connections shall be made between gateways, consoles, architectural systems, and PCs over standard Ethernet distribution systems using 10/100BaseT.
4. The gateway shall support multiple protocols including:
 - a. ANSI E1.17 Architecture for Control Networks (ACN)

- b. ANSI E1.31 Streaming ACN (sACN)
 - c. ANSI E1.11 USITT DMX512-A
 - d. ANSI E1.20 Remote Device Management (RDM)
5. The gateway shall be tested to UL standards and labeled ETL Listed.
 6. The gateway shall be RoHS compliant (lead-free).
 7. The gateway shall be CE compliant.
 8. The gateway shall have a graphic OLED display and four buttons for identification (soft-labeling), configuration, status reporting and troubleshooting.
 - a. Labeling shall be user configurable using ANSI E1.17 Architecture for Control Network (ACN), or a purpose built software configuration tool.
 - b. The OLED display shall show DMX port configuration indication as well as indicate the presence of valid signal.
 - c. Gateways that do not indicate port configuration (input/output) and valid data shall not be acceptable.
 9. Each gateway shall have power and data activity LEDs on the front of the gateway.
- B. DMX Ports
1. DMX Ports shall comply with the requirements of ANSI E1.11 USITT DMX512-A standards.
 2. Each DMX port shall be software or locally-configurable for either input or output functionality.
 3. DMX input shall be optically-isolated from the gateway electronics.
 4. DMX Port shall provide at least 500V isolation to ground and the rest of the electronics.
 5. Each port shall incorporate one DMX512-A connection
 - a. Gateways shall be available with terminal strip for DMX wiring.

6. Network gateways that do not indicate input/ output port configuration or presence of valid data shall not be accepted.
- C. Processor
1. Each gateway shall have sufficient processing power to manage up to 63,999 universes (32,767,488 addresses).
 2. Maximum delay time from input to output shall not be greater than one packet time (approximately 22 mSec.).
 3. A minimum DMX update rate of 40Hz shall be sustained under all conditions unless specifically configured for a slower rate for the sake of compatibility with 3rd party DMX devices.
- D. Mechanical (DIN Rail Mount)
1. The DIN Rail mounted gateway shall be included in an extruded plastic enclosure.
 2. DMX input or output connections using terminal strip or IDC Style Connectors shall be required for connection to the lighting system.
- E. Power
1. A low-voltage DC power input shall be available utilizing an isolated in-line power supply capable of an operating range of 12-24VDC. The power supply shall be provided by the gateway manufacturer.
- F. Configuration
1. The gateway must support local or remote configuration.
 2. Each gateway on the network shall be individually configurable using freely available software configuration tools. The primary configuration tool shall be Net3 Concert configuration software running on a network connected PC. The PC shall only be required for configuration, and shall not be required for normal operation of the system.
 3. Each port of the DMX gateway shall control up to 512 DMX addresses, within the confines of 63,999 universes.
 4. The specific DMX data input or output by the gateway shall be freely configurable by the user.

5. Duplicate outputs of DMX lines (DMX splitter) and discrete outputs shall be fully supported.
6. Multiple DMX universes may be configured with any length up to 512 total addresses. Any range of DMX input addresses shall support selection and routing to the specified sACN output.
7. Multiple sACN sources may be combined with a priority may be assigned to each source sending data to the gateway.
8. All relevant routing information shall be stored in non-volatile memory at each gateway. The system shall recover from a power outage without requiring the PC to be online. Gateways that do not support non-volatile storage of data routing shall not be accepted.

G. Network

1. Communications physical layer shall comply with IEEE 802.3i for 10BASE-T, 802.3u for 100BASE-TX and 802.3af for Power over Ethernet specifications.
2. All network cabling shall be Category 5 (or better), conforming to TIA-568A/B, and shall be installed by a qualified network installer.
3. Data transport shall utilize the TCP/IP suite of protocols to transfer the DMX data.
4. ANSI E1.17 Architecture for Control Networks (ACN) and streaming ACN (sACN) shall be supported. Gateways that do not support ANSI E1.17 shall not be acceptable.
5. Each DMX gateway shall control up to 512 DMX addresses, per DMX port within the confines of up to 63,999 universes (32,767,488 addresses) using Streaming ACN (sACN).
 - a. Any range of DMX addresses may be selected for each universe.
 - b. Multiple sources shall be supported by prioritized Highest Takes Precedence (HTP with priority). Each source shall support assignment of priority to allow override of default HTP behavior.
 - c. Each DMX port shall support its own universe and start address.
6. Gateways shall have built in DMX merger capability on a universe or channel-by-channel basis.

7. Gateways shall support have built in priority on a per-universe or channel-by-channel basis. Gateways that do not support prioritized merging of multiple network sources at independent priorities shall not be accepted.
- H. 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.
- I. Accessories
1. Net3 Concert Configuration and monitoring software
- J. Provide one (1) RSN-DMX4-DIN Response MK2 4-port Gateway - DIN rail mounted.
- 2.07 RDM & DMX Splitter/Booster
- A. The RDM & DMX Splitter/Booster shall be the ISP series as manufactured by Swisson of America Corporation, or equal.
- B. The RDM & DMX Splitter shall process DMX and RDM signals utilizing input and output ports that are individually optically isolated and protected against transient over voltages. Splitter shall be "discoverable", and visible to RDM controllers.
1. The Splitter shall boost incoming DMX signals and split the signal via six output terminal ports while also acting as a repeater to transport DMX signals across larger distances.
 2. RDM shall provide bidirectional operation.
 3. Large DMX installations or long signal lines that cause signal reflection shall not be acceptable. The Splitter shall clean and regenerate the signal by splitting the line into smaller segments to reduce the delay of the reflection at each segment.
- C. Splitters shall be manufactured with a rugged metal housing, with built in terminations. Unit shall be designed for DIN rail installation and require an external DIN mounted power supply.
- D. Technical Data

1. Depth ISP-6 90 mm (3.54 “)
2. Width ISP-6 172 mm (6.8 “)
3. ISP-6 56 mm (2.2 “)
4. Weight ISP-6 560 g (1.25 lb.)
5. Ambient temperature -30°C - 55°C (-22°F - 131°F)
6. DC power 10 V - 48 V
7. Power consumption ISP-6 6 W
8. DMX ANSI E1.11
9. RDM ANSI E1.20
10. Electrical standard signal ports EIA-485

E. Provide one (1) ISP-6R-DC-TERM DMX/RDM DIN Rail Opto Splitter.

2.08 DATA PLUG-IN STATIONS

- A. Data Plug-in Stations shall consist of the appropriate connectors required for the functional intent of the system. These stations shall be available with DMX input or output, Remote Focus Unit, Network, or architectural control connectors as shown on the Drawings or as required.
- B. Connector Options:
1. The following standard components shall be available for Plug-in Stations:
 - a. RJ45 connectors for network connections - twisted pair
- C. Physical:
1. Station faceplates shall be .80” aluminum, finished in fine texture, scratch-resistant black powder coat. Silk-screened graphics shall be white.
 2. The station panel shall mount into an industry standard back box, depending on size and quantity of connectors. A terminal block shall be supplied for contractor terminations.
- D. Provide two (2) ECPB NET Plug-In Stations

2.09 DIGITAL BUTTON STATIONS

A. General

1. The control station shall be the Echo Inspire Station Series as manufactured by ETC, Inc., or equal. It shall be a remote station on an EchoConnect network that can recall presets, provide direct zone control, recall presets and provide room combine actions for a control system.
2. The station shall consist of a dual function (control/ record) push-button with an integral bi-color backlight for each corresponding button and fader.
3. The system shall support up to sixteen independent stations.

B. Mechanical

1. Control stations shall operate using one button.
2. Manufacturer's standard colors shall conform to the RAL CLASSIC Standard, with decorate style faceplate available in cream.
3. Stations shall have bi-color backlights for each button. Indicators shall utilize a blue backlight for active status, and amber for inactive to assist in locating stations in dark environments. Stations that do not provide a lit inactive or deactivated state shall not be allowed. Stations shall support an off backlight state of inactive status when required.
4. Faceplates shall be designed for flush or surface mounting and have no visible means of attachment. Faceplates shall be constructed of ABS plastic and designed based on a standard decorator style faceplate. Station faceplates shall be indelibly marked for each button or fader function. Control station electronics shall mount directly behind the faceplate. The entire assembly shall mount into a single gang back box. Back boxes for flush mounted stations shall be industry standard back boxes. The manufacturer shall supply back boxes for surface mounted stations.

C. Electrical

1. Control station wiring shall be EchoConnect control wiring utilizing 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. The station shall operate on Class 2 voltage provided by the control system via the EchoConnect network. Station wiring must be topology free. It may be point-to-point, bus, loop, home run or any combination of these.
 3. Wiring termination connectors shall be provided with all stations.
 4. Control stations shall be UL/ cUL listed and CE marked and meet WEE compliance.
- D. Station Addressing
1. Station addressing shall be via two 16 position rotary dials and will be set by installers or factory personnel. Station addressing shall require only a space assignment and a device ID assignment.
- E. Provide one (1) E1001 Echo Inspire 1 Button Station for local control of breakers.

2.10 PRESET STATION

- A. General
1. The button station shall be the Echo Preset Button Station as manufactured by ETC, Inc., or equal. It shall be a remote station on an EchoConnect network that can play presets stored in an Echo output product.
 2. The station shall consist of a dual function (program/play) push-button with an integral LED for each corresponding preset. Standard stations shall control 5 presets.
- B. Electrical
1. Button station wiring shall be EchoConnect control wiring that 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). The station shall operate on Class 2 voltage provided by the control system via the EchoConnect network.
 2. Station wiring must be topology free. It may be point-to-point, bus, loop, home run or any combination of these. Wiring termination connectors shall be provided with all stations.
- C. Station Addressing
1. Preset addressing for stations shall be via two 16 position rotary dials and will be set by installers or factory personnel. Multiple

stations may have “overlapping” preset addresses.

2. Each station shall support preset recall in a single space.

D. Play Presets

1. Pressing a button shall play the corresponding preset. The station will send the command to play the preset to all output products.
2. Each station shall monitor the status of presets. If any looks are active in the range of the station's numbered preset, the station shall illuminate the corresponding LED regardless of which device activated the preset.
3. If the button with the active preset (LED lit) is pressed, the station shall send the command to return to normal operation, deactivate the preset and turn off the LED.

E. Physical

1. Control station electronics shall mount directly behind the faceplate. The entire assembly shall mount into a single gang back box. Back boxes for the flush mounted stations shall be industry standard back boxes. The manufacturer shall supply back boxes for surface mounted stations.
2. Station faceplates shall be constructed of ABS plastic and shall use no visible means of attachment. All Button stations shall be available with white, signal white, ivory, gray or black faceplates and buttons.

- F. Provide two (2) EPS05 5 Button Preset Stations.

2.11 LIGHTING CONSOLE AND ACCESSORIES

A. General

1. The lighting control console shall be a microprocessor-based system specifically designed to provide complete control of stage, studio, and entertainment lighting systems. The console shall be the Element 2 as manufactured by Electronic Theatre Controls, Inc., or equal.
2. The system shall provide control of 6,144 outputs on a maximum of 32,768 control channels, which may be any number from 1 to 99,999. Output shall be distributed over a 10/100 MB Ethernet network using Net3/ACN, ETCNet2, Avab and/or Artnet (multi-cast) protocols. The user

shall be able to control the application of protocols at an individual address level.

3. The system shall support full bi-directional RDM communication with compatible devices via Net3 DMX/RDM Gateways. RDM communication shall adhere to ANSI standard E1.20-2006 Entertainment Technology – RDM – Remote Device Management Over DMX512 Networks. Supported RDM features shall include:
 - a. Discovery and Identification of RDM capable devices.
 - b. Setting of start addresses, operating modes and additional settings as exposed by connected devices and controllable via RDM.
 - c. Viewing of sensor data as provided by connected devices.
 - d. Error reporting as provided by connected device.
4. A maximum of 10,000 cues, 1000 groups, 1000 presets, 4 x 1000 palettes (Intensity, Focus, Color and Beam), 99,999 macros, 1000 effects, 1000 curves, 1000 Color Paths and 1000 snapshots may be contained in non-volatile electronic memory and stored to an onboard solid-state hard drive or to any USB storage device.
5. Channels shall respond to cue information by last instruction with discrete rate control provided for all cues. The console may be placed in Tracking or Cue Only mode by the user as a system default and overridden on individual record actions as required. HTP/LTP intensity flags, block, proportional, intensity master or manual master fade control. Priority and Background Priority may be placed on the cue list. It shall also be possible for a cue list to contribute to playback background states or to withhold such contributions.
6. A Master Playback fader pair shall be provided. The fader pair may execute crossfades or all-fades, with IFCB cue level timing.
7. The console shall provide 40 pageable faders that may be operate in either LTP channel or fader mode. Virtual fader control for playbacks is also provided.
8. A high-resolution level wheel shall be provided to control intensity for selected channels and scrolling within selected displays. A high-resolution rate wheel, which may also be used for fader paging shall be provided.

9. Virtual moving light controls shall provide mouse/touch-based tools for all parameters. The tools shall display the current value for each parameter and provide controls for adjusting each parameter.
10. Control and programming features for automated fixtures shall also include: a standard library of fixture profiles, the ability to copy and edit existing profiles and create new profiles, patch displays including channel and output addressing, 16-bit fade resolution, color characterization allowing color in up to six different color spaces.
11. System information, including playback status, live output and blind values for all record targets shall be displayed on a maximum of two external high-resolution monitors, which may also be multi-touch touchscreens. Every display shall support three user-definable workspaces. Each of these workspaces shall provide individually configured frames, with size/scaling controls. Any Windows 7 compatible display may be used.
12. A context sensitive on-line Help feature shall explain and provide an example of the operation of each feature of the system. This help system shall be integrated into the on-board user manual via hyperlinks. Optional dynamic prompts are also provided.
13. A fully integrated Virtual Media Server feature shall allow user to map images and animations to a rig array. 40 such maps may be created, each with 12 layers. System that rely on external hardware or software for this functionality shall not be acceptable.
14. User-definable, interactive displays may be created. These displays, which can be used in live and blind operating modes, allow graphical layout of channels, desk buttons and programming tools. Standard symbols are provided, and the user may import their own symbols or graphics. Each symbol may be individually defined with data feedback characteristics. Non-interactive status information, such as a mirror of other user's command lines, may also be included in the display. A graphical browser is provided for fast selection of these views. Multiple zoom factors and placements may be stored and recalled for each display.
15. An integrated virtual alphanumeric keyboard shall allow labeling of all show content.
16. Console software upgrades shall be made by the user via flash drive. It shall be possible to install software updates in all consoles, processor units and remotes from one device over the network.

17. The console operating software shall be loaded into program execution memory from the internal hard drive when the console is powered. In the event of an uncontrolled shutdown, the console shall return to its last output state when power is restored. Devices requiring a UPS to provide such protections shall not be acceptable.
18. Integrated dimmer monitoring features shall be provided to allow indication of dimming system status, error states and dimmer load monitoring. Adjustment of dimmer configuration from the console shall also be supported. Communications with the dimming system shall utilize ANSI E1.17 2006 - Entertainment Technology - Architecture for Control Networks.
19. Integrated RDM device features shall be provided. The console shall discover and patch RDM devices. The console shall monitor RDM devices to allow indication of RDM device online/offline status error states. The console shall be capable of changing settings of RDM devices such as the DMX start address. Communications with the RDM devices shall utilize ANSI E1.20 2006 – Remote Device Management.
20. Network configuration tools shall be provided from within the desk.
21. Show data may be created and modified on a personal computer, using either Windows 7 or higher or a Macintosh platform running OS 10.11 or later via a free offline editing application. The program shall run natively on Apple operating systems. Applications requiring PC emulation programs shall not be acceptable.
22. A PC, using either Windows 7 (or higher), or a Macintosh running OS 10.11 (or later) using the offline software application shall be able to connect to a control system via the network and view or modify current show data in an independent display environment, using an ETCnomad key. When connected without the key, the computer shall operate in Mirror mode, with the device to be mirrored selectable by the user.
23. Synchronized backup shall be provided via another full console on the network, an ETCnomad/Puck, or by use of a remote processor unit. The backup device shall maintain synchronized playback with the master and shall take over control of the lighting system upon loss of communication with the master.
24. A maximum of 99 users may access and interact with show data simultaneously. Each user shall have an individual workspace. User identification may be assigned to more than one control device, allowing users to work in tandem, or allowing a designer/ALD to mirror the current display format, mode and command line of the associated programmer.

Partitioned control allows discrete control of channel/parameter groupings by user. Partitioned control may be easily enabled and disabled with no need to merge show data from multiple users.

25. The system shall support up to 32 individual simultaneous Time Code inputs or Event lists using Show Control Gateways.
26. Systems that do not provide the above capabilities shall not be acceptable.

B. Controls and Playback: Manual Control and Programming Section

1. The console keyboard shall be grouped by function. Major groupings shall be record target functions, numeric keys, level assignment functions, display navigation functions and controls, as well as non-intensity parameter controls.
2. The command keypad shall be fully interactive with direct selects and other virtual controls, which provide “one touch” selection of channels, groups, palettes, presets, effects, snapshots and macros.
3. Non-intensity parameters may be set numerically via an extensible keypad. This control shall be fully interactive with the moving light controls. The controls shall also access available modes for each parameter type, min and max values for each parameter as applicable, as well as home position on a parameter basis.
4. Only those parameters available for control in the active lighting system shall be displayed for control. Displays shall condense or lowlight parameters not available to selected channels.
5. Lamp controls provide direct access to luminaire functions such as striking and dousing arc lamps and calibrating entire fixtures or individual mechanisms of fixtures, as provided by the luminaire manufacturer. User access to these features is normalized across all manufacturers for ease of use. Use of a “control channel” for accessing these functions shall not be required and systems requiring use of control channels for these functions shall not be acceptable.
6. Fan functions shall be provided both via command line operation and through encoder controls.
7. Highlight shall be supported, with user definable highlight values. Lowligh conditions may be defined for selected, but not specified channels. Rem Dim commands, at specific levels by channel, may be optionally and automatically called with the highlight command.

8. Advanced color control functions provide color mixing in any of six different color spaces. Gel matches are provided via gel picker or by command line control. Tinting tools allow adjusting the color mix irrespective of the native mixing system. Spectrum tools support adjusting the output of additive color systems with more than three emitter types, allowing the X/Y coordinate to be held while adjusting the recipe that achieves that mix. Color Path tools allow the user to control the live fade of fixtures through the color space.
9. The Virtual Media Server function shall allow the user to create layouts of devices, identified as pixel maps. Media content (images, movies, text and procedurally generated effects) may then be applied, manipulated and stored. Stock content is provided and the user may import his own imagery and animations.
10. Macros may be set to run as default. Default macros called manually hall post to the command line, but executed via cue lists shall run in the background. The user may override this behavior by defining the macro to always execute in the foreground or background, regardless of the recall method. Startup, Shutdown and Disconnect macros may also be defined.

C. Controls and Playback: Playback Section

1. The playback faders shall consist of a 100mm Master Fader pair with associated control buttons as well as 40 45mm faders which may be placed in channel or playback mode.
2. Virtual fader controls are also available for playbacks.
3. It shall be possible to instantaneously halt an active cue, back to the previous cue, manually override the intensity fade or manually override the entire fade.
4. It shall be possible for a cue list to contribute to the background state or for the contents to be withheld from such. Priority and background priority states may be established.
5. Channel/Playback Faders
 - a. Up to 999 proportional, fully overlapping additive or inhibitive submasters may be defined. Submasters shall have colored LEDs to indicate submaster status. Each submaster may have fade up, dwell and down fade times. Submasters may be set to priority and background priority status.

- b. Submasters may be set to HTP or LTP intensity. Non-intensity parameters on submasters shall be LTP only.
 - c. Exclusive mode for a submaster shall prohibit the live contribution of that submaster from storing to cues or other submasters. Shield mode prohibits access of associated channels from any other playback or manual control operations.
 - d. A submaster potentiometer may be defined as proportional, master only or intensity master. When set as an intensity master, a mark and unmark feature is supplied.
 - e. The submaster blind buffer shall be linked directly to live playback.
 - f. It shall be possible to set submaster values directly from the command line.
 - g. Submasters may be set to fade to background or to minimum value when the fader is returned toward zero.
 - h. Submaster values may contribute to the background state or withheld from such.
 - i. Presets and IFCB palettes may be mapped to playbacks, either individually or in user defined groupings.
 - j. Channel mode shall allow the user access to the first 120 channels, operating in LTP logic. Faders that are not currently set to the same level as the corresponding channel must be matched to that level before gaining control. Physical channels may be cleared without impacting output using Sneak.
6. Grand Master Faders
- a. The location of the grand master shall be user definable. The grand master shall have associated blackout and blackout enable buttons.
 - b. Blackout shall send all associated intensity outputs to zero. Non-intensity outputs shall not be affected. It shall be possible to exclude channels from blackout and grand master control.
- D. Display Controls
- 1. Format shall change the view of selected displays.

2. It shall be possible for the user to choose which parameter categories or parameters (s)he wishes to display.
3. Flexichannel modes shall change which channels are viewed in selected displays, as follows:
 - a. No modes
 - b. Masters only/cells only
 - c. Use Partitions
4. Flexichannel states shall change which channels are viewed in selected displays, modified by the modes, as follows:
 - a. All/Patched/Show channels
 - b. Active/Moved channels
 - c. Selected/Manual channels
 - d. View channels (user identified list)
 - e. Channels with discrete timing
5. Expand shall extend the selected view sequentially across connected displays, vertically or horizontally.
6. [Time] depressed shall display discrete timing data. [Data] suppressed shall display absolute values of referenced data. These functions may be latched.
7. Displays may also be toggled to show stored data currently manually overridden, the source of the current parameter data, output level, patch assignment, part structure and referenced marking data.
8. Playback status displays are provided with a variety of different formats. Indications are provided per cue for live moves (lights fading from zero and also moving non-intensity parameters) and dark moves (inactive lights which have stored non-intensity parameter moves).
9. Display content including which of the workspaces is in focus on any of the external monitors and what views are docked in those workspaces may be instantly recalled using snapshots.

E. Operating Modes

1. Live Mode

- a. Channel lists may be constructed using the +, -, and Thru keys as well as the direct selects. Channel selection and deselection is fully interactive, regardless of the method used.
- b. Levels may also be set with the keypad, level wheel and non-intensity encoders. "Selected" channels shall be those last addressed and under keypad control. Controls are provided for single button access to the last selected channel list, all channels with manual levels and all active channels.
- c. Channels may be set at a user defined default level using the Level key. +% and -% keys adjust channels quickly by user definable values.
- d. Channels and/or channel parameters may be captured. Capture mode shall allow the user to selectively capture channel data at specific levels. Captured data shall be indicated on the Live display.
- e. Sneak shall be used to restore specified channels to background states, default values, or to send them to specified values, in user specified times.
- f. Selected channels may be set at a level or held to current values while all other channels are set to zero using Rem Dim. Toggling Rem Dim shall restore all unselected channels to original levels. The Rem Dim level shall be user definable via the command line or with a default setup value.
- g. Channels may be recorded into groups for fast recall of commonly used channels. 1000 groups shall be available. Groups shall store selection order. The Offset function supports rapid creation of ordered groups, including reverse and random order.
- h. Parameter settings may be stored to Intensity, Focus, Color and Beam Palettes and to Presets. All referenced data may be stored to whole numbers or to up to 99 decimal places between each whole number.
- i. The following conditions may be placed on a channel or channel parameter to be included with a cue record action.
 - 1) Discrete fade time and/or delay

- 2) Block flag
 - 3) IFCB Filters, which may be set at a parameter level.
 - 4) Release and Restore
- j. Cues may be recorded in any order. Up to 99 decimal cues may be inserted between any two whole number cues. Each cue may contain a maximum of twenty parts.
- k. It shall be possible to record cues and cue parts with the following information:
- 1) Any collection of channel data, as determined by the use of "Record", "Record Only" or selective store commands, combined with parameter filters.
 - 2) Cue Level timing and delays for Intensity Up, Intensity Down, Focus, Color and Beam.
 - 3) Follow or hang time
 - 4) Link instruction
 - 5) Loop value
 - 6) Block, Preheat, and/or Mark Flag
 - 7) Curve
 - 8) Label and note
 - 9) Execute list to trigger other activity
- l. Non-intensity channel parameters may be preset to an upcoming position using Automark. Automark shall set any stored parameter transitions in the cue just prior to intensity becoming active. Automark may be disabled on a cue or cue part basis, enabling a "live" move.
- m. Any channel parameter may be stored with an effect instruction. These effects may contain relative offsets from current value, or absolute instructions. Effects may be progressive action or on/off states. Entry and exit behaviors shall modify the channel parameters activity when beginning and ending the effect.

- n. Update may be used to selectively add modified parameter data quickly to that parameter's current source. Update may be specified to modify referenced data content or break the link to that content. A dialogue informs the user of the content that will be updated. A trace command may be used to modify the data to the original source of its move instruction. It shall be possible to update inactive record targets.
- o. Recall From quickly pulls specified data from record targets or other channels into the current view.
- p. Copy To quickly copies selected data to specified channels or other record targets.
- q. Address and channel check functions shall be provided.
- r. Channel parameters may be "parked" at levels. Those levels are not added to any live record operations, nor may they be changed until the parked element is "unparked". Scaled park provides real time proportional adjustment of stored intensity values. Address Park shall also be provided.
- s. About shall provide detailed status of selected channels or specified record targets. This shall include current source, current value, discrete timing, parked value, marked to and for indications. Background levels and current DMX output are also displayed. Channel usage indicates submaster and cue information and also provide a "dark moves" report on a per channel basis.
- t. 1000 snapshots may be stored which instantly recall specified front panel and display configurations.
- u. Live data may be displayed in a summary view or detailed table orientation.
- v. Query shall allow selection of channels by their current or possible state. Keywords and fixture types shall allow quick access to fixtures.
- w. User definable home positions, on a per channel basis, may be defined.
- x. Channel level offset commands provide channel ordering and sub-grouping functions.

- y. Undo shall be used to sequentially step back through manual operations or to undo record and delete actions. It shall be possible to undo multiple commands in one action.
2. Blind
- a. The Blind display allows viewing and modification of all record targets without affecting stage levels.
 - b. Record target data may be displayed in a summary view, a detailed table orientation or a spreadsheet view, which allows quick data comparisons, move and replace functions.
 - c. Changes to blind data shall be automatically stored. Range selection of both record targets and channels shall be supported.
3. Patch Display
- a. Patch shall be used to display and modify the system control channels with their associated library data.
 - b. Each channel may be provided with a proportional patch level, curve, label, swap and invert functions, as well as keywords to service Query.
 - c. Offset functions in patch shall allow selection of channel ranges and shall allow the user to establish a “custom” footprint for any device output.
 - d. Custom color wheels, color scrolls and gobo wheels shall be defined in patch. These devices shall be created with a simple table and graphical user interface supported by images of major manufacturers.
 - e. RDM discovery and device monitoring shall be supported.
 - f. Copy to and Move functions shall be supported in patch.
4. Setup/Browser
- a. Setup shall access system, user and device configurations.
 - b. It shall be possible to partially import Eos show files. Users shall be able to select as much or as little of the show file as required, with renumber tools.

- c. It shall be possible to import ASCII and Lightwright data files. It shall be possible to export as ASCII or .csv.
 - d. Setup shall also access show data storage, import, export, print to .pdf and clear functions, as well as show data utilities.
 - e. The system shall support programming and playback of real time clock events, including cue, submaster and macro execution at specific times of specified days or at a time based on astronomical events.
 - f. A control screen shall be provided for network configuration, selecting date/time, software update controls, selecting functional language and/or keyboard for labeling option, as well as other system level tools.
 - g. Available languages for prompts, advisories and help messages shall include English, Bulgarian, German, Spanish, French, Italian, Japanese, Korean, Russian, Chinese, simplified and Chinese, traditional.
 - h. Supported keyboards shall include American, United Kingdom, French, German, Italian, Korean, Norwegian, Russian, Slovakian, Turkish, Swiss, Swedish, Finnish and Bulgarian.
- F. Dimmer Monitoring and Configuration
- 1. The lighting control system shall provide communication with an ETC FDX dimming system for remote monitoring and configuration of show specific functions from within the software application.
 - 2. Circuit level configuration and monitoring functions shall include but not be limited to:
 - a. Control mode (dimnable, switched, latch-lock, always on, off or fluorescent)
 - b. Curves
 - c. Control threshold
 - d. Min and Max Scale Voltage
 - e. Preheat
 - f. Scale load

3. Rack status messages shall include but not be limited to:
 - a. State of UL924 panic closure
 - b. DMX port error/failure
 - c. Network error/failure
 - d. A, B, C Phase below 90 or above 139 volts and headroom warning
 - e. Ambient temperatures out of range
 4. Circuit status shall include but not be limited to:
 - a. Module type and location
 - b. Output level
 - c. Control Source
 - d. Overtemp
 5. Advanced circuit feedback shall include but not be limited to:
 - a. Load higher or lower than recorded value
 - b. DC detected on output
 - c. SCR failed on/off
 - d. Breaker trip
 - e. Module has been removed
 - f. Load failure
 - g. Shutdown due to Overtemp
- G. Interface Options
1. The console shall support a variety of local interfaces.
 2. AC input
 3. USB (five ports for items such as alpha-numeric keyboard, mouse, touch screens, USB flash drive)

4. Ethernet (two ports)
 5. Two Display Port output connectors, supporting Windows 7 compliant monitors as 1280x1024 resolution minimum. Touchscreen/multi-touch support of any/all of these monitors is provided.
 6. Contact Closure trigger via D-Sub connector
 7. 4 DMX/RDM ports
 8. Alternative Contact Closure trigger through Gateway
 9. OSC Transmit/Receive
 10. MIDI In/Out, MSC and MIDI Notes through Gateway
 11. SMPTE Timecode through Gateway
- H. Optional Accessories
1. iRFR and iRFR Preview (applications for iPhone, iPod Touch and iPad units)
 2. aRFR (application for Android devices)
- I. Physical
1. All operator controls and console electronics for a standard system shall be housed in a single desktop console, not to exceed 35" wide, 15" deep, 4.5" high, weighing 16 pounds. Console power shall be 90 – 240V AC at 50 or 60Hz, supplied via a detachable locking power cord.
- J. Provide one (1) Element 2 6K console with 25' NET data cable and two (2) Dell P2418HT LCD Touchscreens.

2.12 ELECTRICAL DISTRIBUTION EQUIPMENT

- A. All distribution equipment shall be furnished by the manufacturer of the dimming equipment. Hanging and supporting hardware shall be furnished and installed under Section -11065 – "THEATRE AND STAGE EQUIPMENT- RIGGING SYSTEM" Contractor as shown on the drawings.
- B. POWER DISTRIBUTION – CONNECTOR STRIPS
1. The connector strips shall be the ColorSource Raceway by ETC, Inc.

2. Connector strips shall provide distributed power form incoming circuits to plugs along a raceway.
3. Internal wiring shall be sized to circuit ampacity and shall be rated at 125°C.
4. Connector strips shall support a combination of line voltage power and low voltage data distribution within a single raceway.
5. Connector strips shall be listed by a nationally recognized test lab (NRTL). Connector strips that are not listed shall not be acceptable.
6. Physical
 - a. Connector strips shall be 127mm H x 45mm D and fabricated from 1.6mm aluminum finished in black, white, or silver fine-texture powder coat paint.
 - b. Connector strips shall be available in any length up to 72ft / 2195cm in specified increments of 1ft / 30.5cm and shipped fully wired with all splicing hardware.
 - c. Connector strips shall weigh no more than 2.5lbs/ft. Connector Strips that weigh more than 2.5lbs/ft shall not be acceptable.
 - d. Two connector panels supporting power and data outlets shall be supported for each 1ft / 30.5cm section of strip and shall be mounted on individual 125mm panels.
 - e. Frames and connector panels shall be fabricated from 3mm die cast aluminum finished in black, white, or silver fine-textured powder coat paint.
 - f. Circuits shall be labeled above each connector on the front of the strip using 15mm reverse silk screened lexan labels. All labels match connector strip finish with contrasting color circuit designations. Optional write-on labels shall be available upon request, connector strips that do not support write-on labels shall not be acceptable.
 - g. Connector strips shall be supplied with appropriate brackets and hardware for mounting.
 - h. Connector strips shall utilize junction brackets on 6ft / 152cm centers and support spans up to 12ft / 305cm between hanger brackets.

- i. Mounting brackets shall be 45mm x 3mm and 45mm x 1.9mm ASTM A5008 steel. All mounting hardware shall conform to ISO 898-1 class 8.8.

7. Electrical

- a. Connector strip shall support 120V/60Hz power input per branch circuit with support for multiple outlets wired to each circuit.
- b. The connector strip wiring terminal box shall support a maximum of eight 20A inputs utilized for:
 - 1) Up to six circuits for power distribution along the length of the connector strip.
 - 2) One circuit for DMX Active Pass-thru connectors when required.
- c. The connector strip terminal box shall support hardwired or pluggable connector power and data input.
- d. Pluggable power and data inputs shall be fed by a single multi-conductor cable and a single DMX or Ethernet cable. The LKS data connector by Link S.r.l. or Link USA, Inc shall be supported, connector strips that do not support the LKS data connector shall not be accepted.
- e. Power output connectors shall be 20A grounded stage pin. Connector strips that utilize connectors that are not rated for plugging hot loads shall not be accepted.
- f. Terminations shall be consolidated at one end and utilize feed-through terminals individually labeled with corresponding circuit numbers.
- g. Performance lighting circuits shall utilize tension clamp terminals listed for AWG 20 – 8 / 0.5mm² – 6mm² gauge wire.
- h. DMX Active Pass-Thru circuits shall use tension clamp terminals listed for AWG 20 – 12 / 0.5mm² – 4mm² gauge wire. Terminals that place a screw directly on the wire are not acceptable.
- i. A low voltage data distribution system shall be supported to incorporate DMX/ RDM (ANSI E1.11-2008 USITT DMX512-A and ANSI E1.20 Remote Device Management).

- 1) DMX output ports shall utilize 5-pin XLR style connectors.
 - j. Connector strips shall utilize a voltage barrier to accommodate Class 2 wiring in the same strip as Class one circuits.
 - k. Low voltage signals shall enter the connector strip via a strain relief or connector mounted at the specified end of the connector strip. One low voltage cable shall be supported for each connector strip.
 - l. Connector strips with multiple DMX outputs shall use active DMX/RDM pass through assemblies. Each strip shall support up to 24 active DMX/RDM pass through assemblies.
 - m. DMX outputs without active splitting of the DMX/ RDM signal or that do not support RDM shall not be acceptable.
8. Provide six (6) 12' ColorSource Raceway with the following: one (1) DMX Output and (8) stage pin outlets wired on (4) 20A circuits. Circuit labeling to be provided in the following pattern, and shall read from stage left to stage right: ABCD | ABCD.

2.13 THEATRICAL LIGHTING INSTRUMENT PACKAGE

- A. Theatrical lighting instruments manufactured by Electronic Theatre Controls, Inc. (ETC) are specified herein to provide a basis of quality. Other acceptable manufacturers are ALTMAN.
- B. Theatrical lighting instruments shall be capable of performing with light emitting diodes (LED) as indicated herein with proper heat sink cooling. Phenolic materials shall be employed on the fixtures in order to protect the operator from potential burns.
- C. Each theatrical lighting instrument shall be supplied with a malleable iron clamp (c-clamp) to grip up to a two (2) inch ID pipe, a fixture yoke with locking clutch handle, and three (3) foot long SF2 leads in a fiberglass sleeve.
- D. Minimum performance criterion for all theatrical lighting instruments shall be as herein specified. Each instrument shall be furnished with a power cable (5' PowerCon to Stage Pin or PowerCon to PowerCon Jumper Cable), 5' DMX jumper cable, and safety cable. A minimum of 10% of all jumper cables (PowerCon to PowerCon and DMX) shall be provided in 10' lengths. UL listing shall be required on all theatrical lighting instruments.
- E. COLOR MIXING LIGHT EMITTING DIODE PROFILE FIXTURE

1. The fixture shall be a color-mixing high-intensity LED illuminator with DMX control of intensity and color.
2. The fixture shall be UL 1573 listed for stage and studio use, and shall comply with the USITT DMX-512A standard.
3. The unit shall be constructed of rugged, die cast aluminum and have a rugged black powder coat finish. Unit shall be free of burrs and pits and be provided with:
 - a. Lens secured with silicone shock mounts.
 - b. Shutter assembly shall allow for +/-25° rotation (20 gauge stainless steel shutters).
 - c. Interchangeable lens tubes for different field angles with Teflon guides for smooth tube movement.
 - d. Sturdy integral die cast gel frame holders with two accessory slots, and a top-mounted, quick release gel frame retainer.
 - e. Slot with sliding cover for motorized pattern devices or optional iris.
4. Power supply, cooling and electronics shall be integral to each unit.
5. Optical
 - a. The light beam should have a 2-to-1 center-to-edge drop-off ratio.
 - b. The unit shall provide, but not be limited to: low gate and beam temperatures, and sharp imaging through a three-plane shutter design.
 - c. The unit shall provide, but not be limited to 36 degree field angles with a lens tube for precision, high contrast imaging.
 - 1) High-quality pattern imaging
 - 2) Sharp shutter cuts without halation
 - 3) Shutter warping and burnout in normal use shall be unacceptable
 - 4) Adjustable hard and soft beam edges

6. The fixture shall be ETL and cETL LISTED and/or CE rated, and shall be so labeled when delivered to the job site. The fixture shall be ETL LISTED to the UL1573 standard for stage and studio use. The fixture shall be rated for IP-20 dry location use.
7. Fixture shall be equipped with a cooling fan and utilize advanced thermal management systems to maintain LED life to an average of 70% intensity after 20,000 hours of use. The fixture shall operate in an ambient temperature range of 0°C (32°F) minimum, to 40° C (104°F) maximum ambient temperature. Thermal management shall include multiple temperature sensors within the housing to include:
 - a. LED array circuit board temperatures
 - b. Fixture ambient internal temperature
8. The fixture shall be equipped with a 100V to 240V 50/60Hz internal power supply and shall support power in and thru operation via Neutrik® PowerCon™ input and output connectors. Fixture power wiring and accessory power cables shall be rated to support linking of multiple fixtures up to the capacity of a 15A breaker.
9. The fixture requires power from a non-dim source.
10. Fixtures shall have droop compensation to prevent thermal shift of color or intensity.
11. Power supply outputs shall have self-resetting current-limiting protection. Power supply shall have power factor correction.
12. The fixture shall contain a minimum of four different LED colors to provide color characteristics as described in the Color Section below. All LEDs used in the fixture shall be high brightness and proven quality from established and reputable LED manufacturers.
 - a. Fixture shall utilize Luxeon® Rebel™ LED emitters
 - b. Manufacturer of LED emitters shall utilize an advanced production LED binning process to maintain color consistency.
 - c. LED emitters should be rated for nominal 20,000-hour LED life to 70% intensity
13. All LED fixtures (100% of each lot) shall undergo a minimum three-hour burn-in test during manufacturing.

14. LED system shall comply with all relevant patents.
15. Calibration: Fixture shall be calibrated at factory for achieve consistent color and intensity output between fixtures built at different times and/or from different LED lots or bins. Calibration data shall be stored on the control card as a permanent part of on-board operating system. All arrays, including replacement arrays shall be calibrated to the same standard to insure consistency. Fixtures not offering LED calibration shall not be acceptable.
16. Color: The fixture shall utilize a minimum of 60 LED emitters and use a selective mix of Red, Green, Blue and Lime emitters.
17. Dimming: The LED system shall use 15-bit nonlinear scaling techniques for a high-resolution Incandescent dimming curve optimized for smooth dimming over longer timed fades. The LED system shall be digitally driven using high-speed pulse width modulation (PWM). LED control shall be compatible with broadcast equipment in the following ways:
 - a. PWM control of LED levels shall be imperceptible to video cameras and related equipment.
 - b. PWM shall be capable of being set via RDM to 25,000 Hz.
18. Control and User interface: The fixture shall be USITT DMX 512A-compatible via In and Thru 5-pin XLR connectors and shall be compatible with the ANSI RDM E1.20 standard.
 - a. The fixture shall be equipped with a 7-segment display and a three button user interface. The fixture shall be controlled via RGB data input.
 - 1) All fixture functions shall accessible via RDM protocol for modification from suitably equipped control console.
 - 2) Temperature sensors within the luminaire shall be viewable in real time via RDM.
 - 3) Fixtures not offering RDM compatibility, feature set access or temperature monitoring via RDM shall not be compatible.
 - b. The fixture shall have a 5-channel footprint (IRGBS).
 - c. A variable-rate strobe channel shall be provided.

19. Up to 32 fixtures can be linked together with standard DMX cables and controlled from designated master fixture.
 20. Provide eight (8) ETC ColorSource Spot (Deep Blue) with 36° Lens Tubes, safety cables, c-clamps, 5'-0" DMX cables, 4 Powercon to StagePin Power cables, and 4 PowerCon to Powercon Jumper Cables. Or provide eight (8) Altman Phoenix 3 with safety cables, c-clamps and 18" DMX jumper cables and PowerCon cables per Altman Phoenix.
- F. COLOR MIXING LIGHT EMITTING DIODE WASH FIXTURE
1. The fixture shall be a color-mixing high-intensity LED illuminator with DMX control of intensity and color. The fixture shall be a ColorSource Par Deep Blue.
 2. The fixture shall be UL 1573 listed for stage and studio use and shall comply with the USITT DMX512-A standard.
 3. The fixture shall be provided with the minimum warranty of 5 years full fixture coverage and 10 years LED array coverage.
 4. Physical: The fixture shall be contained in a rugged all-metal die-cast housing, free of burrs and pits with a rugged black powdercoat finish.
 5. Power supply, cooling and electronics shall be integral to each unit.
 6. Fixture housing shall provide two easy-access slots for secondary lenses and other accessories. Slots shall be equipped with locking retaining clip. Secondary lens options to include multiple angles in the following pattern:
 - a. Round
 7. Light output shall be via a round aperture. Aperture and accessory slots shall accommodate standard 7.5" accessories such as used in other similar-sized fixtures.
 8. Environmental and Agency Compliance: The fixture shall be UL and cUL LISTED and/or CE rated, and shall be so labeled when delivered to the job site. The fixture shall be UL LISTED to the UL1573 standard for stage and studio use, and shall be rated for IP-20 dry location use.
 9. Thermal: The fixture shall be cooled with a variable speed fan. The fixture shall utilize advanced thermal management systems to maintain LED life to an average of 70% intensity after 20,000 hours of use for color mixing versions and 36,000 hours of use for Pearl variety. Thermal management shall include multiple temperature sensors within the housing to include:

- a. The LED array
- b. The control board
10. The fixture shall operate in an ambient temperature range of 0°C (32°F) minimum, to 40° C (104°F) maximum ambient temperature.
11. Electrical: The fixture shall be equipped with 100V to 240V 50/60 Hz internal power supply, and shall support power in and thru operations via Neutrik® powerCON™ input and output connectors.
12. Fixture power wiring and accessory power cables shall be rated to support linking of multiple fixtures up to the capacity of a 15A breaker.
13. The fixture requires power from non-dim source.
14. Power supply outputs shall have self-resetting current limiting protection. Power supply shall have power factor correction.
15. LED Emitters: The fixture shall contain 4 different LED colors to provide color characteristics, as described in Section “a” below. All LEDs used in the fixture shall be high brightness and proven quality from established and reputable LED manufacturers.
 - a. Fixture shall utilize Luxeon® Z™ LED emitters. The manufacturer of LED emitters shall utilize an advanced production LED binning process to maintain color consistency. LED emitters should be rated for nominal 20,000-hour L70 rating for color mixing versions and 36,000-hour L70 rating for Pearl variant.
16. LED system shall comply with all relevant patents.
17. Calibration: Fixture shall be calibrated at factory for achieve consistent color between fixtures built at different times and/or from different LED lots or bins.
 - a. Calibration data shall be stored in the fixture as a permanent part of on-board operating system.
 - b. All arrays, including replacement arrays shall be calibrated to the same standard to insure consistency.
 - c. Fixtures not offering LED calibration shall not be acceptable.
18. Color: The fixture shall utilize a minimum of 40 LED emitters made up of Red, Green, Indigo and Lime for ColorSource Deep Blue.

19. Dimming: The LED system shall use 15-bit nonlinear scaling techniques for high-resolution dimming. The dimming curve shall be optimized for smooth dimming over longer timed fades.
20. The LED system shall be digitally driven using high-speed pulse width modulation (PWM). LED control shall be compatible with broadcast equipment in the following ways:
 - a. PWM control of LED levels shall be imperceptible to video cameras and related equipment.
 - b. PWM rates shall be adjustable by the user via RDM to avoid any visible interference to video cameras and related equipment.
21. Control and User Interface: The fixture shall be USITT DMX512-A compatible via In and Thru 5-pin XLR connectors, and shall be compatible with the ANSI RDM E1.20 standard.
 - a. All fixture functions shall accessible via RDM protocol for modification from suitably equipped control console.
 - b. Temperature sensors within the luminaire shall be viewable in real time via RDM.
 - c. Fixtures not offering RDM compatibility, feature set access or temperature monitoring via RDM shall not be compatible.
 - d. The fixture shall be equipped with a 7-segment display for easy-to-read status and control, and utilize a three-button user-interface.
 - e. The fixture shall offer RGB control.
 - f. The fixture shall operate in Regulated mode for droop compensation.
 - g. Up to 32 fixtures can be linked together with standard DMX cables and controlled from designated master fixture.
22. Provide eight (8) ETC ColorSource Spot Par (Deep Blue) with full round lens sets, safety cables, c-clamps, 4 Powercon to StagePin Power cables, and 4 PowerCon to Powercon Jumper Cables, and 5'-0" DMX jumper cables – Or provide twelve (12) Altman AP-150 with safety cables, c-clamps and 18" DMX jumper cables and PowerCon cables per Altman AP-150.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. All wiring for lighting and control system shall be run in minimum ¾" conduit as hereinbefore specified. All junction box covers shall be identified as hereinbefore specified. All conduits, device mounting boxes, junction boxes, and enclosures shall be securely fastened with appropriate fittings to ensure positive ground throughout the entire system.
- B. This Contractor shall furnish and install all wiring and make all final connections as indicated in the system manufacturer's shop drawings and standard installation documents. Splices for dimming circuits shall be made only in junction boxes.
- C. All wiring shall be checked and tested by this Contractor to ensure the system is free from grounds, opens, and shorts.
- D. It shall be the responsibility of the Contractor performing the work in this section to coordinate with the theatrical rigging system Contractor for the proper installation and operation of the theatrical lighting, wiring devices, cables, supports, etc.
- E. All work shall be under the supervision of a field engineering technician, accredited by the system manufacturer. It shall be the responsibility of this technician to check and inspect the installation to the Owner's and Architect/Engineer's satisfaction.

3.02 PERSONNEL TRAINING

- A. A field engineering technician, accredited by the system manufacturer shall provide a minimum of four (4) hours of training for the Owner's operating personnel on the proper operation and trouble shooting of the lighting control system equipment.

3.03 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. At the completion of the installation, the manufacturer shall furnish four (4) final sets of "as-built" drawings as well as manuals of instruction as to the proper operation and maintenance of the lighting control system. "As built" drawings shall include all field modifications. Formal turn-on and instruction shall be provided to the Owner's officially designated representative within fourteen (14) days of a written request by the Owner.
- B. This Contractor shall furnish the Owner's officially designated representative(s) with a minimum of four (4) hours of on-the-job instructions in the operation,

maintenance, and diagnostic testing of the system. (This shall not be part of the system turn-on specified above.) This Contractor shall also furnish the Architect/Engineer four (4) bound copies of complete operating and maintenance instruction manuals of the lighting control system including circuit diagrams and all other information necessary for proper operation and service maintenance.

3.04 SYSTEM TEST

- A. This Contractor shall conduct an operating test of the complete system. The system shall test free from grounds, shorts, and other faults. All connections shall be thoroughly checked for mechanical and electrical connections. All lighting control system equipment shall be demonstrated to operate in accordance with the requirements set forth in these Specifications and as shown on the Drawings.
- B. This Contractor shall perform all tests in the presence of the Architect/Engineer. This Contractor shall furnish all personnel and test instruments for use in the test.

3.05 WARRANTY

- A. This Contractor shall deliver the work in a first-class operating condition in every respect.
- B. The manufacturer shall warrant for a minimum of five years that the material, equipment, and workmanship furnished shall be entirely free from defects. Any material, equipment, or workmanship in which defects may develop before or during the warranty period shall be repaired or replaced at the Contractor's own expense. The Contractor shall further warrant that all material, equipment, and workmanship used in the installation, but not specifically mentioned in the Drawings and Specifications, is the best of their respective kinds and that the construction and installation was performed in accordance with the best accepted standard practices in all details.
- C. A signed System Startup Sign Off shall initiate system warranty period.
- D. Warranty Start Date for fixtures and "boxed goods" shall start upon date of shipment. LED fixtures shall be warranted for a period of 5 years (entire fixture). LED array shall be warranted for a period of 10 years.
- E. Optional extended warranty shall be available upon request.
- F. The manufacturer shall offer a service contract for the maintenance of the system after the warranty period.

END OF SECTION

SECTION 16565

MIDDLE SCHOOL STAGE PERFORMANCE LIGHTING AND CONTROLS

PART 1 – GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work covered under this Section shall include the materials and equipment necessary for this Contractor to furnish and install a performance lighting control system(s), wiring devices and performance lighting instruments herein specified for the middle school stage. It shall also include the services of qualified field engineer/technicians regularly employed by the manufacturer of the system(s) who shall review the installation(s) to ensure its proper operation and provide Owner training.
- B. The middle school stage performance lighting systems and controls shall be furnished by a factory authorized Theatrical Contractor and Distributor (TC/D) certified to design, program and service the systems. The Theatrical Contractor shall be responsible for coordination between the electrical installation and other trades installing theatrical equipment and for control terminations, system startup, system training, and warranty repair. A Theatrical Contractor is defined as a dealer who regularly engages in the sale and installation of theatrical supplies and equipment. The Theatrical Contractor must show evidence of successfully furnishing theatrical systems specified for at least five (5) years.
- C. The TC/D shall furnish all necessary as hereinafter detailed for a complete and functional performance lighting control system(s) including the theatrical lighting instruments. Although not every component is called out in every detail, it shall be the responsibility of the manufacturer providing the system to assure that the intended function is furnished.
- D. The system specified herein shall consist of a relay-per-circuit high density system equipment panel, performance lighting control console, network-based signal distribution system, distribution equipment, performance lighting instruments, and all required interconnecting wiring.
- E. The Electrical Contractor shall furnish and install in accordance with the lighting control manufacturer's instructions, all conduits, wiring, and outlet boxes required for the erection and operation of the complete system(s) as herein specified and as shown on the Drawings.

- F. The performance lighting control system shall be supplied as a single integral unit with all dimmer modules, control circuits, circuit breakers, and the like factory wired. Field wiring shall consist of connecting input feeders, dimmer circuits, and remote control wiring to the distribution devices and control console.
- G. It is the intention of this specification section that the entire middle school stage performance lighting control system be available to all bidders and not "Packaged or Bundled" with any other lighting systems or equipment.

1.03 QUALITY ASSURANCE

- A. The Contractor shall furnish submittals for all components of the performance lighting and lighting control system(s) in accordance with SECTION 16010 of these Specifications. The submittals should include the manufacturers working drawings and shall include, but not be limited to the following:
 - 1. Manufacturer's catalog data for all lighting instruments, equipment, and components that shall include all technical data to demonstrate conformance with these Specifications.
 - 2. Complete physical drawings of all items of equipment showing dimensions, metal gauges, etc.
 - 3. Complete load schedules which shall clearly indicate actual connected loads and control channel assignment (where applicable), cross-reference of internal equipment identifications to circuit numbers shown on the Drawings, and all other scheduled information which shall relate the equipment to the project requirements.
 - 4. Complete internal and interconnection wiring diagrams showing number, size, and types of conductors between equipment and from equipment to loads, and feeder quantity and sizes.
- B. The lighting control system equipment specified herein shall be the sole responsibility of a single manufacturer. The manufacturer shall have been producing theatrical lighting and SCR type lighting control systems for at least fifteen (15) years without changes in ownership.
- C. All work shall be in accordance with good engineering practices. All equipment for this system shall be listed by Underwriter's Laboratories, Inc. (UL), bear the UL label, and shall be installed in accordance with all requirements of the National Electrical Code (NEC), state and local codes, and these Specifications.
- D. The entire performance lighting control system shall be completely factory assembled and tested under load conditions prior to shipment of the system.

- E. All equipment provided within this specification shall have a minimum five-year warranty initiated upon receipt of signed System Startup Sign Off.

1.04 QUALIFICATIONS

- A. The Electrical Contractor and the Theatrical Contractor/Distributor shall be required to furnish satisfactory proof of their competence as evidenced by successfully completed previous contracts where control equipment of this nature has been specified.
- B. The TC/D shall visit the site, and shall become familiar with the Drawings outlining this work. The TC/D shall be familiar with the various items of equipment being furnished under other divisions of these Specifications related to this work. The Contractor shall make all necessary investigations relative to the conditions that may be encountered on this project.

1.05 SPARE PARTS

- A. Spare parts shall be furnished to the Owner prior to the installation of the system.
- B. The Contractor shall furnish spare parts for the system as follows:
 - 1. Three (3) spare breakers for relay panel
 - 2. Three (3) spare relays for relay panel
 - 3. Three (3) fuse kits for relay panel. Kit shall include 3 fuses, miscellaneous nuts, screws and hardware.
- C. The Contractor shall furnish spare parts for the theatrical lighting instruments as follows:
 - 1. 10% spare engines for each type of theatrical lighting instrument where the LED array warranty is less than 10 years. 5% spare engines shall be supplied if LED array warranty is met.
 - 2. 10% spare cables for each type and length of jumper cable.
 - 3. 5% spare lenses for each degree of lens.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. The house and stage lighting control system as shown on the Drawings and herein specified shall be as manufactured by ELECTRONIC THEATRE

CONTROLS, INC. (ETC) [Echo Relay panel System] as listed or the equivalent as manufactured by STRAND LIGHTING, INC. [A21 System with relays] which must meet all of the requirements of these Specifications. The system shall utilize the manufacturer's standard products and components with modifications as required meeting the construction and performance requirements of this section.

- B. The theatrical lighting instruments as shown on the drawings and herein specified shall be as manufactured by ELECTRONIC THEATER CONTROLS INC. (ETC) or the equivalents as manufactured by ALTMAN, which must meet all of the construction and performance requirements of these specifications.
- C. The followspots as shown on the drawings and herein specified shall be as manufactured by CANTO USA. Acceptable equivalents shall include LYCIAN, and must meet all of the construction and performance requirements of the basis of design.

2.02 DIMMING SYSTEM RELAY RACK

- A. This Contractor shall furnish and install where shown on the Drawings, a stage lighting dimming system relay rack(s). The racks shall be the ETC ERP24 (24 relay) wall mounted intelligent breaker rack.
 - 1. Relay panels shall be UL508, UL67, and UL924 Listed, and shall be so labeled when delivered.
 - 2. Relay panels shall consist of a main enclosure with 30 pole breaker subpanels, relay/dimmer sub panel, integral control electronics for data terminations, and provision for accessory cards.
- B. Mechanical
 - 1. The panel shall be constructed of 16-gauge steel. All panel components shall be properly treated or finished in fine-textured, scratch resistant paint
 - 2. Relay panels shall be available in 120V AC configuration.
 - a. 120V enclosures shall be 67.5" high by 14.36" wide and 4" deep with a weight not more than 80 pounds.
 - 3. The panel shall be capable of being mounted on the surface of wall or recessed mounted. 120V AC panel shall be capable of mounting between standard wall stud framing (16 inch on center spacing).

4. Choice of panel cover shall be available for a surface or recess mount application. This outer panel shall ship complete with a locking door to limit access to electronics and breakers.
 - a. Optional center-pin reject security screws shall be available for all accessible covers.
 - b. Recess mount doors shall extend 1" beyond all panel edges to hide wall cut-out.
 5. The unit shall provide interior cover over breaker panel to allow access only to Class 2 wiring and prevent direct access to Class 1 line voltage components
 6. The relay panel shall support twenty-four (24) 20A single pole circuits made up of relays.
 - a. Two and three pole relay circuits shall be supported at decreased density where each pole constitutes one of the available single pole circuits. Mixing of circuits in any combination shall be supported.
 7. Relays shall include integral switches for manual control while power is unavailable to the panel such that the critical lighting can be set to an on state, without the need for power to the panel.
 8. Relay output shall accept 6-14AWG copper wire.
 9. Breaker sub panel may include up to twenty-four 20A single pole, up to fourteen 20A double pole, or nine three pole breakers as required in any combination up to capacity.
 10. Control wiring for DMX, station bus and emergency input terminations shall land on removable headers for contractor installation.
- C. User Interface
1. The user interface shall contain a graphical display with button pad to include 0-9 number entry, up, down back arrow navigation and enter.
 2. Test shortcut button shall be available for local activation of preset sequence and set level overrides.
 3. The user interface shall have a power status LED indicator (blue), a DMX status LED indicator (green), a network status LED indicator (green) and an LED indicator (red) for errors. Interface shall allow the backlight to

timeout and shall provide user editable options to shut off backlight completely as well as adjust screen contrast.

4. Ethernet interface (when installed) shall default to automatic IP through link local and DHCP. Upon receiving IP address, the address of the Network Interface Card (NIC) shall display in the about menu. Static address and settings shall also be possible.
5. The control interface shall support a USB memory stick interface for uploads of configurations and software updates.

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 and space number
 - d. DMX address
 - e. sACN address
 - f. Circuit modes
 - 1) Normal (priority and HTP based activation and dimming)
 - 2) Latch-lock
 - 3) Fluorescent
 - 4) DALI
 - g. On and Off threshold level
 - h. Include in UL924 emergency activation
 - i. Allow manual
2. Relay panels shall support discrete addressing of each relay. Panels that are restricted to use of start address with sequential addressing 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 CAN (sACN) and transmit status, control override, and measured energy usage per branch circuit via an internal Web UI or central monitoring interface.
5. Control electronics shall report the following information per branch circuit:
 - a. Breaker state (On/Off)
 - b. Breaker state (Open/Closed)
 - c. Current draw (In Amps)
 - d. Voltage
 - e. Energy usage
6. 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 and 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.
7. 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 every day, 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 the events at the time clock.
 - c. The time clock shall support event override.
 - 1) It shall be possible to hold a timed event from the face panel of the processor.
 - d. The timed 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.
8. 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. Electrical
1. Breaker Panels shall support power input from: 120/208V three phase 4-wire plus ground.
 2. Conduit Entry:
 - a. Feeders:

- 1) Top or top side (upper 6" of either side)
 - 2) Bottom or bottom side 6" of either side
 - 3) Feeders shall enter through the top or bottom according to the orientation of the enclosure.
- b. Load:
- 1) Load wiring shall enter through the top or bottom of the enclosure.
 - 2) Load wiring shall enter through the top/bottom surface nearest to the breaker sub panel.
 - 3) Load wiring may also enter through left and/or right side provided a low voltage chase is not required through the same area. If Class 2 chase is required, a field installable barrier panel shall be provided upon request. When installed, the left or right side of the panel, where the barrier has been installed, shall not permit load wiring.
- c. Low Voltage:
- 1) Top or top side (upper 6" of either side)
 - 2) Bottom or bottom side (bottom 6" of either side)
 - 3) For low voltage conduit entry at the relay end of the cabinet, conduits shall be located at the outer 3" of the top/bottom panel.
 - 4) Field installed low voltage channel shall be provided separately for installation on the left or right side of the panel to allow Class 2 wiring to traverse the panel from top or bottom or bottom to top.
3. All relays shall be mechanically latching.
 4. The relay shall be capable of switching 20A at up to 300V.
 5. The relay panel shall support a maximum feed size of 200A.
 6. Relay panel shall support main circuit breaker options.
 - a. Main breaker options shall be optional and available for purchase on request.

- b. Main breaker shall be field installable.
- c. Main breakers shall be available in 200A for 120V systems.
- d. Series rated SCCR rating apply as follows with appropriate main breaker:
 - 1) 22,000A at 120/240V
 - 2) 10,000A at 100A; 120/208V
 - 3) 10,000A, 22,000A or 42,000A at 200A, 120/208V
- e. Main breakers shall allow the following range of wire sizes:
 - 1) 1AWG-3/0kcmil at 120/240V
 - 2) 3/0 to 300kcmil at 120/208V

F. Relay

- 1. Each relay shall have a manual override switch with on/off status indication.
- 2. Relays shall be rated for use with:
 - a. 16A electronic ballast loads @120V
 - b. 20A tungsten loads at 120V
 - c. Motor loads with ratings of 20A FLA @ 120V, 10,000A symmetrical SCCR.
- 3. Isolation shall be 4000V RMS.
- 4. Relays shall be latching state.
- 5. Rated Life
 - a. 1,000,000 mechanical activations
 - b. 100,000 cycles at full resistive load.
 - c. 30,000 cycles full motor, inductive, tungsten and electronic (LED).
 - d. Decreasing loading shall increase the rated life of the relay inversely proportional the square of the load.
- 6. Relays shall support reporting of current usage with accuracy of five percent of the connected load.

G. Relay Panel Accessories

1. 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
 2. Main breaker options shall be available as specified in Section E.6.
- H. 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 32°F (0°C) and 104°F (40°C), and humidity between 5-95% (non-condensing).
- I. Provide one (1) ERP Relay Panel with (24) 20A relays, Ridethru option card, main breaker, and surface mount door.
1. Provide an engraved nameplate on the front face of the relay rack in a suitable location. The nameplate shall be lettered STAGE LIGHTING RELAY PANEL.

2.03 DIN RAIL ENCLOSURE WITH NETWORK HARDWARE

- A. The DIN rail enclosure will be sized to hold all of the specified equipment with 20% spare capacity.
1. The units shall be wall mounted with removable front panel for access.
 2. The unit shall be constructed of 16-gauge cold-rolled steel and finished in a fine-textured, black powder coat. Conduit punch guide holes shall be provided on all sides.
 3. The enclosure shall include two aligned rails, and a re-positionable voltage divider allowing re-configuration to meet the needs of the installation.
 - a. Two vertically-aligned DIN rails shall be provided.
 - b. DIN rail compliance: DIN43880 (35/7.5 rail)
 4. The unit shall be a large enclosure: 27" (686mm) long (14" x 28") with a depth of 12" (304.8mm)
 5. DIN rail enclosure shall be ETL listed, conform to ANSI/UL Standard 50/50E, and certified to CAN/CSA Standard C22.2 No. 94.1/94.2

- B. Provide one (1) DIN28 wall mounted DIN Rail Enclosure with the following components:
 - 1. One (1) DIN mounted dual power supply (24V/48V)
 - 2. One (1) DIN mounted 5 Port PoE Switch
 - 3. One (1) E-SPS-DIN Station Power Supply
 - 4. One (1) E-DMXC DMX Scene Controller
 - 5. One (1) ISP-6R-DC-TERM RDM/DMX Opto Splitter
 - 6. One (1) RSN-DMX4-DIN Gateway
 - 7. One (1) APC DIN Panel Mount UPS with Standard Battery, 120V

2.04 STATION POWER SUPPLY

- A. The DIN Rail Mount Station Power Supply with 24V Aux shall be the Unison Echo E-SPS-DIN as manufactured by Electronic Theatre Controls, Inc., or equal.
- B. Mechanical
 - 1. The Station Power Supply (SPS) assembly shall be designed for use in DIN rail enclosures
 - 2. The SPS shall convert input power into low-voltage (Class II) power with data line to energize control stations, zone controllers, time clock, and other devices for multi-scene lighting control.
 - 3. The SPS shall be convection cooled.
- C. User Interface
 - 1. The SPS shall utilize light emitting diodes (LED's) to indication function, status and fault.
- D. Electrical
 - 1. The SPS shall require no discrete wiring connections when used in a power control enclosure; all wiring shall be terminated into the dimming enclosure.
 - 2. The SPS shall utilize line-voltage power supplied by the contractor, terminated inside the power supply.

3. The SPS shall support EchoConnect communications with remote devices, including control stations and other devices.
4. The EchoConnect network shall utilize 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.
 - a. The network shall be topology free. Network wiring may be bus, loop, home run, star or any combination of these.
 - b. The control bus wiring shall permit a total wire run of 1640 ft. (500m)
 - c. Wiring between stations shall not exceed 1313 ft. (400m).

E. Functional

1. Capacity
 - a. Each SPS shall supply power for up to 16 control station, zone controllers, time clock stations and other devices.
2. Operation
 - a. The SPS shall not require configuration or programming.
 - b. The SPS shall automatically detect faults in the wiring, indicate the fault, including the fault polarity, and shut down the output power.
 - c. The SPS shall automatically reset when the fault is clear, and can be manually reset by removing and re-inserting the module.

F. Provide one (1) E-SPS-DIN DIN mounted Echo Station Power Supply.

2.05 DIGITAL INTERFACE STATIONS (DMX Playback Controllers)

A. General

1. The DMX playback controller be the Echo DMX Scene Controller by ETC, Inc., or equal. The scene controller shall allow for control of DMX lighting through:
 - a. DMX input for snapshot capture of lighting presets
 - b. Live control of intensity, hue and saturation of patch DMX Zones from connected stations and mobile apps

2. The scene controller shall support 32 presets of 512 DMX addresses and control of 16 patched DMX Zones

B. Mechanical

1. The DMX Scene Controllers shall be DIN-Rail Mounted on DIN 43880 (35/7.5) rail and shall be constructed of injection-molded black ABS plastic that fully encloses all electrical components
2. The DMX Scene Controllers shall support onboard mode and termination configuration using toggle switches
3. The DMX scene controllers shall have LED indicators for status of
 - a. Blue colored indicator for power.
 - b. Bi-color DMX activity indicator.

C. Electrical

1. Control station wiring shall be EchoConnect control wiring utilizing 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. The station shall use (2) #16 AWG stranded wires for 24vDC operating power.
3. Station wiring shall be topology free. It may be point-to-point, bus, loop, home run or any combination of these. Stations that require daisy-chain wiring shall not be acceptable.
4. DMX port shall comply with the requirements of ANSI E1.11 USITT DMX512-A standards.
5. DMX input shall be optically-isolated from the gateway electronics.
6. DMX output shall be earth-ground referenced.
7. DMX port shall be capable of withstanding fault voltages of up to 250vAC without damage.
8. DMX ports shall be eight-position removable connectors supporting Belden 9729 (or equivalent) or Category 5 Ethernet wiring.
9. Stations shall support a MicroSD card slot for firmware maintenance.

10. Stations shall be UL/ cUL LISTED and CE marked.

D. Functional

1. The scene controller shall support recall of prerecorded scenes for playback using DMX.
2. There shall be support for 32 presets.
3. The scene controller shall support preset playback as activated by any connected control station.
4. The scene controller shall support DMX pass-through for real-time output of incoming DMX levels.
5. The scene controller shall support live control and recording for multiple DMX fixture profiles.

E. Provide one (1) EDMXSC Echo DMX Scene Controller

2.06 DMX ETHERNET GATEWAY – FOUR PORT

A. General

1. The lighting control gateway shall be a microprocessor-based unit specifically designed to provide DMX-512 control of lighting systems and transport of RDM configuration and status messages. The gateway shall permit DMX-512 data to be encoded, routed over an Ethernet network and decoded back to DMX-512. The unit shall be a Response Mk2 4-port DMX Gateway as provided by ETC, Inc.
2. Gateways shall communicate over Ethernet directly with at least ETC, Inc.'s entertainment and architectural lighting control products and other Ethernet interfaces.
3. Connections shall be made between gateways, consoles, architectural systems, and PCs over standard Ethernet distribution systems using 10/100BaseT.
4. The gateway shall support multiple protocols including:
 - a. ANSI E1.17 Architecture for Control Networks (ACN)
 - b. ANSI E1.31 Streaming ACN (sACN)
 - c. ANSI E1.11 USITT DMX512-A

- d. ANSI E1.20 Remote Device Management (RDM)
 5. The gateway shall be tested to UL standards and labeled ETL listed.
 6. The gateway shall be RoHS compliant (lead-free).
 7. The gateway shall be CE compliant.
 8. The gateway shall have a graphic OLED display and four buttons for identification (soft-labeling), configuration, status reporting and troubleshooting.
 - a. Labeling shall be user configurable using ANSI E1.17 Architecture for Control Network (ACN), or a purpose built software configuration tool.
 - b. The OLED display shall show DMX port configuration indication as well as indicate the presence of valid signal.
 - c. Gateways that do not indicate port configuration (input/output) and valid data shall not be acceptable.
 9. Each gateway shall have power and data activity LEDs on the front of the gateway.
- B. DMX Ports
1. DMX ports shall comply with the requirements of ANSI E1.11 USITT DMX512-A standards.
 2. Each DMX port shall be software or locally-configurable for either input or output functionality.
 3. DMX input shall be optically-isolated from the gateway electronics.
 4. DMX port shall provide at least 500V isolation to ground and the rest of the electronics.
 5. Each port shall incorporate one DMX512-A connection
 - a. Gateways shall be available with terminal strip for DMX wiring.
 6. Network gateways that do not indicate input/ output port configuration or presence of valid data shall not be accepted.
- C. Processor

1. Each gateway shall have sufficient processing power to manage up to 63,999 universes (32,767,488 addresses).
 2. Maximum delay time from input to output shall not be greater than one packet time (approximately 22 mSec.).
 3. A minimum DMX update rate of 40Hz shall be sustained under all conditions unless specifically configured for a slower rate for the sake of compatibility with 3rd party DMX devices.
- D. Mechanical (DIN Rail Mount)
1. The DIN rail mounted gateway shall be included in an extruded plastic enclosure.
 2. DMX input or output connections using terminal strip or IDC Style Connectors shall be required for connection to the lighting system
- E. Power
1. A low-voltage DC power input shall be available utilizing an isolated in-line power supply capable of an operating range of 12-24VDC. The power supply shall be provided by the gateway manufacturer.
- F. Configuration
1. The Gateway must support local or remote configuration.
 2. Each gateway on the network shall be individually configurable using freely available software configuration tools. The primary configuration tool shall be Net3 Concert configuration software running on a network connected PC. The PC shall only be required for configuration, and shall not be required for normal operation of the system.
 3. Each port of the DMX gateway shall control up to 512 DMX addresses, within the confines of 63,999 universes.
 4. The specific DMX data input or output by the gateway shall be freely configurable by the user.
 5. Duplicate outputs of DMX lines (DMX splitter) and discrete outputs shall be fully supported.
 6. Multiple DMX universes may be configured with any length up to 512 total addresses. Any range of DMX input addresses shall support selection and routing to the specified sACN output.

7. Multiple sACN sources may be combined with a priority may be assigned to each source sending data to the gateway
8. All relevant routing information shall be stored in non-volatile memory at each gateway. The system shall recover from a power outage without requiring the PC to be online. Gateways that do not support non-volatile storage of data routing shall not be accepted.

G. Network

1. Communications physical layer shall comply with IEEE 802.3i for 10BASE-T, 802.3u for 100BASE-TX and 802.3af for Power over Ethernet specifications.
2. All network cabling shall be Category 5 (or better), conforming to TIA-568A/B, and shall be installed by a qualified network installer.
3. Data transport shall utilize the TCP/IP suite of protocols to transfer the DMX data.
4. ANSI E1.17 Architecture for Control Networks (ACN) and streaming ACN (sACN) shall be supported. Gateways that do not support ANSI E1.17 shall not be acceptable.
5. Each DMX gateway shall control up to 512 DMX addresses, per DMX port within the confines of up to 63,999 universes (32,767,488 addresses) using Streaming ACN (sACN).
 - a. Any range of DMX addresses may be selected for each universe.
 - b. Multiple sources shall be supported by prioritized Highest Takes Precedence (HTP with priority). Each source shall support assignment of priority to allow override of default HTP behavior.
 - c. Each DMX port shall support its own universe and start address.
6. Gateways shall have built in DMX merger capability on a universe or channel-by-channel basis.
7. Gateways shall support have built in priority on a per-universe or channel-by-channel basis. Gateways that do not support prioritized merging of multiple network sources at independent priorities shall not be accepted.

H. 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.
- I. Accessories
 1. Net3 Concert Configuration and monitoring software
- J. Provide one (1) RSN-DMX4-DIN Response MK2 4-port Gateway - DIN rail mounted.

2.07 RDM & DMX Splitter/Booster

- A. The RDM & DMX Splitter/Booster shall be the ISP series as manufactured by Swisson of America Corporation, or equal.
- B. The RDM & DMX Splitter shall process DMX and RDM signals utilizing input and output ports that are individually optically isolated and protected against transient over voltages. Splitter shall be "discoverable", and visible to RDM controllers.
 1. The splitter shall boost incoming DMX signals and split the signal via six output terminal ports while also acting as a repeater to transport DMX signals across larger distances.
 2. RDM shall provide bidirectional operation.
 3. Large DMX installations or long signal lines that cause signal reflection shall not be acceptable. The Splitter shall clean and regenerate the signal by splitting the line into smaller segments to reduce the delay of the reflection at each segment.
- C. Splitters shall be manufactured with a rugged metal housing, with built in terminations. Unit shall be designed for DIN Rail installation and require an external DIN mounted power supply.
- D. Technical Data
 1. Depth ISP-6 90 mm (3.54 ")
 2. Width ISP-6 172 mm (6.8 ")
 3. ISP-6 56 mm (2.2 ")
 4. Weight ISP-6 560 g (1.25 lb.)
 5. Ambient temperature -30°C - 55°C (-22°F - 131°F)

- 6. DC power 10 V - 48 V
- 7. Power consumption ISP-6 6 W
- 8. DMX ANSI E1.11
- 9. RDM ANSI E1.20
- 10. Electrical standard signal ports EIA-485

E. Provide one (1) ISP-6R-DC-TERM DMX/RDM DIN Rail Opto Splitter.

2.08 DATA PLUG-IN STATIONS

A. Data Plug-in Stations shall consist of the appropriate connectors required for the functional intent of the system. These stations shall be available with DMX input or output, Remote Focus Unit, Network, or architectural control connectors as shown on the Drawings or as required.

B. Connector Options:

1. The following standard components shall be available for Plug-in Stations:

- a. RJ45 connectors for network connections - twisted pair

C. Physical:

- 1. Station faceplates shall be .80" aluminum, finished in fine texture, scratch-resistant black powder coat. Silk-screened graphics shall be white.
- 2. The station panel shall mount into an industry standard back box, depending on size and quantity of connectors. A terminal block shall be supplied for contractor terminations.

D. Provide two (2) ECPB NET Plug-In Stations.

2.09 DIGITAL BUTTON STATIONS

A. General

- 1. The control station shall be the Echo Inspire Station Series as manufactured by ETC, Inc., or equal. It shall be a remote station on an EchoConnect network that can recall presets, provide direct zone control, recall presets and provide room combine actions for a control system.

2. The station shall consist of a dual function (control/ record) push-button with an integral bi-color backlight for each corresponding button and fader.
3. The system shall support up to sixteen independent stations.

B. Mechanical

1. Control stations shall operate using one button.
2. Manufacturer's standard colors shall conform to the RAL CLASSIC Standard, with decorate style faceplate available in cream.
3. Stations shall have bi-color backlights for each button. Indicators shall utilize a blue backlight for active status, and amber for inactive to assist in locating stations in dark environments. Stations that do not provide a lit inactive or deactivated state shall not be allowed. Stations shall support an off backlight state of inactive status when required.
4. Faceplates shall be designed for flush or surface mounting and have no visible means of attachment. Faceplates shall be constructed of ABS plastic and designed based on a standard decorator style faceplate. Station faceplates shall be indelibly marked for each button or fader function. Control station electronics shall mount directly behind the faceplate. The entire assembly shall mount into a single gang back box. Back boxes for flush mounted stations shall be industry standard back boxes. The manufacturer shall supply back boxes for surface mounted stations.

C. Electrical

1. Control station wiring shall be EchoConnect control wiring utilizing 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. The station shall operate on Class 2 voltage provided by the control system via the EchoConnect network. Station wiring must be topology free. It may be point-to-point, bus, loop, home run or any combination of these.
3. Wiring termination connectors shall be provided with all stations.
4. Control stations shall be UL/ cUL listed and CE marked and meet WEE compliance.

D. Station Addressing

1. Station addressing shall be via two 16 position rotary dials and will be set by installers or factory personnel. Station addressing shall require only a space assignment and a device ID assignment.
- E. Provide one (1) E1001 Echo Inspire 1 Button Station for local control of breakers
- 2.10 PRESET STATION
- A. General
1. The button station shall be the Echo Preset Button Station as manufactured by ETC, Inc., or equal. It shall be a remote station on an EchoConnect network that can play presets stored in an Echo output product.
 2. The station shall consist of a dual function (program/play) push-button with an integral LED for each corresponding preset. Standard stations shall control 5 presets.
- B. Electrical
1. Button station wiring shall be EchoConnect control wiring that 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). The station shall operate on Class 2 voltage provided by the control system via the EchoConnect network.
 2. Station wiring must be topology free. It may be point-to-point, bus, loop, home run or any combination of these. Wiring termination connectors shall be provided with all stations.
- C. Station Addressing
1. Preset addressing for stations shall be via two 16 position rotary dials and will be set by installers or factory personnel. Multiple stations may have "overlapping" preset addresses.
 2. Each station shall support preset recall in a single space.
- D. Play Presets
1. Pressing a button shall play the corresponding preset. The station will send the command to play the preset to all output products.
 2. Each station shall monitor the status of presets. If any looks are active in the range of the station's numbered preset, the station shall illuminate the corresponding LED regardless of which device activated the preset.

3. If the button with the active preset (LED lit) is pressed, the station shall send the command to return to normal operation, deactivate the preset and turn off the LED.

E. Physical

1. Control station electronics shall mount directly behind the faceplate. The entire assembly shall mount into a single gang back box. Back boxes for the flush mounted stations shall be industry standard back boxes. The manufacturer shall supply back boxes for surface mounted stations.
2. Station faceplates shall be constructed of ABS plastic and shall use no visible means of attachment. All Button stations shall be available with white, signal white, ivory, gray or black faceplates and buttons.

F. Provide two (2) EPS05 5 Button Preset Stations.

2.11 LIGHTING CONSOLE AND ACCESSORIES

A. General

1. The lighting control console shall be a microprocessor-based system specifically designed to provide complete control of stage, studio, and entertainment lighting systems. The console shall be the Element 2 as manufactured by Electronic Theatre Controls, Inc., or equal.
2. The system shall provide control of 6,144 outputs on a maximum of 32,768 control channels, which may be any number from 1 to 99,999. Output shall be distributed over a 10/100 MB Ethernet network using Net3/ACN, ETCNet2, Avab and/or Artnet (multi-cast) protocols. The user shall be able to control the application of protocols at an individual address level.
3. The system shall support full bi-directional RDM communication with compatible devices via Net3 DMX/RDM Gateways. RDM communication shall adhere to ANSI standard E1.20-2006 Entertainment Technology – RDM – Remote Device Management Over DMX512 Networks. Supported RDM features shall include:
 - a. Discovery and Identification of RDM capable devices.
 - b. Setting of start addresses, operating modes and additional settings as exposed by connected devices and controllable via RDM.
 - c. Viewing of sensor data as provided by connected devices.

- d. Error reporting as provided by connected device.
4. A maximum of 10,000 cues, 1000 groups, 1000 presets, 4 x 1000 palettes (Intensity, Focus, Color and Beam), 99,999 macros, 1000 effects, 1000 curves, 1000 Color Paths and 1000 snapshots may be contained in non-volatile electronic memory and stored to an onboard solid-state hard drive or to any USB storage device.
5. Channels shall respond to cue information by last instruction with discrete rate control provided for all cues. The console may be placed in Tracking or Cue Only mode by the user as a system default and overridden on individual record actions as required. HTP/LTP intensity flags, block, proportional, intensity master or manual master fade control. Priority and Background Priority may be placed on the cue list. It shall also be possible for a cue list to contribute to playback background states or to withhold such contributions.
6. A Master Playback fader pair shall be provided. The fader pair may execute crossfades or all-fades, with IFCB cue level timing.
7. The console shall provide 40 pageable faders that may be operate in either LTP channel or fader mode. Virtual fader control for playbacks is also provided.
8. A high-resolution level wheel shall be provided to control intensity for selected channels and scrolling within selected displays. A high-resolution rate wheel, which may also be used for fader paging shall be provided.
9. Virtual moving light controls shall provide mouse/touch-based tools for all parameters. The tools shall display the current value for each parameter and provide controls for adjusting each parameter.
10. Control and programming features for automated fixtures shall also include: a standard library of fixture profiles, the ability to copy and edit existing profiles and create new profiles, patch displays including channel and output addressing, 16-bit fade resolution, color characterization allowing color in up to six different color spaces.
11. System information, including playback status, live output and blind values for all record targets shall be displayed on a maximum of two external high resolution monitors, which may also be multi-touch touch-screens. Every display shall support three user-definable workspaces. Each of these workspaces shall provide individually configured frames, with size/scaling controls. Any Windows 7 compatible display may be used.

12. A context sensitive on-line Help feature shall explain and provide an example of the operation of each feature of the system. This help system shall be integrated into the on-board user manual via hyperlinks. Optional dynamic prompts are also provided.
13. A fully integrated Virtual Media Server feature shall allow user to map images and animations to a rig array. 40 such maps may be created, each with 12 layers. System that rely on external hardware or software for this functionality shall not be acceptable.
14. User-definable, interactive displays may be created. These displays, which can be used in live and blind operating modes, allow graphical layout of channels, desk buttons and programming tools. Standard symbols are provided, and the user may import their own symbols or graphics. Each symbol may be individually defined with data feedback characteristics. Non-interactive status information, such as a mirror of other user's command lines, may also be included in the display. A graphical browser is provided for fast selection of these views. Multiple zoom factors and placements may be stored and recalled for each display.
15. An integrated virtual alphanumeric keyboard shall allow labeling of all show content.
16. Console software upgrades shall be made by the user via flash drive. It shall be possible to install software updates in all consoles, processor units and remotes from one device over the network.
17. The console operating software shall be loaded into program execution memory from the internal hard drive when the console is powered. In the event of an uncontrolled shutdown, the console shall return to its last output state when power is restored. Devices requiring a UPS to provide such protections shall not be acceptable.
18. Integrated dimmer monitoring features shall be provided to allow indication of dimming system status, error states and dimmer load monitoring. Adjustment of dimmer configuration from the console shall also be supported. Communications with the dimming system shall utilize ANSI E1.17 2006 - Entertainment Technology - Architecture for Control Networks.
19. Integrated RDM device features shall be provided. The console shall discover and patch RDM devices. The console shall monitor RDM devices to allow indication of RDM device online/offline status error states. The console shall be capable of changing settings of RDM devices such as the DMX start address. Communications with the RDM devices shall utilize ANSI E1.20 2006 – Remote Device Management.

20. Network configuration tools shall be provided from within the desk.
 21. Show data may be created and modified on a personal computer, using either Windows 7 or higher or a Macintosh platform running OS 10.11 or later via a free offline editing application. The program shall run natively on Apple operating systems. Applications requiring PC emulation programs shall not be acceptable.
 22. A PC, using either Windows 7 (or higher), or a Macintosh running OS 10.11 (or later) using the offline software application shall be able to connect to a control system via the network and view or modify current show data in an independent display environment, using an ETCnomad key. When connected without the key, the computer shall operate in Mirror mode, with the device to be mirrored selectable by the user.
 23. Synchronized backup shall be provided via another full console on the network, an ETCnomad/Puck, or by use of a remote processor unit. The backup device shall maintain synchronized playback with the master and shall take over control of the lighting system upon loss of communication with the master.
 24. A maximum of 99 users may access and interact with show data simultaneously. Each user shall have an individual workspace. User identification may be assigned to more than one control device, allowing users to work in tandem, or allowing a designer/ALD to mirror the current display format, mode and command line of the associated programmer. Partitioned control allows discrete control of channel/parameter groupings by user. Partitioned control may be easily enabled and disabled with no need to merge show data from multiple users.
 25. The system shall support up to 32 individual simultaneous Time Code inputs or Event lists using Show Control Gateways.
 26. Systems that do not provide the above capabilities shall not be acceptable.
- B. Controls and Playback: Manual Control and Programming Section
1. The console keyboard shall be grouped by function. Major groupings shall be record target functions, numeric keys, level assignment functions, display navigation functions and controls, as well as non-intensity parameter controls.
 2. The command keypad shall be fully interactive with direct selects and other virtual controls, which provide “one touch” selection of channels, groups, palettes, presets, effects, snapshots and macros.

3. Non-intensity parameters may be set numerically via an extensible keypad. This control shall be fully interactive with the moving light controls. The controls shall also access available modes for each parameter type, min and max values for each parameter as applicable, as well as home position on a parameter basis.
4. Only those parameters available for control in the active lighting system shall be displayed for control. Displays shall condense or lowlight parameters not available to selected channels.
5. Lamp controls provide direct access to luminaire functions such as striking and dousing arc lamps and calibrating entire fixtures or individual mechanisms of fixtures, as provided by the luminaire manufacturer. User access to these features is normalized across all manufacturers for ease of use. Use of a "control channel" for accessing these functions shall not be required and systems requiring use of control channels for these functions shall not be acceptable.
6. Fan functions shall be provided both via command line operation and through encoder controls.
7. Highlight shall be supported, with user definable highlight values. Lowligh conditions may be defined for selected, but not specified channels. Rem Dim commands, at specific levels by channel, may be optionally and automatically called with the highlight command.
8. Advanced color control functions provide color mixing in any of six different color spaces. Gel matches are provided via gel picker or by command line control. Tinting tools allow adjusting the color mix irrespective of the native mixing system. Spectrum tools support adjusting the output of additive color systems with more than three emitter types, allowing the X/Y coordinate to be held while adjusting the recipe that achieves that mix. Color Path tools allow the user to control the live fade of fixtures through the color space.
9. The Virtual Media Server function shall allow the user to create layouts of devices, identified as pixel maps. Media content (images, movies, text and procedurally generated effects) may then be applied, manipulated and stored. Stock content is provided and the user may import his own imagery and animations.
10. Macros may be set to run as default. Default macros called manually shall post to the command line, but executed via cue lists shall run in the background. The user may override this behavior by defining the macro to always execute in the foreground or background, regardless of the recall method. Startup, Shutdown and Disconnect macros may also be defined.

C. Controls and Playback: Playback Section

1. The playback faders shall consist of a 100mm master fader pair with associated control buttons as well as 40 45mm faders which may be placed in channel or playback mode.
2. Virtual fader controls are also available for playbacks.
3. It shall be possible to instantaneously halt an active cue, back to the previous cue, manually override the intensity fade or manually override the entire fade.
4. It shall be possible for a cue list to contribute to the background state or for the contents to be withheld from such. Priority and background priority states may be established.
5. Channel/Playback Faders
 - a. Up to 999 proportional, fully overlapping additive or inhibitive submasters may be defined. Submasters shall have colored LEDs to indicate submaster status. Each submaster may have fade up, dwell and down fade times. Submasters may be set to priority and background priority status.
 - b. Submasters may be set to HTP or LTP intensity. Non-intensity parameters on submasters shall be LTP only.
 - c. Exclusive mode for a submaster shall prohibit the live contribution of that submaster from storing to cues or other submasters. Shield mode prohibits access of associated channels from any other playback or manual control operations.
 - d. A submaster potentiometer may be defined as proportional, master only or intensity master. When set as an intensity master, a mark and unmark feature is supplied.
 - e. The submaster blind buffer shall be linked directly to live playback.
 - f. It shall be possible to set submaster values directly from the command line.
 - g. Submasters may be set to fade to background or to minimum value when the fader is returned toward zero.
 - h. Submaster values may contribute to the background state or withheld from such.

- i. Presets and IFCB palettes may be mapped to playbacks, either individually or in user defined groupings.
 - j. Channel mode shall allow the user access to the first 120 channels, operating in LTP logic. Faders that are not currently set to the same level as the corresponding channel must be matched to that level before gaining control. Physical channels may be cleared without impacting output using Sneak.
 - 6. Grand Master Faders
 - a. The location of the grand master shall be user definable. The grand master shall have associated blackout and blackout enable buttons.
 - b. Blackout shall send all associated intensity outputs to zero. Non-intensity outputs shall not be affected. It shall be possible to exclude channels from blackout and grand master control.
- D. Display Controls
 - 1. Format shall change the view of selected displays.
 - 2. It shall be possible for the user to choose which parameter categories or parameters (s)he wishes to display.
 - 3. Flexichannel modes shall change which channels are viewed in selected displays, as follows:
 - a. No modes
 - b. Masters only/cells only
 - c. Use Partitions
 - 4. Flexichannel states shall change which channels are viewed in selected displays, modified by the modes, as follows:
 - a. All/Patched/Show channels
 - b. Active/Moved channels
 - c. Selected/Manual channels
 - d. View channels (user identified list)
 - e. Channels with discrete timing

5. Expand shall extend the selected view sequentially across connected displays, vertically or horizontally.
6. [Time] depressed shall display discrete timing data. [Data] suppressed shall display absolute values of referenced data. These functions may be latched.
7. Displays may also be toggled to show stored data currently manually overridden, the source of the current parameter data, output level, patch assignment, part structure and referenced marking data.
8. Playback status displays are provided with a variety of different formats. Indications are provided per cue for live moves (lights fading from zero and also moving non-intensity parameters) and dark moves (inactive lights which have stored non-intensity parameter moves).
9. Display content including which of the workspaces is in focus on any of the external monitors and what views are docked in those workspaces may be instantly recalled using snapshots.

E. Operating Modes

1. Live Mode
 - a. Channel lists may be constructed using the +, -, and Thru keys as well as the direct selects. Channel selection and deselection is fully interactive, regardless of the method used.
 - b. Levels may also be set with the keypad, level wheel and non-intensity encoders. "Selected" channels shall be those last addressed and under keypad control. Controls are provided for single button access to the last selected channel list, all channels with manual levels and all active channels.
 - c. Channels may be set at a user defined default level using the Level key. +% and -% keys adjust channels quickly by user definable values.
 - d. Channels and/or channel parameters may be captured. Capture mode shall allow the user to selectively capture channel data at specific levels. Captured data shall be indicated on the Live display.
 - e. Sneak shall be used to restore specified channels to background states, default values, or to send them to specified values, in user specified times.

- f. Selected channels may be set at a level or held to current values while all other channels are set to zero using Rem Dim. Toggling Rem Dim shall restore all unselected channels to original levels. The Rem Dim level shall be user definable via the command line or with a default setup value.
- g. Channels may be recorded into groups for fast recall of commonly used channels. 1000 groups shall be available. Groups shall store selection order. The Offset function supports rapid creation of ordered groups, including reverse and random order.
- h. Parameter settings may be stored to Intensity, Focus, Color and Beam Palettes and to Presets. All referenced data may be stored to whole numbers or to up to 99 decimal places between each whole number.
- i. The following conditions may be placed on a channel or channel parameter to be included with a cue record action.
 - 1) Discrete fade time and/or delay
 - 2) Block flag
 - 3) IFCB Filters, which may be set at a parameter level.
 - 4) Release and Restore
- j. Cues may be recorded in any order. Up to 99 decimal cues may be inserted between any two whole number cues. Each cue may contain a maximum of twenty parts.
- k. It shall be possible to record cues and cue parts with the following information:
 - 1) Any collection of channel data, as determined by the use of "Record", "Record Only" or selective store commands, combined with parameter filters.
 - 2) Cue Level timing and delays for Intensity Up, Intensity Down, Focus, Color and Beam.
 - 3) Follow or hang time
 - 4) Link instruction
 - 5) Loop value

- 6) Block, Preheat, and/or Mark Flag
 - 7) Curve
 - 8) Label and note
 - 9) Execute list to trigger other activity
- l. Non-intensity channel parameters may be preset to an upcoming position using Automark. Automark shall set any stored parameter transitions in the cue just prior to intensity becoming active. Automark may be disabled on a cue or cue part basis, enabling a “live” move.
 - m. Any channel parameter may be stored with an effect instruction. These effects may contain relative offsets from current value, or absolute instructions. Effects may be progressive action or on/off states. Entry and exit behaviors shall modify the channel parameters activity when beginning and ending the effect.
 - n. Update may be used to selectively add modified parameter data quickly to that parameter’s current source. Update may be specified to modify referenced data content or break the link to that content. A dialogue informs the user of the content that will be updated. A trace command may be used to modify the data to the original source of its move instruction. It shall be possible to update inactive record targets.
 - o. Recall From quickly pulls specified data from record targets or other channels into the current view.
 - p. Copy To quickly copies selected data to specified channels or other record targets.
 - q. Address and channel check functions shall be provided.
 - r. Channel parameters may be “parked” at levels. Those levels are not added to any live record operations, nor may they be changed until the parked element is “unparked”. Scaled park provides real time proportional adjustment of stored intensity values. Address Park shall also be provided.
 - s. About shall provide detailed status of selected channels or specified record targets. This shall include current source, current value, discrete timing, parked value, marked to and for indications. Background levels and current DMX output are also displayed.

Channel usage indicates submaster and cue information and also provide a "dark moves" report on a per channel basis.

- t. 1000 snapshots may be stored which instantly recall specified front panel and display configurations.
- u. Live data may be displayed in a summary view or detailed table orientation.
- v. Query shall allow selection of channels by their current or possible state. Keywords and fixture types shall allow quick access to fixtures.
- w. User definable home positions, on a per channel basis, may be defined.
- x. Channel level offset commands provide channel ordering and sub-grouping functions.
- y. Undo shall be used to sequentially step back through manual operations or to undo record and delete actions. It shall be possible to undo multiple commands in one action.

2. Blind

- a. The Blind display allows viewing and modification of all record targets without affecting stage levels.
- b. Record target data may be displayed in a summary view, a detailed table orientation or a spreadsheet view, which allows quick data comparisons, move and replace functions.
- c. Changes to blind data shall be automatically stored. Range selection of both record targets and channels shall be supported.

3. Patch Display

- a. Patch shall be used to display and modify the system control channels with their associated library data.
- b. Each channel may be provided with a proportional patch level, curve, label, swap and invert functions, as well as keywords to service Query.
- c. Offset functions in patch shall allow selection of channel ranges and shall allow the user to establish a "custom" footprint for any device output.

- d. Custom color wheels, color scrolls and gobo wheels shall be defined in patch. These devices shall be created with a simple table and graphical user interface supported by images of major manufacturers.
 - e. RDM discovery and device monitoring shall be supported.
 - f. Copy to and Move functions shall be supported in patch.
4. Setup/Browser
- a. Setup shall access system, user and device configurations.
 - b. It shall be possible to partially import Eos show files. Users shall be able to select as much or as little of the show file as required, with renumber tools.
 - c. It shall be possible to import ASCII and Lightwright data files. It shall be possible to export as ASCII or .csv.
 - d. Setup shall also access show data storage, import, export, print to .pdf and clear functions, as well as show data utilities.
 - e. The system shall support programming and playback of real time clock events, including cue, submaster and macro execution at specific times of specified days or at a time based on astronomical events.
 - f. A control screen shall be provided for network configuration, selecting date/time, software update controls, selecting functional language and/or keyboard for labeling option, as well as other system level tools.
 - g. Available languages for prompts, advisories and help messages shall include English, Bulgarian, German, Spanish, French, Italian, Japanese, Korean, Russian, Chinese, simplified and Chinese, traditional.
 - h. Supported keyboards shall include American, United Kingdom, French, German, Italian, Korean, Norwegian, Russian, Slovakian, Turkish, Swiss, Swedish, Finnish and Bulgarian.
- F. Dimmer Monitoring and Configuration
- 1. The lighting control system shall provide communication with an ETC FDX dimming system for remote monitoring and configuration of show specific functions from within the software application.

2. Circuit level configuration and monitoring functions shall include but not be limited to:
 - a. Control mode (dimmable, switched, latch-lock, always on, off or fluorescent).
 - b. Curves
 - c. Control threshold
 - d. Min and Max Scale Voltage
 - e. Preheat
 - f. Scale load
3. Rack status messages shall include but not be limited to:
 - a. State of UL924 panic closure
 - b. DMX port error/failure
 - c. Network error/failure
 - d. A, B, C Phase below 90 or above 139 volts and headroom warning
 - e. Ambient temperatures out of range
4. Circuit status shall include but not be limited to:
 - a. Module type and location
 - b. Output level
 - c. Control Source
 - d. Overtemp
5. Advanced circuit feedback shall include but not be limited to:
 - a. Load higher or lower than recorded value
 - b. DC detected on output
 - c. SCR failed on/off

- d. Breaker trip
 - e. Module has been removed
 - f. Load failure
 - g. Shutdown due to Overtemp
- G. Interface Options
- 1. The console shall support a variety of local interfaces.
 - 2. AC input
 - 3. USB (five ports for items such as alpha-numeric keyboard, mouse, touch screens, USB flash drive)
 - 4. Ethernet (two ports)
 - 5. Two Display Port output connectors, supporting Windows 7 compliant monitors as 1280x1024 resolution minimum. Touchscreen/multi-touch support of any/all of these monitors is provided.
 - 6. Contact Closure trigger via D-Sub connector
 - 7. 4 DMX/RDM ports
 - 8. Alternative Contact Closure trigger through Gateway
 - 9. OSC Transmit/Receive
 - 10. MIDI In/Out, MSC and MIDI Notes through Gateway
 - 11. SMPTE Timecode through Gateway
- H. Optional Accessories
- 1. iRFR and iRFR Preview (applications for iPhone, iPod Touch and iPad units)
 - 2. aRFR (application for Android devices)
- I. Physical
- 1. All operator controls and console electronics for a standard system shall be housed in a single desktop console, not to exceed 35" wide, 15" deep,

4.5" high, weighing 16 pounds. Console power shall be 90 – 240V AC at 50 or 60Hz, supplied via a detachable locking power cord.

- J. Provide one (1) Element 2 6K console with 25'NET data cable and two (2) Dell P2418HT LCD Touchscreens.

2.12 ELECTRICAL DISTRIBUTION EQUIPMENT

- A. All distribution equipment shall be furnished by the manufacturer of the dimming equipment. Hanging and supporting hardware shall be furnished and installed by under SECTION 11065 "THEATRE AND STAGE EQUIPMENT - RIGGING SYSTEMS" as shown on the drawings.

B. POWER DISTRIBUTION – CONNECTOR STRIPS

1. The connector strips shall be the ColorSource Raceway by ETC, Inc.
2. Connector strips shall provide distributed power from incoming circuits to plugs along a raceway.
3. Internal wiring shall be sized to circuit ampacity and shall be rated at 125°C.
4. Connector strips shall support a combination of line voltage power and low voltage data distribution within a single raceway.
5. Connector strips shall be listed by a nationally recognized test lab (NRTL). Connector strips that are not listed shall not be acceptable
6. Physical
 - a. Connector strips shall be 127mm H x 45mm D and fabricated from 1.6mm aluminum finished in black, white, or silver fine-texture powder coat paint.
 - b. Connector strips shall be available in any length up to 72ft / 2195cm in specified increments of 1ft / 30.5cm and shipped fully wired with all splicing hardware.
 - c. Connector strips shall weigh no more than 2.5lbs/ft. Connector Strips that weigh more than 2.5lbs/ft shall not be acceptable.
 - d. Two connector panels supporting power and data outlets shall be supported for each 1ft / 30.5cm section of strip and shall be mounted on individual 125mm panels.

- e. Frames and connector panels shall be fabricated from 3mm die cast aluminum finished in black, white, or silver fine-textured powder coat paint.
 - f. Circuits shall be labeled above each connector on the front of the strip using 15mm reverse silk screened lexan labels. All labels match connector strip finish with contrasting color circuit designations. Optional write-on labels shall be available upon request, connector strips that do not support write-on labels shall not be acceptable.
 - g. Connector strips shall be supplied with appropriate brackets and hardware for mounting.
 - h. Connector strips shall utilize junction brackets on 6ft / 152cm centers and support spans up to 12ft / 305cm between hanger brackets.
 - i. Mounting brackets shall be 45mm x 3mm and 45mm x 1.9mm ASTM A5008 steel. All mounting hardware shall conform to ISO 898-1 class 8.8.
7. Electrical
- a. Connector strip shall support 120V/60Hz power input per branch circuit with support for multiple outlets wired to each circuit
 - b. The connector strip wiring terminal box shall support a maximum of eight 20A inputs utilized for:
 - 1) Up to six circuits for power distribution along the length of the connector strip.
 - 2) One circuit for DMX Active Pass-thru connectors when required.
 - c. The connector strip terminal box shall support hardwired or pluggable connector power and data input
 - d. Pluggable power and data inputs shall be fed by a single multi-conductor cable and a single DMX or Ethernet cable. The LKS data connector by Link S.r.l. or Link USA, Inc shall be supported, connector strips that do not support the LKS data connector shall not be accepted.

- e. Power output connectors shall be 20A grounded stage pin. Connector strips that utilize connectors that are not rated for plugging hot loads shall not be accepted.
 - f. Terminations shall be consolidated at one end and utilize feed-through terminals individually labeled with corresponding circuit numbers
 - g. Performance lighting circuits shall utilize tension clamp terminals listed for AWG 20 – 8 / 0.5mm² – 6mm² gauge wire
 - h. DMX Active Pass-thru circuits shall use tension clamp terminals listed for AWG 20 – 12 / 0.5mm² – 4mm² gauge wire. Terminals that place a screw directly on the wire are not acceptable.
 - i. A low voltage data distribution system shall be supported to incorporate DMX/ RDM (ANSI E1.11-2008 USITT DMX512-A and ANSI E1.20 Remote Device Management).
 - 1) DMX output ports shall utilize 5-pin XLR style connectors.
 - j. Connector strips shall utilize a voltage barrier to accommodate Class 2 wiring in the same strip as Class one circuits.
 - k. Low voltage signals shall enter the connector strip via a strain relief or connector mounted at the specified end of the connector strip. One low voltage cable shall be supported for each connector strip
 - l. Connector strips with multiple DMX outputs shall use active DMX/RDM pass through assemblies. Each strip shall support up to 24 active DMX/RDM pass through assemblies
 - m. DMX outputs without active splitting of the DMX/ RDM signal or that do not support RDM shall not be acceptable.
8. Provide six (6) 12' ColorSource Raceways with (1) DMX Output and (8) stage pin outlets wired on (4) 20A circuits. Circuit labeling to be provided in the following pattern, and shall read from stage left to stage right: ABCD | ABCD.

2.13 PORTABLE SYSTEM

- A. Engineer, include this section only when stage is off of a gym. **Consult with FCPS.**
- B. PORTABLE LIGHTING SUPPORT STANDS

1. Portable tripod lighting support stands shall be provided for mounting self-contained connector strip/dimmer bar units.
2. The support stand shall be the SmartStand™ as manufactured by Electronic Theatre Controls, Inc. (ETC), or equal.
3. The crank-up stand may be loaded with a dimmer bar and theatrical lighting instruments to provide lighting for temporary setups.
4. The heavy duty stand shall rise to a maximum height of 12' (380cm) and shall raise and lower up to a maximum of 68 pounds (31 kg).
5. Mechanical:
 - a. The unit shall be manufactured of black anodized steel with a geared column. Three tubular sections, with diameters of 2.2" (55mm), 1.8" (45mm), and 1.5" (38mm) respectively, shall allow the stand to extend at an elevation of 1.7" (44mm) per handle turn. A fold-away hand crank shall be used for gradual height adjustment.
 - b. The geared column shall use a dual cable control process for safety. The dual cable control shall ensure simultaneous retrieval of all sections as height is adjusted.
 - c. The unit shall have three legs with stabilizers, each 1.2" (30mm) diameter. One leg shall be an articulating leg to level the stand when placed on uneven surfaces. The full stand base diameter shall be 65" (166cm).
 - d. A sturdy adjustable foot step shall be included on the base section of the stand.
 - e. An industry standard senior stud adapter shall be included (1-1/8" diameter stud with 1/2"-13 thread) for mounting accessories to the stand. The top head of the stand shall also have a 1-1/8" receiver and 5/8" retractable baby stud (standard television head).
 - f. The total folded length of the unit shall be 6'0" (182cm).
 - g. The weight of the stand shall be 49.5 lbs. (22.4 kg), and with casters, 58.5lbs. (26.5 kg).
6. Required:
 - a. The following options for the stand shall be provided:

- 1) An additional stand adapter (stud).
 - 2) A set of three (3) locking casters – 3.9” (100mm) diameter casters with brakes.
7. Provide four (4) SmartStand Light Stands with Bar.
 8. Each portable lighting support stand shall have three (3) black heavy duty nylon construction bags containing 25 pounds of sand for anchoring the tripod support stand.
 9. Loose cables shall be provided as follows:
 - a. Four (4) 12/3 SO extension cables, 50 feet long, with a NEMA 5-15P plug on one end and a 20 amp female grounded stage pin connector on the other end.
 - b. Two (2) 12/3 SO extension cables, 25 feet long, with a NEMA 5-15P plug on one end and a 20 amp female grounded stage pin connector on the other end.
 - c. Four (4) DMX data cables, 50 feet long, with 5-pin XLR data line, male to female connectors. Type as recommended by the system manufacturer.
 - d. Four (4) DMX data cables, 10 feet long, with 5-pin XLR data line, male to female connectors. Type as recommended by the system manufacturer.
 - e. Six (6) TMB 6’ Pro Cable PowerData Assembly PowerCon and DMX combo cables.

2.14 THEATRICAL LIGHTING INSTRUMENT PACKAGE

- A. Theatrical lighting instruments manufactured by ELECTRONIC THEATER CONTROLS, INC. (ETC), are specified herein to provide a basis of quality. Other acceptable manufacturers are ALTMAN.
 1. Followspot lighting instruments shall be manufactured by CANTO USA. Other acceptable manufacturers are LYCIAN.
- B. Theatrical lighting instruments shall be capable of performing with light emitting diodes (LED) as indicated herein with proper heat sink cooling. Phenolic materials shall be employed on the fixtures in order to protect the operator from potential burns.
- C. Each theatrical lighting instrument shall be supplied with a malleable iron clamp

(c-clamp) to grip up to a two (2) inch ID pipe, and a fixture yoke with locking clutch handle. Each instrument shall be furnished with a power cable (5' PowerCon to Stage Pin or PowerCon to PowerCon Jumper Cable), 5' DMX jumper cable, and safety cable. A minimum of 10% of all jumper cables (PowerCon to PowerCon and DMX) shall be provided in 10' lengths.

- D. Minimum performance criterion for all theatrical lighting instruments shall be as herein specified. Each instrument shall be furnished with a three pole, grounded stage-pin (GSP) connector and safety cable. UL listing is required on all theatrical lighting instruments.
- E. COLOR MIXING OR WHITE-LIGHT LIGHT EMITTING DIODE PROFILE FIXTURE
1. The fixture shall be a color-mixing high-intensity LED illuminator with DMX control of intensity and color. The fixture shall be a ColorSource Spot Deep Blue as manufactured by Electronic Theatre Controls, Inc. or the equivalent as manufactured by ALTMAN (Phoenix 3) which must meet all the requirements of these Specifications.
 2. The fixture shall be UL 1573 listed for stage and studio use, and shall comply with the USITT DMX-512A standard.
 3. The unit shall be constructed of rugged, die cast aluminum and have a rugged black powder coat finish. Unit shall be free of burrs and pits and be provided with:
 - a. Lens secured with silicone shock mounts,
 - b. Shutter assembly shall allow for +/-25° rotation (20-gauge stainless steel shutters).
 - c. Interchangeable lens tubes for different field angles with Teflon guides for smooth tube movement.
 - d. Sturdy integral die cast gel frame holders with two accessory slots, and a top-mounted, quick release gel frame retainer.
 - e. Slot with sliding cover for motorized pattern devices or optional iris.
 4. Power supply, cooling and electronics shall be integral to each unit.
 5. Optical
 - a. The light beam should have a 2-to-1 center-to-edge drop-off ratio.

- b. The unit shall provide, but not be limited to: low gate and beam temperatures, and sharp imaging through a three-plane shutter design.
 - c. The unit shall provide, but not be limited to 36 degree field angles with a lens tube for precision, high contrast imaging.
 - 1) High-quality pattern imaging
 - 2) Sharp shutter cuts without halation
 - 3) Shutter warping and burnout in normal use shall be unacceptable
 - 4) Adjustable hard and soft beam edges
6. The fixture shall be ETL and cETL LISTED and/or CE rated, and shall be so labeled when delivered to the job site. The fixture shall be ETL LISTED to the UL1573 standard for stage and studio use. The fixture shall be rated for IP-20 dry location use.
7. Fixture shall be equipped with a cooling fan and utilize advanced thermal management systems to maintain LED life to an average of 70% intensity after 20,000 hours of use. The fixture shall operate in an ambient temperature range of 0°C (32°F) minimum, to 40° C (104°F) maximum ambient temperature. Thermal management shall include multiple temperature sensors within the housing to include:
 - a. LED array circuit board temperatures
 - b. Fixture ambient internal temperature
8. The fixture shall be equipped with a 100V to 240V 50/60Hz internal power supply and shall support power in and thru operation via Neutrik® PowerCon™ input and output connectors. Fixture power wiring and accessory power cables shall be rated to support linking of multiple fixtures up to the capacity of a 15A breaker.
9. The fixture requires power from a non-dim source.
10. Fixtures shall have droop compensation to prevent thermal shift of color or intensity.
11. Power supply outputs shall have self-resetting current-limiting protection. Power supply shall have power factor correction

12. The fixture shall contain a minimum of four different LED colors to provide color characteristics as described in the color section below. All LEDs used in the fixture shall be high brightness and proven quality from established and reputable LED manufacturers.
 - a. Fixture shall utilize Luxeon® Rebel™ LED emitters.
 - b. Manufacturer of LED emitters shall utilize an advanced production LED binning process to maintain color consistency.
 - c. LED emitters should be rated for nominal 20,000-hour LED life to 70% intensity
13. All LED fixtures (100% of each lot) shall undergo a minimum three-hour burn-in test during manufacturing.
14. LED system shall comply with all relevant patents
15. Calibration: Fixture shall be calibrated at factory for achieve consistent color and intensity output between fixtures built at different times and/or from different LED lots or bins. Calibration data shall be stored on the control card as a permanent part of on-board operating system. All arrays, including replacement arrays shall be calibrated to the same standard to insure consistency. Fixtures not offering LED calibration shall not be acceptable.
16. Color: The fixture shall utilize a minimum of 60 LED emitters and use a selective mix of Red, Green, Blue and Lime emitters.
17. Dimming: The LED system shall use 15-bit nonlinear scaling techniques for a high-resolution Incandescent dimming curve optimized for smooth dimming over longer timed fades. The LED system shall be digitally driven using high-speed pulse width modulation (PWM). LED control shall be compatible with broadcast equipment in the following ways:
 - a. PWM control of LED levels shall be imperceptible to video cameras and related equipment.
 - b. PWM shall be capable of being set via RDM to 25,000 Hz.
18. Control and User interface: The fixture shall be USITT DMX 512A-compatible via In and Thru 5-pin XLR connectors and shall be compatible with the ANSI RDM E1.20 standard.
 - a. The fixture shall be equipped with a 7 segment display and a three button user interface. The fixture shall be controlled via RGB data input.

- 1) All fixture functions shall accessible via RDM protocol for modification from suitably equipped control console
 - 2) Temperature sensors within the luminaire shall be viewable in real time via RDM.
 - 3) Fixtures not offering RDM compatibility, feature set access or temperature monitoring via RDM shall not be compatible
- b. The fixture shall have a 5-channel footprint (IRGBS).
 - c. A variable-rate strobe channel shall be provided.
19. Up to 32 fixtures can be linked together with standard DMX cables and controlled from designated master fixture.
20. Provide sixteen (16) LED ColorSource Spot Deep Blue with eight (8) 26° Lens Tubes, and eight (8) 50° Lens Tubes, safety cables, c-clamps, 6 PowerCon to Stagepin Power cables, 10 PowerCon to Powercon Jumper cables, and 5'-0" DMX jumper cables- Or- provide sixteen (16) Altman Phoenix 3. Provide safety cables, c-clamps, and 18" DMX jumper cables and Powercon cables for each Altman Phoenix 3.

F. COLOR MIXING LIGHT EMITTING DIODE CYCLORAMA FIXTURE

1. The fixture shall be a color-mixing high-intensity LED illuminator with DMX control of intensity and color. The fixture shall be a ColorSource® CYC as manufactured by Electronic Theatre Controls, Inc. or the equivalent as manufactured by ALTMAN (Spectra Cyc 200) which must meet all the requirements of the specifications.
2. General
 - a. All LED fixtures shall be provided by a single manufacturer to ensure compatibility.
 - b. The fixture shall be UL 1573 listed for stage and studio use
 - c. The fixture shall comply with the USITT DMX512-A standard
3. Physical
 - a. The fixture shall be contained in a rugged all-metal die-cast housing, free of burrs and pits.
 - b. The housing shall have a rugged black powder coat finish.

- c. Power supply and electronics shall be integral to each unit.
- d. Fixture housing shall provide built in spill control.
- e. Fixture shall operate directly by hanging via yoke.
- f. Light output shall be produce an asymmetrical beam.
- g. Lensing shall be designed to provide smooth coverage both horizontally and vertically for seamless blending from fixture to fixture.
- h. With a minimum setback from the cyclorama of 2', the fixtures shall be able to achieve a 2-to-1 spacing ration and maintain smooth coverage

4. ENVIRONMENTAL AND AGENCY COMPLIANCE

- a. The fixture shall be UL and cUL LISTED and/or CE rated, and shall be so labeled when delivered to the job site.
- b. The fixture shall be UL LISTED to the UL1573 standard for stage and studio use.
- c. The fixture shall be rated for IP-20 dry location use.

5. THERMAL

- a. The fixture shall be natural convection cooled and shall not use a fan.
- b. The fixture shall utilize advanced thermal management systems to maintain LED life to an average of 70% intensity after 50,000 hours of use.
- c. Thermal management shall include multiple temperature sensors within the housing to include the LED array and control board.
- d. The fixture shall operate in an ambient temperature range of 0°C (32°F) minimum, to 40° C (104°F) maximum ambient temperature.

6. ELECTRICAL

- a. The fixture shall be equipped with 100V to 240V 50/60 Hz internal power supply.

- b. The fixture shall support power in and thru operation via Neutrik® PowerCON™ input and output connectors.
- c. Fixture power wiring and accessory power cables shall be rated to support linking of multiple fixtures up to the capacity of a 15A breaker
- d. The fixture requires power from non-dim source.
- e. Power supply shall have power factor correction.

7. LED Emitters

- a. The fixture shall contain 5 different LED colors to provide color characteristics as described in Section H below.
- b. All LEDs used in the fixture shall be high brightness and proven quality from established and reputable LED manufacturers.
- c. Fixture shall utilize Luxeon® C™ LED emitters. Manufacturer of LED emitters shall utilize an advanced production LED binning process to maintain color consistency.
- d. LED emitters should be rated for nominal 50,000 hour LED life to 70% intensity
- e. LED system shall comply with all relevant patents.
- f. Fixtures shall have a flicker free mode that will set the LED refresh rate to 25,000 Hz for flicker free operation on camera.

8. CALIBRATION

- a. Fixture shall be calibrated at factory for achieve consistent color between fixtures built at different times and/or from different LED lots or bins.
- b. Calibration data shall be stored in the fixture as a permanent part of on-board operating system.
- c. All arrays, including replacement arrays shall be calibrated to the same standard to ensure consistency.
- d. Fixtures not offering LED calibration shall not be acceptable.
- e. Fixture shall have droop compensation to overcome thermal droop in the LEDs to maintain output levels and color point.

9. COLOR

- a. The fixture shall utilize a minimum of 42 LED emitters made up of Red, Green, Blue, Indigo and Lime.

10. DIMMING

- a. The LED system shall use 15-bit nonlinear scaling techniques for high-resolution dimming.
- b. The dimming curve shall be optimized for smooth dimming over longer timed fades.
- c. The LED system shall be digitally driven using high-speed pulse width modulation (PWM).
- d. LED control shall be compatible with broadcast equipment in the following ways:
 - 1) PWM control of LED levels shall be imperceptible to video cameras and related equipment.
 - 2) PWM rates shall be adjustable by the user via RDM to avoid any visible interference to video cameras and related equipment.

11. CONTROL AND USER INTERFACE

- a. The fixture shall be USITT DMX512-A compatible via In and Thru 5-pin XLR connectors or RJ45 connectors.
- b. The fixture shall be compatible with the ANSI RDM E1.20 standard.
 - 1) All fixture functions shall accessible via RDM protocol for modification from suitably equipped control console.
 - 2) Temperature sensors within the luminaire shall be viewable in real time via RDM.
 - 3) Fixtures not offering RDM compatibility, feature set access or temperature monitoring via RDM shall not be compatible.
- c. The fixture shall be equipped with a 7-segment display for easy-to-read status and control

- d. The fixture shall be equipped with a three-button user-interface.
 - e. The fixture shall offer multiple control modes including but not limited to: RGB, 5 channel (IRGBS), Direct, Single channel.
 - f. The fixture shall operate in Regulated mode for droop compensation.
 - g. Up to 32 fixtures may be linked together with standard DMX cables and controlled from designated master fixture.
 - h. Provide seven (7) ColorSource Cyc LED Fixtures.
- G. Color Mixing Light Emitting Diode (LED) Wash Fixtures:
- 1. The fixture shall be a color-mixing high-intensity LED illuminator with DMX control of intensity and color. The fixture shall be a Colorsource Par Deep Blue as manufactured by Electronic Theatre Controls, Inc. or the equivalent as manufactured by ALTMAN (AP-150) which must meet all of the requirements of these Specifications.
 - 2. The fixture shall be UL 1573 listed for stage and studio use and shall comply with the USITT DMX512-A standard.
 - 3. The fixture shall be provided with the minimum warranty of 5 years full fixture coverage and 10 years LED array coverage.
 - 4. Physical: The fixture shall be contained in a rugged all-metal die-cast housing, free of burrs and pits with a rugged black powdercoat finish.
 - 5. Power supply, cooling and electronics shall be integral to each unit.
 - 6. Fixture housing shall provide two easy-access slots for secondary lenses and other accessories. Slots shall be equipped with locking retaining clip. Secondary lens options to include multiple angles in the following pattern:
 - a. Round
 - 7. Light output shall be via a round aperture. Aperture and accessory slots shall accommodate standard 7.5" accessories such as used in other similar-sized fixtures.
 - 8. Environmental and Agency Compliance: The fixture shall be UL and cUL LISTED and/or CE rated, and shall be so labeled when delivered to the job site. The fixture shall be UL LISTED to the UL1573 standard for stage and studio use, and shall be rated for IP-20 dry location use.

9. Thermal: The fixture shall be cooled with a variable speed fan. The fixture shall utilize advanced thermal management systems to maintain LED life to an average of 70% intensity after 20,000 hours of use for color mixing versions and 36,000 hours of use for Pearl variety. Thermal management shall include multiple temperature sensors within the housing to include:
 - a. The LED array
 - b. The control board
10. The fixture shall operate in an ambient temperature range of 0°C (32°F) minimum, to 40° C (104°F) maximum ambient temperature.
11. Electrical : The fixture shall be equipped with 100V to 240V 50/60 Hz internal power supply, and shall support power in and thru operations via Neutrik® powerCON™ input and output connectors.
12. Fixture power wiring and accessory power cables shall be rated to support linking of multiple fixtures up to the capacity of a 15A breaker.
13. The fixture requires power from non-dim source.
14. Power supply outputs shall have self-resetting current limiting protection. Power supply shall have power factor correction.
15. LED Emitters: The fixture shall contain 4 different LED colors to provide color characteristics, as described in Section “a” below. All LEDs used in the fixture shall be high brightness and proven quality from established and reputable LED manufacturers.
 - a. Fixture shall utilize Luxeon® Z™ LED emitters. The manufacturer of LED emitters shall utilize an advanced production LED binning process to maintain color consistency. LED emitters should be rated for nominal 20,000-hour L70 rating for color mixing versions and 36,000-hour L70 rating for Pearl variant.
16. LED system shall comply with all relevant patents.
17. Calibration: Fixture shall be calibrated at factory for achieve consistent color between fixtures built at different times and/or from different LED lots or bins.
 - a. Calibration data shall be stored in the fixture as a permanent part of on-board operating system.
 - b. All arrays, including replacement arrays shall be calibrated to the same standard to ensure consistency.

- c. Fixtures not offering LED calibration shall not be acceptable
18. Color: The fixture shall utilize a minimum of 40 LED emitters made up of Red, Green, Indigo and Lime for ColorSource Deep Blue.
 19. Dimming: The LED system shall use 15-bit nonlinear scaling techniques for high-resolution dimming. The dimming curve shall be optimized for smooth dimming over longer timed fades.
 20. The LED system shall be digitally driven using high-speed pulse width modulation (PWM). LED control shall be compatible with broadcast equipment in the following ways:
 - a. PWM control of LED levels shall be imperceptible to video cameras and related equipment.
 - b. PWM rates shall be adjustable by the user via RDM to avoid any visible interference to video cameras and related equipment
 21. Control and User Interface: The fixture shall be USITT DMX512-A compatible via In and Thru 5-pin XLR connectors, and shall be compatible with the ANSI RDM E1.20 standard.
 - a. All fixture functions shall accessible via RDM protocol for modification from suitably equipped control console
 - b. Temperature sensors within the luminaire shall be viewable in real time via RDM.
 - c. Fixtures not offering RDM compatibility, feature set access or temperature monitoring via RDM shall not be compatible.
 - d. The fixture shall be equipped with a 7-segment display for easy-to-read status and control, and utilize a three-button user-interface.
 - e. The fixture shall offer RGB control.
 - f. The fixture shall operate in Regulated mode for droop compensation.
 - g. Up to 32 fixtures can be linked together with standard DMX cables and controlled from designated master fixture.
 22. Provide fourteen (14) ColorSource PAR Deep Blue with full round lens set, safety cables, c-clamps, 6 Powercon to Satgepin Power cables, 8 Powercon to Powercon Jumper Cables, and 5'-0" DMX jumper cables –

OR- provide twenty (20) Altman AP-150 PAR with safety cables, c-clamps, and 18" DMX jumper cable and Powercon cables per each Altman AP150PAR.

H. Followspots:

1. The basis of this design shall be the Canto Astro LED follow spotlight, as marketed by CantoUSA. This covers the Astro 500 (400 watts)
2. Physical
 - a. The unit frame and enclosure shall be constructed of formed cold rolled steel and sturdy aluminum extrusions, free of burrs and protected by a black powder coat finish.
 - b. Handles shall be provided to facilitate smooth operation and to lift the unit.
 - c. The unit shall be mounted on a stable, folding three-point floor stand with:
 - 1) Easy height adjustments,
 - 2) Horizontal Swing Control Lever and
 - 3) Vertical Tilt Control Lever
 - d. The Power Supply shall be integral to the followspot and field replaceable.
 - e. Weight of Head, including power supply, shall not exceed 34 pounds.
 - f. Length of head unit with color changing boomerang shall not exceed 41".
 - g. A sliding panel shall provide access to lenses without the use of tools.
 - h. LED lamphouse head must be of a modular design for servicing and be fully upgradeable to a higher output LED engine by the removal of 8 screws. Any alternate fixture that does not comply with this requirement must be rejected.
3. Controls
 - a. The lamphouse shall as a minimum incorporate the following:

- 1) Cold forced fan cooling system;
 - 2) Bulb positioning controls.
 - b. The body of the unit shall, as minimum incorporate the following:
 - 1) Optical dimmer iris mechanism for smooth manual dimming with an option of a single handle control linked to the sizing iris. Any alternate will be rejected.
 - 2) Four shutters mounted on two planes, for both vertical and horizontal masking
 - 3) Drop-in nichrome steel iris
 - 4) Drop-in Gobo Holder
 - 5) Zoom focus controls with calibrations silk screened on followspot body.
 - c. With the iris fully open this followspot shall be capable of producing a continuous range of field angles from 10.6 degrees in spot to 19.2 degrees in flood.
 - d. At any field angle the beam shall be adjustable between soft and sharp edges.
 - e. The front of the unit shall house a five color, self-canceling boomerang with color filters.
4. Optical
- The unit's optical train shall consist of:
- a. Modular mounted LED 230 watt or higher LED engine, with the following features:
 - 1) 3,200K, 5600K, or 6500K color temperature;
 - 2) CRI greater than 82 in 3200K or 80 in 5600K;
 - 3) 25000 hour average life on LED engine
 - 4) Upgradeable LED light engine
 - b. Fixed Optical Quality Glass Reflector and double condenser lens;

- c. Variable focus lens system utilizing optical-quality glass;
 - d. Iris/Gobo Holder, shutters for beam shaping control;
 - e. Optical dimmer Iris;
 - f. Five or six color boomerang.
 - g. The zoom focus shall increase light intensity as it decreases the spot diameter.
5. Electrical
- a. Lamp system input shall be 90-265 V.AC, 50/60 Hertz, single phase.
 - b. 0-100% dimming either by DMX input or manual potentiometer control (Astro 200 only) or front mounted manual dimmer control.
 - c. Unit to have rear information panel if utilizing the DMX option, Astro 200 only.
6. Performance
- a. Adjusted for flat field (approximately 70%) the unit shall produce a continuous range of illumination from 136,800 beam candlepower in Flood focus to 227,200 beam candlepower in Spot focus.
 - b. The field diameter at a 60 foot throw shall be continuously adjustable from 20.3 feet in Flood focus to 11.2 feet in Spot focus. With full iris the field diameter in spot focus shall be less than 15".
7. Provide two (2) Canto Astro 500 Followspots complete with Iris, Gobo Holder, Color Changer, Stand, and Castor Kit or-provide two (2) Lycian followspots complete with all necessary accessories.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. All wiring for lighting and control system shall be run in minimum ¾" conduit as hereinbefore specified. All junction box covers shall be identified as hereinbefore specified. All conduits, device mounting boxes, junction boxes, and enclosures shall be securely fastened with appropriate fittings to ensure positive ground throughout the entire system.

- B. This Contractor shall furnish and install all wiring and make all final connections as indicated in the system manufacturer's shop drawings and standard installation documents. Splices for dimming circuits shall be made only in junction boxes.
- C. All wiring shall be checked and tested by this Contractor to ensure the system is free from grounds, opens, and shorts.
- D. All work shall be under the supervision of a field engineering technician, accredited by the system manufacturer. It shall be the responsibility of this technician to check and inspect the installation to the Owner's and Architect/Engineer's satisfaction. This technician shall also provide a minimum of four (4) hours of training for the Owner's operating personnel on the proper operation and maintenance of the lighting control system equipment.

3.02 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. At the completion of the installation, the manufacturer shall furnish four (4) final sets of "as-built" drawings as well as manuals of instruction as to the proper operation and maintenance of the lighting control system. "As built" drawings shall include all field modifications. Formal turn-on and instruction shall be provided to the Owner's officially designated representative within fourteen (14) days of a written request by the Owner.
- B. This Contractor shall furnish the Owner's officially designated representative(s) with a minimum of three (3) hours of on-the-job instructions in the operation, maintenance, and diagnostic testing of the system. (This shall not be part of the system turn-on specified above.) This Contractor shall also furnish the Architect/Engineer four (4) bound copies of complete operating and maintenance instruction manuals of the lighting control system including circuit diagrams and all other information necessary for proper operation and service maintenance.

3.03 SYSTEM TEST

- A. This Contractor shall conduct an operating test of the complete system. The system shall test free from grounds, shorts, and other faults. All connections shall be thoroughly checked for mechanical and electrical connections. All lighting control system equipment shall be demonstrated to operate in accordance with the requirements set forth in these Specifications and as shown on the Drawings.
- B. This Contractor shall perform all tests in the presence of the Architect/Engineer. This Contractor shall furnish all personnel and test instruments for use in the test.

3.04 WARRANTY

- A. The Contractors shall deliver the work in a first-class operating condition in every respect.
- B. The manufacturer shall warrant for a minimum of five years that the material, equipment, and workmanship furnished shall be entirely free from defects. Any material, equipment, or workmanship in which defects may develop before or during the warranty period shall be repaired or replaced at the Contractor's own expense. The Contractor shall further warrant that all material, equipment, and workmanship used in the installation, but not specifically mentioned in the Drawings and Specifications, is the best of their respective kinds and that the construction and installation was performed in accordance with the best accepted standard practices in all details.
- C. A signed System Startup Sign Off shall initiate system warranty period.
- D. Warranty start date for fixtures and "boxed goods" shall start upon date of shipment. LED fixtures shall be warranted for a period of 5 years (entire fixture). LED array shall be warranted for a period of 10 years.
- E. Optional extended warranty shall be available upon request.
- F. The manufacturer shall offer a service contract for the maintenance of the system after the warranty period.

END OF SECTION

SECTION 16570

SCHOOL ZONE WARNING SIGNALS (SOLAR)

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work covered under this Section shall include the materials and equipment necessary for this Contractor to furnish and install, a minimum of two (2), solar powered school zone warning signals, including a concrete base, where shown on the Drawings or where directed by the Owner, usually off site.
- B. This Contractor shall furnish and install all necessary equipment and components as hereinafter detailed for a complete and functional signal.

1.03 QUALITY ASSURANCE

- A. This Contractor shall furnish submittals for all components of the school zone warning signals in accordance with SECTION 16010 of these Specifications. The submittals should include, but not be limited to the following.
 - 1. Manufacturer's catalog data for all equipment and components which shall include all technical data to demonstrate conformance with these Specifications.
 - 2. Complete physical drawings of all items of equipment showing dimensions, metal gauges, etc.
 - 3. Complete internal and interconnection wiring diagrams showing number, size, and types of conductors between components.
- B. The school zone warning signals specified herein shall be the sole responsibility of a single supplier.
- C. All work shall be in accordance with good engineering practices. All equipment for this system shall be installed in accordance with all requirements of the National Electrical Code (NEC), state and local codes, and these Specifications.

PART 2 - PRODUCTS**2.01 SOLAR PANEL**

- A. Each school zone warning signal shall be furnished complete with solar panels as detailed on the Drawings. The solar panels shall consist of vandal resistant, ultra-violet stabilized, 40 watt, silicon solar modules and glass laminated face with an aluminum backplate and an anodized aluminum frame. The solar modules shall have a peak output voltage of 19.0 volts DC under standard test conditions of 1000W/m² at 25°C.
- B. Integral bypass diodes shall be included in each cell to allow the modules to produce power when partially shaded.
- C. Minimum recovery time shall be three (3) hours in optimum sun conditions based upon five (5) hours of run time.
- D. The solar panel shall have a minimum twenty (20) year output warranty.
- E. The solar panel shall be complete with a weatherproof junction box providing wire termination for #14 AWG conductors.

2.02 BATTERY BANK

- A. Each school zone warning signal shall be furnished complete with a battery bank. The battery bank shall consist of two (2) to four (4) Group 29 sealed maintenance free, deep cycle, gel lead acid type, 12VDC batteries (DEKA SG31 or Interstate battery equivalent).
- B. The batteries shall provide for a minimum of twelve (12) days of no sun operation based upon five (5) hours of operation at 78 degrees ambient cell temperature.
- C. The batteries shall be housed in a separate pole mounted weatherproof NEMA 3R ventilated aluminum enclosure .125 inches thick complete with a gasketed door and a standard traffic/police type lock and continuous piano hinge. The enclosure shall be mounted to the pole as detailed on the Drawings.

2.03 CONTROLS

- A. Each school zone warning signal shall be furnished complete with the following control electronics. All control electronics shall be mounted on a removable sub-assembly.
- B. Two Circuit Solid State Time Switch

1. The time switch shall be equipped with a means for mounting to a suitable back plane. Mounting holes that provide clearance for at least a No. 10 screw will be acceptable.
2. The time switch shall not exceed 8 3/8"h x 4 7/8"w x 2"d without harness and 10 3/8"h x 4 7/8"w x 2"d with harness. A case shall be provided to protect the time switch circuitry from dust. The unit shall fasten securely to the case and must be easily removable from the case with the use of simple tools.
3. Interface to the power source (AC or DC) and to the controlled device shall be provided by means of a quick disconnect connector with a mating harness. The AC and DC power inputs shall be protected with a fuse and MOV.
4. The time switch shall operate on either 12 volt DC +/-2VDC or an AC power source between 95 and 135 VAC and from -30 to +74 degrees C.
5. The AC & DC power supply shall be an integral part of the time switch circuit board for operation in AC powered or solar DC powered systems.
6. A separate 12VDC power supply module, similar to those used for calculators and battery chargers, is not acceptable.
7. No time shall be gained or lost during changeover from AC power to the back-up system and back to AC power.
8. Programming
 - a. All programming shall be accomplished via a 16 key positive action push button keyboard which is an integral part of the unit. Prompt messages shall be displayed during the programming process to guide the operator as the data is being entered.
 - b. Time switch can also be programmed via 9-pin serial cable using a computer, radio, or M2M cellular device.
 - c. The time of day shall be able to be set to one second.
 - d. Time of day, day of week, date, year and the operation of the 2 relay outputs shall be able to be easily set from the integral keyboard. The functions of the keys shall be clearly marked on the keypad. Prompt messages shall be displayed during the programming process to guide the operator as the data is being entered. All data required to properly set and program the unit and review the stored program shall be clearly displayed without

the use of auxiliary devices.

- e. Changeover from standard time to daylight savings time or vice versa shall be accomplished automatically. The operator shall have the capability of entering the daylight savings time information from the keyboard thus eliminating the need for a PROM change should the current U.S. law change. The daylight savings time feature shall be able to be defeated from the keyboard. Leap year compensation shall be automatic.
- f. When the user is programming the unit, the display shall provide for verification of each piece of data prior to its being entered. Provision shall be made for correction of any incorrect data prior to entering it. It shall be possible to alter any individual program step without disturbing any other step in the program.
- g. When an instruction is given to turn the output/s on or off, that instruction time shall be able to be set to one minute, and the change shall take place at the zero second of that minute.
- h. A set of clear operating instructions shall be furnished with each time switch.
- i. RTC MANUFACTURING, INC. Cat. No. 503644 AP22.

C. M2M Remote Communication System

- 1. Each time switch shall be equipped with a M2M communications device. The M2M will communicate to and from the time switch using text messaging and/or packet data.
- 2. The M2M device shall be equipped with an RS-232 serial interface to connect to the time switch and transfer data and power for the M2M device.
- 3. The time switch will receive a time sync via the M2M device from the cell system every 24 hours.
- 4. Antenna and coax cable (as needed) will be furnished with each M2M device. External and directional antennas will be made available in locations where needed for sufficient signal strength at no additional charge. In locations where the external and directional antennas are used, the agency will return the unused antennas to the vendor.
- 5. Term of M2M service will be 5 years in the area at no additional cost to the agency.

- 6. A technology obsolescence warranty will be made available as an additional cost option. If this option is accepted and the hardware cellular technology changes, making the installed devices obsolete and inoperative, the vendor will replace the obsolete technology with devices current to the cellular technology available.
- 7. RTC MANUFACTURING, INC. Cat. No. M2M5TR-4K.

D. Integrated Solid State Flasher and System Diagnostic Hardware

- 1. A two (2) circuit 12VDC flasher shall be integral to the flasher and diagnostic interface board. The flasher shall be of all solid-state construction and shall be rated at a minimum of 6.0 amps per circuit. The flasher shall utilize zero-voltage turn-on and turn-off of current, thus eliminating electromagnetic interference.
- 2. The flasher and interface board shall have two terminal blocks for connecting the wiring of the cabinet. Barrier type terminal blocks shall be used to terminate all wires. The terminal blocks shall terminate the following functions:

TB-1	TB-2
LD-	Solar Panel +
Door	Solar Panel -
Time Switch Normally Open	Battery +
Time Switch Common	Battery -
DC + Power To Time Switch	Load
DC - To Time Switch	Load
	Load
	Conf
	LED 2
	LED 1

- 3. The above functions shall be clearly silk screened on the circuit board adjacent to the appropriate terminal.
- 4. The flasher and interface board shall be pre-wired for connection to a solar regulator. The wires connecting the flasher and interface board to the solar regulator shall be a minimum of 16AWG and shall be permanently soldered to the flasher and interface board.
- 5. The flasher and interface board shall be pre-wired with a 16-position, CPC type, quick disconnect connector to accommodate a time switch. The time switch connector shall be wired as follows:

- a. Pin 4: Relay Normally Open NO
 - b. Pin 10: Relay Com Movable Contact
 - c. Pin 13: DC common
 - d. Pin 15: DC +
6. The flasher and interface board shall include 3 separate fuses to protect the solar array, the battery and the load. The fuses shall be easily replaceable from the front of the board with the use of a standard fuse removal tool.
 7. RTC MANUFACTURING, INC. Cat. No. GUARD2.
- E. Control Components Cabinet
1. The control electronics shall be housed in a separate pole mounted weatherproof NEMA 3R aluminum enclosure .125 inches thick complete with a gasketed door and a standard traffic/police type lock and continuous piano hinge. The enclosure shall be mounted to the pole above the battery enclosure as detailed on the Drawings.
- F. Central Software System
1. A software package shall be provided that will allow the operator to upload programming and download programming to the time switch from a Windows laptop, PC.
 2. A software license will be provided at no additional charge with no seat licensing requirement.
 3. The software shall have an interactive map with the status of the field device displayed.
 4. A color-coded calendar for creating the individual schedules of the schools.
 5. The programming shall include all day plans, week plans, annual plans and a unique name assigned by the operator.
- G. Fault Alert System
1. The flasher shall continuously monitor the following functions of the flasher cabinet assembly:

- a. Solar Panel Voltage: The flasher shall monitor the solar panel voltage every 15 minutes and chart this information. This chart, when reviewed by agency personnel, will illustrate anomalies or drops in solar panel charging that may indicate a malfunction.
- b. Battery Voltage: The flasher shall monitor the voltage of the battery that supplies power to the flasher cabinet every 15 minutes and chart this information. The flasher shall send an immediate alert to the central computer should the battery voltage fall below the level pre-set by the end user.
- c. The flasher shall monitor the load output of the solar regulator and shall send an immediate alert to the central computer when the load has been disconnected.
- d. The flasher shall monitor both of the primary flasher outputs independently and send an immediate alert to the central computer when an indicator failure is detected.
- e. The flasher shall monitor the confirmation light output and send an immediate alert to the central computer when an indicator failure is detected.
- f. The flasher shall monitor the low voltage of the time switch in the flasher cabinet and send an immediate alert to the central computer when a time switch failure is detected.
- g. The flasher shall have the capability of monitoring the position of the cabinet door. If this option is used, the flasher shall send an immediate alert to the central computer when the cabinet door is opened and when the cabinet door is closed.
- h. The flasher shall have the capability of sending an immediate alert to the central computer when the battery is disconnected due to maintenance or theft. The flasher shall maintain power to the cell modem long enough to send the alert when the battery is removed.

2.04 SIGNAL BEACONS

- A. The school zone warning signal shall be furnished complete with two (2) eight (8) inch diameter LED type signal beacons as detailed on the Drawings. Each signal beacon shall have: a one-piece aluminum body; one-piece aluminum cutaway visor attached at four (4) points to a one-piece aluminum door; terminal block, UL type 1015, 600 volt, color coded wiring; and solid state LED amber lamp elements suitable for operation on 12 VDC as described below. The door shall have stainless steel hinge pins and thread lock hex-head screws. The

signal beacons shall be the Virginia Department of Transportation (VDOT) type VR-6 only.

- B. The LED lamp elements shall be high efficiency, solid state amber LED lamps with a size of eight (8) inches. The lamp shall have optically matched LED elements for uniform color output of 590 nanometers. The amber elements shall contain LED elements constructed from TSiInGaP. Lamps shall incorporate multiple main circuits comprised of four (4) LEDs per string and shall be self-regulating with input voltages of 10.5 – 18.0 VDC. The lamp lens shall be either a clear or tinted UV stabilized acrylic which shall be easily removed and replaced. The lens of the lamps shall be designed to have up to 300 collector lenses for each LED with up to 450 exit facets to direct the light to meet a 17.5 degree vertical by 55 degree horizontal beam pattern.

2.05 SIGN FACE

- A. Each school zone warning signal shall be furnished complete with one (1) sign face as detailed on the Drawings. The sign face shall be fabricated from .125 inch thick aluminum alloy conforming to ASTM B209, Alloy 5052-H38, 5154-H38, or 6061-T6. The background field shall be reflectorized. The message and borders shall be black. The sign face shall be pole mounted as detailed on the Drawings.
- B. Sign faces are available free of charge from the Virginia Department of Transportation.

2.06 POLE AND BASE

- A. Each school zone warning signal shall be furnished complete with one (1) fifteen (15) foot high, 4-1/2" diameter, spun aluminum or .250 inch thick steel, schedule 40 pole as detailed on the Drawings. The pole shall be complete with a hot dipped galvanized finish.
- B. The pole shall be complete with an eight-inch square, 3/4-inch thick base plate as detailed on the Drawings. The base plate shall be welded to the pole and shall be complete with four (4) 1-1/4 inch diameter anchor bolt holes meeting ASTM A-36.
- C. The pole shall be furnished complete with four (4) one (1) inch diameter by thirty-six (36) inch long hot dipped galvanized anchor bolts as detailed on the Drawings. The anchor bolts shall have a minimum yield strength of 55,000 psi.
- D. The pole shall be complete with a three (3) inch by five (5) inch hand hole with cover as detailed on the Drawings.
- E. The pole shall be complete with four (4) breakaway support couplings as detailed

on the Drawings. The couplings shall comply with AASHTO standards and shall be equal to ALCOA model 100-1. A sheet metal skirt shall be installed around the couplings.

- F. This Contractor shall provide a quick disconnect for each conductor passing through the pole base. The connector shall be the weatherproof "Y" type installed at the base.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. This Contractor shall install the school zone warning signals in accordance with the Manual on Permits, Virginia Department of Transportation.
- B. This Contractor shall assembly all components of the school zone warning signal in accordance with the manufacturer's/supplier's instructions.
- C. The school zone warning signal shall be installed on a concrete base as detailed on the Drawings.
- D. This Contractor shall be responsible for all damages to existing facilities, roadway, grass areas, sidewalks, etc. damaged during the installation of the school zone warning signals.
- E. This Contractor shall furnish the Owner's officially designated representative with a minimum of eight (8) hours of on-the-job instructions in the operation, maintenance, and diagnostic testing of the system. This Contractor shall also furnish the Architect/Engineer four (4) bound copies of complete operating and maintenance instructions of the lighting control system including circuit diagrams and all other information necessary for proper operation and service maintenance.

3.02 SYSTEM TEST

- A. This Contractor shall conduct an operating test of the completed school zone warning signal. Each signal shall test free from grounds, shorts, and other faults. All connections shall be thoroughly checked for mechanical and electrical connections. All control electronics shall be demonstrated to operate in accordance with the requirements set forth in these Specifications and as shown on the Drawings.
- B. This Contractor shall perform all tests in the presence of the Architect/Engineer. This Contractor shall furnish all personnel and test instruments for use in the test.

3.03 WARRANTY

- A. This Contractor shall deliver the work in a first-class operating condition in every respect.
- B. This Contractor shall warrant that the material, equipment, and workmanship furnished shall be entirely free from defects, and shall repair or replace at this Contractor's own expense any material, equipment, or workmanship in which defects may develop before or during the warranty period. Refer to SECTION 01740 for the start of the warranty period. This Contractor shall further warrant that all material, equipment, and workmanship used in the installation, but not specifically mentioned in the Drawings and Specifications, shall be the best of their respective kinds and that the construction and installation shall be in accordance with the best accepted standard practices in all details.
- C. All materials used shall be new and of good quality conforming to these Specifications. Any material not specified or reviewed by the Architect/Engineer that is incorporated in the work used or delivered to the site, shall be immediately removed upon the order of the Architect/Engineer and replaced to the satisfaction of the Architect/Engineer at this Contractor's expense.
- D. If any work has not been installed in accordance with the Drawings, Specifications, or the manufacturer's instructions, or becomes damaged during the progress of the work, such materials or work shall, at the sole expense of this Contractor, be removed and replaced to the satisfaction of the Architect/Engineer together with any work disarranged by such alterations.
- E. Each control system component unit shall be warranted to be free from defects in material and workmanship for a period of five years from the date of shipment from the factory.
- F. Any warranty service required shall be promptly performed at the manufacturer's facility of the manufacturer's authorized service agency. The purchaser will notify the manufacturer and a prepaid shipping label will be emailed, and the manufacturer will pay those costs to return the unit by normal surface transportation means.

END OF SECTION

SECTION 16610

FIRE DETECTION AND ALARM SYSTEM

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work covered under this Section shall include engineering, designing, testing, furnishing and installing a complete and operable addressable type analog fire detection and alarm system shown on the Drawings and herein specified. The system shall include, but not be limited to: control panel including backbox; remote graphic annunciator panel including backbox; alarm initiating and indicating peripheral devices; outlet boxes; conduit; line and low voltage wiring; and all accessories required.
- B. The existing fire detection and alarm system shall remain in operation during the construction period until the new system has been installed, tested, and approved by the Fairfax County Fire Marshal and the Owner. The existing system shall then be removed as shown on the Drawings.

1.03 QUALITY ASSURANCE

- A. All devices and equipment for this system shall be listed by the Underwriter's Laboratories, Inc. (UL), bear the UL label and shall conform to the applicable sections of National Fire Protection Association (NFPA) 72 and 90A, and the Americans with Disabilities Act (ADA) Code of Federal Regulation.
- B. The installation shall be in accordance with all requirements of NFPA, the National Electrical Code (NEC), all state and local codes and requirements, and these Specifications.
- C. This Contractor shall furnish shop drawings submittals for all components of this system in accordance with SECTION 16010 of these specifications. Submittals shall include the following for review. Submittals not containing all of the information listed below will be rejected.
 - 1. A complete list by model number of each component of the system with a statement of how many pieces of each model are to be furnished and a listing of the specific data sheet.
 - 2. A description of the system as it functions by component in the system

- using model numbers where applicable.
 3. A complete battery calculation listing by module for the system.
 4. A data sheet shall be furnished for each component of the system. The specific information shall be highlighted.
 5. A detailed drawing of the control panel shall be furnished showing all modules in their specific location with the specific terminal terminations shown.
 6. A detailed set of floor plans for the complete building shall be furnished showing the locations of all equipment and devices, their addresses, and their required interconnections. The interconnections shown shall indicate the system manufacturer's recommended number, size, and type of wires as described in this Specification. The plans shall show the locations of all required control and monitor modules and their addresses. The layout of all fire detection and alarm system equipment, devices, and conduit routings shall closely follow that shown on the Drawings.
 7. A detailed drawing shall be furnished of each type of device showing the exact terminal designations.
 8. A detailed list shall be furnished of each type of device in the system stating its program function in the system.
 9. A detailed list shall be furnished of the relays in the system and their program function.
 10. A detailed manufacturer's drawing shall be furnished of the graphic annunciator panel, as it shall appear on the wall in the location of its installation.
 11. Certification by the equipment distributor of the required service response time.
- D. Following review of the submittals by the Architect/Engineer and Owner, and prior to release of the fire alarm equipment, this Contractor shall submit to the Fairfax County Fire Marshal's office all copies of the corrected submittals for review, comment, and approval. This contractor shall not release any equipment prior to receiving the Fairfax County Fire Marshal approved shop drawing. This contractor shall be responsible for paying all fees associated with the Fire Marshal's review.
- E. The installation of all equipment and the final connection of all components and wiring shall be performed under the direct supervision of the system manufacturer's technical staff.

- F. Upon completion, the system shall be thoroughly tested by this Contractor to ensure proper interfacing of all components.
- G. Prior to final inspection, this Contractor shall furnish to the prime Contractor, five (5) copies of the manufacturer's submittal drawings up-dated to reflect: any and all revisions to the system made during construction; and the final addresses of all devices. A printed list of system devices, which will include the following: device type, address, and custom message.
- H. The equipment to be furnished by this Contractor under these Specifications shall be the standard product of one manufacturer. Acceptable manufacturers shall be engaged in the manufacture of multiplexed fire alarm equipment for at least seven (7) years and have a fully equipped, factory trained and authorized service organization that will have a response time of four (4) hours or less to the job site The acceptable manufacturers shall be as follows EDWARDS SYSTEMS TECHNOLOGY (EST); NOTIFIER; and SIMPLEX TIME RECORDER CO.
- I. The fire detection and alarm system shall be furnished by a factory authorized distributor certified to design, program, and service the system. This distributor must show evidence of successfully furnishing systems as specified for at least five (5) years. This distributor shall provide twenty four (24) hour, seven (7) day a week (including holidays) service capability with a maximum four (4) hour response time. This distributor shall provide certification of this capability as part of the submittals.
- J. This Contractor shall furnish to the Owner the following keys in the quantities indicated.
 - 1. Fire Alarm Annunciator Panel Access – Two (2)
 - 2. Fire Alarm Annunciator Control Switches – Five (5).
 - 3. Fire Alarm Control Panel – Five (5)

1.04 DESCRIPTION OF SYSTEM

- A. The fire detection and alarm system shall be individual point addressable, general alarm, electrically supervised, continuously sounding temporal tone signal with audible and visual alarm and trouble indications.
 - 1. Each individual alarm initiating device shall report to the control panel as a separate "address".
 - 2. The remote graphic annunciator panel's fire zone and sprinkler zone boundaries shall be in accordance with the Fairfax County's regulations and the Architect/Engineer's detail on the Drawings.

- B. Activation of a manual fire alarm pull station; automatic smoke, heat detector; kitchen hood extinguishing system; or waterflow switch shall cause the following: (Activation of a carbon monoxide detector shall actuate items #1, #3, #6, #7)
1. All audible/visual-signaling devices shall sound continuously having a temporal tone signal until manually silenced. A subsequent alarm received after silencing shall again cause the alarm indicating circuits to be activated. The fire alarm signals shall be distinctive from all other alarm signals and shall be clearly audible throughout the entire building.
 2. The appropriate alarm source indicating lamps shall energize on the remote graphic annunciator panel and indicate type of device and geographic fire zone. Graphic annunciator panel lamps, when lighted, shall be constantly illuminated. Flashing lamps will not be acceptable.
 3. Auxiliary contacts shall activate the security intrusion system.
 4. Operation of any intelligent thermal detector in the elevator machine room and/or elevator shaft shall automatically shut down the associated elevator.
 5. Close all normally held-open smoke doors.
 6. Carbon monoxide detectors (CO) shall actuate a local sounder base with a Temporal 4 Tone. The CO detector shall be programmed as a latching device. Activation of the Alarm Silence button on the FACP shall not silence the Temporal 4 Tone on the CO detector sounder base. The CO sounder base shall only silence upon reset of of the FACP.
 7. The system shall identify all off normal conditions and log each condition into the system as an event.
 - a. The system shall automatically display on the control panel Liquid Crystal Display (LCD) the first (oldest) event of the highest priority by type. The event priority shall be alarm, supervisory, trouble, and monitor.
 - b. The system shall utilize four event queues, and shall not require event acknowledgment by the system operator. Labeled, color coded indicators shall be provided for each type of event queue: alarm - red, supervisory - yellow, trouble - yellow, monitor - yellow. When an unseen event exists for a given type, the indicator shall be lit.

- c. For each event, the display shall include the current time, the total number of events, the type of event, the time the event occurred and up to a 42 character custom user description.
 - d. The user shall be able to review each event queue by simply selecting scrolling keys (up-down) for the event type.
 - e. New alarm, supervisory, or trouble events shall sound a distinct, silenceable audible signal at the control panel.
 - f. The LCD shall show the number of active alarm, supervisory, trouble and monitor events.
 - g. The LCD shall show the system time and the number of active and disabled points in the system.
 - h. Specific input/output devices shall operate in accordance with the alarm, supervisory, trouble, monitor sections that follow and the input/output matrix.
8. **(Engineer to edit out for middle and elementary)** Activation of a manual striking station (only) shall initiate a three (3) minute delay in activating the signal circuits including the activation of the auxiliary contacts. This delay shall be activated and deactivated through a key switch on the fire alarm graphic annunciator panel and include an "delay activated" indicator light. Alarm indications at the fire alarm control panel and fire alarm graphic annunciator panel shall not be delayed.
- C. **(Engineer to edit)** Activation of a sprinkler valve tamper switch; dry pipe HI/LO air; air duct type detector; fire pump fault; or generator fault shall cause the following:
1. The appropriate amber alarm source indicating lamp shall energize on the remote graphic annunciator panel and the integral audible trouble signal shall sound.
 2. Auxiliary contacts shall activate the security intrusion system.
 3. The system shall identify all off normal conditions and log each condition into the system as an event.
 - a. The system shall automatically display on the control panel Liquid Crystal Display (LCD) the first (oldest) event of the highest priority by type. The event priority shall be alarm, supervisory, trouble,

- and monitor.
- b. The system shall utilize four event queues, and shall not require event acknowledgment by the system operator. Labeled, color coded indicators shall be provided for each type of event queue: alarm - red, supervisory - yellow, trouble - yellow, monitor - yellow. When an unseen event exists for a given type, the indicator shall be lit.
 - c. For each event, the display shall include the current time, the total number of events, the type of event, the time the event occurred and up to a 42 character custom user description.
 - d. The user shall be able to review each event queue by simply selecting scrolling keys (up-down) for the event type.
 - e. New alarm, supervisory, or trouble events shall sound a distinct, silenceable audible signal at the control panel.
 - f. The LCD shall show the number of active alarm, supervisory, trouble and monitor events
 - g. The LCD shall show the system time and the number of active and disabled points in the system.
 - h. Specific input/output devices shall operate in accordance with the alarm, supervisory, trouble, monitor sections that follow and the input/output matrix.
4. Operation of any air duct type smoke detector shall automatically shut down the associated air-handling unit and units which serve the same area, such as gymnasiums, cafeteria, auditoriums, etc.
- D. The system, including the remote graphic annunciator panel, shall remain in alarm condition until the initiating device is reset to normal and the control panel is reset. System reset shall be accomplished on a single key-operated switch on the remote graphic annunciator panel.
- E. The system shall use 120-volt commercial power as its normal source of power. Upon failure of the normal source, the system shall automatically transfer to the standby power supply which shall be capable of supporting all system supervisory functions for all initiation and signal circuits for a period of four (4) hours as required by NFPA 72A.

- F. In the event of failure of operating power, an open, or ground condition on the system wiring, the trouble signals (both audible and visual) shall actuate at the remote graphic annunciator panel. It shall be possible to silence audible trouble signals by means of silencing switches; however, it shall not be possible to extinguish the visual signals until the disarrangement has been corrected. Upon correction of the trouble condition, the audible trouble signal shall sound until the silencing switch is returned to normal or the system automatically resets the trouble indication. Alarm or trouble indication shall cause an auxiliary contact operation connected to the security system field interface device.
- G. The system shall allow for trouble monitoring of each booster panel using a SIGA CT1 intelligent monitoring module.
- H. Each output function shall be bypassable via switch at the FACP. Any bypass feature shall generate a trouble condition on the FACP and to school security. Each bypass feature shall be grouped by type, audio/visual, door holders, elevator recall and any other outputs. One switch shall be programmed per type of output event.

1.05 TESTING

- A. Upon final completion of the installation, and acceptance of each construction phased space, and after satisfactory testing of the system by this Contractor in the presence of the equipment supplier, this Contractor shall test the system in the presence of the Technical Inspector(s), Fire Marshal, Owner, and other authorities having jurisdiction. The manufacturer shall furnish to the Owner a two (2) year contract effective from the date of acceptance, for maintenance and inspection service of the manufacturers' equipment on the completion of fire alarm system for the project. The manufacturer shall maintain an adequate supply of spare parts for ten (10) years, and shall provide supervision of the installation. The manufacturer and/or their distributor shall provide twenty-four (24) hour/seven (7) day (including holidays) service to the system as hereinbefore described.

1.06 WARRANTY

- A. This Contractor shall deliver the work described herein in a first-class operating condition in every respect. This Contractor shall also warrant that the material, equipment, and workmanship furnished shall be entirely free from defects. Any materials, equipment, or workmanship in which defects may develop before or during the warranty period shall be repaired or replaced at the Contractor's own expense. The contractor shall further warrant that all material, equipment, and workmanship used in the installation, but not specifically mentioned in the Drawings and Specifications, is the best of their respective kinds and that the construction and installation was performed in accordance with the best accepted standard practices in all details.

- B. It is the intention of this Specification that a complete life-safety system be furnished from a single manufacturer. Equipment shall be UL listed for fire alarm use.
- C. The warranty shall commence after the complete testing and acceptance by Fire Marshal, Fairfax County on the final completion of the project.

1.07 INSTRUCTION AND MANUALS

- A. The equipment manufacturer shall provide eight (8) hours of instruction to the Owner's maintenance personnel and shall furnish three (3) complete field service manuals.

1.08 SPARE PARTS

- A. This Contractor shall furnish to the Owner spare parts as follows. Spare parts shall be furnished prior to the installation of the system.
 - 1. Two (2) intelligent smoke detectors including bases.
 - 2. Two (2) intelligent thermal type detectors including bases.
 - 3. Two (2) air duct type smoke detectors.
 - 4. Four (4) intelligent control modules.
 - 5. Four (4) intelligent monitor modules; one (1) single intelligent monitor module and three (3) dual intelligent monitor modules.
 - 6. Two (2) manual pull stations and intelligent monitor modules for each.
 - 7. Six (6) audio/visual alarm signals.
 - 8. Two (2) exterior alarm signals including surface mounted weatherproof backboxes.
 - 9. Four (4) visual only alarm signals
 - 10. Two (2) synchronization output modules; one (1) standard mount and one (1) board mount.

PART 2 - PRODUCTS

2.01 NEW MAIN CONTROL PANEL

- A. The fire alarm control panel(s) shall be a multi-processor based networked system designed specifically for fire, one-way notification communications. The control panel shall be listed and approved for the application standard(s) as listed in the References section of this specification.
- B. The control panel shall include all required hardware, software and site specific system programming to provide a complete and operational system. The control panel(s) shall be designed such that interactions between any applications can be configured, and modified using software provided by the manufacturer. The control panel(s) operational priority shall ensure that life safety takes precedence among the activities coordinated by the control panel.
- C. The operating controls shall be located in a dead-front steel enclosure behind a locked door with viewing window. All control modules shall be labeled, and all zone locations shall be identified. All panel modules shall be placement supervised for and signal a trouble if damaged or removed.
- D. System Features. Each control panel shall include the following capabilities:
 - 1. Supervision of the system electronics, wiring, detection devices and software.
 - 2. Up to 2500 analog/addressable input/output points
 - 3. Network connections with up to 63 other control panels and annunciators.
 - 4. Support multiple dialers (DACTs) and modems
 - 5. Two communication ports
 - 6. An internal audible signal with different patterns to distinguish between alarm, supervisory, trouble and monitor events
 - 7. Support multiple 24 VDC and audio NACs
 - 8. User configurable switches and LED indicators to support auxiliary functions
 - 9. Log up to 1740 chronological events
 - 10. The ability to download all applications and firmware from the configuration computer at a single location on the fire network

11. A real-time clock for time stamps and timed event control
 12. Electronic addressing of intelligent addressable devices
 13. Provide an independent hardware watchdog to supervise software and CPU operation
 14. "Dry" alarm, trouble and supervisory relay contacts
 15. Control panel modules shall plug in to a chassis assembly for ease of maintenance
 16. Field wiring shall connect to the panel using removable connectors
- E. User Oriented Features. Each control panel shall include the following user oriented features:
1. An LCD user interface control/display that shall annunciate and control system functions.
 2. Provide discreet system control switches for reset, alarm silence, panel silence, drill switch, previous message switch, next message switch and details.
 3. A "lamp test" feature shall verify operation of all visual indicators on the panel.
 4. An authorized user shall have the ability to operate or modify system functions including system time, date, passwords, holiday dates, restart the system and clear control panel event history file.
 5. An authorized user shall have the ability to disable/enable devices, zones, actions, timers and sequences.
 - a) An authorized user shall have the ability to activate/restore outputs, actions, sequences, and simulate detector smoke levels.
 - b) An authorized user shall have the ability to enter time and date, reconfigure an external port for download programming, initiate programming and change passwords.
 6. An authorized user shall have the ability to test the functions of the installed system.

7. Service groups shall facilitate one-man walk testing. Service/test groups shall be capable of being configured with any combination of addressable devices, independent of SLC wiring. It shall be possible to program alternate device responses when the device's service group is active. Devices not in an active service group shall process all events normally.
8. Provide internal system diagnostics and maintenance user interface controls to display/report the power, communication, and general status of specific panel components, detectors, and modules.
 - a) SLC loop controller diagnostics shall identify common alarm, trouble, ground fault, Class A fault, and map faults. Map faults include wire changes, device type changes by location, device additions/deletions and conventional open, short, and ground conditions. Ground faults on the supervised circuit wiring of remote addressable modules shall be identified by device address.
 - b) An authorized user shall have the ability to generate a report history for alarm, supervisory, monitor, trouble, smoke verification, watchdog, and restore activity.
9. System reports shall provide detailed description of the status of system parameters for corrective action or for preventative maintenance programs. Reports shall be displayed by the operator interface or capable of being printed on a printer.
10. An authorized user shall have the ability to display/report the condition of addressable analog detectors. Reports shall include device address, device type, percent obscuration, and maintenance indication. The maintenance indication shall provide the user with a measure of contamination of a device upon which cleaning decisions can be made.
11. Programmability; A Windows-based Configuration Utility (CU) shall be used to create the site-specific system programming. The utility shall facilitate programming of any input point to any output point. The utility shall allow customization of fundamental system operations using initiating events to start actions, timers, sequences and logical algorithms.
12. Zoning of initiation devices.
13. Initiation of events by time of day, day of week, day of year.
14. Initiation of events by matrix groups (X-Y coordinate relationships) for releasing systems.

15. Initiation of events using OR, AND, NOT and counting functions.
 16. Prioritizing system events.
 17. Programmable activation of detector sounder bases by detector, groups of bases, or all bases.
 18. Directing selected device messages to specific panel annunciators
 19. Detector sensitivity selection by time of day
 20. Support of 256 central monitoring station accounts and directing selected device messages to any one of ten central monitoring stations.
- F. The configuration utility shall time and date stamp all changes to the site-specific program, and shall facilitate program versioning and shall store all previous program version data. The utility shall provide a compare feature to identify the differences between different versions of the site-specific program.
- G. The configuration utility shall be capable of generating reports which detail the configurations of all fire alarm panels, addressable devices and their configuration settings including generating electrical maps of the addressable device SLCs.
- H. The configuration utility shall support the use of bar code readers to expedite electronic addressing and custom programming functions.
- I. The fire alarm control panel shall be an Edwards 3-CPU3 and support components in an appropriately sized enclosure.
- J. A main fire alarm control panel, which will meet this Specification, shall consist of an EST Model No. EST-3 wall mounted equipment cabinet(s) complete with the following modules of the quantity required to perform all of the specified functions.
1. EST-3
 - a. EST model no. 3-CPU3 central processor unit.
 - b. EST model no. 3-RS485B network communications card.
 - c. EST model no. 3-RS232 RS232 communications card.
 - d. EST model no. 3-SSDC1 signature single driver controller.
 - e. EST model no. 3-PPS/M power supply.

- f. EST model no. MN-COM1S
- g. EST model no. 3-12/S1RY
- K. Other main fire alarm control panels which will meet this Specification are:
 - 1. NOTIFIER Model No. NFS2-640
 - 2. SIMPLEX TIME RECORDER CO. Model No. 4100-U

2.02 INTELLIGENT PERIPHERAL REQUIREMENTS

- A. This Contractor shall furnish and install intelligent devices as shown on the Drawings and herein specified. All remote intelligent devices shall have a microprocessor with non-volatile memory to support their functionality and serviceability. Each device shall store as required for its functionality the following data: device serial number; device address; device type; personality code; date of manufacture; hours in use; time and date of last alarm; amount of environmental compensation left/used; last maintenance date; job/project number; current detector sensitivity values; diagnostic information (trouble codes); and algorithms required to process sensor data and perform communications with the loop controller. Each device shall be capable of electronic addressing either automatically or application programmed assigned, to support physical/electrical mapping and supervision by location. Setting a device's address by physical means shall not be necessary.
- B. The intelligent detectors shall be capable of full digital communications using both broadcast and polling protocol. Each detector shall be capable of performing independent fire detection algorithms. The fire detection algorithm shall measure sensor signal dimensions, time patterns, and combine different fire parameters to increase reliability and distinguish real fire conditions from unwanted deceptive nuisance alarms. The devices shall eliminate by digital filters, signal patterns that are not typical of fires. Devices not capable of combining different fire parameters or employing digital filters shall not be acceptable. Each detector shall have an integral microprocessor capable of making alarm decisions based on fire parameter information stored in the detector head. Distributed intelligence shall improve response time by decreasing the data flow between detector and analog loop controller. Detectors not capable of making independent alarm decisions shall not be acceptable. Maximum total analog loop response time for detectors changing state shall be 0.5 seconds. Each detector shall have a separate means of displaying communication and alarm status. A green LED shall flash to confirm communication with the analog loop controller. A red LED shall flash to display alarm status. The detector shall be capable of identifying up to thirty-two (32) diagnostic codes. This information shall be available for system maintenance. The diagnostic code shall be stored at the detector. Each smoke detector shall be capable of transmitting pre-alarm and alarm signals in addition to the normal,

trouble, and need cleaning information. It shall be possible to program control panel activity to each level. It shall be possible to individually program each smoke detector to operate at any one of five (5) sensitivity settings. Each detector microprocessor shall contain an environmental compensation algorithm, which shall identify and set ambient "environmental thresholds" approximately six (6) times an hour. The microprocessor shall continually monitor the environmental impact of temperature, humidity, other types of contaminants, as well as detector aging. The process shall employ digital compensation to adapt the detector to both twenty-four (24) hour long term and four (4) hour short term environmental changes. The microprocessor shall monitor the environmental compensation value and alert the system operator when the detector approaches eighty percent (80%) and one hundred percent (100%) of the allowable environmental compensation value. Differential sensing algorithms shall maintain a constant differential between selected detector sensitivity and the "learned" base line sensitivity. The base line sensitivity information shall be updated and permanently stored at the detector approximately once every hour.

2.03 INTELLIGENT PHOTOELECTRIC TYPE SMOKE DETECTOR

- A. This Contractor shall furnish and install intelligent photoelectric type smoke detectors as shown on the Drawings and herein specified. The analog photoelectric type smoke detector shall utilize a light scattering type photoelectric smoke sensor to sense changes in air samples from its surroundings. The integral microprocessor shall dynamically examine values from the sensor and initiate an alarm based on the analysis of data. Systems using central intelligence for alarm decisions shall not be acceptable. The detector shall continually monitor any changes in sensitivity due to the environmental affects of dirt, smoke, temperature, aging, and humidity. The information shall be stored in the integral processor and transferred to the analog loop controller for retrieval using a laptop PC or similar program/service tool. The detector shall be rated for ceiling installation at a minimum of thirty (30) feet centers and shall be suitable for wall mount applications. The percent smoke obscuration per foot alarm set point shall be field selectable to any of five (5) sensitivity settings ranging from one percent (1%) to three and a half percent (3-1/2%). The photoelectric smoke detector shall be suitable for direct insertion into air ducts up to 3 ft (0.91m) high and 3 ft (0.91m) wide with air velocities up to 5,000 ft/min. (0-25.39 m/sec) without requiring specific duct detector housings or supply tubes. The detector shall be suitable for operation in the following environment:
1. Temperature: thirty-two (32)°F to one hundred twenty (120)°F.
 2. Humidity: zero (0) to ninety-three percent (93%) relative humidity, non-condensing.
 3. Elevation: no limit.
- B. Where noted on the Drawings, intelligent photoelectric type smoke detectors

shall be furnished and installed by this Contractor complete with wire guards.

- C. An intelligent photoelectric type smoke detector, which will meet this Specification, is EST model no. SIGA-OSD complete with model no. SIGA-SB 4 (with skirt) base suitable for mounting over a four (4) inch octagonal or square outlet box.

2.04 INTELLIGENT THERMAL DETECTOR

- A. This Contractor shall furnish and install intelligent combination fixed temperature/rate-of-rise thermal detectors as shown on the Drawings and herein specified. The thermal detector shall have a low mass thermistor heat sensor and operate at a fixed temperature and at a temperature rate-of-rise. The detector shall continually monitor the temperature of the air in its' surroundings to minimize thermal lag to the time required to process an alarm. The integral microprocessor shall determine if an alarm condition exists and initiate an alarm based on the analysis of the data. Systems using central intelligence for alarm decisions shall not be acceptable. The intelligent thermal detector shall have a nominal fixed temperature alarm point rating of one hundred thirty-five (135)°F and a rate-of-rise alarm point of fifteen (15)°F per minute. The intelligent thermal detector shall be rated for ceiling installation at a minimum of seventy (70) foot centers and be suitable for wall mount applications.
- B. An intelligent thermal detector which will meet this Specification is EST model no. SIGA-HRD complete with Model No. SIGA-SB4 (with skirt) base suitable for mounting over a four (4) inch octagonal or square outlet box.

2.05 INTELLIGENT CARBON MONOXIDE (CO) DETECTOR

- A. This Contractor shall furnish and install intelligent carbon monoxide detectors with remote indicator as shown on the Drawings and herein specified. The carbon monoxide detectors detector shall have advanced electromechanical carbon monoxide sensing technology, ground fault detection, field replaceable carbon monoxide sensor/daughterboard module and automatic device mapping with electronic addressing. The intelligent carbon monoxide detectors shall have a operating temperature range of 32°F To 120°F. The intelligent carbon monoxide detectors shall be rated for both ceiling and wall mounted installation. Wall mounted detectors shall be mounted at a height recommended by the system manufacturer.
- B. An intelligent carbon monoxide detector, which will meet this Specification, shall consist of the following.
 - 1. One (1) EST model no. SIGA-COD intelligent carbon monoxide detectors.
 - 2. One (1) EST model no. SIGA-AB4G/T audible base.

3. One (1) EST model no. SIGA -TCDR temporal pattern generator
4. One (1) EST model no. SIGA-LED remote indicator.

2.06 INTELLIGENT MONITOR MODULE

- A. This Contractor shall furnish and install intelligent single input monitor modules as shown on the Drawings and herein specified. The intelligent single input monitor module shall provide one (1) supervised Class B input circuit capable of a minimum of four (4) personalities, each with a distinct operation. The module shall be suitable for mounting on a 2-1/2" deep single gang outlet box or a 1-1/2" deep four (4) inch square outlet box. The single input module shall support the following circuit types:
1. Normally-open alarm latching for manual pull stations, thermal detectors, etc.
 2. Normally-open alarm delayed latching for sprinkler flow alarm switches.
 3. Normally-open active non-latching for monitor, fans, dampers, door hold-open, etc.
 4. Normally-open active latching for supervisory and sprinkler valve tamper switches.
- B. It shall be possible to address each intelligent monitor module without the use of DIP or rotary switches. Modules using DIP switches for addressing shall be acceptable. The personality of multifunction modules shall be programmable at the site to suit conditions and shall be changeable at any time using a personality code downloaded from the analog loop controller. Modules requiring EPROM, PROM, or ROM changes shall not be acceptable. DIP switch and/or jumper changes shall be acceptable. The module shall have a minimum of two (2) diagnostic LEDs mounted behind a finished cover plate. A green LED shall flash to confirm communication with the loop controller. A red LED shall flash to display alarm status. The module shall be capable of storing up to twenty-four (24) diagnostic codes that may be retrieved for troubleshooting assistance. Input and output circuit wiring shall be supervised for open and ground faults. The module shall be suitable for operation in the following environment:
1. Temperature: thirty-two (32)°F to one hundred twenty (120)°F.
 2. Humidity: Zero (0) to ninety-three percent (93%) relative humidity, non-condensing.
- C. An intelligent monitor module, which will meet this Specification, is EST model no. SIGA-CT1 complete with a cover plate designed to conceal the address

setting means but allow the polling LED to show.

2.07 INTELLIGENT CONTROL MODULE

- A. This Contractor shall furnish and install intelligent control relay modules as shown on the Drawings and herein specified. The intelligent control relay module shall provide one (1) form C dry relay contact rated at two (2) amps at 24 VDC to control external appliances or equipment shutdown. The control relay shall be rated for pilot duty and releasing systems. The position of the relay contact shall be confirmed by the system firmware. The module shall be suitable for mounting on a 2-1/2" deep single gang outlet box or a 1-1/2" deep four (4) inch square outlet box.
- B. It shall be possible to address each intelligent monitor module without the use of DIP or rotary switches. Modules using DIP switches for addressing shall be acceptable. The personality of multifunction modules shall be programmable at the site to suit conditions and shall be changeable at any time using a personality code downloaded from the analog loop controller. Modules requiring EPROM, PROM, or ROM changes shall not be acceptable. Modules using DIP switch and/or jumper changes shall be acceptable. The module shall have a minimum of two (2) diagnostic LEDs mounted behind a finished cover plate. A green LED shall flash to confirm communication with the loop controller. A red LED shall flash to display alarm status. The module shall be capable of storing up to twenty-four (24) diagnostic codes that may be retrieved for troubleshooting assistance. Input and output circuit wiring shall be supervised for open and ground faults. The module shall be suitable for operation in the following environment:
1. Temperature: thirty-two (32)°F to one hundred twenty (120)°F.
 2. Humidity: Zero (0) to ninety-three percent (93%) relative humidity, non-condensing.
- C. An intelligent control module, which will meet this Specification, is EST Module model no. SIGA-CR complete with a cover plate designed to conceal the address setting means but allow the polling LED to show.

2.08 INTERIOR MANUAL PULL STATIONS

- A. This Contractor shall furnish and install single action, single stage, and manual pull stations as shown on the Drawings and herein specified. The single action manual pull stations shall be addressable. Pull stations using DIP or rotary switches shall be acceptable. Pull stations shall have a minimum of two (2) diagnostic LEDs mounted on their integral, factory assembled single or two stage input module. A green LED shall flash to confirm communication with the loop controller. A red LED shall flash to display alarm status. The station shall be capable of storing up to twenty-four (24) diagnostic codes that shall be

capable of being retrieved for troubleshooting assistance. The pull station shall include a locked test feature and an internal toggle switch. The red manual station shall be constructed of rugged aluminum or high impact Lexan and shall be complete with a break glass rod. Stations shall be keyed alike with the control panel. The module shall be suitable for mounting on a 2-1/2" deep single gang outlet box or a 1-1/2" deep four (4) inch square outlet box with a single gang cover. The manual station shall be suitable for operation in the following environment:

1. Temperature: thirty-two (32)°F to one hundred twenty (120)°F.
 2. Humidity: zero (0) to ninety-three percent (93%) relative humidity, non-condensing.
- B. Manual stations areas noted on the Drawings shall be complete with wire guards furnished and installed by this Contractor.
- C. A manual pull station, which will meet this Specification, is EST model no. SIGA-270 complete with model no. 950017C wire guard (where noted on the Drawings), and model no. 27193-11 surface mounted steel outlet box (where noted on the Drawings to be surface mounted).
- D. Furnish and install Safety Technology International, Inc. (STI) clear lexan alarm covers Model No. 1100 (flush mounted) and/or 1130 (surface mounted) Stopper II, except in gymnasiums where manual pull stations shall be provided with wire guards.

2.09 EXTERIOR MANUAL PULL STATIONS

- A. This Contractor shall furnish and install weatherproof single action, single stage, and manual pull stations as shown on the Drawings and herein specified. The single action manual pull stations shall be addressable. Pull stations using DIP or rotary switches shall be acceptable. Pull stations shall be solid corrosion-resistant type construction rated NEMA 4X for outdoor use. The manual pull station shall come complete with a surface mounted backbox with gasket.
1. Temperature: negative 30 (-30)°F to one hundred fifty (150)°F.
- B. Manual stations shall be complete with an intelligent monitor module. The monitor module shall be installed in the interior of the building at a location near the exterior manual pull station location.
- C. A weatherproof manual pull station and backbox which will meet this Specification, is EST model no. MPSR1-SHTW-GE.
- D. Furnish and install Safety Technology International, Inc. (STI) clear lexan alarm covers model no. STI-13020FR (flush mounted) and/or STI-13220FR (surface

mounted) Stopper II.

2.10 AIR DUCT TYPE SMOKE DETECTORS

- A. This Contractor shall furnish photoelectric duct smoke detectors as shown on the Drawings and herein specified. The intelligent duct smoke detector shall operate in ducts having from 100ft/min to 4,000ft/min air velocity. The detector shall be suitable for operation over a temperature range of -20 to 158°F and offer a harsh environment gasket option. The detector shall utilize an air exhaust tube and an air sampling inlet tube that extends into the duct air stream up to ten (10) feet. Design of the detector shall permit sampling tube installation from either side of the detector and permit sampling tube installation in 45-degree increments to ensure proper alignment with duct airflow. Drilling templates and gaskets to facilitate locating and mounting the housing shall be provided. The intelligent duct smoke detector shall obtain information from a photoelectric sensing element. The detector shall be able to differentiate between a long term drift above the pre alarm threshold and fast rise above the threshold. The detector shall monitor the sensitivity of the smoke sensor. If the sensitivity shifts outside the UL limits, a trouble signal shall be sent to the panel. Each detector shall utilize an environmental compensation algorithm that shall automatically adjust for background environmental conditions such as dust, temperature, and pressure. The detector shall provide a maintenance alert signal when 80% (dirty) of the available compensation range has been used. The detector shall provide a dirty fault signal when 100% or greater compensation has been used. Each duct detector shall be installed and tested in accordance with manufacturer's instructions.
- B. The detectors shall be furnished complete with auxiliary relay contacts to shut down the associated air handling unit upon activation of the duct detector and to provide contact closure for connection to building ATC system for associated HVAC unit(s) shutdown. The intelligent duct smoke detector shall provide a form "C" auxiliary alarm relay rated at 2 amps @ 30 Vdc. The position of the relay contact shall be supervised by the control panel software. Operation of the relay shall be controlled either by its respective detector processor or under program control from the control panel as required by the application. Detector relays not capable of programmed operation independent of the detector's state shall not be considered as equal. The detector shall be equipped with a local magnet-activated test switch.
- C. Air duct type smoke detectors shall be furnished by this Contractor and installed in the air duct under DIVISION 15. Motor control wiring shall be furnished and installed under DIVISION 15. The detector shall be made part of the fire detection and alarm system by this Contractor.
- D. Where duct detectors are installed in area with a suspended ceiling, each duct detector shall be complete with an engraved name plate mounted adjacent to the duct detector and lettered with air handling unit number.

- E. This Contractor shall furnish and install a remote alarm indicator for each air duct type smoke detector. Each alarm indicator shall be complete with an engraved nameplate mounted adjacent to the indicator by this Contractor and lettered with the air handling unit number.
- F. An air duct type smoke detector, which will meet this Specification, shall consist of the following.
 - 1. One (1) EST model no. SIGA-SD intelligent photoelectric duct type detector.
 - 2. One (1) EST model no. SD-60 sampling tube of the length required to suit the duct dimension.
 - 3. One (1) EST model no. SIGA-CRH intelligent control module for shutdown of the air handling equipment.
 - 4. One (1) EST Model No. SIGA-LED remote indicator.

2.11 SPRINKLER WATERFLOW SWITCHES

- A. Sprinkler waterflow switches shall be furnished and installed under DIVISION 15. This Contractor shall make connections to the fire detection and alarm system.
- B. This Contractor shall furnish and install an intelligent monitor module for each waterflow switch installed.

2.12 VALVE TAMPER SWITCHES

- A. Valve tamper switches shall be furnished and installed under DIVISION 15. This Contractor shall make connections to the fire detection on and alarm system.
- B. This Contractor shall furnish and install an intelligent monitor module for each tamper switch installed.

2.13 WALL MOUNTED AUDIO/VISUAL ALARM SIGNALS

- A. This Contractor shall furnish and install wall mounted electronic alarm signals as shown on the Drawings and herein specified. The alarm signals shall be of solid-state construction and shall produce a temporal horn sound output of 94.5 dBA avg. and 97.6 dBA peak at ten (10) feet. The strobes shall be selectable to produce a minimum of 15, 30, 75 or 110 candela effective intensity as shown on the drawings. The flash rate shall not exceed three (3) flashes per second nor be less than one (1) flash every three (3) seconds. This Contractor shall furnish and install wall mounting styles for surface, semi-flush, or flush installation as shown on the Drawings. Alarm signals shall be complete with screw terminals for in-out field wiring of up to No. 12 AWG conductors and a red finish.

- B. Audio/visual alarm signals shall be listed to: UL 1971; UL 1638; UL 464; ULC S525 and S526; ADA Chapter 28, Part 36 Final Rule; and NFPA 72.
- C. All audio/visual alarm signals shall be UL listed for fire protective service.
- D. Audio/visual alarm signals shall be capable of operating from standard signaling circuits or from addressable intelligent signal modules.
- E. Audio/visual alarm signals in areas noted on the Drawings shall be installed complete with wire guards furnished and installed by this Contractor. The wire guards shall be listed for use with the appliance as per NFPA 72.
- F. The wall mounted audio/visual alarm signals, which meet this Specification, are EST Model No. G4AVRF multi-candela strobe field selectable at 15, 30, 75 or 110 candela and model No. G4RSB red finished surface mounting box (where indicated on the Drawings to be surface mounted).

2.14 CEILING MOUNTED AUDIO/VISUAL ALARM SIGNALS

- A. This Contractor shall furnish and install ceiling mounted electronic alarm signals as shown on the Drawings and herein specified. The alarm signals shall be of solid state construction and shall produce temporal horn sound output of 94.5 dBA avg. and 97.6 dBA peak at ten (10) feet. The strobes shall be selectable to produce a minimum of 15, 30, 75, 95, 115, 150 and 177 Candela. The flash rate shall not exceed three (3) flashes per second nor be less than one (1) flash every three (3) seconds. This Contractor shall furnish and install a mounting style for installation flush in the ceiling as shown on the Drawings. Alarm signals shall be complete with screw terminals for in-out field wiring of up to No. 12 AWG conductors and a red finish.
- B. Audio/visual alarm signals shall be listed to: UL 1971; UL 1638; UL 464; ULC S525 and S526; ULC S525; ADA Chapter 28, Part 36 Final Rule; and NFPA 72.
- C. Audio/visual alarm signals shall be capable of operating from standard signaling circuits or from addressable intelligent signal modules.
- D. The ceiling mounted audio/visual alarm signals, which will meet this Specification, are EST model no. GCAVWF multi-candela strobe field selectable at 15, 30, 75 or 95 Candela, and GCF-HDVMH multi-candela strobe field selectable at 95, 115, 150 or 177 candela. Complete with white finish, mounting plate and ceiling orientated lettering.

2.15 WALL MOUNTED VISUAL ONLY ALARM SIGNALS

- A. This Contractor shall furnish and install wall mounted electronic visual only alarm signals as shown on the Drawings and herein specified. The visual only alarm

signal strobes shall be selectable to produce a minimum of 15, 30, 75 or 110 candela effective intensity as shown on the drawings. The flash rate shall not exceed three (3) flashes per second nor be less than one (1) flash every three (3) seconds. This Contractor shall furnish and install wall mounting styles for surface or semi-flush installation as shown on the Drawings. Visual only alarm signals shall be complete with screw terminals for in-out field wiring of up to No. 12 AWG conductors and a red finish.

- B. Visual only alarm signals shall be listed to: UL 1971; UL 1638; ULC S525 and S526; ADA Chapter 28, Part 36 Final Rule; and NFPA 72.
- C. Visual only alarm signals shall be capable of operating from standard signaling circuits or from addressable intelligent control modules.
- D. Visual only alarm signal noted on the Drawings shall be complete with wire guards furnished and installed by this Contractor. The wire guards shall be listed for use with the appliance as per NFPA 72.
- E. The wall mounted visual alarm signals, which will meet this Specification, are EST model no. G4VRF multi-candela strobe field selectable at 15, 30, 75 or 110 and Model No. G4RSB red finished surface mounting box (where indicated on the Drawings to be surface mounted).
- F. This Contractor shall furnish and install a flush mounted electronic visual only alarm signal with a red lens for alert of Carbon Monoxide Detector Operation. The wall mounted visual alarm signal for Carbon Monoxide Detector Operation which will meet this Specification, are WHEELLOCK model no. STWW-NR- (red) multi – candela strobe field selectable at 15, 30, 75 or 95 candela. The visual only alarm device shall be located in the main administrative suite at a location visible to the office staff or as directed by the owner. Coordinate location with owners technical staff prior to installation. Label device “CO Detection Alarm”.

2.16 CEILING MOUNTED VISUAL ONLY ALARM SIGNALS

- A. This Contractor shall furnish and install ceiling mounted electronic visual only alarm signals as shown on the Drawings and herein specified. The visual only alarm signals strobes shall be selectable to produce a minimum of 15, 30, 75, 95, 115, 150 and 177 candela effective intensity as shown on the drawings. The flash rate shall not exceed three (3) flashes per second nor be less than one (1) flash every three (3) seconds. This Contractor shall furnish and install a ceiling mounting style for flush installation as shown on the Drawings. Visual only alarm signals shall be complete with screw terminals for in-out field wiring of up to No. 12 AWG conductors and a red finish.
- B. Visual only alarm signals shall be listed to: UL 1971; UL 1638; ULC S525 and S526; ADA Chapter 28, Part 36 Final Rule; and NFPA 72.

- C. Visual only alarm signals shall be capable of operating from standard signaling circuits or from addressable intelligent control modules.
- D. The ceiling mounted visual only alarm signals, which will meet this Specification, is EST model no. GCVWF multi-candela ceiling strobe field selectable at 15, 30, 75 or 95 candela and GCVWF-VMH multi-candela strobe field selectable at 95, 115, 150 or 177 candela complete with white finish, mounting plate, and ceiling orientated lettering.

2.17 EXTERIOR ALARM SIGNALS

- A. This Contractor shall furnish and install exterior alarm signals as shown on the Drawings and herein specified. The exterior alarm signals shall be of solid state construction and shall produce a temporal horn sound output of 92 dBA peak at ten (10) feet. Maximum current shall be 0.023 amps at 24 VDC. Exterior alarm signals shall be complete with screw terminals for in-out field wiring of up to No. 12 AWG conductors and a red finish.
- B. Exterior alarm signals shall be listed to: UL 1971; UL 1638; UL 464; ULC S525 and S526; ADA Chapter 28, Part 36 Final Rule; and NFPA 72.
- C. All exterior alarm signals shall be UL listed for fire protective service.
- D. Exterior alarm signals shall be capable of operating from standard signaling circuits or from addressable intelligent signal modules.
- E. Exterior alarm signals shall be suitable for installation of the exterior of the building, bear the appropriate UL label, and shall be furnished complete with a surface mounted weatherproof outlet box.
- F. An exterior alarm signal that will meet this Specification is EST model no. WGRF-H complete with red finish, mounting plate, and model no. 74347U red finished surface mounted weatherproof outlet box with model no. WG4RTS and red trim skirt.
- G. Provide an exterior waterflow bell mounted in a weatherproof backbox. The bell will be on a separate individual circuit, which shall be sound upon any waterflow activation. The bell shall mount on the exterior of the building or pole mounted as shown on the drawings (**Engineer to Edit**). An exterior bell which meets this specification is EST model 439-10AWR with an EST model 449 weatherproof backbox.

2.18 EXTERIOR AUDIO/VISUAL ALARM SIGNALS

- A. This Contractor shall furnish and install exterior audio/visual alarm signals as shown on the Drawings and herein specified. The exterior alarm signals shall be

of solid state construction and shall produce a temporal horn sound output of 92 dBA peak at ten (10) feet. The strobes shall be minimum of 75 and 110 candela. The flash rate shall not exceed three (3) flashes per second nor be less than one (1) flash every three (3) seconds. This Contractor shall furnish and install wall mounting styles for surface or semi-flush installation as shown on the Drawings. Audio/visual alarm signals shall be complete with screw terminals for in-out field wiring of up to No. 12 AWG conductors and a red finish.

- B. Exterior audio/visual alarm signals shall be listed to: UL 1971; UL 1638; UL 464; ULC S525 and S526; ADA Chapter 28, Part 36 Final Rule; and NFPA 72.
- C. All exterior audio/visual alarm signals shall be UL listed for fire protective service.
- D. Exterior audio/visual alarm signals shall be capable of operating from standard signaling circuits or from addressable intelligent signal modules.
- E. Exterior audio/visual alarm signals shall be suitable for installation of the exterior of the building, bear the appropriate UL label, and shall be furnished complete with a surface mounted weatherproof outlet box.
- F. An exterior audio/visual alarm signals that will meet this Specification is EST model no. WG4RF-HVMHC complete with white finish, mounting plate, and model no. 74347U red finished surface mounted weatherproof outlet box with model no. WG4RTS red trim skirt.

2.19 REMOTE GRAPHIC ANNUNCIATOR PANEL

- A. This Contractor shall furnish and install where shown on the Drawings, a remote graphic annunciator panel. The annunciator panel shall have black photo-emulsion graphics as detailed on the Drawings. The graphics shall be applied to a white plexiglas panel to assure legibility and ease of future on-site updating. The graphics panel shall be protected by a outer layer of non-glare plexiglas. All electrical connections shall be made to screw terminals mounted on a back plate that shall connect to the faceplate with ribbon cables. The LED system, positioned behind the graphic panel shall be visible only in the ON mode. The panel shall be framed in architectural gray aluminum and mounted by this Contractor in a flush steel backbox. A key lock and hidden-screw construction shall be provided for tamper resistance. The annunciator panel shall be keyed alike for all the control switches but different from the annunciator panel door access key.
- B. In addition to LED graphic annunciator, a LCD display annunciator shall be mounted adjacent to the LED graphic annunciator. LCD annunciator shall consist of EST Model No. 3-LCDANN with EST model no. RLCM/B backbox.

2.20 MAGNETIC DOOR HOLDERS

- A. Magnetic door holders shall be furnished and installed by this Contractor as

required for the mounting conditions and controlled by the fire alarm and detection system. This Contractor shall coordinate with the hardware supplier and the door installer to assure proper alignment, preparation, and operation with the associated doors. The door mounted magnets shall be mounted with bolts through the door with finish grade back plates. Magnets shall be 24VDC and shall be mounted as indicated on the Drawings.

- B. This Contractor shall furnish and install an intelligent control module for each set, or adjacent sets, of magnetic door holders as shown on the Drawings or provide a power source at the main FACP with a control relay for deactivation.
- C. A magnetic door holder, which will meet this Specification, is EST model no. 1504-AQ (flush mounted with a long catch plate), 1505-AQ (flush mounted with a short catch plate), or 1508-AQ (surface mounted).
- D. Magnetic door holders shall be recessed in the wall. For surface mounting, mount magnetic door holder in FS box. Wiremold surface mounted box shall not be accepted.

2.21 FIELD WIRING

- A. Field wiring for each intelligent loop shall consist of cables furnished and installed by this Contractor in minimum 1/2 inch conduit and as hereinbefore specified. The type, size, and number of conductors in the cable shall be in strict compliance with the manufacturer's requirements.
- B. Field wiring for all alarm signals shall consist of cables furnished and installed by this Contractor in minimum 1/2 inch conduit and as hereinbefore specified. The type, size, and number of conductors in the cable shall be in strict compliance with the manufacturer's requirements.
- C. Magnetic door holder power wiring from the main control panel shall consist of two (2) conductor, No. 12 AWG, furnished and installed by this Contractor in 1/2 inch conduit and as hereinbefore specified.

PART 3 EXECUTION

3.01 FIRE ALARM CONTROL EQUIPMENT

- A. All fire alarm control equipment, including the main control panel and any signal extender panels shall be supplied from the building's 120 volt EMERGENCY power source as shown on the Drawings. All fire alarm control equipment, including the main control panel and any signal extender panels shall be located in the Communications Room as shown on the Drawings. Contractor shall be responsible for providing any additional devices required by code or these

specifications for any control equipment located other than in the Communications Room, including 120 volt EMERGENCY power. These other locations must be specifically approved by the Owner.

3.02 MAIN CONTROL PANEL

- A. The main control panel backbox(s) shall be mounted on the wall, and all interior components furnished and installed by this Contractor, at the location shown on the Drawings in accordance with manufacturer's recommendations. Mounting height shall be approximately sixty (60) inches above the finished floor to the center of cabin.

3.03 MANUAL STATIONS

- A. Manual stations shown on the Drawings to be installed on existing walls or partitions shall be furnished and installed in surface device boxes of the appropriate size and shall be suitable for use with surface metal raceway. Existing conduits concealed in masonry walls may be reused only with the written approval of the Owner.
- B. Manual stations shown on the Drawings to be installed in new construction shall be furnished and installed by this Contractor to flush device boxes of the appropriate size as recommended by the equipment manufacturer.
- C. Wire guards shown on the Drawings to be installed over manual stations shall be furnished and installed by this Contractor. Wire guards shall not be anchored into acoustical wall panels. This Contractor shall insure that wood blocking is installed behind the wall panels. The wire guards shall be anchored through the wall panels and into the wood blocking.

3.04 SMOKE DETECTORS

- A. Smoke detectors shown on the Drawings to be installed in areas with suspended ceilings shall be surface mounted as high as possible on ceiling with concealed outlet boxes supported from structure.
- B. Smoke detectors shown on the Drawings to be installed in areas without suspended ceilings shall be mounted to a surface mounted outlet box rigidly attached to the building structure independently of the associated conduits.
- C. Smoke detectors required for smoke damper control shall be furnished and installed by this contractor. Coordinate locations with Mechanical drawings.
- D. All smoke detectors shall be thoroughly cleaned at the end of the project prior to the system being turned over to the Owner.

3.05 THERMAL DETECTORS

- A. Thermal detectors shown on the Drawings to be installed in areas with suspended ceilings shall be surface mounted on the ceiling with concealed outlet boxes.
- B. Thermal detectors shown on the Drawings to be installed in areas without suspended ceilings shall be mounted as high as possible to surface mounted outlet boxes rigidly attached to the building structure independently of the associated conduits.

3.06 INTELLIGENT CARBON MONOXIDE (CO) DETECTOR

- A. Intelligent carbon monoxide detectors shown on the Drawings to be installed in areas with suspended ceilings shall be surface mounted as high as possible on ceiling with concealed outlet boxes supported from structure.
- B. Intelligent carbon monoxide detectors shown on the Drawings to be installed in areas without suspended ceilings shall be mounted to a surface mounted outlet box rigidly attached to the building structure independently of the associated conduits.
- C. All intelligent carbon monoxide detectors shall be thoroughly cleaned at the end of the project prior to the system being turned over to the Owner.

3.07 INTELLIGENT CONTROL, MONITOR, AND SIGNAL MODULES

- A. Intelligent control, monitor, and signal modules shall be flush mounted in the ceiling as close as possible to the associated device. In areas without ceilings, the modules may be mounted to the underside of the structure, or wall mounted. Wherever possible, the modules shall be ganged together.
- B. Intelligent control and monitor modules for sprinkler flow and tamper switches and the fire pump shall be flush mounted in the front face of a wiring trough as detailed on the Drawings.

3.08 REMOTE GRAPHIC ANNUNCIATOR PANEL

- A. The remote graphic annunciator panel backbox shall be flush mounted and all interior components furnished and installed by this Contractor, at the location shown on the Drawings in accordance with manufacturer's recommendations. Mounting height shall be approximately fifty two (52) inches above finished floor to the center of cabinet.

3.09 SPRINKLER FLOW ALARM SWITCHES

- A. All sprinkler flow switches shall be furnished and installed under DIVISION 15. This Contractor shall make all electrical connections necessary to properly integrate these devices into the fire detection and alarm system.

3.10 SPRINKLER VALVE TAMPER SWITCHES

- A. Sprinkler valve tamper switches shall be furnished and installed on all sprinkler system valves under DIVISION 15. This Contractor shall make all electrical connections necessary to properly integrate these devices into the fire detection and alarm system.

3.11 ALARM SIGNALS

- A. Audio/visual and visual only alarm signals shown on the Drawings to be installed on existing walls or partitions shall be furnished and installed by this Contractor over surface device boxes of appropriate size and suitable for use with surface metal raceways.
- B. Audio/visual and visual only alarm signals shown on the Drawings to be installed in new construction shall be furnished and installed by this Contractor over concealed device boxes of appropriate size with the appropriate trim rings.
- C. Wire guards shown on the Drawings to be installed over alarm signals shall be furnished and installed by this Contractor. Wire guards shall not be anchored into acoustical wall panels. This Contractor shall insure that wood blocking is installed behind the wall panels. The wire guards shall be anchored through the wall panels and into the wood blocking.
- D. Audio/visual and visual only alarm signals shown on the Drawings to be installed flush and/or semi-flush mounted in ceilings shall be installed by this Contractor over concealed flush mounted device boxes of appropriate size with the appropriate trim rings. The box shall be supported by ceiling support bridges and steel wire directly to building structure.
- E. Audio/visual and visual only alarm signals shown on the Drawings to be ceiling mounted in areas with open structure (no suspended ceiling) shall be furnished by this contractor over surface device boxes of the appropriate size and suitable for use with surface conduit. The boxes shall be mounted directly to the underside of the structural members or metal framing channels bridging the structural members.

3.12 AIR DUCT TYPE SMOKE DETECTORS

- A. Air duct type smoke detectors shall be furnished under this DIVISION and mounted into ducts and connected to the air handler control circuit under DIVISION 15. This Contractor shall perform all wiring connections to the fire detection and alarm system and complete system test.
- B. Air duct type smoke detectors shall be thoroughly cleaned at the end of the project prior to the system being turned over to the Owner.

3.13 FIELD WIRING

- A. All line and low voltage wiring, conduit, backboxes, device mounting boxes, and junction boxes required for the fire detection and alarm system shall be furnished and installed by this Contractor.
- B. All low voltage field wiring shall be installed, by this Contractor, in ½" conduit and/or surface metal raceway.
- C. This Contractor shall make all connections to panels, devices, and detectors with crimp type spade terminal connectors. Splices in station circuits shall be made only in junction boxes and shall be crimp connected.
- D. All wiring shall be checked and tested by this Contractor to ensure the system is free from grounds, opens, and shorts.
- E. The installation and final connections of all components and devices shall be performed in accordance with manufacturer's instructions and recommendations. Manufacturer's technical staff shall verify proper installation during testing.
- F. A maximum of ten (10) T-taps on the Signaling Line Circuit (SLC) shall be allowed only at the FACP head end cabinet location. **(Note: T-taps in the field are prohibited).**
- G. A copy of the SLC device map shall be provided to the owner upon completion and acceptance of the system.
- H. The end of line (EOL) resistor shall be terminated on barrier strip and from barrier strip, #14AWG wiring shall go to the fire alarm device.

3.14 FIELD PROGRAMMING

- A. The manufacturer's technical representative shall field program the fire detection and alarm system after all related equipment has been installed and prior to any final testing. The technical representative shall be factory certified for programming. The initial program shall be developed by the equipment supplier in conjunction with the Owner and Fire Marshal.
- B. In addition to the initial field programming described above, the manufacturer shall furnish an additional two (2) sessions of field programming changes to be performed at any time during the warranty period at no additional expense to the Owner.

3.15 TEMPORARY COVERAGE DURING CONSTRUCTION

- A. This contractor shall provide two (2) audio/visual devices with 100ft of 1/2" EMT conduit and 500 ft. of Fire alarm cable per device for each phase. If the material is not used during construction, contractor shall provide applicable credit to the Owner.

3.16 ON-SITE AS-BUILT DRAWINGS

- A. The Contractor shall provide one (1) set of the fire alarm system supplier's as-built drawings for permanent use on-site. The Contractor shall: laminate each page of these drawings; provide a rigid means for mounting such as 1/4 inch thick x two (2) inch wide x width of the drawings through-bolted wood along the left edge of the drawings; furnish and install hanging hooks on the back of the Communications Room door; and hang the bound set of drawings.

END OF SECTION

SECTION 16612

FIRE DETECTION AND ALARM SYSTEM (MODULAR BUILDINGS)

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work covered under this Section shall include engineering, designing, testing, furnishing and installing a complete and operable addressable type analog fire detection and alarm system shown on the Drawings and herein specified. The system shall include, but not be limited to: control panel including backbox; remote annunciator panel including backbox; remote LED annunciator and drill switch in main building main office, alarm initiating and indicating peripheral devices; outlet boxes; conduit; line and low voltage wiring; and all accessories required.

1.03 QUALITY ASSURANCE

- A. All devices and equipment for this system shall be listed by the Underwriter's Laboratories, Inc. (UL), bear the UL label and shall conform to the applicable sections of National Fire Protection Association (NFPA) 72 and 90A, and the Americans with Disabilities Act (ADA) Code of Federal Regulation.
- B. The installation shall be in accordance with all requirements of NFPA, the National Electrical Code (NEC), all state and local codes and requirements, and these Specifications.
- C. This Contractor shall furnish shop drawings submittals for all components of this system in accordance with SECTION 16010 of these specifications. Submittals shall include the following for review. Submittals not containing all of the information listed below will be rejected.
 - 1. A complete list by model number of each component of the system with a statement of how many pieces of each model are to be furnished and a listing of the specific data sheet
 - 2. A description of the system as it functions by component in the system using model numbers where applicable.
 - 3. A complete battery calculation listing by module for the system.

4. A data sheet shall be furnished for each component of the system. The specific information shall be highlighted.
 5. A detailed drawing of the control panel shall be furnished showing all modules in their specific location with the specific terminal terminations shown.
 6. A detailed set of engineered floor plans for the complete building shall be furnished showing the locations of all equipment and devices, their addresses, and their required interconnections. The interconnections shown shall indicate the system manufacturer's recommended number, size, and type of wires as described in this Specification. The plans shall show the locations of all required control and monitor modules and their addresses. The layout of all fire detection and alarm system equipment, devices, and conduit routings shall closely follow that shown on the Drawings.
 7. A detailed drawing shall be furnished of each type of device showing the exact terminal designations.
 8. A detailed list shall be furnished of each type of device in the system stating its program function in the system.
 9. A detailed list shall be furnished of the relays in the system and their program function.
 10. A detailed manufacturer's drawing shall be furnished of the annunciator panel and the remote LED alarm/drill switch (main building) as it shall appear on the wall in the location of its installation.
 11. Certification by the equipment distributor of the required service response time.
- D. All equipment and components shall be the manufacturer's current models. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approval agency for use as part of a protected premises protective signaling (fire alarm) system. The Contractor shall provide, from the acceptable manufacturer's current product lines, equipment and components that comply with the requirements of these Specifications. Equipment or components, which do not provide the performance and features, required by these specifications are not acceptable, regardless of manufacturer.
- E. Submission of products purported to be equal to EDWARDS SYSTEMS TECHNOLOGY (EST); products will be considered only when the following requirements have been met:

1. The Contractor shall submit a point-by-point statement of compliance for all sections of this specification. The statement of compliance shall consist of a list of all paragraphs within these sections.
 - a. Where the proposed system complies fully with the paragraph, as written, total compliance shall be indicated by placing the word "comply" opposite the paragraph number.
 - b. Where the proposed system does not fully comply with the paragraph as written; but the Contractor feels the substituted equipment will accomplish the intent of the paragraph, a full description of the intent as well as a full description of how the proposal meets the intent of the original specification shall be provided.
 - c. Any submission that does not include a point-by-point statement of compliance as described herein shall be disqualified.
- F. Following review of the submittals by the Architect/Engineer and Owner, and prior to release of the fire alarm equipment, this Contractor shall submit to the Fairfax County Fire Marshal's office all copies of the corrected submittals for review, comment, and approval. This Contractor shall not release any equipment prior to receiving the Fairfax County Fire Marshal approved shop drawing. This contractor shall be responsible for paying all fees associated with the fire marshal's review.
- G. The installation of all equipment and the final connection of all components and wiring shall be performed under the direct supervision of the system manufacturer's technical staff.
- H. Upon completion, the system shall be thoroughly tested by this Contractor to assure proper interfacing of all components.
- I. Prior to final inspection, this Contractor shall furnish to the prime Contractor, five (5) copies of the manufacturer's submittal drawings up-dated to reflect: any and all revisions to the system made during construction; and the final addresses of all devices.
- J. The equipment to be furnished by this Contractor under these Specifications shall be the standard product of one manufacturer. Acceptable manufacturers shall be engaged in the manufacture of multiplexed fire alarm equipment for at least seven (7) years and have a fully equipped, factory trained and authorized service organization that will have a response time of four (4) hours or less to the job site. The specified and approved equipment manufacturer is EDWARDS SYSTEMS TECHNOLOGY (EST); EST products constitute the minimum type and quality of equipment to be installed. Alternate equipment manufacturer's equipment will be considered from NOTIFIER; and SIMPLEX TIME RECORDER CO.

- K. The fire detection and alarm system shall be furnished by a factory-authorized distributor certified to design, program, and service the system. This distributor must show evidence of successfully furnishing systems as specified for at least five (5) years. This distributor shall provide twenty four (24) hour, seven (7) day a week (including holidays) service capability with a maximum four (4) hour response time. This distributor shall provide certification of this capability as part of the submittals.

1.04 DESCRIPTION OF SYSTEM:

- A. The fire detection and alarm system shall be a microprocessor based system designed specifically for smoke and fire detection applications
- B. The fire detection and alarm system shall be individual point addressable, general alarm, electrically supervised, non-coded, continuously sounding temporal tone signal, with audible and visual alarm and trouble indications.
 - 1. Each individual alarm-initiating device shall report to the control panel as a separate "address".
 - 2. Each individual alarm-initiating device shall report to the remote annunciator panel as a separate "address".
- C. Activation of a manual fire alarm pull stations or; automatic smoke detector shall cause the following:
 - 1. All audible/visual-signaling devices shall sound continuously having a temporal tone signal until manually silenced. A subsequent alarm received after silencing shall again cause the alarm indicating circuits to be activated. The fire alarm signals shall be distinctive from all other alarm signals and shall be clearly audible throughout the entire building.
 - 2. The internal audible device shall sound at the control panel and/or remote annunciators, any remote or local annunciator LCD/LEDs associated with the alarm zone shall be illuminated.
 - 3. Auxiliary contacts shall activate the existing main building security intrusion system.
 - 4. Close all normally held-open smoke doors.
 - 5. The LCD display shall indicate all applicable information associated with the alarm condition including; zone, device type, device location and time/date.
- D. The system, including the remote annunciator panels, shall remain in alarm condition until the initiating device is reset to normal and the control panel is reset.

- E. The system shall use 120-volt commercial power as its normal source of power. Upon failure of the normal source, the system shall automatically transfer to the integral standby power supply (battery) which shall be capable of supporting all system supervisory functions for all initiation and signal circuits for a period of twenty-four (24) hours as required by NFPA 72A. The fire detection and alarm system shall be UL listed under Standards 864 (*Control Units for Fire-Protective Signaling Systems*) under category UOJZ.
- F. In the event of failure of operating power, an open, or ground condition on the system wiring, the trouble signals (both audible and visual) shall actuate at the remote annunciator panel. It shall be possible to silence audible trouble signals by means of silencing switches; however, it shall not be possible to extinguish the visual signals until the disarrangement has been corrected. Upon correction of the trouble condition, the audible trouble signal shall sound until the silencing switch is returned to normal or the system automatically resets the trouble indication. Alarm or trouble indication shall cause an auxiliary contact operation connected to the existing building's security system field interface device.

1.05 TESTING

- A. Upon final completion of the installation and after satisfactory testing of the system by this Contractor in the presence of the equipment supplier, this Contractor shall test the system in the presence of the Architect/Engineer, Fire Marshal, Owner, and other authorities having jurisdiction. The manufacturer shall furnish to the Owner a two (2) year contract effective from the date of acceptance, for maintenance and inspection service of the manufacturers' equipment. The manufacturer shall maintain an adequate supply of spare parts for ten (10) years, and shall provide supervision of the installation. The manufacturer and/or their distributor shall provide twenty-four (24) hour/seven (7) day (including holidays) service to the system as hereinbefore described.

1.06 WARRANTY

- A. This Contractor shall deliver the work described herein in a first-class operating condition in every respect. This Contractor shall also warrant that the material, equipment, and workmanship furnished shall be entirely free from defects. Any materials, equipment, or workmanship in which defects may develop before or during the warranty period shall be repaired or replaced at the Contractor's own expense. Refer to SECTION 01740 for the start of the warranty period. The Contractor shall further warrant that all material, equipment, and workmanship used in the installation, but not specifically mentioned in the Drawings and Specifications, is the best of their respective kinds and that the construction and installation was performed in accordance with the best accepted standard practices in all details.
- B. It is the intention of this Specification that a complete life-safety system be furnished from a single manufacturer. Equipment shall be UL listed for fire alarm use.

1.07 INSTRUCTION AND MANUALS

- A. The equipment manufacturer shall provide eight (8) hours of instruction to the Owner's maintenance personnel and shall furnish three (3) complete field service manuals.

1.08 SPARE PARTS

- A. This Contractor shall furnish to the Owner spare parts as follows. Spare parts shall be furnished prior to the installation of the system.
1. Two (2) intelligent smoke detectors including bases.
 2. Two (2) intelligent control modules.
 3. Two (2) intelligent monitor modules.
 4. Two (2) manual pull stations including surface mounted backboxes and intelligent monitor modules for each.
 5. Two (2) audio/visual alarm signals including surface mounted backboxes.
 6. Two (2) visual only alarm signals including surface mounted backboxes.

PART 2 – PRODUCTS**2.01 NEW MAIN CONTROL PANEL****A. GENERAL**

1. The control panel shall be a multi-processor based system designed specifically for fire and releasing system applications. The control panel shall be listed and approved for the application standard(s) as listed under the "General" section.
2. The control panel shall include all required hardware, software and system programming to provide a complete and operational system. The control panel shall ensure that life safety takes precedence among all panel activities.
3. The control panel shall include the following capacities:
 - a. Support up to 64 analog/addressable points.
 - b. Support up to 8 fully supervised remote annunciators.
 - c. Support digital dialer (DACT) with multiple communication protocols

- d. Support up to 1000 chronological events.
4. The control panel shall include the following features:
 - a. Provide electronic addressing of analog/addressable devices.
 - b. Provide an operator interface display that shall include functions required to annunciate, command and control system functions.
 - c. Provide an internal audible signal with different programmable patterns to distinguish between alarm, supervisory, trouble and monitor conditions.
 - d. Provide a discreet system control switch provided for reset, alarm silence, panel silence, drill switch, up/down/right/left switches, status switch and help switch.
 - e. Provide system reports.
 - f. Provide an authorized operator with the ability to operate or modify system functions like system time, date, passwords, holiday dates, restart the system and clear control panel event history file.
 - g. Provide an authorized operator to perform test functions within the installed system.
 - h. All system programming and history shall be permanently stored in non-volatile memory to ensure that no programming or history is lost. Systems which store initial programming or field programming changes in battery backed memory will not be accepted.
 5. Supervision of system components, wiring, initiating devices and software shall be provided by the control panel. Failure or fault of system component or wiring shall be indicated by type and location on the LCD display.
 6. Software and processor operation shall be independently monitored for failure. The system shall provide fail-safe operation, with a backup level of system operation.
 7. A compare utility shall identify programming and device changes on the system.
- B. Operators' Interface:
1. A Liquid Crystal Display (LCD) shall provide the means to inform the system operator with detailed information about the off-normal status of the installed fire detection and alarm system. The LCD shall automatically respond to the status of the system, and shall display that status in 224-character front panel display.
 2. The following status functions shall be annunciated by the LCD display:

- a. When the fire detection and alarm system is in the "Normal" mode, the panel shall display: current date and time, a two-line custom system title, and a summary total of system events.
 - b. With the fire detection and alarm system is in the off-normal mode, the LCD display shall automatically reconfigure into three logical areas.
 - c. Panel Status Area - The LCD shall show the system time, the number of active points, and disabled points in the system.
 - d. Event Area - The LCD shall show the first two active events of the highest priority .
 - e. Type Status Area - The LCD shall show the total number of active events in the system, by the following event types: "Alarm Events", "Supervisory Events", "Active Trouble Events", and "Active Monitor Events".
- C. Addressable Device Controller:
1. A 100% digital loop controller shall be provided in the fire detection and alarm system panel to interface with the intelligent microprocessor-based detectors and modules.
 2. It shall be possible to connect the loop controller to the detectors and modules using any wiring material or method complying with Chapter 3 of the National Electrical Code without the need for special shielding, twisted wire, or conduits. The loop controller shall be capable of supporting Class A (Style 7) or Class B (Style 4) circuits without the need for additional hardware modules. It shall be possible to wire multiple branch circuits (t-taps) from Class B Circuits (Style 4).
 3. The loop controller shall be capable of setting the address of all Intelligent microprocessor-based devices connected to it electronically, without the need to set switches at any of the individual devices.
 4. The loop controller shall provide a minimum of 6 types of supervision for each smoke detector on the circuit:
 - a. Device location
 - b. Unexpected device add/Delete
 - c. Missing device address
 - d. Changes in the physical wiring of the circuit
 - e. Changes in device settings
 - f. Device maintenance alert
 5. The loop controller shall determine the electrical location of each connected detector and module. The location and type of each connected device shall be mapped and stored in memory in the loop controller. It shall be possible to access and display this map.

6. It shall be possible to obtain a mapping report of all devices connected to the loop controller for confirmation of "as-built" wiring. The mapping report shall show the electrical relationship of all connected devices, including t-taps, device types, and the panel addresses of devices on the circuit. The loop controller shall be capable of reporting any additional device addresses, which may have been added to the circuit, and/or changes that may have been made to the wiring in the data circuit. A specific trouble shall be reported for any and all off-normal non-alarm condition.
7. The loop controller shall notify the system when any connected smoke detector reports a "routine maintenance required" signal to the system.

D. Notification Appliance Circuits:

1. Provide as indicated on the plans, supervised hard-wired Notification Appliance Circuits (NAC) for the control of 24Vdc notification appliances. Each NAC shall operate as Class B (Style Y) power limited circuit.
2. NACs shall be capable of providing steady, 20bps, 120bps or temporal rate outputs.

E. Power Supply

1. Each system power supply shall be a minimum of 6 amps @ 24 vdc.
2. Upon failure of normal (AC) power, the affected portion(s) of the system shall automatically switch over to integral secondary power (battery) without losing any alarm, trouble or operator acknowledgement signals.
3. Each system power supply shall be annunciated individually and shall annunciate as a trouble signal, identifying the inoperable power supply(ies).
4. All standby batteries shall be continuously monitored by the system. Low battery and disconnection of battery power supply conditions shall immediately annunciate as a trouble signal, identifying the deficient batteries.
5. All system power supplies shall be capable of recharging their associated batteries, from a fully discharged condition to a capacity sufficient to allow the system to perform consistent with the requirements of this section, in 48 hours maximum.

F. System Reports

1. The system shall provide the operator with system reports that give detailed description of the status of system parameters for corrective

action, or for preventative maintenance programs. The system shall provide these reports via the main LCD, and shall be capable of being printed on the system printer.

2. The system shall provide a report that gives a sensitivity listing of all detectors that have less than 80% environmental compensation remaining. The system shall provide a report that provides a sensitivity (% obscuration per foot) listing of any particular detector.
3. The system shall provide a report that gives a listing of the sensitivity of all of the detectors on the system, or any given analog/addressable device circuit.
4. The system shall provide a report that gives a chronological listing of up to the last 1000 system events.
5. The system shall provide a listing of all of the firmware revision listings for all of the installed components in the system.

G. System Programmable Operations:

1. The routing of all system annunciation and control parameters shall be configurable to any or all-remote annunciators on the system manually, or automatically as a function of the time of day or date.
2. Each remote annunciator connected to the panel shall be configurable to show the status of any combination or of Alarm, Supervisory, Trouble, and Monitor functions pertaining to any point in the system.
3. Each point in the system shall be labeled with up to a 36 character custom message.
4. System shall have the capability to provide logical "Counting AND" Groups and "Matrix Groups. Each matrix group shall be programmable by radius and activation number.
5. System shall have the ability to define Service groups. A Service group shall consist of any addressable field device and shall not be defined or limited by the physical layout of the fire detection and alarm system, or its application to the protected premises. The system shall include the ability to define an alternate set of device commands, which may be used in combination with the system test command, and service groups for the testing of the connected intelligent microprocessor based devices.
6. The system shall include Time Control functions that have the ability to control any system output or system operational sequence as a function of the month, day of week, date, hour, minute, or holiday.

7. The system shall support software defined Logical Zone Groups which may group any input from any initiating device circuit, in order to control a system output or function, or initiate any system operational sequence. A device or IDC may be a member of one Zone.
- H. A main fire alarm control panel, which will meet this Specification, shall consist of an EST model no. iO1000R with red wall mounted equipment enclosure(s) with the following modules of the quantity required to perform all of the specified functions.
- I. The system shall have the ability to download data from the intelligent devices to a PC while the system is on-line and operational in the protected premises. The downloaded data may then be analyzed in a diagnostic program supplied by the system manufacturer.
 1. EST Model No. iO64R FACP, 1-2 Loop, 64 pt max, 2 CI B NACs, red.

2.02 INTELLIGENT PERIPHERAL REQUIREMENTS:

- A. System shall use analytical microprocessor-based detectors that are capable of full digital communications with the fire detection and alarm system using both broadcast and polling communications protocols. Each detector shall be capable of performing independent advanced fire detection algorithms. The fire detection algorithm shall measure sensor signal dimensions, time patterns, and combine different fire parameters to increase reliability and distinguish real fire conditions from unwanted nuisance alarms caused by environmental events. Signal patterns that are not typical of fires shall be eliminated by digital filters and shall not cause a system alarm condition. Devices not capable of combining different fire parameters or employing digital filters will not be acceptable.
- B. Each detector shall have an integral microprocessor capable of making alarm decisions based on fire parameter information stored in the detector's memory. Detector's not capable of making independent alarm decisions are not acceptable.
- C. Each detector shall have a separate means of locally displaying system communication and detector alarm status. A different LED indication for alarm and trouble shall be provided (devices in which the LED does not flash in supervisory mode are not acceptable).
- D. Each detector shall be capable of identifying diagnostic codes to be used for system maintenance. All diagnostic codes shall be stored in the detector. Each smoke detector shall be capable of transmitting pre-alarm, alarm, and maintenance signals to the fire alarm control panel via the loop controller.
- E. Each detector microprocessor shall contain an environmental compensation algorithm, which identifies and sets ambient "Environmental Thresholds" continually and periodically. In this manner, the environmental impact of

temperature, humidity, environmental contaminants as well as detector aging shall be automatically monitored and adjusted for. This process shall employ digital compensation techniques to adapt the detector to both long term and short-term changes in the environment in which they are installed. The microprocessor shall monitor this environmental compensation value and alert the system operator when the detector approaches 80% and 100% of the allowable environmental compensation value. Differential sensing algorithms shall maintain a constant differential between selected detector sensitivity and the derived base line sensitivity that the detector has sensed in its environment. The base line sensitivity information shall be automatically and periodically updated and permanently stored in the detector.

- F. Each detector shall be capable of automatic electronic addressing and/or custom addressing, without the use of DIP or rotary switches, and shall mount on a common base to allow the simple replacement of one detector type with another detector type. The addressing of the detectors shall not depend on the electrical position of the detector in the circuit.
- G. If devices require DIP or rotary switches for addressing, every device shall be physically removed and verified during final checkout with engineer to confirm devices are located and programmed correctly. All switch addressed devices and their bases must be labeled with engraved plastic labels to identify device address and intended location. Labels shall have a red background with white letters; letters shall be a minimum of 1/4" in height.

2.03 INTELLIGENT PHOTOELECTRIC SMOKE DETECTORS

- A. Photoelectric detector shall utilize a light scattering type photoelectric smoke sensor to detect visible particulates produced by combustion. The integral microprocessor shall dynamically examine values from the sensor and initiate a system alarm based on the analysis of data. Detector shall continually monitor any changes in sensitivity due to the environmental affects of dirt, smoke, temperature, aging and humidity. Information shall be stored in the detector's memory and shall be transferred to the electronic loop controller for retrieval using a laptop PC or the intelligent detector program/service tool designed by the manufacturer specifically for the purpose.
- B. The alarm set point shall be field selectable to any of five sensitivity settings ranging from 1.0% to 3.5% smoke obscuration per foot. The photo detector shall be suitable for operation in the following environment:
 - 1. Temperature: thirty-two (32) degrees F to one hundred twenty (120) degrees F.
 - 2. Humidity: zero (0) to ninety-three percent (93%) relative humidity, non-condensing.
 - 3. Elevation: no limit

- C. Where noted on the Drawings, intelligent photoelectric type smoke detectors shall be furnished and installed by this Contractor complete with wire guards.
- D. An intelligent photoelectric type smoke detector, which will meet this Specification, is EST model no. SIGA-OSD complete with Model No. SIGA-SB base suitable for mounting over a four (4) inch octagonal or square outlet box.

2.04 INTELLIGENT CONTROL, MONITOR, AND SIGNAL MODULES

- A. Fire detection and alarm system shall incorporate microprocessor-based addressable modules for the monitoring and control of system Input and Output functions over a 2-wire electronic communications loop, using both broadcast and serial polling protocols. All modules shall display communications and alarm status via LED indicators.
- B. The function of each connected module shall be determined by the module type, and shall be defined in the system software through the application of a personality code. Simply changing the associated personality code may change module operation at any time.
- C. All addressing of the microprocessor-based addressable modules shall be done electronically, and the electrical location of each module shall be automatically reported to the Fire Alarm Control Panel, where it may be downloaded into a PC, or printed out. The addressing of the modules will not be dependent on their electrical location on the circuit. It shall be possible to address each intelligent monitor module without the use of DIP or rotary switches. Modules using DIP switches for addressing shall not be acceptable.
- D. All microprocessor-based addressable modules shall have a visual means to confirm communications with the panel, and a visual means to confirm the alarm status of the modules. The module shall have a minimum of two (2) diagnostic LEDs mounted behind a finished cover plate. A green LED shall flash to confirm communication with the loop controller. A red LED shall flash to display alarm status.
- E. All field wiring to the microprocessor-based addressable modules shall be supervised for opens and ground faults and shall be location identified to the module of incidence. Diagnostic circuitry, and their associated indicators, with reviewable trouble codes, shall be integral to the microprocessor-based Addressable Modules to assist in troubleshooting system faults.
- F. The modules shall be suitable for operation in the following environment:
 - 1. Temperature: thirty-two (32) degrees F to one hundred twenty (120) degrees F.
 - 2. Humidity: zero (0) to ninety-three percent (93%) relative humidity, non-condensing.

2.05 INTELLIGENT MONITOR MODULES:

- A. This Contractor shall furnish and install intelligent single input monitor modules as herein specified. The module shall be suitable for mounting on a 2-1/2" deep single gang outlet box or a 1-1/2" deep four (4) inch square outlet box with a single gang cover.
- B. Microprocessor-based addressable modules shall be used to provide one (1) supervised Class B (style B) input circuit capable of latching operation for use with contact devices, non-damped Waterflow Switches, non-latching supervisory sprinkler switches.
- C. An intelligent monitor module, which will meet this Specification, is EST Model No. SIGA-CT1

2.06 INTELLIGENT SIGNAL MODULE:

- A. This Contractor shall furnish and install intelligent signal modules as herein specified. The module shall be suitable for mounting on a 2-1/2" deep single gang outlet box or a 1-1/2" deep four (4) inch square outlet box with a single gang cover.
- B. The Microprocessor-based addressable single input signal module shall provide one (1) supervised Class B (style Y) Notification Appliance Circuit capable of a controlling 2A of polarized 24 VDC Notification Appliances.
- C. An intelligent signal module, which will meet this Specification, is EST model no. SIGA-CC1S.

2.07 INTELLIGENT CONTROL MODULE:

- A. This Contractor shall furnish and install intelligent single control relay modules as herein specified. The module shall be suitable for mounting on a 2-1/2" deep single gang outlet box or a 1-1/2" deep four (4) inch square outlet box with a single gang cover.
- B. Microprocessor-based Addressable Control Relay Modules shall provide one form "C" dry relay contact rated at 2 amps @ 24 Vdc or 0.5 amps at 120 VAC to, control external appliances or equipment processes. The control relay module shall be rated for pilot duty applications and releasing systems service. The position of the relay contact shall be confirmed by the system firmware.
- C. An intelligent control module, which will meet this Specification, is EST Model No. SIGA-CR.

2.08 MANUAL PULL STATIONS

- A. This Contractor shall furnish and install single action, single stage, and manual pull stations as shown on the Drawings and herein specified. The single action manual pull stations shall be addressable. Pull stations using DIP or rotary switches shall be acceptable. Pull stations shall have a minimum of two (2) diagnostic LEDs mounted on their integral, factory assembled single or two stage input module. A green LED shall flash to confirm communication with the loop controller. A red LED shall flash to display alarm status. The station shall be capable of storing up to twenty-four (24) diagnostic codes that shall be capable of being retrieved for troubleshooting assistance. The pull station shall include a locked test feature and an internal toggle switch. The red manual station shall be constructed of rugged aluminum or high impact Lexan and shall be complete with a break glass rod. Stations shall be keyed alike with the control panel. The module shall be suitable for mounting on a 2-1/2" deep single gang outlet box or a 1-1/2" deep four (4) inch square outlet box with a single gang cover. The manual station shall be suitable for operation in the following environment:
1. Temperature: thirty-two (32) degrees F to one hundred twenty (120) degrees F.
 2. Humidity: zero (0) to ninety-three percent (93%) relative humidity, non-condensing.
- B. Manual stations areas noted on the Drawings shall be complete with wire guards furnished and installed by this Contractor.
- C. A manual pull station, which will meet this Specification, is EST model No. SIGA-270 complete with model no. 950017C wire guard (where noted on the Drawings), STI, Inc. model no. 1100 (flush mounted) and/or 1130 (surface mounted) Stopper II (high and middle Schools only), and model No. 27193-11 surface mounted steel outlet box (where noted on the Drawings to be surface mounted).

2.09 WALL MOUNTED AUDIO/VISUAL ALARM SIGNALS

- A. This Contractor shall furnish and install wall mounted electronic alarm signals as shown on the Drawings and herein specified. The alarm signals shall be of solid-state construction and shall produce a temporal horn sound output of 94.5 dBA avg. and 97.6 dBA peak at ten (10) feet. Maximum current shall be 0.200 amps at 24 VDC. The strobes shall be selectable to produce a minimum of 15, 30, 75 and 110 candela effective intensity as shown on the drawings. The flash rate shall not exceed three (3) flashes per second nor be less than one (1) flash every three (3) seconds. This Contractor shall furnish and install wall mounting styles for surface, semi-flush, or flush installation as shown on the Drawings. Alarm signals shall be complete with screw terminals for in-out field wiring of up to No. 12 AWG conductors and a red finish.
- B. Audio/visual alarm signals shall be listed to: UL 1971; UL 1638; UL 464; ULC

- S525 and S526; ADA Chapter 28, Part 36 Final Rule; and NFPA 72.
- C. All audio/visual alarm signals shall be UL listed for fire protective service.
 - D. Audio/visual alarm signals shall be capable of operating from standard signaling circuits or from addressable intelligent signal modules.
 - E. Audio/visual alarm signals in areas noted on the Drawings shall be installed complete with wire guards furnished and installed by this Contractor.
 - F. The wall mounted audio/visual alarm signals, which meet this Specification, are EST model no. G4AVRF multi-candela Horn strobe field selectable at 15, 30, 75 or 110 candela complete with red finish, mounting plate, and model No. G4RSB red finished surface mounting box (where indicated on the Drawings to be surface mounted).

2.10. CEILING MOUNTED AUDIO/VISUAL ALARM SIGNALS

- A. This Contractor shall furnish and install ceiling mounted electronic alarm signals as shown on the Drawings and herein specified. The alarm signals shall be of solid state construction and shall produce temporal horn sound output of 94.5 dBA avg. and 97.6 dBA peak at ten (10) feet. Maximum current shall be 0.201 amps mean at 24 VDC. The strobes shall be selectable to produce a minimum of 15, 30, 75 and 95 candela. The flash rate shall not exceed three (3) flashes per second nor be less than one (1) flash every three (3) seconds. This Contractor shall furnish and install a mounting style for installation flush in the ceiling as shown on the Drawings. Alarm signals shall be complete with screw terminals for in-out field wiring of up to No. 12 AWG conductors and a red finish.
- B. Audio/visual alarm signals shall be listed to: UL 1971; UL 1638; UL 464; ULC S525 and S526; ULC S525; ADA Chapter 28, Part 36 Final Rule; and NFPA 72.
- C. Audio/visual alarm signals shall be capable of operating from standard signaling circuits or from addressable intelligent signal modules.
- D. The ceiling mounted audio/visual alarm signals, which will meet this Specification, are EST model no. GCAVWF multi-candela strobe field selectable at 15, 30, 75 or 110 Candela complete with white finish, mounting plate and ceiling orientated lettering

2.11 WALL MOUNTED VISUAL ONLY ALARM SIGNALS

- A. This Contractor shall furnish and install wall mounted electronic visual only alarm signals as shown on the Drawings and herein specified. The visual only alarm signal strobes shall be selectable to produce a minimum of 15, 30, 75 and 110 candela effective intensity as shown on the drawings. The flash rate shall not exceed three (3) flashes per second nor be less than one (1) flash every three (3) seconds. This Contractor shall furnish and install wall mounting styles for surface or semi-flush installation as shown on the Drawings. Visual only alarm

signals shall be complete with screw terminals for in-out field wiring of up to No. 12 AWG conductors and a red finish.

- B. Visual only alarm signals shall be listed to: UL 1971; UL 1638; ULC S525 and S526; ADA Chapter 28, Part 36 Final Rule; and NFPA 72.
- C. Visual only alarm signals shall be capable of operating from standard signaling circuits or from addressable intelligent control modules.
- D. Visual only alarm signal noted on the Drawings shall be complete with wire guards furnished and installed by this Contractor.
- E. The wall mounted visual alarm signals, which will meet this Specification, are EST model no. G4AVRF Multi-candela Strobe field selectable at 15, 30, 75 or 110 Candela complete with red finish, mounting plate, and Model No. G4RSB red finished surface mounting box (where indicated on the Drawings to be surface mounted).

2.12 CEILING MOUNTED VISUAL ONLY ALARM SIGNALS

- A. This Contractor shall furnish and install ceiling mounted electronic visual only alarm signals as shown on the Drawings and herein specified. The visual only alarm signals strobes shall be selectable to produce a minimum of 15, 30, 75 and 95 candela effective intensity as shown on the drawings. The flash rate shall not exceed three (3) flashes per second nor be less than one (1) flash every three (3) seconds. This Contractor shall furnish and install a ceiling mounting style for flush installation as shown on the Drawings. Visual only alarm signals shall be complete with screw terminals for in-out field wiring of up to No. 12 AWG conductors and a red finish.
- B. Visual only alarm signals shall be listed to: UL 1971; UL 1638; ULC S525 and S526; ADA Chapter 28, Part 36 Final Rule; and NFPA 72.
- C. Visual only alarm signals shall be capable of operating from standard signaling circuits or from addressable intelligent control modules.
- D. The ceiling mounted visual only alarm signals, which will meet this Specification, is EST Model No. GCVWF Multi-candela ceiling strobe field selectable at 15, 30, 75 or 110 candela complete with white finish, mounting plate, and ceiling orientated lettering.

2.13 EXTERIOR ALARM SIGNALS

- A. This Contractor shall furnish and install exterior alarm signals as shown on the Drawings and herein specified. The exterior alarm signals shall be of solid state construction and shall produce a broadband horn sound output of 92 dBA peak at ten (10) feet. Maximum current shall be 0.023 amps at 24 VDC. Exterior alarm signals shall be complete with screw terminals for in-out field wiring of up

to No. 12 AWG conductors and a red finish.

- B. Exterior alarm signals shall be listed to: UL 1971; UL 1638; UL 464; ULC S525 and S526; ADA Chapter 28, Part 36 Final Rule; and NFPA 72.
- C. All exterior alarm signals shall be UL listed for fire protective service.
- D. Exterior alarm signals shall be capable of operating from standard signaling circuits or from addressable intelligent signal modules.
- E. Exterior alarm signals shall be suitable for installation of the exterior of the building, bear the appropriate UL label, and shall be furnished complete with a surface mounted weatherproof outlet box.
- F. An exterior alarm signal that will meet this Specification is EST Model No. WGRF-H complete with red finish, mounting plate, and model no. 74347U red finished surface mounted weatherproof outlet box with Model No. WG4RTS red alarm skirt.

2.14 REMOTE LCD ANNUNCIATOR:

- A. Remote LCD annunciator shall have the full ability and duplicate all functions of the main user interface located on the control panel. This includes the ability to control all system functions and duplicate panel annunciation.
- B. Annunciator shall also include the ability to support programmable switches and or LED's as required for special functions with out the need to add additional wires or cabinets as detailed on the drawings.
- C. The annunciator shall be supplied with Surface mounted backboxes as shown on drawings. EST model no. RLCD-CR remote LCD text annunciator with common controls and RA-ENC-1 single remote annunciator enclosure.

2.15 REMOTE DRILL SWITCH/ALARM INDICATOR

- A. This contractor shall furnish and install all necessary components to provide a remote drill switch/alarm indicator as detailed on the drawings. Locate the remote drill switch/alarm indicator in the existing school buildings' main office adjacent to the existing fire alarm annunciator.
- B. This contractor to install the required type and quantity of wiring, as determined by the equipment manufacturer, in 1/2" conduit from the remote drill switch/alarm indicator to the fire alarm control panel.

2.16 MAGNETIC DOOR HOLDERS

- A. Magnetic door holders shall be furnished and installed by this Contractor as required for the mounting conditions and controlled by the fire alarm and

detection system. This Contractor shall coordinate with the hardware supplier and the door installer to assure alignment, preparation, and operation with the associated doors. The door mounted magnets shall be mounted with bolts through the door with finish grade back plate. Magnets shall be 24VDC and shall be mounted as indicated on the Drawings.

- B. This Contractor shall furnish and install an intelligent control module for each set, or adjacent sets, of magnetic door holders as shown on the Drawings or provide a power source at the main FACP with a control relay for deactivation.
- C. A magnetic door holder, which will meet this Specification, is EST model no. 1504-AQ (flush mounted with a long catch plate), or 1505-AQ (flush mounted with a short catch plate).
- D. Magnetic door holders shall be recessed in the wall. For surface mounting, mount magnetic door holder in FS Box. Wiremold surface mounted box shall not be accepted.

2.17 FIELD WIRING

- A. Field wiring for each intelligent loop shall consist of cables furnished and installed by this Contractor and shall be plenum rated cable in minimum ½" EMT conduit and as hereinbefore specified. The type, size, and number of conductors in the cable shall be in strict compliance with the manufacturer's requirements.
- B. Field wiring for all alarm signals shall consist of cables furnished and installed by this Contractor and shall be plenum rated cable in minimum ½" EMT conduit and as herein before specified. The type, size, and number of conductors in the cable shall be in strict compliance with the manufacturer's requirements.
- C. Magnetic door holder power wiring from the main control panel shall be two (2) conductors, No. 12 AWG, furnish and installed by this Contractor and shall be plenum rated cable in minimum ½" EMT conduit and as herein before specified. The type, size, and number of conductors in the cable shall be in strict compliance with the manufacturer's requirements.

PART 3 EXECUTION

3.01 FIRE ALARM CONTROL EQUIPMENT

- A. All fire alarm control equipment, including the main control panel and any signal extender panels shall be supplied from the building's 120 volt power source as shown on the Drawings. All fire alarm control equipment, including the main control panel and any signal extender panels shall be located in the Communications Room as shown on the Drawings. This Contractor shall be responsible for providing any additional devices required by code or these

specifications for any control equipment located other than in the Communications Room, including 120 volt EMERGENCY power. These other locations must be specifically approved by the Owner.

3.02 MAIN CONTROL PANEL

- A. The main control panel backbox(s) shall be mounted on the wall, and all interior components furnished and installed by this Contractor, at the location shown on the Drawings in accordance with manufacturer's recommendations. Mounting height shall be approximately sixty (60) inches above the finished floor to the center of cabinet.

3.03 MANUAL STATIONS

- A. Manual stations shown on the Drawings to be installed on existing walls or partitions shall be furnished and installed in surface device boxes of the appropriate size and shall be suitable for use with surface metal raceway. Existing conduits concealed in masonry walls may be reused only with the written approval of the Owner.
- B. Manual stations shown on the Drawings to be installed in new construction shall be furnished and installed by this Contractor to flush device boxes of the appropriate size as recommended by the equipment manufacturer.
- C. Wire guards shown on the Drawings to be installed over manual stations shall be furnished and installed by this Contractor. Wire guards shall not be anchored into acoustical wall panels. This Contractor shall ensure that wood blocking is installed behind the wall panels. The wire guards shall be anchored through the wall panels and into the wood blocking.

3.04 SMOKE DETECTORS

- A. Smoke detectors shown on the Drawings to be installed in areas with suspended ceilings shall be surface mounted as high as possible on ceiling with concealed outlet boxes supported from structure.
- B. Smoke detectors shown on the Drawings to be installed in areas without suspended ceilings shall be mounted to a surface mounted outlet box rigidly attached to the building structure independently of the associated conduits.

3.05 INTELLIGENT CONTROL, MONITOR, AND SIGNAL MODULES

- A. Intelligent control, monitor, and signal modules shall be flush mounted in the ceiling as close as possible to the associated device. In areas without ceilings, the modules may be mounted to the underside of the structure, or wall mounted. Wherever possible, the modules shall be ganged together.

3.06 REMOTE ANNUNCIATOR PANEL

- A. The remote annunciator panel backbox shall be flush or surface mounted as shown on drawings, and all interior components furnished and installed by this Contractor, at the location shown on the Drawings in accordance with manufacturer's recommendations. Mounting height shall be approximately fifty two (52) inches above finished floor to the center of cabinet.

3.07 ALARM SIGNALS

- A. Audio/visual and visual only alarm signals shown on the Drawings to be installed on existing walls or partitions shall be furnished and installed by this Contractor over surface device boxes of appropriate size and suitable for use with surface metal raceways.
- B. Audio/visual and visual only alarm signals shown on the Drawings to be installed in new construction shall be furnished and installed by this Contractor over concealed device boxes of appropriate size with the appropriate trim rings.
- C. Wire guards shown on the Drawings to be installed over alarm signals shall be furnished and installed by this Contractor. Wire guards shall not be anchored into acoustical wall panels. This Contractor shall insure that wood blocking is installed behind the wall panels. The wire guards shall be anchored through the wall panels and into the wood blocking.
- D. Audio/visual and visual only alarm signals shown on the Drawings to be installed flush and/or semi-flush mounted in ceilings shall be installed by this Contractor over concealed flush mounted device boxes of appropriate size with the appropriate trim rings. The box shall be supported by ceiling support bridges and steel wire directly to building structure.

3.08 FIELD WIRING

- A. All line and low voltage wiring, conduit, backboxes, device mounting boxes, and junction boxes required for the fire detection and alarm system shall be furnished and installed by this Contractor.
- B. All vertical low-voltage field wiring shall be installed by this Contractor in conduit and/or surface metal raceway as shown on the Drawings. Conduit fill shall not exceed the conduit space capacity.
- C. All horizontal wiring for the fire detection and alarm system to be installed in areas without a ceiling or in areas without an accessible ceiling shall be installed by this Contractor in conduit. Conduit fill shall not exceed the conduit space capacity.
- D. All horizontal low voltage field wiring to be installed in areas with accessible ceilings shall be installed by this Contractor in minimum ½" EMT conduit above the ceilings.

- E. All horizontal low-voltage field wiring in minimum ½" EMT conduit shall be run at right angles to the building structure.
- F. All horizontal low voltage field wiring shall be installed below the roof/floor structural supports (joists, beams, girders, etc.). Wiring installed between the structural supports mentioned above and the roof or floor deck will not be acceptable.
- G. All horizontal low voltage field wiring penetrations through walls shall be sleeved. Minimum sleeve size shall be ¾ inch. All sleeves shall be bushed both sides.
- H. This Contractor shall make all connections to panels, devices, and detectors with crimp type spade terminal connectors. Splices in station circuits shall be made only in junction boxes and shall be crimp connected.
- I. All wiring shall be checked and tested by this Contractor to insure the system is free from grounds, opens, and shorts.
- J. The installation and final connections of all components and devices shall be performed under the direct supervision of the system manufacturer's technical staff.

3.09 FIELD PROGRAMMING

- A. The manufacturer's technical representative shall field program the fire detection and alarm system after all related equipment has been installed and prior to any final testing. The technical representative shall be factory certified for programming. The initial program shall be developed by the equipment supplier in conjunction with the Owner and Fire Marshal.
- B. In addition to the initial field programming described above, the manufacturer shall furnish an additional two (2) field programming changes to be performed at any time during the warranty period at no additional expense to the Owner.

3.10 ON-SITE AS-BUILT DRAWINGS

- A. The Contractor shall provide one (1) set of the fire alarm system supplier's as-built drawings for permanent use on-site. The Contractor shall laminate each page of these drawings; provide a rigid means for mounting such as 1/4 inch thick x two (2) inch wide x width of the drawings through-bolted wood along the left edge of the drawings; furnish and install hanging hooks on the back of the Communications Room door; and hang the bound set of drawings.

END OF SECTION

SECTION 16620

SECURITY INTRUSION SYSTEM

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work covered under this Section shall include furnishing and installing a centrally controlled complete and satisfactorily operating security intrusion system for the pick-up, amplification, and annunciation of: building intrusion; fire alarm activation and trouble signals; emergency engine generator set run and fault signals; and boiler trouble signals to the Owner's central office.

1.03 QUALITY ASSURANCE

- A. All equipment and materials for this system shall be listed by Underwriter's Laboratories, Inc. (UL), bear the UL label, and shall be installed in accordance with all requirements of the National Electrical Code (NEC), all state and local codes, and these Specifications.
- B. This Contractor must show evidence of successfully furnishing and installing systems specified for at least five (5) years, and shall be Department of Criminal Justice Services (DCJS) certified for security installations by the Commonwealth of Virginia.
- C. Equipment shall be constructed in accordance with National Electrical Manufacturer's Association (NEMA) standards.
- D. This Contractor shall furnish submittals for all components of the security system in accordance with SECTION 16010 of these Specifications. Submittals shall include the following for review. Submittals not containing all of the information listed below will be rejected.
 - 1. A complete list by model number of each component of the system with a statement of how many pieces of each model to be furnished and a listing of the specific data sheet.
 - 2. A description of the system as it functions by component in the system using model numbers where applicable.
 - 3. A data sheet shall be furnished for each component of the system. The

- specific information shall be highlighted.
4. A detailed set of floor plans for the complete building shall be furnished showing the locations of all equipment and devices and their required interconnections. Security devices shall be zoned as shown on the Drawings. The interconnections shown shall indicate the number, size, and type of wires as described in this Specification. The layout of all security intrusion system equipment and devices shall closely follow that shown on the Drawings.
 5. A detailed drawing shall be furnished of each type of device showing the exact terminal designations.
 6. A detailed list shall be furnished of each type of device in the system stating its program function in the system.
- E. This Contractor shall furnish and install all outlet boxes, conduit, wiring, door switches, security motion detectors, equipment locations, terminals, and all other accessories required to install a security intrusion system as herein specified and as indicated on the Drawings. The system shall be installed, connected, tested, and left in a first class operating condition.
- F. Catalog numbers specified for the security system constitute type, quality, and operating characteristics of the equipment and system to be furnished. The master and all peripheral devices that comprise the system shall be listed by Underwriter's Laboratories, Inc., (UL) and shall bear the UL label and shall be installed in accordance with all requirements of the National Electrical Code (NEC), all local codes, and these Specifications.

1.04 DOCUMENTATION

- A. This Contractor shall furnish to the Owner four (4) bound copies of complete operating and maintenance instructions of the system including Digital Monitoring Products (DMP) XR500 series programming sheets, circuit diagrams and all other information necessary for the proper operation, service, and maintenance.
- B. This Contractor shall furnish to the Owner a set of "as-built" drawings complete with field wiring diagrams.

1.05 TRAINING

- A. This Contractor shall furnish the Owner's designated representatives eight (8) hours of on-the-job technical service instructions in the operating, maintenance, and troubleshooting of the system.

1.06 DESCRIPTION OF OPERATION

- A. The security system shall be furnished and installed as shown on the Drawings and as specified herein and shall function as follows:
1. Monitor the normally open (with resistor at end of the line) door switch zones. Zones shall be circuited as shown on the Drawings.
 2. Monitor the fire detection and alarm system through normally opened contacts at the fire alarm control panel to activate by contact break on alarm condition and on a trouble condition.
 3. Respond to motion detection contacts normally open (with resistor at end of the line) and tamper. Zones shall be circuited as shown on the Drawings.
 4. Monitor roof hatch openings by opening switch contacts in normally open (with resistor at end of the line) zone loops. Zones shall be circuited as shown on the Drawings.
 5. Provide remote arming and disarming of the system from a semi-flush mounted keypad.
 6. Monitor the normally open (with resistor at end of the line) knock box zone. Zones shall be circuited as shown on the Drawings.
 7. Monitor the normally open contacts on the emergency generator for generator run and fault. Zones shall be circuited as shown on the Drawings.
 8. Monitor the normally open contacts for each boiler shown for boiler alarm. Zones shall be circuited as shown on the Drawings.
 9. Monitor the normally open contacts at automatic temperature control (ATC) main control panel for panel trouble and building temperature sensor (to be programmable at ATC panel). Zones shall be circuited as shown on the Drawings.

1.07 SYSTEM TEST AND ACCEPTANCE

- A. Prior to the Architect/Engineer's final site visitation, and acceptance of each construction phase, this Contractor shall conduct an operating test of the complete system including each device. The system shall test free from grounds, shorts, and other faults. All connections shall be thoroughly checked for mechanical and electrical connection. All equipment shall be demonstrated to operate in accordance with the requirements set forth in these Specifications and as shown on the Drawings.
- B. This Contractor shall perform all tests in the presence of the Owner. This

Contractor shall furnish all personnel for use in the test.

- C. When the work on the system has been completed and is ready for final review, a visit shall be made by the Owner at which time the Contractor shall demonstrate that the requirements of the Contract as it applies to this system have been carried out and that the system has been adjusted and operated in accordance herewith.

1.08 WARRANTY

- A. This Contractor shall deliver the work in first-class operating condition in every respect. This Contractor shall also warrant that the material, equipment, and workmanship furnished shall be entirely free from defects. Any materials, equipment, or workmanship in which defects may develop before or during the warranty period shall be repaired or replaced at the Contractor's own expense. Refer to SECTION 01740 for the start of the warranty period. This Contractor shall further warrant that all material, equipment, and workmanship used in the installation, but not specifically mentioned in the Drawings and Specifications, is the best of their respective kinds and that the construction and installation was performed in accordance with the best accepted standard practices in all details.

1.09 SPARE PARTS

- A. This Contractor shall furnish to the Owner spare parts as follows. Spare parts shall be furnished prior to the installation of the system.
 - 1. Two (2) wide pattern, narrow pattern and barrier pattern type motion detectors.

1.10 EQUIPMENT LOCATIONS

- A. This Contractor shall furnish and install where shown on the Drawings, wall mounted main and sub-distribution equipment locations consisting of fire resistant 3/4 inch thick plywood backboards and the distribution equipment as detailed on the Drawings.

PART 2 - PRODUCTS

2.01 FIELD INTERFACE COMMUNICATOR DEVICE

- A. The (new) field interface communicator device shall be furnished and installed by this Contractor as detailed on the Drawings. Digital Monitoring Products (DMP) Cat. No. XR550 complete with 16.5 VAC 50 VA transformer, one (1) 893A dual phone line module, one (1) 318 battery harness and two (2) 365 lead-acid batteries.

- B. The field interface communicator device exists and shall be relocated (removed) by this Contractor as detailed on the Drawings.

2.02 ZONE EXPANDER MODULES

- A. The zone expander modules shall be furnished and installed by this Contractor as detailed on the Drawings.
 - 1. LX-Bus zone expander modules shall be Digital Monitoring Products (DMP) Cat. No. 714-16 sixteen (16) zone expander. Refer to floor plans for exact number required.
 - 2. Keypad zone expander modules shall be Digital Monitoring Products Cat. No. 714 four (4) zone expander surface mounted on a single gang device box. Refer to floor plans for exact number required.
- B. The zone expander modules exist and shall be relocated by this Contractor as detailed on the Drawings.

2.03 SECURITY DOOR SWITCHES

- A. Security door switches shall be HONEYWELL Cat. No. 7939-2 complete with spacers, covers and mounting screws.

2.04 SECURITY OVERHEAD DOOR AND ROOF HATCH SWITCHES

- A. Security overhead door and roof hatch switches shall be single pole, single throw, two (2) wire, HONEYWELL Cat. No. 958-2.

2.05 SECURITY MOTION DETECTORS

- A. Security wall mounted motion detectors noted on the Drawings to be the wide pattern type shall be HONEYWELL Cat. No. DT-900 or BOSCH Cat. No. DS720i anti-mask type and shall include mounting brackets and hardware for wall mounting as shown on the Drawings.
- B. Security wall mounted motion sensors noted on the Drawings to be the narrow pattern type shall be HONEYWELL Cat. No. DT-906 or BOSCH Cat. No. DS720i anti-mask type and shall include mounting brackets and hardware for wall mounting as shown on the Drawings.
- C. Security wall mounted motion sensors noted on the Drawings to be the barrier pattern type shall be HONEYWELL Cat. No. DT-7450C or BOSCH Cat. No. OD850 and shall include mounting brackets and hardware for wall mounting as shown on the Drawings.

2.06 POWER SUPPLY FOR SECURITY MOTION DETECTORS

- A. This Contractor shall furnish and install at the main distribution equipment location power supply unit(s) rated 12 volts DC with a minimum six (6) amp capacity. The power supply shall be ALTRONIX or approved equal.

2.07 REMOTE KEYPAD

- A. The remote keypad shall be furnished and installed by this Contractor over a flush mounted single gang outlet box as detailed on the Drawings. Digital Monitoring Products (DMP) Cat. No. 7060N (white) security command keypad mounted on a 696-W back box.
- B. The remote keypad is existing and shall be relocated by this Contractor as shown on the Drawings. The outlet box shall be furnished and installed by this Contractor.

2.08 EQUIPMENT LOCATIONS

- A. This Contractor shall furnish and install where shown on the Drawings, wall mounted main and sub-distribution equipment locations consisting of fire resistant 3/4-inch thick plywood backboards and IDEAL cat. No. 89-212 terminal strips as detailed on the Drawings.

2.09 WIRING

- A. Zone wiring for security door switches (including the overhead door and roof hatch switches), as shown on the Drawings shall be furnished and installed by this Contractor and shall consist of a two (2) conductor, No. 18 AWG, plenum rated cable with a temperature range for dry locations of minus ten (10) degrees C to sixty (60) degrees C. A cable which will meet this Specification is WEST PENN Cat. No. 25224B or equal as manufactured by BELDEN, CONSOLIDATED WIRE, GENERAL CABLE, PAIGE, WINDY CITY WIRE or TAPPAN.
- B. Zone wiring and power wiring for the security motion detectors as shown on the Drawings shall be furnished and installed by this Contractor and shall consist of a single four (4) conductor, No. 18 AWG, unshielded, plenum rated cable with a temperature range for dry locations of minus ten (10) degrees C to seventy-five (75) degrees C. A cable, which will meet the specification, is WEST PENN Cat. No. 25244B or equal as manufactured by BELDEN, CONSOLIDATED WIRE, GENERAL CABLE, PAIGE, WINDY CITY WIRE or TAPPAN. Conductor colors shall be white and green conductors for zone wiring and red (positive) and black (negative) conductors for power wiring.
- C. Security motion detectors' power wiring from the main power supply (located at the main distribution equipment location [SIS-MDEL-A]) to each sub-distribution

equipment location shall be two (2) conductor, No. 12 AWG plenum rated cable with a temperature range for dry locations of minus ten (10) degrees C to sixty (60) degrees C. A cable that will meet this Specification is WEST PENN Cat. No. 25227B or equal as manufactured by BELDEN, CONSOLIDATED WIRE, GENERAL CABLE, PAIGE or WINDY CITY WIRE. Conductor colors shall be red (positive) and black (negative).

- D. This Contractor shall furnish and install one (1) six (6) conductor, No. 18 AWG, unshielded, plenum rated cable with a temperature range for dry locations of minus ten (10) degrees C to seventy-five (75) degrees C in 1/2 inch conduit to the fire alarm control panel and connect to the normally open auxiliary trouble and alarm relays as detailed on the Drawings. A cable that will meet this Specification is WEST PENN Cat. No. 25186B or equal as manufactured by BELDEN, CONSOLIDATED WIRE, GENERAL CABLE, PAIGE or WINDY CITY WIRE.
- E. Wiring for the remote keypad and LX busses shall be furnished and installed by this Contractor and shall consist of a one (1) four (4) conductor, No. 18 AWG unshielded, plenum rated cable with a temperature range for dry locations of minus ten (10) degrees C to seventy-five (75) degrees C to the field interface device as shown on the Drawings. A cable that will meet this Specification is WEST PENN Cat. No. 25244 or equal as manufactured by BELDEN, CONSOLIDATED WIRE, GENERAL CABLE, PAIGE or WINDY CITY WIRE.
- F. Outside plant (flooded) wiring for LX busses shall be furnished and installed by this Contractor and shall consist of a one (1) four (4) conductor, No. 18 AWG unshielded cable to the field interface device as shown on the Drawings. A cable that will meet this Specification is WEST PENN Cat. No. AQ244 or equal as manufactured by BELDEN, CONSOLIDATED WIRE, GENERAL CABLE, PAIGE or WINDY CITY WIRE.

2.10 MISCELLANEOUS EQUIPMENT

- A. This Contractor shall furnish, where shown on the drawing, the following equipment:
 - 1. LX and keypad bus extender modules, Digital Monitoring Products (DMP) Cat. No. 708.
 - 2. LX and keypad bus splitter/repeater module, Digital Monitoring Products (DMP) Cat. No. 710.

PART 3 - EXECUTION

3.01 FIELD INTERFACE COMMUNICATOR DEVICE

- A. The field interface communicator device shall be furnished and installed by this Contractor adjacent to the security intrusion system main distribution equipment location. This Contractor shall extend LX and keypad bus wiring as detailed on the Drawings and connect as directed by the Owner.
- B. The field interface communicator device exists and shall be relocated by this Contractor adjacent to the security intrusion system main distribution equipment location. This Contractor shall extend LX and keypad bus wiring as detailed on the Drawings and connect as directed by the Owner.

3.02 ZONE EXPANDER MODULE

- A. The zone expander module(s) shall be furnished and installed by this Contractor as detailed on the Drawings. All connections to the field interface communicator shall be as directed by the Owner. This Contractor shall extend zone wiring from the security intrusion device(s) (door switches, motion detectors) to the zone expander module(s) as detailed on the Drawings and connect as directed by the Owner.
- B. The zone expander module(s) exists and shall be relocated by this Contractor as detailed on the Drawings. All connections to the field interface communicator shall be as directed by the Owner. This Contractor shall extend zone wiring from the security intrusion device(s) (door switches, motion detectors) to the zone expander module(s) as detailed on the Drawings and connect as directed by the Owner.

3.03 DOOR SWITCHES

- A. This Contractor shall install the door switches, including overhead door and roof hatch switches, in accordance with mounting details as shown on the Drawings and as appropriate for each field condition.

3.04 SECURITY INTRUSION SYSTEM MOTION DETECTORS

- A. The wall mounted security motion detectors shall be securely mounted to the wall. Wide and narrow pattern motion detectors shall be mounted directly to wall 10'-0" above the floor. Where ceiling heights do not allow a 10'-0" mounting, then mount twelve (12) inches below the ceiling. Do not mount wide and narrow pattern motion detectors to a flush or surface mounted device box. The barrier pattern motion detectors shall be mounted at 7'-6" above the floor and be mounted to a flush or surface mounted device box. Where ceiling heights do not allow a 7'-6" mounting, then mount six (6) inches below the ceiling. All mounting measurements shall be to the bottom of the wall mounting bracket.

3.05 FIELD WIRING

- A. All vertical low voltage field wiring shall be installed by this Contractor in 1/2-inch

conduit and/or surface metal raceway as shown on the Drawings.

- B. All horizontal low voltage field wiring to be installed in areas without a ceiling or in areas without an accessible ceiling shall be installed by this Contractor in 1/2-inch conduit. Conduit is not required in areas designated on the Drawings as "Electric/Communications" rooms or closets.
- C. All horizontal low voltage field wiring to be installed in areas with accessible ceilings shall be installed by this Contractor bundled together and run exposed above the ceilings. Bundles shall be supported by "J" hooks mounted not more than four (4) feet on center. "J" hooks to be dedicated to the wiring specified in this specification section.
- D. All horizontal low voltage field wiring shall be installed below the roof/floor structural supports (joists, beams, girders, etc). The wiring installed between the structural supports mentioned above and the roof or floor deck will not be acceptable.
- E. This Contractor, with insulated crimp wire connections, shall make all low voltage wiring terminations. All low voltage field-wiring interconnections shall be made in junction boxes. All junction box covers shall be stenciled for distinct identification.
- F. All conduits, device mounting boxes, junction boxes, and line voltage wiring shall be furnished and installed by this Contractor.
- G. All wiring installed outside the footprint of a building shall be outside plant (flooded), indoor/outdoor, type cables.

3.06 INSTALLATION

- A. All low-voltage wiring and connections shall be made by this Contractor as directed by the equipment manufacturer.
- B. This Contractor shall label all security intrusion system junction boxes covers with the zone numbers contained therein.
- C. All wiring shall be checked and tested by this Contractor to ensure the system is free from grounds, opens, and shorts.
- D. The interconnections of components shall be as recommended by the manufacturer of the equipment including the fire alarm system interface.
- E. Door switches shall be wired by this Contractor in series for each zone as shown on the Drawings.
- F. The installation and final connections of all components and wiring shall be

performed by this Contractor under the direct supervision of the Owner's technical staff.

- G. Final connection of all security zones' wiring to the field interface device shall be performed by this Contractor under the supervision of the Owner's technical staff. Security system zones shall be as shown on the drawings.
- H. All horizontal low voltage field-wiring penetrations through new and/or existing walls shall be sleeved. Minimum sleeve size shall be 3/4 inch. All sleeves shall be bushed both sides. Cables pulled through sleeves without bushings, cut bushings, wrapped with tape will not be accepted and shall be replaced by the Contractor.
- I. All horizontal, low voltage field wiring shall be run at right angles to the building structure.
- J. Motion detector tamper switches and anti-mask shall be wired by this Contractor in strict conformance with the manufacturer's recommendations.

3.07 TEMPORARY COVERAGE DURING CONSTRUCTION

- A. This Contractor shall provide three (3) motion detectors (wide/narrow pattern) and one security door switch for temporary coverage for each phase. Contractor shall consider 1000 ft. cable per device for temporary coverage for each phase. If the material is not used during construction, Contractor shall provide applicable credit to the Owner.

3.08 ON-SITE AS-BUILT DRAWINGS

- A. The Contractor shall provide one (1) set of the security intrusion system supplier's as-built drawings for permanent use on-site. The Contractor shall: laminate each page of these drawings; provide a rigid means for mounting such as 1/4 inch thick x two (2) inch wide x width of the drawings through-bolted wood along the left edge of the drawings; furnish and install hanging hooks on the back of the Communications Room door; and hang the bound set of drawings.

END OF SECTION

SECTION 16625

DOOR ACCESS VIDEO ENTRY SYSTEM

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work covered under this Section shall include furnishing and installing a centrally controlled, complete and satisfactorily operating door access video entry system for the monitoring, control and recording of access to the building.

1.03 QUALITY ASSURANCE

- A. The purpose of the door access and video entry is to protect the safety and security of students, employees, and authorized visitors on school system property. Program guidelines, installation, and system programming must be strictly adhered to.
- B. This Contractor shall follow the door access and video entry drawings and schedule from Owner. The drawings and schedule indicate the door access devices and supporting accessories to furnish and install.
 - 1. Automatic door openers, also known as door operators, support building entry for disabled visitors; the openers shall be installed to work in tandem with door access video entry stations at the main entrance of a school. The automatic door opener shall be installed on the same door that is scheduled to receive an electronic strike/lock. The door access video entry station, electronic strike and automatic door opener shall be configured together at a single point of entry. The door shall open on demand by authorized staff interface and other doors at the entrance may remain locked.
- C. All equipment and materials for this system shall be listed by Underwriter's Laboratories, Inc. (UL), bear the UL label, and shall be installed in accordance with all requirements of the National Electrical Code (NEC), all state and local codes, and these Specifications.
- D. Equipment shall be constructed in accordance with National Electrical Manufacturer's Association (NEMA) standards.
- E. This Contractor shall furnish submittals for all components of the security access

video entry system in accordance with SECTION 16010 of these Specifications. Submittals shall include the following for review. Submittals not containing all of the information listed below will be rejected.

1. A complete list by model number of each component of the system with a statement of how many pieces of each model to be furnished and a listing of the specific data sheet.
 2. A description of the system as it functions by component in the system using model numbers where applicable.
 3. A data sheet shall be furnished for each component of the system. The specific information shall be highlighted.
 4. A detailed set of floor plans for the complete building shall be furnished showing the locations of all equipment and devices and their required interconnections. Door access devices shall be addressed as shown on the Drawings. The interconnections shown shall indicate the number, size, and type of wires as described in this Specification.
 5. Door access and video entry devices shall be addressed as shown on the drawings and schedule provided by the Owner. Addresses are required for system programming and edge device purposes. Addresses shown will distinguish from the Digital Monitoring Product (DMP) and the Aiphone system components. The first address for DMP proximity devices shall be labeled as DMP. The second address refers to the Aiphone system and its control unit. Aiphone addresses shall be labeled as AIPHONE.
 6. A detailed drawing shall be furnished of each type of device showing the exact terminal designations.
 7. A detailed list shall be furnished of each type of device in the system stating its program function in the system.
- F. This Contractor shall furnish and install all outlet boxes, conduit, wiring, terminals strips, door readers, video door stations, master and sub stations, power supplies, adapters, backboxes, enclosures, associated equipment and all other accessories required to install a door access video entry system as herein specified and as indicated on the Drawings. The system shall be installed, connected, tested, and left in a first class operating condition.
- G. Catalog numbers specified for the door access video entry system constitute type, quality, and operating characteristics of the equipment and system to be furnished. The master and all peripheral devices that comprise the system shall be listed by Underwriter's Laboratories, Inc., (UL) and shall bear the UL label and shall be installed in accordance with all requirements of the National Electrical

- Code (NEC), all local codes, and these Specifications.
- H. The equipment to be furnished by this Contractor under these Specifications shall be by the approved manufacturer. Acceptable manufacturers shall be engaged in the manufacture of door access video entry equipment for at least seven (7) years and have a fully equipped, factory trained and authorized service organization within a fifty (50) mile radius of the job site. The acceptable manufacturers shall be as follows: DMP, AIPHONE.
 - I. The door access video entry system shall be furnished by a factory-authorized distributor certified to design, program, and service the system. This distributor must show evidence of successfully furnishing systems as specified for at least five (5) years. This distributor shall provide twenty four (24) hour, seven (7) day a week (including holidays) service capability with a maximum four (4) hour response time. This distributor shall provide certification of this capability as part of the submittals.
 - J. This Contractor must show evidence of successfully furnishing systems specified for at least five (5) years, and shall be Department of Criminal Justice Services (DCJS) certified for security installations by the Commonwealth of Virginia.
 - K. Scope Changes-This Contractor shall make no changes in the work without an issuance of a written scope change request to Owner. Conversely, at times when the Owner deems it necessary for a scope change, a written request will be provided to Construction Representative and General Contractor.
 - L. Point of Contact-This Contractor shall provide a specific point of contact, in addition to the Design & Construction Field Representative, to Owner at the beginning of the installation. Information, changes, questions, problems and general communication about the door access and video entry or cable installation shall be between the Owner, Field Representative, and the Contractor's established point of contact.

1.04 DOCUMENTATION

- A. This Contractor shall furnish to the Owner four (4) bound copies of complete operating and maintenance instructions of the system including circuit diagrams and all other information necessary for the proper operation, service and maintenance.
- B. This Contractor shall furnish to the Owner a set of "as-built" drawings complete with field wiring diagrams upon completion of the project.

1.05 TRAINING

- A. The Owner, Office of Safety and Security (OSS), will provide specialty installation technique training to this Contractor as required.

- B. In most cases, the Owner shall provide programming to system control and edge devices. When directed, the Contractor may be directed to program some local, non-FCPS network LAN/WAN devices. The Owner, Office of Safety and Security, will provide this Contractor base level system program training as required.
- C. This Contractor shall not provide end user training to school staff to operate door access and video entry and use of supporting software. Training for end users shall be provided by the Owner, Office of Safety and Security.

1.06 DESCRIPTION OF OPERATION

- A. The door access video entry system on shall be furnished and installed as shown on the Drawings and as specified herein and shall function as follows:
 - 1. Provide video and two-way communication from the video monitoring station to each master station.
 - 2. Monitor all access door status from the controller.
 - 3. Provide ability to control access from controller to each access door.
 - 4. Activate door release lock from master station.
 - 5. Egress through doors shall not be impeded by loss of power. In the event of a fire emergency it shall be possible for free egress through doors.

1.07 SYSTEM TEST AND ACCEPTANCE

- A. Prior to the Architect's/Engineer's/OSS's final site visitation, this Contractor shall conduct an operating test of the complete system including each device. The system shall test free from grounds, shorts, and other faults. All connections shall be thoroughly checked for mechanical and electrical connection. All equipment shall be demonstrated to operate in accordance with the requirements set forth in these Specifications and as shown on the Drawings.
- B. This Contractor shall perform all tests in the presence of the Owner/OSS. This Contractor shall furnish all personnel for use in the test.
- C. When the work on the system has been completed and is ready for final review, this Contractor shall arrange through Owner's OSS representative, and D&C site representative, a system inspection. The Contractor shall demonstrate that the requirements of the Contract, as it applies to this system, have been carried out and that the system has been adjusted and operated in accordance herewith.

1.08 WARRANTY

- A. This Contractor shall deliver the work in first-class operating condition in every respect. This Contractor shall also warrant that the material, equipment, and workmanship furnished shall be entirely free from defects. Any materials, equipment, or workmanship in which defects may develop before or during the warranty period shall be repaired or replaced at the Contractor's own expense. Refer to SECTION 01740 for the start of the warranty period. The Contractor shall further warrant that all material, equipment, and workmanship used in the installation, but not specifically mentioned in the Drawings and Specifications, is the best of their respective kinds and that the construction and installation was performed in accordance with the best accepted standard practices in all details.

PART 2 - PRODUCTS

2.01 DOOR ACCESS INTERFACE DEVICE

- A. The (new) door access interface device shall be furnished and installed by this Contractor as detailed on the Drawings. Digital Monitoring Products (DMP) Cat. No. XR550 complete with 16.5 VAC 50 VA transformer, one (1) 318 battery harness and two (2) 365 lead-acid batteries. **Engineer to edit.**
- B. The existing door access interface device shall be removed or relocated by this Contractor as detailed on the Drawings.

2.02 DOOR ACCESS POWER SUPPLY

- A. Digital Monitoring Products Cat. No. 340 panel enclosure complete with 502-12 power supply with one (1) 318 battery harness, one (1) 367 lead-acid battery, and 321 (40 va) plug-in transformer with ES501 transformer enclosure.
- B. Where door access entrance locations have removable door mullions, this Contractor shall furnish and install a Von Duprin Cat. No. PS-914 power supply with battery back-up.

2.03 VIDEO DOOR STATIONS

- A. Video Door Station with Embedded Proximity Reader shall be Aiphone Cat No. IX-DVF-P with SBX-IDVFRA stainless steel surface mounted box. It shall incorporate the following features:
1. Built-in $\frac{1}{3}$ " CMOS 1.23 megapixel camera, speaker and mic for communications.
 2. Embedded HID multiCLASS SE® RP10 reader.
 3. Stainless steel faceplate with flame and shatter resistant Lexan camera

cover.

4. Surface mounted with tamper proof screws
 5. Dimensions (HxWxD) 11-11/16" x 7" x 3- 5/16" (top); 2- 5/16" (bottom) (outer panel dimensions)
- B. School Age Child Care (S.A.C.C.) entrance video door station shall be Aiphone Cat. No. IX-DVF-P with SBX-IDVFRA. It shall incorporate the following features:
1. Built-in 1/3" CMOS 1.23 megapixel camera, speaker and mic for communications.
 2. Embedded HID multiCLASS SE® RP10 reader.
 3. Stainless steel faceplate with flame and shatter resistant Lexan camera cover.
 4. Surface mounted with tamper proof screws
 5. Dimensions (HxWxD) 11-11/16" x 7" x 3- 5/16" (top); 2- 5/16" (bottom) (outer panel dimensions)
 6. The SACC entrance video door station shall be configured to ring at the SACC master station, not the main school office.

2.04 PROXIMITY READER

- A. The proximity reader shall be compatible with door access controller. It shall incorporate the following features:
1. Built in self-test routine at start up
 2. Weatherized enclosure for indoor and outdoor mounting applications
 3. Indicator LED for card read verification
 4. Able to recognize over 137 billion unique codes
 5. Wiegand interface
 6. Operate voltage between 5 – 16 volts
 7. Dimensions of 3.135" x 1.720" x 0.66"
 8. Operating current of 30mA avg, 75mA peak
- B. The proximity reader shall be a DMP - PROXPOINT PLUS Cat No. PP6005B

Manufactured by H.I.D.

2.05 MASTER STATION(S)

- A. The master stations for the video entry systems shall incorporate the following features:
1. 7" color touchscreen
 2. Handset for privacy or hands-free VOX communications
 3. Built-in cameras for two-way master-to-master video conferencing (w/ privacy shutter).
 4. Eight (8) speed dial buttons
 5. 2 contact outputs, 4 trigger inputs
 6. PoE (IEEE 802.3 af class 0) Power Source
 7. Desk stand included
- B. The master stations shall be Aiphone Cat No. IX-MV7-HB.

2.06 ELECTRIC DOOR STRIKE

- A. Furnish and install VON DUPRIN Model No. 6300 (surface) electric strike or 5100 (recessed) electric strike.
- B. Where door access entrance location have removable door mullions, this Contractor shall furnish and install, within the Von Duprin 99 exit rim device, a Von Duprin "EL" conversion kit and Keedex cat no. K-DLA armored cable.
- C. Installation of all electric door strikes and controlled panic rim devices shall be installed by a qualified door hardware installer.

2.07 REMOTE KEYPAD

- A. The remote keypad shall be furnished and installed by this Contractor over a surface mounted single gang outlet box as detailed on the Drawings. Digital Monitoring Products (DMP) Cat. No. 690-W security command keypad mounted on a 696-W back box.

2.08 VIDEO ENTRY SYSTEM OUTLET

- A. This Contractor shall furnish and install where shown on the Drawings, wall mounted video entry system outlets each consisting of: one (1) ORTRONICS Part No. OR-40300270 single-gang faceplate; one (1) ORTRONICS

Part No. OR-41900017 TrackJack frame; one (1) ORTRONICS Part No. OR-TJ600-27 (purple) single category 6, RJ-45 (568A/B) TrackJack inserts; and two (2) ORTRONICS Part No. OR-42100002 blank TrackJack inserts mounted in a single-gang outlet box. The equivalent outlets as manufactured by AMP, HUBBELL, P&S ACTIVATE, LEVITON, OPTICAL CABLE CORP., or PANDUIT, will also be considered provided they are fully equal to the type specified herein.

2.09 WIRING

A. Wiring for video door station (IS-DVF-P) to network switch from master station(s) (IX-MV7-HB) as shown on the Drawings shall be furnished and installed by this Contractor and shall consist of one of the following cables:

1. The cable shall be UL listed, plenum rated, unshielded, four (4) twisted pairs, No. 23 AWG, category 6, extended distance, high speed data type with a flame retardant polyvinyl chloride jacket and a temperature range for dry locations of minus ten (10) degrees C to sixty (60) degrees C. A telecommunications cable, which meets this specification, is BERK-TEK Cat. No. 10137364 (Violet) or equal as manufactured by AMP, AT&T, BELDON, THE CABLE COMPANY, GENERAL CABLE, GENISIS, HITACHI, MOHAWK, NORTHERN TELECOM, OPTICAL CABLE CORP. or PAIGE,
2. This cable shall be certified, and prior to the final site visitation and acceptance of each construction phased spaces, this Contractor shall conduct an operating test of all door access telecommunications system cabling. The cabling shall test free from grounds, shorts, and other faults. All connections shall be checked for mechanical and electrical connection. Phased space test results shall be furnished to the Owner in bound binders prior to acceptance.
3. This Contractor shall perform the following tests certifying each cable by device type and address.
4. Telecommunications outlet cable. Test results shall be tabulated listing each outlet (by number), the cable, and the test results.

TEST	FREQUENCY	REQUIREMENTS
1. Impedance:	1 MHz	100 ohms \pm 15%
	10 MHz	
	25 MHz	

	100 MHz	
	250 MHz	
2. Attenuation	1 MHz	2 dB max. per 100m
	10 MHz	6 dB max. per 100m
	25 MHz	9.5 dB max. per 100m
	100 MHz	19.8 dB max. per 100m
	250 MHz	32.8 dB max per 100m
3. Crosstalk (Next):	1 MHz	min. 62 dB
	10 MHz	min. 47 dB
	25 MHz	min. 41 dB
	100 MHz	min. 44.3 dB
4. PS-Next (min)	100 MHz	42.3 dB
5. EL-FEXT (min)	100 MHz	27.8 dB
6. PS-ELFEXT (min)	100 MHz	24.8 dB
7. Return Loss (min)	100 MHz	20.1 dB
8. Delay Skew (max)	100 MHz	45 nS
9. Mutual Capacitance:	less than 46 pf per meter	
10. Cable Length:	less than 100 meters	

5. This Contractor shall perform all tests in the presence of the Architect/Engineer. This Contractor shall furnish all personnel and test instruments required for use in the test.

6. This Contractor shall provide cable certification test results to OSS at the

end of each phase. The results should include per cable ID, door access device, address designation number and communication closet designator.

7. This Contractor shall be prepared, upon request by the Owner, to show current ownership of all instruments and equipment necessary to perform all of the tests.
- B. Video door station with embedded proximity reader (IX-DVF-P) to door access Controller/Power supply (DMP) wiring as shown on the Drawings shall be furnished and installed by this Contractor and shall consist of the following cable:
1. A six (6) conductor, No. 18 AWG, overall shielded, plenum rated cable with a temperature range for dry locations of minus ten (10) degrees C to seventy-five (75) degrees. A cable that meets this Specification is West Penn Cat. No. 253186B or equal as manufactured by BELDEN, CONSOLIDATED WIRE, GENERAL CABLE, or PAIGE.
 2. A two (2) conductor, No. 18 AWG, twisted pair, plenum rated cable with a temperature range for dry locations of minus ten (10) degrees C to seventy-five (75) degrees A cable that meets this Specification is West Penn Cat. No. 25224B or equal as manufactured by BELDEN, CONSOLIDATED WIRE, GENERAL CABLE, or PAIGE.
 3. A category 6, 4-Pair, UTP cable, plenum violet. A cable that meets this specification is HITACHI cat. No. 30025-8-VI or approved equal.
- C. Video door station (IX-MV7-HB) to FCPS provided network switch wiring as shown on the Drawings shall be furnished and installed by this contractor and shall consist of following cable:
1. A category 6, 4-Pair, UTP cable, plenum violet. A cable that meets this specification is HITACHI cat. no. 30025-8-VI or approved equal.
- D. Proximity reader (HID Prox Point Plus) to door access controller/power supply (DMP) wiring as shown on the Drawings shall be furnished and installed by this Contractor and shall consist of the following cable:
1. A six (6) conductor, No. 18 AWG, overall shielded, plenum rated cable with a temperature range for dry locations of minus ten (10) degrees C to seventy-five (75) degrees. A cable that meets this Specification is West Penn Cat. No. 253186B or equal as manufactured by BELDEN, CONSOLIDATED WIRE, GENERAL CABLE, or PAIGE.
- E. Door access controller/power supply (DMP) to electric door strike (6300 and/or 5100) and video door station (IX-DVF-P) wiring as shown on the Drawings shall be furnished and installed by this Contractor and shall consist of the following

cable:

1. A two (2) conductor, No. 18 AWG, twisted pair, plenum rated cable with a temperature range for dry locations of minus ten (10) degrees C to seventy-five (75) degrees and resistance of 6.2-ohm per 1000 ft. A cable that meets this Specification is West Penn Cat. No. 25224B or equal as manufactured by BELDEN, CONSOLIDATED WIRE, GENERAL CABLE, or PAIGE.
- F. Door access controller/power supply (DMP) to door access interface device wiring as shown on the Drawings shall be furnished and installed by this Contractor and shall consist of the following cable:
1. A four (4) conductor, No. 18 AWG, twisted pair, plenum rated cable with a temperature range for dry locations of minus ten (10) degrees C to seventy-five (75) degrees and resistance of 6.2-ohm per 1000 ft. A cable that meets this Specification is West Penn Cat. No. 25244B or equal as manufactured by BELDEN, CONSOLIDATED WIRE, GENERAL CABLE, or PAIGE.

2.10 MISCELLANEOUS EQUIPMENT/SOFTWARE/PROGRAMMING

This Contractor shall furnish to the Owner, OSS, the following equipment.

- A. Two hundred (200) Microprox Tags, gray, match # (format H10301, facility code 129), MODEL # 1391LSSMN/HID/ Prox Tag numeric range shall be provided to this Contractor and may be found on the door access drawing and schedules.
- B. Software from this Contractor is not required. The Owner, OSS, shall furnish, install and configure the door access/video entry system software, DMP remote link.
- C. This Contractor shall furnish to the Owner one (1) Digital Monitoring Products (DMP) ENROLLMENT USB READER (HID Proximity READER) Model # 1301P.
- D. PROGRAMMING AIPHONE AND DMP

The Owner shall administer door access and video entry system and edge device programming. There are three levels of security programming.

1. Edge devices or door controllers at the Weigand interface shall be programmed by this Contractor. Follow the drawing and schedule programming address accordingly as shown. The address shown on the drawing will denote the device number associated with the DMP control panel and correspond to the door and its controller where a proximity reader is installed. This Contractor shall program these addresses by adjusting dip switch settings at the 734 card or Wiegand interface. For

example, the drawing and schedule address will indicate that a door and its associated proximity reader receive the address, ADDRESS: DMP-DEVICE #.

2. The DMP control panel interface shall be programmed by Owner, OSS. The control system attributes will be pre-programmed for the panel and sent to the panel during installation. This will also include programming the panel to specific edge device proximity readers that correspond to the dip switch settings at the door controller. OSS will arrange for network connectivity and send the final programming to the DMP panel. This Contractor shall physically input the system *account number, IP, subnet mask, and Gateway network address* into the DMP panel via the specified keypad. This Contractor *shall not* access, troubleshoot, or try to program the DMP panel other than what is listed above.
3. This Contractor may be directed to the program local, non FCPS network LAN/WAN devices specifically, the Aiphone desk and door stations. These devices do not reside on the FCPS network. During installation, this Contractor shall use the manufacturer's default administrative password supplied with the units. Strict adherence to the scheduled addresses listed within the drawing and device schedule is required. The address shown on the drawing will denote the device number associated with the FCPS provided network switch and correspond to door and desk stations installed. For example, the drawing and schedule address will indicate that a door/desk station is programmed as, ADDRESS: NETWORK-SWITCH #, AREA, STATION #, STATION NAME, STATION TYPE.

2.11 HANDICAP ENTRANCE LOCATIONS

- A. The main entrance automatic door opener shall only be installed on the door scheduled to receive door access and video entry as shown on the drawing and schedule. The automatic door opener shall be installed above the door that is scheduled for an electronic door strike/lock. If an interior vestibule door inside the main entrance is scheduled for an automatic door opener, the opener shall only be installed on the door scheduled to receive a door access- video entry device and above the door that is scheduled for an electronic door strike/lock. The automatic door opener in the vestibule shall work independently from the main entrance automatic opener. This door opener shall not be sequenced nor configured to the main entrance automatic door opener.
- B. The operating circuits for the handicapped entrance mechanical hardware device (refer to Architectural specifications) and the "Push to Open" assistance switches located on the interior of the building shall be connected to an isolated relay of the DMP Cat. NO. 734 Weigand interface module. The handicapped entrance devices and electronic door strike or controlled panic rim device shall be controlled by both the proximity reader and/or the master stations of the video

entry system. The installation shall be done in strict conformance with the handicapped entrance mechanical hardware and door access system manufacturer's recommendations. Install so that the 734 Weigand interface module **will not** go into alarm after the exit timer has expired.

- C. The system shall come complete with a microprocessor type Delay on Make/Delay on Break Time Delay Module (BEA Model No. BR3) to provide relay outputs for the purpose of coordinating handicapped door operation with electronic door strike or controlled panic rim operation.
- D. Sequence of Operation:
 - 1. Upon operation of the door access system with a proximity card the Von Duprin electric door strike shall release and the handicapped entrance door shall operate. When the handicapped door operation is complete the door shall close and the electric door strike shall return to its locked position.
 - 2. Upon operation of the video entry system master station door release contact button the Von Duprin electric door strike shall release and the handicapped entrance door shall operate. When the handicapped door operation is complete the door shall close and the electric door strike shall return to its locked position.
 - 3. The delay on break timer on the time delay module will release the electronic door strike or controlled panic rim and then the delay on make timer will enable the door to remain open and be held open for a set period of time per ADA requirements.
- E. Wiring from the handicapped entrance mechanical hardware device to the DMP Weigand interface module shall be in strict conformance with the handicapped entrance mechanical hardware device manufacturer's recommendations.

PART 3 - EXECUTION

3.01 DOOR ACCESS INTERFACE DEVICE

- A. The door access interface and associated modules shall be furnished and installed by a licensed contractor.
- B. Prior to the installation of any door access device, this Contractor shall contact an OSS representative as well as a D&C representative, to schedule a pre-installation inspection.
- C. During renovations, this Contractor shall maintain and relocate existing door

access devices as indicated on drawings to support school safety and security transitions.

- D. Removed parts during renovation, to include Aiphone door & desk stations, HID readers, etc. shall be provided to Owner. This Contractor shall notify a D&C field representative and/or OSS to pick up removed equipment.
- E. This Contractor shall only install new system components at the completion of each phase of the renovation.

3.02 FIELD WIRING

- A. All vertical low voltage field wiring shall be installed by this Contractor in 1/2-inch conduit and/or surface metal raceway as shown on the Drawings.
- B. All horizontal low voltage field wiring to be installed in areas without a ceiling or in areas without an accessible ceiling shall be installed by this Contractor in 1/2-inch conduit. Conduit is not required in areas designated on the Drawings as "Communications" rooms or closets.
- C. All horizontal low voltage field wiring to be installed in areas with accessible ceilings shall be installed by this Contractor bundled together and run exposed above the ceilings. Bundles shall be supported by "J" hooks mounted not more than four (4) feet on center. "J" hooks to be dedicated to the wiring specified in this specification section.
- D. All horizontal low voltage field wiring shall be installed below the roof/floor structural supports (joists, beams, girders, etc). The wiring installed between the structural supports mentioned above and the roof or floor deck will not be acceptable.
- E. All low voltage wiring terminations shall be made by this Contractor with insulated crimp wire connections. All low voltage field-wiring interconnections shall be made in junction boxes. All junction box covers shall be stenciled for distinct identification.
- F. All conduit, device mounting boxes, junction boxes, and line voltage wiring shall be furnished and installed by this Contractor.
- G. All low voltage field wiring shall be labeled at the main distribution equipment location with the door entrance security number and video entry system outlet location(s).

3.03 INSTALLATION

- A. Prior to and during door access and video entry device installation, this Contractor shall contact the Owner, OSS, to arrange a site inspection. The

inspection will consist of a walk through to review for each door access device at defined location.

- B. This Contractor shall give OSS and D&C sufficient notice prior to installation, at which time OSS will prepare /provide a supplemental photo pack of each door access location to be utilized for installation.
- C. This Contractor shall install the door access and video entry devices as directed on the drawing, schedule, and provided photo package from Owner, OSS.
- D. All low-voltage wiring, patch cables and connections shall be furnished and installed by this Contractor as directed by the system manufacturer.
- E. This Contractor shall label all door access/video entry intrusion system power supply covers with door entrance security number.
- F. All wiring shall be checked and tested by this Contractor to ensure the system is free from grounds, opens, and shorts.
- G. The installation and final connections of all components and wiring shall be performed by this Contractor under the direct supervision of the Owner's technical staff. Contractor will arrange a date/time with Owner, OSS representative and D&C representative for the supervision. Final connection of all door access and video entry wiring to the door access interface device shall be performed by this Contractor under the supervision of the Owner's, OSS technical staff. Door Access addresses shall be as shown on the drawings or as provided by the Owner.
- H. The interconnections of components shall be as recommended by the manufacturer of the equipment.
- I. All horizontal low voltage field wiring penetrations through new and/or existing walls shall be sleeved. Minimum sleeve size shall be 3/4 inch. All sleeves shall be bushed both sides. Cables pulled through sleeves without bushings, cut bushings, wrapped with tape will not be accepted and shall be replaced by the Contractor. Cables pulled through sleeves without bushings, cut bushings, wrapped with tape will not be accepted and shall be replaced by the Contractor.
- J. All horizontal, low voltage field wiring shall be run at right angles to the building structure.
- K. All transformer enclosures shall be labeled with branch circuit panelboard identification and circuit number.
- L. This Contractor shall label, as directed by the Owner, the ceiling grid where all door access controller and power supplies are installed.

- M. Furnish and install one (1) video entry system master station for every video entry system outlet shown on the drawings.
- N. School Age Child Care (S.A.C.C.) video door station shall have a 1/16 inch thick laminated plastic sign with 2" inch high white letters on a black background and shall be engraved "S.A.C.C. ONLY". Sign shall be securely mounted.
- O. SACC video door station shall be programmed through the NETWORK SWITCH to only be displayed/controlled from the SACC master station. No other video door stations shall be displayed/controlled from the SACC master station.
- P. Video entry system master stations and video entry door stations shall connect to local FCPS provided network switches over Category 6 cabling.

3.04 ON-SITE AS-BUILT DRAWINGS

- A. The Contractor shall provide one (1) set of the door access/video entry system supplier's as-built drawings for permanent use on-site. The Contractor shall: laminate each page of these drawings; provide a rigid means for mounting such as 1/4 inch thick x two (2) inch wide x width of the drawings through-bolted wood along the left edge of the drawings; furnish and install hanging hooks on the back of the Communications Room door; and hang the bound set of drawings.

END OF SECTION

SECTION 16626

CCTV SURVEILLANCE SYSTEM

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.
- B. The Office of Safety and Security (OSS) will be Owner of the CCTV surveillance system equipment for operation: the installation/testing of all related equipment shall be carried out as per the instructions of OSS.

1.02 SCOPE

- A. The work covered under this Section shall include furnishing and installing a site controlled, complete, and satisfactorily operating CCTV system for the monitoring and recording of associated activities adjacent to and within the building.

1.03 QUALITY ASSURANCE

- A. All equipment and materials for this system shall be listed by Underwriter's Laboratories, Inc. (UL), bear the UL label, and shall be installed in accordance with all requirements of the National Electrical Code (NEC), with all state and local codes, and with these Specifications.
- B. Equipment shall be constructed in accordance with National Electrical Manufacturer's Association (NEMA) standards.
- C. This Contractor shall furnish submittals for all components of the CCTV Surveillance System in accordance with Section 16010 of these Specifications. Submittals shall include the following for review. Submittals which do not contain all of the information listed below will be rejected.
 - 1. A complete list by model number of each component of the system with a statement of how many pieces of each model will be furnished and a listing of the specific data sheet associated with it.
 - 2. A detailed set of floor plans for the complete building shall be furnished showing the locations of all equipment and devices and their required interconnections. CCTV surveillance cameras shall be addressed as shown on the Drawings. The interconnections shown shall indicate the number, size, and type of wires as described in this Specification. The layout of all CCTV Surveillance camera equipment and devices shall be that which is shown on the Drawings.

3. The CCTV cameras shall be furnished by a factory-authorized distributor certified to design, program, and service the system. The distributor must certify the following:
 - a. Successful furnishing and support of a similar system, as specified, for a minimum of five years.
 - b. Twenty-four hour, seven day a week (including holidays) service capability.
 - c. A maximum four hour service call response time.
 4. The Contractor shall be Department of Criminal Justice Services (DCJS) certified for CCTV/security installations by the Commonwealth of Virginia.
- D. The cameras shall be installed, connected, tested, and left in first-class operating condition 24/7.
- E. Each camera placement is view specific. The Contractor shall only make changes in the scope of work per the process defined in Section 01153 of these specifications.

1.04 DOCUMENTATION

- A. The Contractor shall furnish four (4) bound copies of complete operating and maintenance instructions of the system to the Owner including circuit diagrams and all other information necessary for proper operation, service, and maintenance.
- B. The Contractor shall furnish to the Owner a set of "as-built" drawings complete with field wiring diagrams.

1.05 DESCRIPTION OF OPERATION

- A. The CCTV cameras approved by Owner shall be furnished and installed as shown on the Drawings and Schedule as specified herein and shall function as follows:
 1. Cameras shall be compatible with Owner's EXACQVISION ENTERPRISE VIDEO MANAGEMENT SYSTEM and tested by the Manufacturer (EXACQ) for full integration and functionality.
 2. Each camera's purpose shall be pre-defined by the Owner based upon location-subject matter, expected field of view (F.O.V), physical surroundings, lighting and obstructions. Pre-defined location and F.O.V. will be provided in the submittal photo package.
 3. Cameras shall be IP based and comply with established network and

video standards.

4. Cameras shall, at the minimum, utilize H.264 compression (MPEG-4 AVC) for video encoding at 30 frames/second.
5. Cameras shall have the ability to encrypt video streams to the Exacq server.
6. Cameras shall have the following security built in: Password protection, IP address filtering, HTTPSa encryption, IEEE 802.1Xa network access control, digest authentication, user access log, centralized certificate management, and brute force delay protection.
7. Cameras shall have the ability to record motion events to an on-board SD card in the event of a network outage. In the event of a post-network outage, the data from the SD card shall automatically be sent to the Exacq server for official storage. Contractor shall not furnish SD cards unless requested by Owner.
8. Cameras shall have the ability to reduce bandwidth consumption, reduce server storage size, and limit bit rate. Acceptable methods to ensure that relevant forensic information is identified recorded and sent in full resolution and at full frame rate to the video server is through Dynamic ROI, Dynamic GOP and Dynamic FPS technologies.
9. Cameras shall have at the least the following built-in analytics without additional fees from manufacturer:
 - a. Video Motion Detection
 - b. Active Tampering Alarm
10. Cameras shall be powered by the switch utilizing network cable. Power injectors shall be provided and installed by the Contractor where required to maintain specified level of operation or if cable length exceeds maximum cable specification. All power injectors shall be installed in communication room(s).
11. Cameras shall be fully supported by an open API for software integration including camera application platform. ONVIF Profile S and ONVIF Profile G.
12. Cameras shall comply with relevant ONVIF (global standard for the interface of IP-based physical security products).

13. Cameras shall have the ability to trigger the following events: Analytics, edge storage events, virtual inputs through API.
14. Cameras shall have the ability to respond to event actions, record video to an SD card and network share; upload of images or video clips via FTP, SFTP, HTTP, HTTPS, network share and email; pre- and post-alarm video or image buffering for recording or; upload notification: email, HTTP, HTTPS, TCP and SNMP trap; overlay text.
15. Cameras shall have support for micro SD/microSDHC/microSDXC card support for recording to a dedicated network-attached storage (NAS) for SD card and NAS.

1.06 SYSTEM TEST AND ACCEPTANCE

- A. The Contractor shall conduct an operating test of the complete system including each device. The system shall test free from grounds, shorts, and other faults. All connections shall be thoroughly checked for mechanical and electrical connection. All equipment shall be demonstrated to operate in accordance with the requirements set forth in these Specifications and as shown on the Drawings.
- B. The Contractor shall perform all tests in the presence of the Owner's representative. The Contractor shall furnish all required personnel for use in the test.
- C. When contractual work on the system is ready for final review, a site visit shall be arranged by the Owner's representative. The Contractor shall demonstrate that the requirements of the Contract, as it applies to this system, have been carried out, and that the system has been adjusted and operates in accordance herewith.

1.07 WARRANTY

- A. The Contractor shall deliver the work in first-class operating condition in every respect. The Contractor shall warrant that the material, equipment, and workmanship furnished shall be entirely free from defects. Any materials, equipment, or workmanship in which defects may develop before or during the warranty period shall be repaired or replaced at the Contractor's own expense. Refer to Section 01740 for the start of the warranty period. CCTV cameras and components shall be fully warranted from the manufacturer for a minimum of three (3) years from the date of final acceptance. Labor, cabling, and workmanship shall be fully warranted by the Contractor for a minimum of one (1) year from the date of final acceptance.

1.08 SPARE PARTS

- A. The Contractor shall furnish to the Owner spare parts as follows. All spare parts

shall be furnished to the Owner prior to the turnover of the first phase of the system.

1. One (1) spare camera of each type listed in the contract drawings.
2. Two (2) power injectors identical to those installed.

PART 2 – PRODUCTS

2.01 GENERAL

- A. Refer to the contract drawings for the make and model number of camera(s) including their mounting arrangement, etc.

2.02 CCTV SURVEILLANCE CAMERAS (**ENGINEER TO EDIT**)

- A. Schools
 1. Elementary Schools (Exterior Cameras Only)
 2. Middle School (Exterior and Interior)
 3. High Schools (Exterior and Interior)
- B. Acceptable Manufacturer- Axis Cameras or approved equal.

2.03 WIRING

- A. This Contractor shall furnish and install CCTV camera cables where shown on the Drawings and specified herein. The cable shall be UL listed, plenum rated, unshielded, four (4) twisted pairs, No. 23 AWG, category 6, extended distance, high speed data type with a flame retardant polyvinyl chloride jacket and a temperature range for dry locations of minus ten (10) degrees C to sixty (60) degrees C. BERK-TEK Cat. No 10136748 (Green) or equal as manufactured by AMP, BELDEN, CORNING, GENERAL CABLE, MOHAWK, OPTICAL CABLE CORP., PAIGE, SIECOR, SUMITOMO ELECTRIC, or WEST PENN.
- B. All wiring for the CCTV system shall be terminated in the main and sub distribution frames on the designated CCTV patch panel as shown on the drawings and herein specified.
- C. All wiring for the CCTV camera(s) shall be terminated with a female RJ-45 (568A) RJ-45 connector. The Contractor shall leave twenty five (25) feet of slack in the wiring for CCTV camera termination.
- D. Cable certification test results of CCTV camera cables shall be furnished to the Owner prior to phase turnover.
- E. 12-foot outdoor rated gel filled cable is required to connect exterior cameras to female RJ-45 termination as noted in 2.03 C above.

2.04 WIRING - SYSTEM TEST AND ACCEPTANCE

- A. Prior to Owner acceptance, the Contractor shall conduct an operating test of all CCTV telecommunications system cabling. The cabling shall test free from grounds, shorts, and other faults. All connections shall be checked for mechanical and electrical connection.
- B. The Contractor shall perform the following tests, certifying each Telecommunications outlet Cat 6 cable. Test results shall be tabulated listing each outlet (by number), the cable, and the test results.

TEST	FREQUENCY	REQUIREMENTS
1. Impedance:	1 MHz 10 MHz 25 MHz 100 MHz 250 MHz	100 ohms \pm 15%
2. Attenuation:	1 MHz 10 MHz 25 MHz 100 MHz 250 MHz	2 dB max. per 100m 6 dB max. per 100m 9.5 dB max. per 100m 19.8 dB max. per 100m 32.8 dB max per 100m
3. Crosstalk (Next):	1 MHz 10 MHz 25 MHz 100 MHz	min. 62 dB min. 47 dB min. 41 dB min. 44.3 dB
4. PS-Next (min)	100 MHz	42.3 dB
5. EL-FEXT (min)	100 MHz	27.8 dB
6.PS- ELFEXT (min)	100 MHz	24.8 db
7. Return Loss (min)	100 MHz	20.1 dB
8. Delay Skew (max)	100 MHz	45 nS
9. Mutual Capacitance:	less than 46 pf per meter	
10. Cable Length:	less than 100 meter	

- C. Each fiber optic cable shall have a FOIRL specification, bi-directional testing at both 850 nm and 1300 nm with 3 db light signal loss per km and 2000/500 MHz-km bandwidth at 850/1300nm.
- D. The Contractor shall perform all tests in the presence of the Architect/Engineer. The Contractor shall furnish all personnel and instruments required for use in all required tests.

- E. The Contractor shall provide the cable certification test results to the Owner prior to turnover of finished work. The results should include cable ID, camera designation number, and communication closet designator. Results shall be submitted in bound hard copy 8 ½" x 11" format.
- F. The Contractor shall be prepared, upon request by the Owner, to exhibit current ownership of all instruments and equipment necessary to perform all required tests.

PART 3 - EXECUTION

3.01 FIELD WIRING

- A. All vertical low voltage field wiring shall be installed by this Contractor in 1/2-inch conduit and/or surface metal raceway as shown on the Drawings.
- B. All horizontal low voltage field wiring to be installed in areas without a ceiling or in areas without an accessible ceiling shall be installed by this Contractor in 1/2-inch conduit. Conduit is not required in areas designated on the Contract Drawings as "Communication" rooms or closets.
- C. All horizontal low voltage field wiring to be installed in areas with accessible ceilings shall be installed by this Contractor bundled together and run exposed above the ceilings. Bundles shall be supported by "J" hooks mounted not more than four (4) feet on center. "J" hooks to be dedicated to the wiring specified in this specification section.
- D. All horizontal low voltage field wiring shall be installed below the structural supports (joists, beams, girders, etc). Wiring installed between the structural supports mentioned above and the roof or floor deck will not be acceptable.
- E. All low voltage wiring terminations shall be made by the Contractor with insulated crimp wire connections. All low voltage field-wiring interconnections shall be made in junction boxes. All junction box covers shall have a unique identifying label.
- F. All conduit, device mounting boxes, junction boxes, and line voltage wiring shall be furnished and installed by the Contractor.
- G. All low voltage field wiring shall be labeled at the main/sub-telecommunication equipment location and CCTV camera outlet location(s) with the CCTV camera number as identified in the CCTV schedule.

3.02 INSTALLATION WIRING

- A. All low-voltage wiring, patch cables and connections shall be furnished and installed by the Contractor as directed by the system manufacturer.
- B. All horizontal low voltage field wiring penetrations through new and/or existing

walls shall be sleeved. Minimum sleeve size shall be $\frac{3}{4}$ inch. All sleeves shall be bushed both sides. Cables pulled through sleeves without bushings, cut bushings, or wrapped with tape will not be accepted and shall be replaced by the Contractor.

- C. All horizontal, low voltage field wiring shall be run at right angles to the building structure.

3.03 INSTALLATION OF CAMERAS

- A. Prior to camera phase installation, the Contractor shall contact the Owner to arrange a site survey. The survey will consist of a walk through to review each camera's defined location.
- B. The Contractor shall receive from Owner a supplemental photo package of each camera's location and a pre-defined expected field of view. This will be provided after site survey as stipulated in 3.03A.
- C. The Contractor shall aim and focus each camera as per the Owner provided field of view schedule and photo package.
- D. The Contractor shall provide and discretely label all CCTV cameras inside the housing with the Owner provided camera number. The label shall not be visible to persons near the camera.
- E. The Contractor shall configure an Owner provided IP address to each camera as per Contract documents. Camera IP scheme is identified in the Owner's schedule that will be provided after contract award.
- F. The Contractor shall program each camera with a temporary username and password provided by the Owner after contract award. No system/product default passwords shall be allowed.
- G. All cameras and devices installed on a drop ceiling must be supported by the structure, independent of drop ceiling.

3.04 ON-SITE PRECONSTRUCTION MEETING

- A. Prior to the beginning of construction, the Contractor shall contact the Owner (Office of Safety and Security) through the FCPS Construction Site Representative to arrange a site survey with the Security Technology Manager.

3.05 ON-SITE AS-BUILT DRAWINGS

- A. The Contractor shall provide one (1) hardcopy set of the CCTV camera

supplier's system as-built drawings to Owner. A CD shall also be provided that includes the following:

1. An AutoCAD file that includes CCTV as-built information for the entire building.
2. PDF's of each individual sheet (of the hardcopy) saved as a separate file.

END OF SECTION

SECTION 16630

WIRELESS MASTER CLOCK AND PROGRAM SYSTEM

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work covered under this Section shall include furnishing and installing a complete and satisfactorily operating wireless master clock and program system as shown on the Drawings and herein specified for selected clock correction and distribution of program signals.
- B. The existing master clock and program system shall remain in operation during the construction period until the new system has been installed and tested, ready for operation. After the new system has been placed in operation, the existing system shall be removed as shown on the Drawings.

1.03 QUALITY ASSURANCE

- A. All equipment described herein shall be the product of a manufacturer of established reputation and experience who shall have produced similar apparatus for a period of at least ten (10) years and who shall be able to, upon request, refer to similar installations now rendering satisfactory service.
- B. The wireless master clock and program system shall be furnished by a factory authorized distributor certified to design, program, and service the system. The distributor must show evidence of successfully furnishing systems specified for at least five (5) years
- C. All equipment for this system shall be listed by Underwriters Laboratories, Inc. (UL), bear the UL label, and shall be installed in accordance with all requirements of the National Electrical Code (NEC), all state and local codes, and these Specifications.
- D. The entire wireless master clock and program system installation shall be performed under the direct supervision of a factory trained service specialist.
- E. Shop drawing submittals are required per SECTION 16010 and shall include the following for review. Submittals not containing all of the information listed below will be rejected.

1. A complete list of equipment shall be furnished indicating the specific quantities to be furnished by the manufacturer. The catalog or model number for each module of the system shall be listed next to the quantities. This shall be provided in the front of the submittal.
2. A specific description of the system shall be furnished describing each module and how it shall function in the system.
3. A detailed set of floor plans for the complete building shall be furnished showing the locations of all equipment and devices and their required interconnections. The interconnections shown shall indicate the number, size, and type of wires as described in this Specification. The layout of all wireless master clock and program system equipment, devices, and conduit routings shall closely follow that shown on the Drawings.
4. A data sheet shall be furnished for each component and device. The information shall be highlighted that applies to the module or device.
5. A detailed diagram on how to connect each device shall be furnished showing exact hook-up information.

1.04 DOCUMENTATION

- A. This Contractor shall furnish to the Contractor one (1) set of "As Built" drawings depicting the complete field wiring system and component interconnections.
- B. This Contractor shall furnish to the Contractor four (4) sets of factory service manuals. These manuals shall include factory service manuals with complete parts lists, wiring and component schematics including circuit diagrams, and other information necessary for the proper operation and service maintenance of the system.

1.05 TRAINING

- A. This Contractor shall furnish eight (8) hours of technical service training to the Owner's technical staff using the factory service manuals previously specified.
- B. This Contractor shall furnish twenty-four (24) hours of operating and programming training to the Owner's operating staff that shall be delivered in six (6) four (4) hour sessions to be scheduled at the Owner's convenience over the warranty period.
- C. All training specified herein shall be performed by a factory certified technician.

1.06 DESCRIPTION OF OPERATION

- A. Transmitter Operation: When power is first applied to the master transmitter, the master transmitter checks for and displays the software version. The master transmitter then checks the position of the switches and stores their position in memory. The master transmitter looks for the GPS time signal. Once the master transmitter has received the GPS time, it sets its internal clock to that time. The master transmitter then starts to transmit its internal time once every second. The master transmitter updates its internal clock every time it receives valid time data from the GPS. The wireless master clock and program system shall be connected to the master clock and program system in the sound and intercommunications system for time and tone synchronization.
- B. Analog Clock Operation:
 - 1. Apply power then follow set up procedures detailed in manufacturer's instructions.
 - 2. After initial setup, the clock will shut off the receiver. Six times each day, the microprocessor will activate the receiver and starting with the stored channel, it will again look for a valid time signal. If necessary, the clocks will resynchronize to the correct time.
 - 3. If the clock has not decoded a valid time signal a pre-determined number of days, it will go to a step mode.
- C. This Contractor shall furnish and install, where required, wireless repeater/transmitter(s). The number of repeater/transmitters shall be as needed for a complete, functioning wireless master clock and program system.

1.07 SYSTEM TEST AND ACCEPTANCE

- A. Prior to the final site visitation, this Contractor shall conduct an operating test of the complete wireless master clock and program system. The system shall test free from grounds, shorts, and other faults. All connections shall be thoroughly checked for mechanical and electrical connections. All equipment shall be demonstrated to operate in accordance with the requirements set forth in these Specifications and as shown on the Drawings.
- B. This Contractor shall perform all tests in the presence of the Architect/Engineer and Owner. This Contractor shall furnish all personnel and test instruments for use in the test.
- C. When the work on the entire wireless master clock and program system has been completed and is ready for final review, this Contractor shall demonstrate that the requirements of the Contract as it applies to this work have been carried out and that the system has been adjusted and operated in accordance therewith.

1.08 WARRANTY

- A. This Contractor shall deliver the work described herein in a first class operating condition in every respect. This Contractor shall also warrant that the material, equipment, and workmanship shall be entirely free from defects. Any materials, equipment, or workmanship in which defects may develop before or during the warranty period shall be repaired or replaced at the Contractors own expense. Refer to SECTION 01740 for the start of the warranty period. The contractor shall further warrant that all material, equipment, and workmanship used in the installation, but not specifically mentioned in the Drawings and Specifications, is the best of their respective kinds and that the construction and installation was performed in accordance with the best accepted standard practices in all details.

PART 2 - PRODUCTS

2.01 MANUFACTURER

- A. The wireless clock and program system shall be manufactured by PRIMEX WIRELESS, INC., or approved equal from SAPLING INC.

2.02 EQUIPMENT

- A. General: The wireless master clock and program system shall include a transmitter with external antenna, an outdoor ground plane antenna, a roof mounted GPS receiver, indicating clocks, and all accessories for complete operation.

- B. GPS roof mounted receiver:

The following items are included with primary transmitter:

- 16' (5m) cable, 50, 100, 150 and 200 foot (15.24m, 30.48m, 45.72m and 60.69m extensions available.
- Mounting bracket and hardware included for rooftop or window installation.
- Dimensions 2.5" W x.75" Hx4.5" D (8.89cm x 3.56cm x 11.43cm)
- Weight:0.75lb (0.34kg)
- Operating range: -32° – 158° F (-30° -70°C)

- C. Master Transmitter: Primex Wireless Model TX4001EM, consisting of Sync OneVue Transmitter 1 watt with external antenna, NTP and GPS input.

- D. ANT – NP5 Sync Non – Penetrating Mast Mounting Antenna Kit – for use with the External Antenna Transmitters (TX 4001M).
- E. Q12660-3 200', Extension Cable for XR Transmitters
- F. XR01AP, Sync Transmitter Rack Shelf and UPS.
1. Transmission:
 - a. Frequency range: 72 MHz.
 - b. Transmission range: One mile, open field.
 - c. Radio technology: Narrowband FM
 - d. Number of channels: 49
 - e. Channel bandwidth: 20 kHz maximum
 - f. Transition mode: One-way communication
 - g. Data rate: 2 KBps
 2. Transmitter: Cabling 100' (30.48m) between transmitter antenna and antenna provided.
 - FCC Part 90 accepted
 - IC RSS -119 accepted
 - Weight 9 lbs. (4.1kg)
 - 72MHz frequency range
 - 49 channels available (pre-programmed prior to shipping)
 - Daylight saving time and time zone controlled through blue tooth app or cloud control panel
 - Dimensions: 17.0" L x 12.0" W x 1.7" D (43.2cm x 30.5cm x 4.32cm)
 - Power supply
 - Input: 120VAC, 50/60Hz, 0.6 amp
 - Output: 9VDC, 2.78 amp (6 ft cord, 1.83m)
 - Operating Range: 32° - 122° F (0° - 50° C)
 3. Outdoor ground plane antenna for use with TX4001EM transmitters.
 - Dimensions: 29"H x 41.5" W (74.7cm x 105.41cm)
 - Lightning protection: direct ground
 - Cabling: 100' (30.48m) between transmitter and antenna provided.
 - FCC Part 90 accepted
 - IC RSS -119 accepted
 - Weight: 8.25 lbs. (3.75kg).

4. Transmitter housing shall incorporate a display which shall include the following:
 - a. Time readout
 - b. AM and PM indicator if 12-hour time display is set
 - c. Day and date readout
 - d. Indicator for daylight savings or standard time
 - e. LED which shall flash red in event of reception problem
 - f. GPS reception indicator
5. Transmitter shall contain an internal clock such that failure of reception from the GPS will not disable operation of the clocks.
6. Where wireless analog clocks that are out of range from the master transmitter, this contractor shall furnish and install one (1) wireless Repeater Primex Model TX4001NR. Repeater/transmitter shall receive the signal from the wireless receiver switches and transmit the signal to the devices in its vicinity. The repeater/transmitter shall be installed in location as agreed upon by the Owner and shall be optional and based on a site survey. The unit shall include the following:
 - a. Antenna shall be 46 inches high, commercial type, antenna gain shall be <math>< 2.2\text{dB}</math>. Antenna polarization shall be vertical.
 - b. Power Supply:
 - Input 120VAC, 50/60Hz, 0.6 amp
 - Output: 9V DC, 2.78 amp (6ft. cord, 1.83m)
 - Operating range: 32° - 122° F (0° - 50° C)
 - b. XR01AP sync transmitter/repeater accessory pack – transmitter/repeater rack mounting shelf and UPS.
 - c. Approximately one-watt transmission
 - e. 72MHz frequency.
- G. This Contractor shall furnish and install where shown on the Drawings analog, wireless clocks. Clocks shall have polycarbonate frame, lexan lens, and two (2) clock locks. Face shall be white. Hour and minute hands shall be black. Analog

clocks shall be provided with red sweep hand, 12.5 or 16" inch, 120 VAC with proper cord and cap, and 18-inch pigtail to plug into a single pole, 120 volt clock receptacle. Primex Model 14155E (12 inch), 14163E (16 inch).

1. Analog clocks shall be capable of adjusting for daylight savings time.
 2. Time shall be automatically updated from the transmitter 6 times per day.
 3. If power is interrupted, the clock will stop until power resumes. Upon resumption of power, the clock will self correct to the current time.
 4. If transmitter stops transmitting valid time signals due to power failure, the clocks will continue to function as accurate quartz clocks until a valid time signal is decoded.
 5. Clocks shall have wire guards where indicated on drawings. Primex Model 14123, Sync. 18" x 18" Analog Wire Guard (for 12.5" and 16" clocks)
- H. This Contractor shall furnish and install where shown on the Drawings digital, wireless clocks. Clocks shall have 7-segment LED digits, 12 or 24 hour time display, PM indicator light. Digital clocks shall be 120 VAC with minimum 30 inch long pigtail connection. Primex Model XRA7A202/Q12285 (surface mount).

2.03 BELL SCHEDULE:

- A. This Contractor shall furnish and install Primex Wireless Notify Bell Relay, PoE. Model No. E-130E series sensors.
- B. Notify 5-Year Bell Controller License per Bell Relay Primex Wireless BELSUB - SA.

2.04 CLOCK RECEPTACLE

- A. Refer to specification section 16130.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. GPS Unit: Install on roof in location indicated, in clear view of the sky. Install unit in location free from standing water, and above accumulations of snow, leaves or debris. Seal cable connection to GPS with cable connection sealant. Any added cable lengths must be protected from outside elements. The GPS unit shall be mounted on the roof. In each case, the GPS unit must have a clear view of the sky. The GPS unit mounted on the roof must be located on a

suitable bracket, well above the level of standing or incidental water and drifting snow.

- B. Master Transmitter and Wireless Repeater/Transmitter(s):
1. Locate master transmitter where indicated, a minimum of 2 to 3 feet above the floor, away from large metal objects such as filing cabinets, lockers or metal framed walls.
 2. Attach GPS receiver to master transmitter using cable.
 3. Connect antenna to transmitter(s), using care not to strip threads.
 4. Connect power supply to the transmitter(s).
 5. Set the channel number on the display to correspond to the FCC license.
 6. Plug power supply into electrical outlet.
- C. Analog clocks (AC): Perform the following operations with each clock:
1. Apply power (120 VAC).
 2. Observe clock until valid time signals are received and analog clock adjusts itself to correct time.
 3. Install the analog on the wall in the indicated location, plumb, level, and tight against the wall. All wireless system clocks shall be mounted over a flush mounted clock outlet where indicated on floor plans. Analog clocks shall be mounted with two (2) Primex Wireless, Inc. clock locks.

3.02 FIELD WIRING

- A. Local 120 VAC power shall be provided to the system clocks.
- B. All clock system connections and wiring shall be made by this Contractor as directed by the equipment manufacturer.
- C. All clock system wiring shall be checked and tested by this Contractor to ensure the system is free from grounds, opens, and shorts.

3.03 ON-SITE AS-BUILT DRAWINGS

- A. The Contractor shall provide one (1) set of the wireless master clock and program system supplier's as-built drawings for permanent use on-site. The Contractor shall: laminate each page of these drawings; provide a rigid means for mounting such as 1/4-inch thick x two (2) inch wide x width of the drawings through-bolted wood along the left edge of the drawings; furnish and

install hanging hooks on the back of the Communications Room door; and hang the bound set of drawings.

END OF SECTION

SECTION 16710

SOUND AND INTERCOMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work covered under this Section shall include furnishing and installing a centrally controlled complete and satisfactorily operating sound and intercommunications system within the building and around the building's perimeter as shown on the Drawings and herein specified for: the pick-up, amplification, reproduction, and distribution of voice and/or music; intercommunications between areas.
- B. The existing sound and intercommunications system shall remain in operation during the construction period until the new system has been installed and tested, ready for operation. After the new system has been placed in operation, the existing system shall be removed as shown on the Drawings.

1.03 QUALITY ASSURANCE

- A. All equipment described herein shall be the product of a manufacturer of established reputation and experience who shall have produced similar apparatus for a period of at least ten (10) years and who shall be able to, upon request, refer to similar installations now rendering satisfactory service.
- B. The sound and intercommunications system shall be furnished by a factory authorized distributor certified to design, program, and service the system. The distributor must show evidence of successfully furnishing systems specified for at least five (5) years
- C. All equipment for this system shall be listed by Underwriters Laboratories, Inc. (UL), bear the UL label, and shall be installed in accordance with all requirements of the National Electrical Code (NEC), all state and local codes, and these Specifications.
- D. All equipment with digital apparatus (microprocessors) that generates and utilizes timing signals at a rate in excess of ten thousand (10,000) pulses per second to compute and operate shall be Federal Communications Commission (FCC) approved. Equipment without the above approval will not be accepted.
- E. The entire sound and intercommunications system installation shall be

- performed under the direct supervision of a factory trained service specialist.
- F. Shop drawing submittals are required per SECTION 16010 and shall include the following for review. Submittals not containing all of the information listed below will be rejected.
1. A complete list of equipment shall be furnished indicating the specific quantities to be furnished by the manufacturer. The catalog or model number for each module of the system shall be listed next to the quantities. This shall be provided in the front of the submittal.
 2. A specific description of the system shall be furnished describing each module and how it shall function in the system.
 3. A detailed set of floor plans for the complete building shall be furnished showing the locations of all equipment, loudspeakers, and devices and their required interconnections. The interconnections shown shall indicate the number, size, and type of wires as described in this Specification. Loudspeakers shall be zoned as shown on the Drawings. The layout of all sound and intercommunications system equipment, and devices, shall closely follow that shown on the Drawings. Electronic microdisks or disquettes containing the building's background (only) will be available from the Architect for this purpose. However, this Contractor will be responsible for maintaining the accuracy of these Drawings.
 4. A specific drawing shall be furnished of the main sound equipment rack. Each module shall be shown in its location with its terminal designation shown.
 5. A data sheet shall be furnished for each module, component, and device. The information shall be highlighted that applies to the module or device.
 6. A detailed diagram on how to connect each device shall be furnished showing exact hook-up information.

1.04 DOCUMENTATION

- A. This Contractor shall furnish to the Owner one (1) set of "As Built" drawings depicting the complete field wiring system and component interconnections in the system equipment rack.
- B. This Contractor shall furnish to the Owner four (4) sets of factory service manuals. These manuals shall include factory service manuals with complete parts lists, wiring and component schematics including circuit diagrams, and other information necessary for the proper operation, service, and maintenance of the system.
- C. This Contractor shall furnish to the Owner a typed written sound system zone legend. This legend shall include the following; zone card numbers, default

numbers, dial numbers, room locations, comments, ACS, paging zone numbers, mic cable numbers, and zone cable numbers.

1.05 TRAINING

- A. This Contractor shall furnish eight (8) hours of technical service training to the Owner's technical staff using the factory service manuals previously specified.
- B. This Contractor shall furnish twenty four (24) hours of operating and programming training to the Owner's operating staff which shall be delivered in six (6) four (4) hour sessions to be scheduled at the Owner's convenience over the warranty period.
- C. All training specified herein shall be performed by a factory certified technician.

1.06 DESCRIPTION OF OPERATION

- A. This Contractor shall furnish and install a microprocessor controlled voice communication system with all low voltage wiring and equipment as shown on the Drawings and as herein specified to furnish a complete sound, program, distribution, and intercommunication system in the building.
- B. System Capacity:
 - 1. It shall be possible to field program any Owner furnished telephone instrument to function as part of the sound and intercommunications system.
 - 2. This Contractor shall furnish and install one (1) desk mounted Administrative Control Station (ACS) in the Communications Room.
 - 3. The system shall provide a minimum of one (1) conversation path for each programmed telephone instrument and/or Administrative Control Station (ACS).
 - 4. Room stations reporting to different programmed telephone instruments and/or an ACS shall be capable of calling simultaneously without interference.
 - 5. Programmed telephone instruments and/or an ACS calling to assigned rooms shall be capable of calling simultaneously without interference.
- C. System Configuration:
 - 1. Programmed telephone instruments and/or an Administrative Control Station (ACS) shall receive calls from classrooms and other indicated areas as shown on the Drawings.

2. Specific classrooms and other areas as shown on the Drawings shall contain a flush wall mounted callback switch to signal the designated programmed telephone instrument and/or ACS.
 3. Classrooms, corridors, and other areas as indicated on the Drawings shall contain flush ceiling mounted speakers.
 4. Mechanical rooms and other similar type areas, and the building exterior shall contain surface mounted horn type speakers as shown on the Drawings.
 5. A hand-held microphone and a flush mounted microphone outlet shall be furnished and installed by this Contractor at the bus loading area as shown on the Drawings. Keying this microphone shall automatically annunciate over the ALL CALL system without the assistance of an operator.
- D. Calling Sequence of Operation:
1. Classroom station calls shall initiate manually a preset status of call to the designated programmed telephone instrument and/or ACS.
 2. Programmed telephone instrument and/or ACS to classroom calls shall establish two-way voice communication with classrooms and/or any or all other areas equipped with a loudspeaker.
 3. ACS to ACS, or programmed telephone instrument to ACS, or programmed telephone instrument to programmed telephone instrument calls shall establish a two-way telephone conversation.

1.07 SYSTEM OPERATION

- A. The system shall allow for user-programmable room number assignment in the form of 3, 4, 5 or 6-digit alphanumeric format for architectural room numbering and a 60 character alpha-numeric caller ID description associated with each audio port.
- B. The system shall allow for a minimum of 64 page/time/program zones that can be assigned and configured as desired.
- C. The system shall allow for the assigning of each call-in button to one or more of 32 distinct call-in destination groups.
- D. The system's administrative telephone shall allow for the user to view the alphanumeric room address and the caller-ID information of the calling station and the call priority (e.g., emergency, normal) on the display. The administrative telephone shall use distinctive ringing patterns to annunciate the type of call.

- E. The system shall be capable of receiving 2048 call-ins simultaneously without data collisions or loss of any call-ins. Call-ins shall remain in the system call queue until answered. Emergency call-ins shall automatically move to the top of the call-in queue and announced in the in-use telephone earpiece to notify the user of an emergency call.
- F. The system shall provide priority override capability to all remote independent sound systems (auxiliary, auditorium, gymnasium, etc.) located inside the building. Independent sound systems located outside the building (baseball, football, stadium, etc.) shall not require priority override capabilities.
- G. The system shall communicate with each classroom phone. The classroom phone shall be integrated with the classroom speaker. If the staff member or occupant in the classroom lifts the classroom phone while in communication over the classroom loud speaker classroom, audio will automatically be transferred to the classroom phone.
- H. The system shall contain an integral master clock. The system master clock shall correct secondary clocks, analog or digital or both. The system master clock shall be capable of being synchronized by a Network Time Server (NTP). The system master clock shall provide for automatic daylight saving time adjustment with leap year programming and shall support unlimited schedules with unlimited events on said schedules. The system master clock shall be calendar based capable of future event programming at least 30 years in the future. The system master clock shall allow for scheduling tone events, output events, program source events, and video camera events.
- I. The system shall operate under the following audio priority scheme.
 - a. An emergency page suspends all other audio.
 - b. An emergency tone suspends all other audio except the above.
 - c. A normal page suspends all other audio except the above.
 - d. A tone suspends all other audio except the above.
 - e. A program source audio event suspends nothing.
 - f. Interrupted lower priority functions shall be restored after conclusion of the higher priority function.
- J. The system shall allow a call-in to be escalated from a normal call-in to an emergency call-in at any time by pressing the call button twice within 2 seconds.
- K. The system shall allow for any connected telephone to place an emergency voice paging announcement.
- L. The system shall allow for operation via a GUI based PC based application. The PC application shall allow for emergency paging, normal paging,

intercom, activation of any system/user tone, schedule changes, program distribution, call-in management, and on the fly room exclusion.

- M. The system shall use a PC based GUI scheduling tool for schedules and tone management. This tool shall not allow access to any system configuration controls. This tool shall not prevent the system from operating when being used. This tool shall allow the user to schedule events and manage tones over the local LAN/WAN and the Internet. It shall not be required to be directly connected to the central system to use this tool.
- N. The system shall have a built in 30 day log of every system function and access.
- O. The system shall have a built in real time system diagnostics application.
- P. The system shall allow for system diagnostics, system log access firmware updates, and programming over the local LAN/WAN or over the Internet.

1.08 SYSTEM TEST AND ACCEPTANCE

- A. Prior to the final site visitation, and acceptance of each construction phase, this Contractor shall conduct an operating test of the complete sound and intercommunications systems. The system shall test free from grounds, shorts, and other faults. All connections shall be thoroughly checked for mechanical and electrical connections. All equipment shall be demonstrated to operate in accordance with the requirements set forth in these Specifications and as shown on the Drawings.
- B. This Contractor shall perform all tests in the presence of the Architect/Engineer and Owner. This Contractor shall furnish all personnel and test instruments for use in the test.
- C. When the work on the entire sound and intercommunications system has been completed and is ready for final review, this Contractor shall demonstrate that the requirements of the Contract as it applies to this work have been carried out and that the system has been adjusted and operated in accordance therewith.

1.09 EQUIPMENT LOCATIONS

- A. This Contractor shall furnish and install where shown on the Drawings, wall mounted main and sub-distribution equipment locations consisting of fire resistant 3/4 inch thick plywood backboards and the distribution equipment as detailed on the Drawings.

1.10 WARRANTY

- A. This Contractor shall deliver the work described herein in a first-class operating condition in every respect. This Contractor shall also warrant that the material, equipment, and workmanship furnished shall be entirely free from defects. Any

materials, equipment, or workmanship in which defects may develop before or during the warranty period shall be repaired or replaced at the Contractor's own expense. Refer to SECTION 01740 for the start of the warranty period. The Contractor shall further warrant that all material, equipment, and workmanship used in the installation, but not specifically mentioned in the Drawings and Specifications, is the best of their respective kinds and that the construction and installation was performed in accordance with the best accepted standard practices in all details.

PART 2 - PRODUCTS

2.01 MANUFACTURER

- A. The sound and intercommunications system shall be the DUKANE "CareHawk" system, or equal as manufactured by RAULAND-BORG or BOGAN system as shown on the Drawings and herein specified.

2.02 ADMINISTRATIVE CONTROL STATION

- A. The Administrative Control Station (ACS) shall be desk mounted and contain a matching telephone handset with retractable coiled cord and conductive rubber button switches with clearly designated touch points. The housing shall be constructed of high impact flame-retardant plastic and shall terminate using a RJ-45 modular telephone type jack. Additional features shall include:
 - 1. Conductive rubber moisture sealed buttons
 - 2. Twenty (20) character alphanumeric LCD back lit display
 - 3. Menu driven display
 - 4. Handset and hands-free intercom with a "Push-to-Talk" button for manual audio direction control in the hands-free mode
 - 5. Alphanumeric three (3), four (4), or five (5) digit dialing
 - 6. Distinctive electronic ring signals
 - 7. Twelve (12) button keypad
 - 8. SPEAKER PHONE, TALK, ringer VOLUME UP/DOWN, EMERGENCY, TONE, PAGE, PROGRAM, MENU, and eight (8) additional user-programmable special function keys
 - 9. Telephone type modular connector

10. Sensitive loudspeaker
 11. Built-in condenser microphone
 12. Queuing
 13. Data communications; local operating networks (LON), RS-485
 14. Telephone style handset with dynamic receiver and electret transmitter
 15. HOLD button
- B. The ACS shall provide the following functions and features.
1. User programmable two, three, four, or five digit alpha-numeric direct dialing number assignment to the following locations: ACS to classroom speaker(s); ACS to programmed telephone instrument; or ACS to ACS.
 2. The ACS shall employ membrane switches that shall provide the user with a positive feel of switch activation.
 3. The ACS shall be equipped with a large sixteen (16) character LCD alpha-numeric readout which shall provide the following:
 - a. Queuing of calling room numbers and telephones
 - b. Sequential displays of calls "waiting" with no limit to the number of calls
 - c. EMERGENCY, PRIORITY, and NORMAL calls shall be displayed in order received and according to their priority.
 - d. Display of the alphanumeric room number or location of the calling station
 - e. Display of current time in twelve (12) or twenty-four (24) hour format in idle state
 - f. Full menu driven display of operator function dialing
 - g. Full menu driven display of menu prompting
- C. The ACS shall provide two (2) modes of communication to classroom loudspeakers. Communications shall be via handset or microphone/speaker, activated by a hands-free speakerphone or built-in talk/listen switch.
- D. Answering calls from loudspeaker locations shall be accomplished by picking up the handset or depressing the SPEAKERPHONE button.

- E. Call-in from an ACS, programmed telephone instrument, or callback switch shall be displayed in the following manner.
1. The first call entered shall appear in the display window of the ACS that shall display the dial number of the calling station.
 2. Any number of calls shall be stored in memory, up to the total capacity of the system with the quantity of those calls waiting displayed at the ACS.
 3. NORMAL and lower level calls shall annunciate with slower, repetitive rate, audio tone than EMERGENCY calls. Calls shall sort and stack automatically according to the preprogrammed priority level assignments. Each incoming call shall be automatically registered first in order of priority and then by order placed.
 4. Calls that have been upgraded by the caller shall automatically move to the EMERGENCY level and appear in proper sequence.
 5. EMERGENCY calls shall be distinguishable from NORMAL calls by designation and unique tone pattern. It shall be possible to visually or audibly determine whether the call-in is an emergency or normal call-in.
 6. The ACS shall have the ability to forward its call-in coverage to another ACS or programmed telephone instrument. This shall be a manual operation or at a predetermined time, automatically forwarded.
 7. It shall be possible to manually activate and sound the time tone event signal to any of the thirty-two (32) multi-purpose zones from any ACS and/or programmed telephone instrument.
 8. The ACS shall include a PROGRAM button for selection and distribution of each of the program channels to loudspeaker zones. The program channels shall be distributed via the ACS to loudspeaker zones, a group of loudspeaker zones, or all loudspeaker zones. It shall be possible to initiate changes to the distribution of the programs while program distribution is already in progress without having to first defeat the current distribution.
- F. The ACS shall be provided with an interconnecting cord set with modular connectors at each end.
- G. The system shall provide for transferring a call from the ACS to any other ACS and/or programmed telephone instrument.
- H. The system shall be equipped with the necessary ports that shall allow diagnostics via any standard computer terminal and modem interface that shall allow remote engineering assistance from the system manufacturer.

- I. The ACS shall provide for review of call-in coverage assignments to an ACS including review of identification numbers of remote stations assigned to either of the two (2) program channels and review of which ACS is forwarding coverage.
- J. The System shall, through a standard telephone card, allow for the installation of a standard 1.9 GHz cordless telephone as an ACS.
- K. An ACS which will meet this Specification is Dukane/Carehawk Model no. AP1.

2.03 CORDLESS ADMINISTRATIVE CONTROL STATION

- A. The Administrative Control Station (ACS) shall be desk mounted and contain a matching cordless handset. The unit shall terminate using a RJ-45 modular telephone type jack.
- B. Furnish and install one (1) digital waterproof 1.9 GHz cordless ACS. A cordless ACS that meets this specification is a UNIDEN Model No. D1760 or approved equal. Install cordless ACS as directed by FCPS.

2.04 CENTRAL EQUIPMENT

- A. This Contractor shall furnish and install (a) standard nineteen (19) inch wall mounted cabinet(s) for housing the central equipment. The central equipment shall be furnished and installed in the cabinet(s) by this Contractor and shall consist of the following items of equipment in the quantities required to perform the hereinbefore specified functions.
 - 1. Ortronics Model No. OR-WMRF-8-18 wall mounted equipment rack.
 - 2. Dukane Carehawk Model No. CH1000-2I-8T Central Controller with two (2) intercom paths and eight (8) telephone paths. Other central equipment components shall consist but not limited to:
 - a. CC200/CC300 installed module for single or dual systems (middle and high schools
 - b. SS16/SS32 Switching Security Card (16/32 Port)
 - c. OC 16-2 Dual Add on module f/u/w SS16 for priority override
 - d. GS 108Tv2 Prosafe 8 port Gig Smart Switch by Netgear
 - e. TC2 Telephone Communication Module for Telephone Interface
 - f. VTM VoIP Telephone Module
 - g. VG2/VG4 FXO VoIP Gateway
 - 3. APC Model No. AP7900 Power Panel with Surge protection.
 - 4. The system shall contain natively RS232, RS485, USB and Ethernet ports for communication to any third party system. The system shall contain five open collectors, three dry contacts, and six general purpose inputs for third party system integration or for general panic buttons. The system shall have integrated surge protection for all audio ports and

switching/line card ports.

5. The system shall use class D digital amplifiers(s) with at least 250 watts RMS and 300 watts peak output. Amplifier distortion shall not exceed 0.2% at 90% load. The class D amplifier shall be direct drive 25V constant voltage type. The system shall filter all voice signals through a Digital Signal Processor (DSP) to maximize voice intelligibility. System amplifiers shall go to sleep mode thus reducing their current draw when not used and shall have built in pink noise generators for testing speaker quality and audio levels.
6. The system shall have at least 25 tones available for bells, reminders and other events and shall support WAV type audio files. The user shall be able to add 25+ custom WAV files for use as pre-recorded announcements, bells, reminders, pre-announced tones, or any other system tones.
7. The system shall support remote switching/line cards with 16 and 32 audio ports available Dukane Model No. SS16/SS32. A single central cabinet shall support up to 32 port cards. The remote switching/line cards shall be powered from the central cabinet out to 2700 feet away from the central cabinet.
8. Denon Model No. DN-300Z AM/FM tuner /CD MP3 player assembly with pre-amp. Monitor speaker and rack mount kit.

2.05 SYSTEM INTEGRITY AND MEMORY

- A. The user programmable functions of the sound and intercommunications system shall be protected by a manufacturer supplied lithium battery with a life expectancy of at least ten (10) years.

2.06 EQUIPMENT LOCATIONS

- A. This Contractor shall furnish and install where shown on the Drawings, wall mounted main and sub-distribution equipment locations consisting of fire resistant 3/4-inch thick plywood backboards.

2.07 ADMINISTRATIVE CONTROL STATION RECEPTACLES

- A. This Contractor shall furnish and install where shown on the Drawings, administrative control station receptacles each consisting of: one (1) ORTRONICS Part No. OR-40300549 single-gang faceplate; and one (1) ORTRONICS Part No. OR-TJ5E00- 22 (red) single, category 5e, RJ-45 (568A/B) TrackJack insert suitable for flush or surface mounting in a single-gang outlet box as noted on the Drawings. Faceplate shall be labeled "Sound System Only". The equivalent outlets as manufactured by AMP, HUBBELL, P&S ACTIVATE, LEVITON, OPTICAL CABLE CORP., or PANDUIT, will also be considered

provided they are fully equal to the type specified herein.

2.08 CLASSROOM CALLBACK SWITCHES

- A. This Contractor shall furnish and install where shown on the Drawings, wall mounted callback switches suitable for flush or surface mounting in a single gang outlet box as noted on the Drawings. The call-back switches shall have a call-in push button to provide a method to annunciate a normal intercom call or an emergency intercom call that is received by the DA1 Display Administrative Console. The call switch shall interface with a SS16/SS32 switching card audio port and shall provide RJ45 connectivity for a Cat 6 cable from the SS16/SS32 switching card port. A classroom callback switch that meets this Specification is DUKANE Model No. CS100.

2.09 FLUSH CEILING MOUNTED SPEAKER ASSEMBLIES

- A. This Contractor shall furnish and install where shown on the Drawings, flush 1'x2' drop-in ceiling speaker assemblies consisting of a loudspeaker, backbox, and baffle. A flush 1'x2' drop-in ceiling speaker assembly that meets this specification is Quam Model No. SYSTEM 5/25 RS (complete with 2' T-Bar) or equal by Atlas Sound. Corridor circuits shall have maximum FIVE speakers per zone.
- B. Flush ceiling mounted speaker assemblies for drywall type ceiling construction shall be the following: loudspeaker shall be Atlas Sound Model No. C803AT72 or equal by Quam; baffle shall be Atlas Sound Model No. 51-8 or equal by Quam; back box shall be Atlas Sound Model No. BMT95-8-7 or equal by Quam for drywall type ceiling installations.

2.10 SURFACE CEILING MOUNTED SPEAKER ASSEMBLIES

- A. This Contractor shall furnish and install where shown on the Drawings, surface mounted speaker assemblies consisting of an Atlas Sound Model No. C803AT72 loudspeaker and an Atlas Sound Model No. Q428-SA backbox complete with regressed speaker grille and a matte white finish (or equal by Quam).

2.11 WALL MOUNTED SPEAKER ASSEMBLIES

- A. This Contractor shall furnish and install where shown on the Drawings, surface mounted speaker/transformer/baffle assemblies. An assembly that meets this specification is QUAM SYSTEM 1 or equal by Atlas Sound. The SYSTEM-1 is a complete loudspeaker system consisting of an 8C5PAX-8 Ω O.D> dual cone loudspeaker with a 5oz. magnet and TBLU-5W 25/70V transformer mounted on a BS8W – square, screw mount, steel baffle with a SE1WP – square, steel vandal resistant, surface mount enclosure with four (4) 8-32 threaded inserts and a single ½” conduit entrance, white powder coat finish.

- B. The recessed wall speakers shall be Atlas Sound No. C5A-T72 speaker and transformer with Atlas No. 191-78 flush wall speaker enclosure and Atlas No. 164-8A square recessed baffle.

2.12 HORN TYPE SPEAKERS

- A. This Contractor shall furnish and install where shown on the Drawings, horn type speakers as shown on the Drawings and as herein specified.
- B. Horn type speakers shall be surface mounted as shown on the Drawings and shall have the following characteristics: a full range power rating of 15 watts; frequency response of 400-14,000Hz; 100 degree dispersion; power taps at 1,2,3,7.8,7.5 and 15 watts; axial sensitivity of 120dB at four (4) feet for 15 watt input; beige baked enamel finish over a corrosion resistant coating; three-way adjustable mounting bracket; and a screw type terminals with a transparent cover and strain relief clamp. A horn type speaker that meets this specification is Atlas Model No. AP-15T(C).
- C. Gymnasium horn type speakers shall be surface mounted as shown on the Drawings and shall have the following characteristics: a full range power rating of 30 watts; frequency response of 300Hz-12kHz; 100 degree dispersion; power taps at 1, 2, 3.7, 7.5, 15 and 30 watts; axial sensitivity of 121dB at four (4) feet for 15 watt input; beige baked enamel finish over a corrosion resistant coating; three-way adjustable mounting bracket; and screw type terminals with a transparent cover and strain relief clamp. A horn type speaker for use in gymnasiums that meets this Specification is Atlas Model No. AP-30TC.

2.13 VOLUME CONTROLS

- A. This Contractor shall furnish and install where shown on the Drawings, wall mounted speaker volume controls as specified herein.
- B. Volume controls shall provide for control of area speaker volume on 25 volt or 70 volt speaker distribution lines controlling up to 10 watts of audio power. Attenuation shall be accomplished in eleven (11) steps, including "0". The switch shall be a twelve (12) position rotary type. Volume controls shall be complete with a satin finished, stainless steel coverplate and the knob shall have a clearly visible white indicator line. The volume control shall mount in a single gang outlet box, flush or surface mounted as noted on the Drawings. A volume control that meets this Specification is Atlas Model No. AP-30TC.

2.14 MICROPHONES

- A. This Contractor shall furnish one (1) desk top paging microphone. A microphone which meets this specification is TOA PM-660U Paging Microphone designed for paging calls and general announcements, the PM-660U desk top microphone comes with a large talk switch and a lock lever for easy and convenient operation. PM-660U microphone shall be equipped with a remote control switch

(interlocked with talk switch) for amplifier power on/off operation.

- B. **(Elementary Schools only, Engineers to edit out)** This Contractor shall furnish one (1) bus call station hand-held communications type, noise-canceling, dynamic, noise-canceling microphone with the following features: frequency response of 100 to 7,500 Hz; double pole, double throw touch-to-talk switch with spring return; wall clip; and a six (6) foot long, four (4) conductor cable having two (2) conductors shielded. A microphone which meets this Specification is ASTATIC Model No. 611L complete with Model No. 40-315 mounting bracket.

2.15 MICROPHONE OUTLETS

- A. This Contractor shall furnish and install where shown on the Drawings, wall mounted microphone outlets suitable for flush or surface mounting in a single gang outlet box as noted on the Drawings. Microphone outlets shall consist of CANNON "XLR" series audio jacks of the type required so as to be compatible with the type of microphone cable connector furnished, and a stainless steel coverplate. A microphone outlet that meets this Specification is Pro Co WP1049DF complete with a five-pin XLR.

2.16 SOUND AND INTERCOMMUNICATIONS SYSTEM CABLE

- A. This Contractor shall furnish and install the following cables for each speaker zone shown.
1. One (1) two (2) conductor, twisted shielded pair, No. 22 AWG stranded plenum rated cable with a temperature range for dry locations of minus ten (10) degrees C to sixty (60) degrees C. A cable, which meets this Specification, is WEST PENN Cat. No. 25291B or equal as manufactured by BELDEN, BERK TEK, CONSOLIDATED WIRE, and GENERAL CABLE, PAIGE, WINDY CITY WIRE or TAPPAN.
 2. Outside plant (flooded) cable, one (1) two (2) conductor, No. 22 AWG stranded, having two (2) twisted conductors shielded. A cable, which meets this Specification, is WEST PENN Cat. No. AQC 291 or equal as manufactured by BELDEN, BERK TEK, CONSOLIDATED WIRE, and GENERAL CABLE, PAIGE, WINDY CITY WIRE or TAPPAN.
- B. This Contractor shall furnish and install the following cables for each microphone outlet shown.
1. One (1) stranded, No. 20 AWG, shielded, single twisted pair plenum rated cable with a temperature range for dry locations of minus ten (10) degrees C to sixty (60) degrees C. A cable that meets this Specification is WEST PENN Cat. No. 25292B or equal as manufactured by BELDEN, BERK TEK, CONSOLIDATED WIRE, GENERAL CABLE, PAIGE, WINDY CITY WIRE or TAPPAN.

- C. This Contractor shall furnish and install the following cables for each ACS shown.
1. One Cat 6 4-pair UTP Cable, plenum with White Jacket, West Penn Model No. 254246WH or equal as manufactured by BELDEN, BERK TEK, CONSOLIDATED WIRE, and GENERAL CABLE, PAIGE, SUPERIOR, ESSEX, WINDY CITY WIRE or TAPPAN.
- D. This Contractor shall furnish and install the following cables for each callback switch.
1. One Cat 6 4-pair UTP Cable, plenum with White Jacket, West Penn Model No. 254246WH or equal as manufactured by BELDEN, BERK TEK, CONSOLIDATED WIRE, and GENERAL CABLE, PAIGE, SUPERIOR, ESSEX, WINDY CITY WIRE or TAPPAN.
- E. This Contractor shall furnish and install the following cables for each volume control shown.
1. One (1) four (4) conductor, No. 20 AWG stranded plenum rated cables with a temperature range for dry locations of minus ten (10) degrees C to sixty (60) degrees C having two (2) twisted conductors shielded and two (2) twisted conductors unshielded. A cable that meets this Specification is WEST PENN Cat. No. 25291B or equal as manufactured by BELDEN, BERK TEK, CONSOLIDATED WIRE, GENERAL CABLE, PAIGE, or TAPPAN.
- F. This Contractor shall furnish and install the following cables for priority override for each independent sound system (i.e. auxiliary, auditorium, gymnasium, etc.) within the building.
1. One (1) four (4) conductor No. 20 AWG stranded, plenum rated cable, with a temperature range for dry locations of minus ten (10) degrees C. to sixty (60) degrees C. A cable that meets this specification is WEST PENN Cat. No. 25359B or equal as manufactured by BELDEN, BERK TEK, CONSOLIDATED WIRE, and GENERAL CABLE, PAIGE, WINDY CITY WIRE or TAPPAN (for priority override).
- G. This Contractor shall furnish and install the following cables for connection between sub-closets and main closet within the building.
1. One Cat 6 4-pair UTP Cable, plenum with White Jacket, West Penn Model No. 254246WH or equal as manufactured by BELDEN, BERK TEK, CONSOLIDATED WIRE, and GENERAL CABLE, PAIGE, SUPERIOR, ESSEX, WINDY CITY WIRE or TAPPAN (from each SS16/SS32 back to the Central Cabinet plus one additional Cat 6 cable per sub-closet for future spare).

2.17 AM/FM ANTENNA

- A. This Contractor shall furnish and install a PIXEL TECHNOLOGIES Model No. AFHD-4 AM/FM and HD antenna complete with: L mounting bracket; weather boot; surge protector; 20dB attenuator; 10dB attenuator; AM/FM separator; U-bolts with washers and nuts; pole mount saddle brackets; F-female to twin-lead adaptor and push-on-F-female to DIN adaptor. This Contractor shall furnish and install a weatherhead, rigid steel conduit mast, and two (2) RG-6 plenum rated cables from the antennas to the tuner located in the sound and intercommunication system equipment rack. This Contractor shall ground the antenna in accordance with the following specification.

PART 3 - EXECUTION

3.01 RACK MOUNTED EQUIPMENT

- A. Rack mounted equipment shall be installed by this Contractor with the proper adapters, rack mounting kits, brackets, and closure panels for unused spaces. All interconnecting wiring shall be labeled, bundled, secured, and terminated by this Contractor in a neat and professional manner.
- B. All rack mounted equipment AC power cords shall be plugged into the mounted power strip by this Contractor.

3.02 ADMINISTRATIVE CONTROL STATIONS

- A. Administrative Control Station (ACS) shall be wired to locations shown on Drawings or described herein by this Contractor and provided with twelve (12) feet of slack cable from the outlet point to the ACS

3.03 ADMINISTRATIVE TELEPHONE RECEPTACLES

- A. Administrative control station receptacles shall be assembled and installed by this Contractor at mounting heights and locations as shown on the Drawings, in outlet boxes appropriate for the location and wire ready for use.

3.04 SPEAKERS

- A. Flush ceiling mounted speaker assemblies shall be supported by this Contractor from the building structure with a minimum of two (2) steel wires. Ceiling baffles shall be finished flush with the ceiling. The speakers shall be secured to the grid with four (4) Caddy 515A lay-in/troffer support clips. Flush ceiling mounted speakers shall be tapped at 0.5 watts unless otherwise indicated.
- B. Surface mounted speakers assemblies shall be securely fastened to the building

structure by this Contractor with threaded rod or bolts as appropriate for the application. Surface mounted speakers shall be tapped at 0.5 watts unless otherwise indicated.

- C. Surface wall mounted speaker assemblies shall be securely fastened to the building structure by this Contractor with bolts as appropriate for the application. Surface mounted speakers shall be tapped at 4.0 watts unless otherwise indicated.
- D. Horn type speaker shall be securely fastened to the building structure by this Contractor with threaded rod, bolts and/or bridging as required for the mounting location. Horn type speakers shall be tapped as directed by the Owner.

3.05 MICROPHONES

- A. This Contractor shall unpack each microphone and assemble with cables and stands and connect ready for operation. Microphones shown for permanent installation shall be mounted by this Contractor in accordance with the Drawings in a manner appropriate for the location.

3.06 MICROPHONES OUTLETS

- A. This Contractor shall assemble microphone outlets and install, connect, and label as shown on the Drawings.

3.07 CALL-BACK SWITCHES

- A. Call-back switches shall be installed by this Contractor at mounting heights and locations as shown on the Drawings, in outlet boxes appropriate for the location and wire ready for operation.

3.08 FIELD WIRING

- A. All vertical low-voltage field wiring shall be installed by this Contractor in conduit and/or surface metal raceway as shown on the Drawings. Conduit fill shall not exceed the conduit space capacity.
- B. All horizontal low voltage wiring to be installed in areas without a ceiling or in areas without an accessible ceiling shall be installed by this Contractor in ½-inch conduit. Conduit is not required in areas designed on the Drawings as "Communications" rooms or closets.
- C. All horizontal low voltage field wiring to be installed in areas with accessible ceilings shall be installed by this Contractor bundled together and run exposed above the ceilings. Bundles shall be supported by "J" hooks mounted not more than four (4) feet on center. "J" hooks to be dedicated to the wiring specified in this specification section. Provide eight to ten feet service loop within one foot of point of entry for any cabling supported by "J" hooks.

- D. All horizontal low-voltage field wiring shall be run at right angles to the building structure.
- E. All horizontal low voltage field wiring shall be installed below the roof/floor structural supports (joists, beams, girders, etc.). Wiring installed between the structural supports mentioned above and the roof or floor deck will not be acceptable. Cables pulled through sleeves without bushings, or cut bushings wrapped with tape will not be accepted and shall be replaced by the Contractor.
- F. All horizontal low voltage field wiring penetrations through new and/or existing walls shall be sleeved. Minimum sleeve size shall be 3/4 inch. All sleeves shall be bushed both sides.
- G. All low voltage field wiring shall be installed, terminated, and labeled by this Contractor as shown on the Drawings. Cables shall not be nicked, strained, or damaged during the pulling operation. Splices shall be permitted at equipment enclosures and junction boxes only. All splices shall utilize insulated crimp type connectors. All junction box covers shall be stenciled for distinct identification.
- H. Microphone cabling shall be installed by this Contractor in accordance with requirements for special cables, however terminations at connectors shall be solder connected.
- I. All low voltage wiring shall be checked and tested by this Contractor to ensure the system is free from grounds, opens, and shorts.
- J. All work shall be under the supervision of a factory accredited sound engineer. It shall be the responsibility of the sound engineer and this Contractor to check and inspect this installation to the Owner's and Architect/Engineer's approval.
- K. All wiring installed outside the footprint of a building shall be outside plant (flooded), indoor/outdoor, type cables.

3.09 ANTENNA INSTALLATION

- A. The antenna shall be bracket mounted by this Contractor above the roof at a location approved by the Owner. The antenna cables shall be run by this Contractor to the equipment rack and connected ready for operation.
- B. The antenna shall be grounded by this Contractor to the secondary building ground system with one (1) No. 10 AWG in 1/2-inch conduit.

3.10 ON-SITE AS-BUILT DRAWINGS

- A. The Contractor shall provide one (1) set of the sound and intercommunications and system supplier's as-built drawings for permanent use on-site. The Contractor shall: laminate each page of these drawings; provide a rigid means

for mounting such as 1/4 inch thick x two (2) inch wide x width of the drawings through-bolted wood along the left edge of the drawings; furnish and install hanging hooks on the back of the Communications Room door; and hang the bound set of drawings.

END OF SECTION

SECTION 16713

CLASSROOM AMPLIFICATION SYSTEMS (Phonak)

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contracts, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work covered under this Section shall include furnishing and installing a locally controlled complete and satisfactorily operating classroom amplification system where shown on the Drawings for the pick up, amplification, and reproduction of voice/audio at classroom locations.

1.03 QUALITY ASSURANCE

- A. All equipment specified herein shall be the product of a manufacturer of established reputation and experience who shall have produced similar apparatus for a period of at least ten (10) years and who shall be able to refer to similar installations now rendering satisfactory service.
- B. The classroom amplification system(s) shall be a dynamic digital modulation (DM) type system. Specifically, it must utilize digital transmission technology in the 2.4 GHz band with automatic frequency hopping to avoid interference issues.
- C. The classroom amplification system(s) shall be furnished by a factory authorized distributor certified to design, program, and service the system. The distributor must show evidence of successfully furnishing similar systems for at least five (5) years.
- D. All equipment for this system shall be listed by Underwriters Laboratories, Inc. (UL), bear the UL label and shall be installed in accordance with all requirements of the National Electrical Code (NEC), state and local codes, and these Specifications.
- E. The classroom amplification system(s) shall be furnished and installed by this Contractor as shown on the Drawings and as specified herein.
- F. Shop drawing submittals are required per SECTION 16010 and shall include the following for review. Submittals not containing all of the information listed below will be rejected.

1. A complete list of equipment shall be furnished indicating the specific quantities to be furnished by this Contractor. The catalog or model number for each module of the system(s) shall be listed next to the quantities. This information shall be furnished in the front of the submittal.
2. A specific description of the system(s) shall be furnished describing each module and how it shall function in the system.
3. A data sheet shall be furnished for each module and device. The information shall be highlighted that applies to the particular module or device to be furnished.
4. A detailed diagram showing how to connect the audio hub device to a computer and the CATV system shall be furnished indicating the exact final connection information.

1.04 DOCUMENTATION

- A This Contractor shall furnish to the Owner four (4) sets of factory operation and maintenance manuals. These manuals shall include factory service manuals with complete parts lists, wiring and component schematics including circuit diagrams, and all other information necessary for the proper operation and service maintenance of the system.

1.05 TRAINING

- A. This Contractor shall furnish eight (8) hours of technical service training to the Owner's technical staff using the factory operation manuals previously specified.
- B. This Contractor shall furnish eight (8) hours of operating and programming training to the Owner's operating staff which shall be delivered in two (2) separate four (4) hour sessions to be scheduled at the Owner's convenience over the warranty period.
- C. All training specified herein shall be performed by a factory certified technician.

1.06 DESCRIPTION OF OPERATION

- A. Each system shall provide for the distribution of voice/audio to associated loudspeaker.
- B. Each system shall provide auxiliary inputs for the connection to a computer and/or the building CATV system.
- C. Each system shall have the capability to interact with a student's hearing aid and/or cochlear implant device.

1.07 SYSTEM TEST AND ACCEPTANCE

- A. Prior to the final site visitation and acceptance of each construction phased spaces, this Contractor shall conduct an operating test of each complete classroom amplification system. Each system shall test free from grounds, shorts, and other faults. All connections shall be checked for mechanical and electrical connection. All equipment shall be demonstrated to operate in accordance with the requirements set forth in these Specifications and as shown on the Drawings.
- B. This Contractor shall perform all tests in the presence of the Architect/Engineer. This Contractor shall furnish all personnel and test instruments required for use in the test.

1.08 WARRANTY

- A. This Contractor shall deliver the work described herein in a first class operating condition in every respect. This Contractor shall also warrant that the material, equipment, and workmanship shall be entirely free from defects. Any materials, equipment, or workmanship in which defects may develop before or during the warranty period shall be repaired or replaced at the Contractor's own expense. Refer to SECTION 01740 for the start of the warranty period. The contractor shall further warrant that all material, equipment, and workmanship used in the installation, but not specifically mentioned in the Drawings and Specifications, is the best of their respective kinds and that the construction and installation was performed in accordance with the best accepted standard practices in all details.

PART 2 - PRODUCTS**2.01 MANUFACTURER**

- A. The classroom amplification system(s) shall be as manufactured by PHONAK or approved equal.

2.02 WALL MOUNTED SPEAKER

- A. This Contractor shall furnish and install a wall mounted classroom amplification system speaker where shown on the Drawings and herein specified.
 - 1. One (1) PHONAK Digimaster 5000 (Elementary, Middle and High Schools) wall mounted speaker complete with the following:
 - a. Wall mounted bracket
 - b. 12 speaker-line array
 - c. Mini USB port
 - d. 3.5 mm audio input

- e. LED status indicating light
 - f. Power supply with mini USB connection
2. One (1) PHONAK Digimaster 7000 (High Schools only, where shown on drawings) wall mounted speaker complete with the following:
- a. Wall mounted bracket
 - b. 15 speaker-line array
 - c. Mini USB port
 - d. 3.5 mm audio input
 - e. LED status indicating light
 - f. Power supply with mini USB connection
 - g. Ability to broadcast signal independently or paired with another Digimaster 7000 speaker.

2.03 TRANSMITTER

- A. This Contractor shall furnish at each classroom amplification wall mounted speaker location shown on the Drawings one (1) PHONAK Transmitter complete with the following:
- 1. DM transmitter mode
 - 2. Voice activity detector
 - 3. Built in automatic and manual directional microphone system
 - 4. One (1) Pass Around (handheld) microphone
 - 5. Touchscreen display
 - 6. Lanyard device to be worn around neck of user

2.04 AUDIO HUB

- A. This Contractor shall furnish at each classroom amplification wall mounted speaker location shown on the Drawings one (1) PHONAK Roger Multimedia Hub complete with the following:
- 1. One (1) audio input
 - 2. Micro USB charging hub
 - 3. On/off switch
 - 4. Connect button
 - 5. One (1) 3.5mm male to 3.5mm male patch cable. Minimum 10ft. in length.
 - 6. Power supply with micro USB connection

PART 3 - EXECUTION

3.01 INSTALLATION

- A. All work shall be under the direct supervision of an accredited factory sound engineer. It shall be the responsibility of the sound engineer and this Contractor to check and inspect this installation to the Owner's approval.
- B. All transmitters, microphones, audio hubs and patch cables shall be properly stored and protected during construction.

3.02 WALL MOUNTED SPEAKER

- A. The classroom amplification system wall mounted speaker(s) shall be installed by this Contractor with the proper adapters, mounting kits, and brackets at 48" above finished floor to bottom of speaker. All interconnecting power wiring shall be secured and terminated by this Contractor in a neat and professional manner.

3.03 TRANSMITTER/MICROPHONES

- A. This Contractor shall unpack each transmitter and microphone, assemble, connect and make ready for operation.

3.04 AUDIO HUB

- A. This Contractor shall unpack each audio hub, connect power and 3.5mm patch cables and make ready for operation.

END OF SECTION

SECTION 16715

AUXILIARY SOUND REINFORCEMENT SYSTEMS

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contracts, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work covered under this Section shall include furnishing and installing locally controlled complete and satisfactorily operating auxiliary stereo sound reinforcement systems in the **Cafeteria (Elementary, Middle and High Schools), Gymnasium (Elementary and Middle Schools), Auxiliary Gymnasium (Middle & High Schools) and Lecture Halls (Middle and High Schools)** for the pick up, amplification, and reproduction of voice and/or music at a remote locations.

1.03 QUALITY ASSURANCE

- A. All equipment specified herein shall be the product of a manufacturer of established reputation and experience who shall have produced similar apparatus for a period of at least ten (10) years and who shall be able to refer to similar installations now rendering satisfactory service.
- B. The auxiliary sound reinforcement system(s) shall be furnished by a factory authorized distributor certified to design, program, and service the system. The distributor must show evidence of successfully furnishing systems specified for at least five (5) years
- C. All equipment for this system shall be listed by Underwriters Laboratories, Inc. (UL), bear the UL label and shall be installed in accordance with all requirements of the National Electrical Code (NEC), state and local codes, and these Specifications.
- D. The auxiliary sound reinforcement system(s) shall be furnished and installed by this Contractor as shown on the Drawings and as specified herein.
- E. Shop drawing submittals are required per SECTION 16010 and shall include the following for review. Submittals not containing all of the information listed below will be rejected.
 - 1. A complete list of equipment shall be furnished indicating the specific quantities to be furnished by this Contractor. The catalog or model

number for each module of the system(s) shall be listed next to the quantities. This information shall be furnished in the front of the submittal.

2. A specific description of the system(s) shall be furnished describing each module and how it shall function in the system.
3. A specific drawing shall be furnished of the (each) equipment rack. Each module shall be shown in its proper location with its terminal designations shown.
4. A data sheet shall be furnished for each module and device. The information shall be highlighted that applies to the particular module or device to be furnished.
5. A detailed diagram showing how to connect each device shall be furnished indicating the exact final connection information.
6. A detailed set of floor plans for the area(s) where the (each) auxiliary sound system(s) is (are) to be installed shall be furnished. The plans shall show the locations of all equipment, loudspeakers, and devices and their required interconnections. The interconnections shown shall indicate the number, size, and type of wires as described in this Specification. Loudspeakers shall be zoned as shown on the Drawings. The layout of all auxiliary sound reinforcement system(s) equipment, devices, and conduit routing shall closely follow that shown on the Drawings.

1.04 DOCUMENTATION

- A. This Contractor shall furnish to the Owner, one (1) set of "As Built" drawings depicting the complete field wiring system and component interconnections in the system equipment rack.
- B. This Contractor shall furnish to the Owner four (4) sets of factory operation and maintenance manuals. These manuals shall include factory service manuals with complete parts lists, wiring and component schematics including circuit diagrams, and all other information necessary for the proper operation and service maintenance of the system.

1.05 TRAINING

- A. This Contractor shall furnish eight (8) hours of technical service training to the Owner's technical staff using the factory operation manuals previously specified.
- B. This Contractor shall furnish eight (8) hours of operating and programming training to the Owner's operating staff which shall be delivered in two (2)

separate four (4) hour sessions to be scheduled at the Owner's convenience over the warranty period.

- C. All training specified herein shall be performed by a factory certified technician.

1.06 DESCRIPTION OF OPERATION

- A. Each system shall provide for the distribution of voice and music to all associated loudspeakers.
- B. Each system shall provide for the reproduction of standard cassette tapes and compact disc recordings and distribute them to all associated loudspeakers.
- C. Each system shall provide for the input and output of an external tape recorder.
- D. Each system shall provide for individual bass and treble controls.
- E. Each system shall provide a personal listening system for use by hearing impaired listeners.
- F. Each auxiliary sound reinforcement system shall accept a priority override signal to mute the system when the main building sound and intercommunications system activates the priority override function .

1.07 SYSTEM TEST AND ACCEPTANCE

- A. Prior to the final site visitation, and acceptance of each construction phased spaces, this Contractor shall conduct an operating test of each complete auxiliary sound reinforcement system. Each system shall test free from grounds, shorts, and other faults. All connections shall be checked for mechanical and electrical connection. All equipment shall be demonstrated to operate in accordance with the requirements set forth in these Specifications and as shown on the Drawings.
- B. This Contractor shall perform all tests in the presence of the Architect/Engineer. This Contractor shall furnish all personnel and test instruments required for use in the test.

1.08 WARRANTY

- A. This Contractor shall deliver the work described herein in a first class operating condition in every respect. This Contractor shall also warrant that the material, equipment, and workmanship shall be entirely free from defects. Any materials, equipment, or workmanship in which defects may develop before or during the warranty period shall be repaired or replaced at the Contractor's own expense. Refer to SECTION 01740 for the start of the warranty period. The Contractor

shall further warrant that all material, equipment, and workmanship used in the installation, but not specifically mentioned in the Drawings and Specifications, is the best of their respective kinds and that the construction and installation was performed in accordance with the best accepted standard practices in all details.

PART 2 - PRODUCTS

2.01 MANUFACTURER

- A. The auxiliary sound reinforcement system(s) equipment shall be manufactured by ATLAS SOUND, CROWN, PASO, SHURE, TASCAM and WILLIAMS SOUND as listed. or equal equipment as manufactured by and RAULAND.

2.02 AUXILIARY SOUND REINFORCEMENT SYSTEM EQUIPMENT RACKS

- A. This Contractor shall furnish and install sectional wall mounted auxiliary sound system equipment racks as shown on the Drawings and herein specified. Each rack shall be ATLAS SOUND model no. WMA24-23 providing a minimum of forty-two (42) vertical inches of standard nineteen (19) inch wide rack mounting space. Each rack shall be complete with a cylinder lock and textured black finish. Each auxiliary sound system equipment rack shall have a sign mounted to the front stating, "Personal Listening Devices Stored Here". The sign shall be 1/16 inch thick laminated plastic with 3/16 inch high white letters on a black background. The following equipment shall be furnished and installed by this Contractor in each rack:
 - 1. One (1) TOA model no. D-901 twelve (12) input, eight (8) output, digital mixer. Mixer shall come complete with:
 - a. One (1) D936R four (4) stereo input module (tuner, CD, MP3 outlets).
 - b. One (1) D971E four (4) channel line output module (personal listening system, amplifier).
 - c. Four (4) D921E 2-channel input modules (microphone/MP3 outlets).
 - 2. One (1) TASCAM model no. CD- 200BT, rack mounted CD player with MP3 dock.
 - 3. One (1) ROLLS Model No. RS81B Quartz PLL synthesized rack mounted stereo AM/FM tuner.

4. One (1) CROWN model no. CDi 2/300 dual channel amplifier with three hundred (300) watts per channel at eight (8) ohms. Amplifier shall be suitable for rack mounting. **(For Cafeteria and Lecture Halls).**
5. Three (3) CROWN model no. CDi 2/300 dual channel amplifier with three hundred (300) watts per channel at 8 ohms. Amplifier shall be suitable for rack mounting **(For Middle School Cafeteria with Stage, Engineer to Delete if no Middle School Stage is Involved).**
6. One (1) CROWN model no. CDi4/600 four channel amplifier with six hundred (600) watts per channel at (4/8) ohms. Amplifier shall be suitable for rack mounting **(For Elementary School Gymnasium with maximum eight SX100 speakers).**
7. Two (2) CROWN model no. CDi 4/600 four channel amplifiers with six hundred (600) watts per channel at (4/8) ohms. Amplifiers shall be suitable for rack mounting **(For Middle School Gymnasium with more than eight SX10 speakers).**
8. One (1) ATLAS SOUND model no. AP-S15L power panel with duplex receptacles and mounting hardware.
9. One (1) WILLIAMS SOUND model No. FM T55 personal listening system base station transmitter complete with WILLIAMS SOUND Model No. RPK 005 rack mounting kit and ANT 025 antenna.
10. This Contractor shall furnish and install in the charging stations thirteen (13) WILLIAMS SOUND model no. PPA R37, seventeen (17) channel personal listening system receivers each complete with: WILLIAMS SOUND model no. EAR 013 single earbud, rechargeable batteries, and belt clip.
11. This Contractor shall furnish to the Owner's representative, four (4) WILLIAMS SOUND model NKL 001 neckloops.
12. This Contractor shall furnish and install one (1) WILLIAMS SOUND model No. CHG 3512 twelve (12) unit charging case and one 3502 two (2) unit charging station for the personal listening system receivers complete with one (1) ATLAS SOUND model No. VTD1-16 rack sliding shelf and WMARR24 optional rear rack rails for WMA24-23 (pair).
13. One (1) Shure ULXD4Q Quad digital receiver, rack mounted four channel microphone receiver complete with one (1) Shure UHF remote antenna cable (field verify length) and one (1) pair of Shure UA874US, directional antennas. The antennas shall be mounted remotely in ceiling and not in the rack. Coordinate with FCPS Field Representative for location.

14. One (1) Atlas Sound Make Storage Drawer – recessed 4RU with 14 inch extension (SD4 -14).

2.03 MICROPHONES

- A. This Contractor shall furnish a total of four (4) SHURE model no. SM58S dynamic cardioid microphones complete with ON-OFF switch and lockplate for each system. Each microphone shall be furnished by this Contractor complete with a twenty five (25) foot connector cord with CANNON XLR connectors.
- B. This Contractor shall furnish and install the following wireless microphones and accessories.
 1. Two (2) Shure ULXD2/SM58 handheld transmitters with SM58 capsule.
 2. Two (2) Shure ULXD1 digital wireless body packs.
 3. Two (2) Shure MX150B cardioid 5mm subminiature microphone.
 4. One (1) Shure SC800-US, 8-bay Shure battery charging station.
 5. All batteries shall be of rechargeable type (Shure SB 900A) as recommended by system manufacturer.
- C. This Contractor shall furnish and install the following microphones and accessories, where shown on Drawings (**for Middle School Cafeteria with Stage, Engineer to delete if there is no Middle School Stage**)
 1. Ceiling mounted microphone outlets consisting of one (1) CANNON "XLR" complete with 3 pin XLR (female), series audio jack of the type required to be compatible with the type of microphone cable connector furnished.
 2. Three (3) SHURE Model No. CVO-B/C overhead microphones at locations shown on the Drawings. Provide one (1) spare windscreen per mic, Shure ACVO4WS.

2.04 MICROPHONE FLOOR STANDS

- A. This Contractor shall furnish a total of four (4) ATLAS SOUNDOLIER model No. MS-20 adjustable microphone floor stands for each system.

2.05 MICROPHONE OUTLETS

- A. This Contractor shall furnish and install where shown on the Drawings, flush or surface wall mounted microphone outlets consisting of one (1) CANNON "XLR", complete with 3 pin XLR (female), series audio jack of the type required so as to be compatible with the type of microphone cable connector furnished, one (1) 3.5mm stereo audio jack (MP3), and a stainless steel coverplate. A microphone/MP3 outlet which meets this Specification shall be as manufactured by CONQUEST AUDIO or approved equal.

2.06 FLUSH CEILING MOUNTED SPEAKER ASSEMBLIES

- A. This Contractor shall furnish and install where shown on the Drawings, flush 1'x2' drop-in ceiling speaker assemblies consisting of a loudspeaker, backbox, and baffle. A flush 1'x2' drop-in ceiling speaker assembly that meets this specification is JBL Model No. LCT 81 C/T complete with 2' T-Bar.
- B. Flush ceiling mounted speaker assemblies for drywall type ceiling construction shall be the following: loudspeaker/transformer shall be JBL Model No. CSS8018; backbox shall be JBL model no. CSS-BB8 and JBL model no. CSS-TR 4/8 rail for drywall type ceiling installations.

2.07 SUSPENDED CEILING MOUNTED SPEAKER ASSEMBLIES

- A. This Contractor shall furnish and install where shown on the drawings, secured/suspended mounted speaker assemblies consisting of Electrovoice model no SX 100 +e_HE (black); 200W speakers, Electrovoice model no. Mb-100-LB, Electrovoice model no. Mb 200 installation kit and Electrovoice model no. Mb 300 horizontal array kit (as required). Speakers shall use the Neutrik connectors (NL4FX).

2.08 WALL MOUNTED SPEAKERS (FOR MIDDLE SCHOOL STAGE)

- A. Wall Mounted Main Speaker
 - 1. This Contractor shall furnish and install where shown on the drawings; JBL model no. AM-5212/64, 2 way loud speaker system (black) with all the mounting accessories. **(Engineer to Delete if no Middle School Stage is Involved).**
- B. Wall Mounted Monitor Speaker
 - 1. This Contractor shall furnish and install where shown on the Drawings JBL model no. Control 29AV-1 with all the mounting accessories. **(Engineer to Delete if No Middle School Stage is Involved).**

2.09 AM/FM ANTENNA

- A. This Contractor shall furnish and install a PIXEL TECHNOLOGIES model no. AFHD-4 AM/FM and HD antenna complete with: L mounting bracket; weather boot; surge protector; 20dB attenuator; 10dB attenuator; AM/FM separator; U-bolts with washers and nuts; pole mount saddle brackets; F-female to twin-lead adaptor and push-on-F-female to DIN adaptor. This Contractor shall furnish and install a weatherhead, rigid steel conduit mast, and two (2) RG-6 plenum rated cables from the antennas to the tuner located in the sound and intercommunication system equipment rack. This Contractor shall ground the

antenna in accordance with the following specification.

2.10 AUXILLARY SOUND SYSTEM CABLE

- A. This Contractor shall furnish and install field wiring for auxiliary sound systems flush mounted drop-in-loudspeakers as shown on the Drawings. Wiring shall be two (2) conductor, No. 16 AWG stranded and shielded cable. A cable that meets this Specification is WEST PENN Cat. No.25294B or equal as manufactured by BELDEN, CONSOLIDATED WIRE, GENERAL CABLE, PAIGE, WINDY CITY WIRE or TAPPAN.
- B. This Contractor shall furnish and install field wiring for auxiliary sound systems, suspended ceiling mounted loudspeakers or wall mounted loudspeakers as shown on the Drawings. Wiring shall be two (2) conductor, No. 12 AWG stranded and shielded cable. A cable that meets this Specification is WEST PENN Cat. No.25227 or equal as manufactured by BELDEN, CONSOLIDATED WIRE, GENERAL CABLE, PAIGE, WINDY CITY WIRE or TAPPAN.
- C. This Contractor shall furnish and install field wiring for microphone outlets as shown on the Drawings. Wiring shall be two (2) conductor, No. 20 AWG stranded and shielded cable. A cable that meets this Specification is WEST PENN Cat. No. 25292B or equal as manufactured by BELDEN, CONSOLIDATED WIRE, GENERAL CABLE, PAIGE, WINDY CITY WIRE or TAPPAN.
- D. This Contractor shall furnish and install field wiring for MP3 outlets as shown on the Drawings. Wiring shall be two (2) conductor, No. 20 AWG stranded and shielded cable. A cable that meets this Specification is WEST PENN Cat. No. 25292B or equal as manufactured by BELDEN, CONSOLIDATED WIRE, GENERAL CABLE, PAIGE, WINDY CITY WIRE or TAPPAN.
- E. This Contractor shall furnish and install, for connection of ceiling mounted projector(s) shown (Cafeteria, Lecture Hall, etc.), to the auxiliary sound system, two (2) conductor, No. 16 AWG stranded and shielded cable. A cable that meets this Specification is WEST PENN cat. no. 25294B or equal as manufactured by BELDEN, CONSOLIDATED WIRE, GENERAL CABLE, PAIGE, WINDY CITY WIRE or TAPPAN. Cable shall be run from the audio out port of the ceiling mounted projector to an audio in port of the auxiliary sound system.
- F. **(Engineer Note: Use This To Tie Two (2) Auxiliary Sound Systems Together)** This Contractor shall furnish and install, for bridge cabling between auxiliary sound systems as shown on the Drawings, two (2) conductor, No. 16 AWG stranded and shielded cables. A cable that meets this Specification is WEST PENN Cat. No. 25294B or equal as manufactured by BELDEN, CONSOLIDATED WIRE, GENERAL CABLE, PAIGE, WINDY CITY WIRE or TAPPAN.

PART 3 - EXECUTION**3.01 INSTALLATION**

- A. All vertical low-voltage field wiring shall be installed by this Contractor in conduit and/or surface metal raceway as shown on the Drawings. Conduit fill shall not exceed the conduit space capacity.
- B. All horizontal to be installed in areas without a ceiling or in areas without an accessible ceiling shall be installed by this Contractor in ½-inch conduit.
- C. All horizontal low voltage field wiring to be installed in areas with accessible ceilings shall be installed by this Contractor bundled together and run exposed above the ceilings. Bundles shall be supported by "J" hooks mounted not more than four (4) feet on center. "J" hooks to be dedicated to the wiring specified in.
- D. All low voltage wiring connections shall be made by this Contractor as directed by the manufacturer. Splices for circuits shall be made only in junction boxes and shall be crimp connected.
- E. All wiring for the auxiliary sound reinforcement systems shall be checked and tested by this Contractor to ensure the system is free from grounds, opens, and shorts.
- F. All work shall be under the direct supervision of an accredited factory sound engineer. It shall be the responsibility of the sound engineer and this Contractor to check and inspect this installation to the Architect/Engineer's approval.
- G. Flush mounted speaker assembly support bridges shall be supported by this Contractor from the building structure with a minimum of two (2) steel wires. Ceiling baffles shall be finished flush with the ceiling by this Contractor.
- H. Surface mounted speakers shall be mounted by this Contractor between bar joists on 1-1/2" x 1-1/2" bridging, flush to the roof deck.

3.02 RACK MOUNTED EQUIPMENT

- A. The auxiliary sound reinforcement system(s) rack mounted equipment shall be installed by this Contractor with the proper adapters, rack mounting kits, brackets, and closure panels for unused spaces. All interconnecting wiring shall be labeled, bundled, secured, and terminated by this Contractor in a neat and professional manner.
- B. All rack mounted equipment AC power cords shall be plugged into the mounted power strip by this Contractor.

3.03 SPEAKER

- A. Flush ceiling mounted speaker assemblies shall be supported by this Contractor from the building structure with a minimum of two (2) steel wires. Ceiling baffles shall be finished flush with the ceiling. The speakers shall be secured to the grid with four (4) Caddy 515A Lay-in/troffer support clips. Flush ceiling mounted speaker assemblies shall be tapped at 2.0 watts unless otherwise indicated.
- B. Surface ceiling mounted speaker assemblies shall be securely fastened to the building structure by this Contractor with threaded rod, bolts and/or bridging as required for the mounting location. Surface ceiling mounted speaker assemblies shall be tapped at 2.0 watts unless otherwise indicated.

3.04 MICROPHONES

- A. This Contractor shall unpack each microphone and assemble with cables and stands and connect ready for operation.

3.05 MICROPHONE OUTLETS

- A. This Contractor shall assemble microphone outlets and install, connect, and label as shown on the Drawings.

3.06 ANTENNA INSTALLATION

- A. The antenna shall be bracket mounted by this Contractor above the roof at a location approved by the Owner. The antenna cables shall be run by this Contractor to the equipment rack and connected ready for operation.
- B. The antenna shall be grounded by this Contractor to the secondary building ground system with one (1) No. 10 AWG in 1/2 inch conduit.

END OF SECTION

SECTION 16720

AUDITORIUM SOUND REINFORCEMENT SYSTEM

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work covered under this Section shall include furnishing and installing a locally controlled complete and satisfactorily operating sound reinforcement system in the auditorium for the pick up, amplification, and reproduction of voice and/or music.

1.03 QUALITY ASSURANCE

- A. All equipment described shall be the product of a manufacturer of established reputation and experience produced similar apparatus for a period of at least ten (10) years and shall be able to refer to similar installations now rendering satisfactory service.
- B. The auditorium sound reinforcement system shall be furnished by a factory-authorized distributor certified to design, program, and service the system. The distributor must show evidence of successfully furnishing systems specified for at least five (5) years.
- C. All equipment for this system shall be listed Underwriters Laboratories, Inc. (UL) bear the UL label and shall be installed in accordance with all requirements of the National Electrical Code (NEC), state and local codes, and these Specifications.
- D. The entire auditorium sound reinforcement system installation shall be performed under the direct supervision of a factory trained service specialist.
- E. Shop drawing submittals are required per SECTION 16010 and shall include the following for review. Submittals not containing all of the information listed below will be rejected.
 - 1. A complete list of equipment shall be furnished indicating the specific quantities to be furnished by this Contractor. The catalog or model number for each module of the system shall be listed next to the quantities. This information shall be furnished in the front of the submittal.

2. A specific description of the system shall be furnished describing each module and how it shall function in the system.
3. A specific drawing shall be furnished of the auditorium sound reinforcement system equipment rack. Each module shall be shown in its proper location with its terminal designation shown.
4. A data sheet shall be furnished for each module and device. The information shall be highlighted that applies to the particular module or device to be furnished.
5. A detailed diagram showing how to connect each device shall be furnished indicating exact final connection information.
6. A detailed drawing showing how to mount the main house speakers shall be furnished, including necessary hardware and mounting devices.
7. A detailed floor plan for the auditorium and associated surrounding areas shall be furnished. The plan shall show the locations of all equipment, loudspeakers, and devices and their required interconnections. The interconnections shown shall indicate the number, size, and type of wires as described in this Specification. Loudspeakers shall be zoned as shown on the Drawings. The layout of all auditorium sound reinforcement system equipment, devices, and conduit routings shall closely follow that shown on the Drawings.

1.04 DOCUMENTATION

- A. This Contractor shall furnish to the Owner, one (1) set of "As Built" drawings depicting the complete field wiring system and component interconnections in the system equipment rack.
- B. This Contractor shall furnish to the Owner, four (4) sets of factory operation and maintenance manuals. These manuals shall include factory service manuals with complete parts lists, wiring and component schematics including circuit diagrams, and all other information necessary for the proper operation, service, and maintenance of the system.

1.05 TRAINING

- A. This Contractor shall furnish eight (8) hours of technical service training to the Owner's technical staff using the factory service manuals previously specified.
- B. This Contractor shall furnish eight (8) hours of operating and programming training to the Owner's operating staff which shall be delivered in two (2) separate four (4) hours sessions to be scheduled at the Owner's convenience over the two (2) year warranty period.
- C. All training specified herein shall be performed by a factory certified technician.

1.06 DESCRIPTION OF OPERATION

- A. This Contractor shall furnish and install an auditorium sound reinforcement system with all conduit, cable, outlets, devices, and equipment as shown on the Drawings and as herein specified to furnish a complete system.
- B. The auditorium sound reinforcement system shall provide for reception of AM or FM radio broadcasts, the amplification of music and voice, and the reproduction of recorded music or other program materials, and their distribution to all associated loudspeakers.
- C. The auditorium sound reinforcement system shall provide a personal listening system for use by hearing impaired listeners.
- D. The auditorium sound reinforcement system shall also provide for a two (2) channel intercommunications system. The intercommunications system shall provide hands-free, two-way voice communications between areas shown on the Drawings to be equipped with intercommunications system headset outlets.
- E. The auditorium sound reinforcement system shall allow the Section 16710 main school intercom to transmit emergency messages via a stereo audio auto switch which shall mute the main house speakers during the emergency transmission and allow the Section 16710 speakers to transmit to the audience.

1.07 SYSTEM TEST AND ACCEPTANCE

- A. Prior to the final site visitation this Contractor shall conduct an operating test of the complete auditorium sound reinforcement system. The system shall test free from grounds, shorts, and other faults. All connections shall be thoroughly checked for mechanical and electrical connections. All equipment shall be demonstrated to operate in accordance with the requirements set forth in these Specifications and as shown on the Drawings.
- B. This Contractor shall perform all tests in the presence of the Architect/Engineer. This Contractor shall furnish all personnel and test instruments for use in the test.
- C. When the work on entire auditorium sound reinforcement system has been completed and is ready for final review, this Contractor shall demonstrate that the requirements of the Contract as it applies to this work have been carried out and that the system has been adjusted and operated in accordance therewith.

1.08 WARRANTY

- A. This Contractor shall deliver the work described herein in a first-class operating condition in every respect. This Contractor shall also warrant that the material,

equipment, and workmanship furnished shall be entirely free from defects. Any materials, equipment, or workmanship in which defects may develop before or during the warranty period shall be repaired or replaced at the Contractor's own expense. Refer to SECTION 01740 for the start of the warranty period. The Contractor shall further warrant that all material, equipment, and workmanship used in the installation, but not specifically mentioned in the Drawings and Specifications, is the best of their respective kinds and that the construction and installation was performed in accordance with the best accepted standard practices in all details.

PART 2 - PRODUCTS

2.01 MAIN EQUIPMENT RACK

- A. This Contractor shall furnish and install (a) floor mounted equipment rack(s) for the auditorium sound reinforcement system as shown on the Drawings and as specified herein. The rack(s) shall be MIDDLE ATLANTIC ERK Series providing a minimum of seventy-seven (77) inches of standard nineteen (19) inch rack mounting space. The rack (s) shall be complete with plexiglass door with cylinder lock and handle, and a flush spring-hinged door with cylinder lock (front and rear locks shall be keyed differently). Provide blank panels as required to fill in blank rack spaces. Each auditorium sound system equipment rack shall have a sign mounted to the. Each auditorium sound system equipment rack shall have a sign mounted to the front stating, "Personal Listening Devices Stored Here". The sign shall be 1/16 inch thick laminated plastic with 3/16 inch high white letters on a black background. The rack(s) shall house the following equipment:
1. Four(4) CROWN model no. DCi 2/1250N dual channel amplifiers, (1250 watts at 4/8 ohms power amplifier with BLU link) one for each main house speaker arrays and one for each main house subwoofer.
 2. One (1) CROWN model no. DCi 2/300N dual channel amplifier, (300 watts at 4/8 ohms power amplifier with BLU link), for the stage monitor speakers.
 3. One (1) TOA Model No. TOA BG 220 amplifiers with MB- 25B-BK rack kit for the dressing room speakers.
 4. One (1) Allen and Heath GX4816 I/O Expander.
 5. One (1) BSS BLU-100 Digital Signal Processor.
 6. One (1) WILLIAMS SOUND model no. FM T55 personal listening system base station transmitter complete with WILLIAMS SOUND model no. RPK 005 rack mounting kit and ANT 025 antenna.
 7. This Contractor shall furnish and install in the charging stations, thirty

- (30) WILLIAMS SOUND model no. PPA R37, seventeen (17) channel personal listening system receivers each complete with WILLIAMS SOUND model no. EAR 013 single ear bud, rechargeable batteries, and belt clip.
8. This Contractor shall furnish to the Owner's representative, eight (8) WILLIAMS SOUND model NKL 001 neckloops.
 9. This Contractor shall furnish and install, three (3) WILLIAMS SOUND model no. CHG 3512 twelve (12) unit charging cases for the personal listening system receivers complete with three (3) ATLAS SOUND model no. VTD1-16 rack sliding shelves.
 10. One (1) ROLLS model no. RS81B Quartz PLL synthesized rack mounted stereo AM/FM tuner.
 11. One (1) TASCAM model no. SS-CDR 250N, rack mounted CD player with MP3 dock.
 12. Two (2) Furman PL-PRO DMC 20 Amp Power Conditioners to provide power for all rack mounted equipment.
 13. One (1) RCI custom rack mount panel with seven (7) RJ-45 Ethercon connectors and one (1) Cisco C2960C-8PC-L 8 – Port POE Switch or equal from Netgear (mounted in Middle Atlantic no. U1 shelf).
 14. One (1) TELEX Model Audiocom MS-2002, rack mounted, two (2) channel intercom master station and power supply.
 15. Two (2) Shure ULXD 4Q Quad Digital Rack mounted four (4) channels wireless microphone receivers. Provide two (2) Shure UA 874 active directional antennas, and an appropriate amount of Shure UHF antenna cabling as required.
 16. One (1) Middle Atlantic D3 Rack Storage Drawer, 3RU with spring-loaded latches and rugged.
 17. One (1) Henry Engineering Model Autoswitch Stereo Audio Switcher for connection to the main school PA/intercom emergency override function.

2.02 REMOTE SOUND MIXING EQUIPMENT RACK

- A. Remote sound mixing equipment rack shall house the following equipment:
 1. One (1) Allen and Heath model no. SQ-7-48 Channel/36 Bus Digital Mixing Console with dust cover.
 2. Two (2) Allen and Heath DX168 Portable DX Expanders.

3. Two (2) Allen and Heath model AH10885-1 50M drums of Ether Flex cable.
4. One (1) pair of Sennheiser model HD 280 PRO headphones.
5. One (1) pair of JBL 305P Mk II 5-inch powered stereo monitors.

2.03 MAIN HOUSE SPEAKER ARRAY

- A. This Contractor shall furnish and install where shown on the Drawings a ceiling mounted speaker array consisting of the following:
 1. Two (2) JBL model no. VRX918S18" enclosed, suspended sound reinforcement subwoofers. With a frequency range of 31Hz to 220Hz and a program rating of 1600 watts. The subwoofer shall be complete with mounting hardware and NEUTRIK SPEAKRON connectors.
 2. Six (6) JBL model no. VRX932LA-1 12" two-way constant curvature line array speakers with a frequency range of 57Hz to 20 kHz and a power rating of 1600 watts. The main house speakers shall come complete with mounting hardware and NEUTRIK SPEAKON connectors.
 3. Two (2) JBL model no. VRX-AF array mounting brackets.

2.04 STAGE MONITOR SPEAKERS

- A. This Contractor shall furnish and install where shown on the Drawings, JBL model no. C29AV-1 eight (8) inch wall mounted stage monitor speakers.
- B. Provide one (1) pair of Sennheiser model HD 280 PRO headphones.

2.05 DRESSING ROOM FLUSH CEILING MOUNTED STAGE MONITOR SPEAKER ASSEMBLIES

- A. This Contractor shall furnish and install where shown on the Drawings, flush 1'x2' drop-in ceiling speaker assemblies consisting of a loudspeaker, back box, and baffle. A flush 1'x2' drop-in ceiling speaker assembly that meets this specification is ATLAS SOUNDOLIER Model No. DT12 complete with 2' T-Bar.

2.06 DRESSING ROOM SPEAKER VOLUME CONTROLS

- A. This Contractor shall furnish and install where shown on the Drawings, ATLAS SOUND model AT-10.flush or surface (as indicated on the Drawings) wall mounted dressing room speaker volume controls.

2.07 MICROPHONES

- A. This Contractor shall furnish to the Owner's representative, six (6) SHURE model no. SM58S dynamic cardioids microphones each complete with an ON/OFF switch. Each microphone shall be furnished by this Contractor complete with a twenty five (25) foot connector cord with CANNON XLR connectors.

- B. This Contractor shall furnish and install six (6) SHURE model no. CVO-B/C hanging microphones at locations shown on the drawings.
- C. This Contractor shall furnish and install the following wireless microphones and accessories.
 - 1. Eight (8) Shure ULXD2/SM58 handheld transmitters with SM58 capsule.
 - 2. Eight (8) Shure ULXD1 digital wireless body packs.
 - 3. Four (4) Shure MX150 B/O-TQG Ominidirectional 5mm subminiature lavalier microphones.
 - 4. Two (2) Shure SC800-US, 8-bay Shure battery charging stations.
 - 5. Sixteen (16) SB900A rechargeable lithium-ion batteries.
 - 6. Four (4) Shure MX 153 T/O Omnidirectional over-the-ear microphones.

2.08 MICROPHONE STANDS

- A. This Contractor shall furnish to the Owner's representative, six (6) ATLAS SOUND model no. MS-20E microphone floor stands.
- B. This Contractor shall furnish to the Owner's representative, six (6) ATLAS SOUND model no. PB15EB microphone booms.

2.09 MICROPHONE OUTLETS

- A. This Contractor shall furnish and install where shown on the Drawings, flush or surface wall mounted microphone outlets consisting of one (1) CANNON "XLR", complete with 3 pin XLR (female), series audio jack of the type required so as to be compatible with the type of microphone cable connector furnished, one (1) 3.5mm stereo audio jack (MP3), and a stainless steel coverplate. A Microphone/MP3 outlet, which meets this Specification shall be as manufactured by CONQUEST AUDIO or approved equal.
- B. This Contractor shall furnish and install where shown on the Drawings, flush or surface wall mounted stereo input plate (Type "B") consisting of one (1) pair of RCA jacks and one (1) 3.5MM stereo audio jack. A stereo input plate which meets this specification shall be WHIRLWIND MIP6 as manufactured by WHIRLWIND or approved equal.
- C. This Contractor shall furnish and install where shown on the Drawings, flush floor mounted microphone outlets (Type "A") consisting of CANNON XLR complete with 3 pin XLR (female) series audio jack of the type required to be compatible with the type of microphone cable connector furnished and mounted by this contractor in a MAXICOM "telematic" floor box complete with one (1) NEMA 5-20R duplex receptacle (as herein specified), non- skid type top, and tamperproof screws.

2.10 AM/FM ANTENNA

- A. This Contractor shall furnish and install a PIXEL TECHNOLOGIES model no. AFHD-4 AM/FM and HD antenna complete with: L mounting bracket; weather

boot; surge protector; 20dB attenuator; 10dB attenuator; AM/FM separator; U-bolts with washers and nuts; pole mount saddle brackets; F-female to twin-lead adaptor and push-on-F-female to DIN adaptor. This Contractor shall furnish and install a weatherhead, rigid steel conduit mast, and two (2) RG-6 plenum rated cables from the antennas to the tuner located in the sound and intercommunication system equipment rack. This Contractor shall ground the antenna in accordance with the following specification

2.11 INTERCOM SUB-STATIONS

- A. This Contractor shall furnish and install where shown on the Drawings, TELEX AUDIOCOM model no. WM-2000 remote headset intercom sub-stations mounted in a two-gang flush or surface wall outlet box as indicated on the Drawings.
- B. This Contractor shall furnish and install where shown on the Drawings, TELEX AUDIOCOM model no. SS-2002 remote dual channel speaker station.
- C. This Contractor shall furnish and install where shown on the Drawings, TELEX AUDIOCOM model no. WP-3 remote dual channel wall plate mounted in a single flush or surface wall mounted outlet box as indicated on the Drawings.

2.12 INTERCOM HEADSETS

- A. This Contractor shall furnish to the Owner's representative TELEX model no. PH-88 single-sided intercom headsets. One (1) headset for every master and sub-station intercom, beltpacks plus one (1) spare headset.
- B. This Contractor shall furnish to the Owner's representative, six (6) TELEX model no. HE-15 fifteen (15) foot headset extension cables and two (2) TELEX model no. HE-30 thirty (30) foot headset extension cables.
- C. Provide six (6) Telex BP-6000 Dual Channel Intercom Beltpacks. Provide one (1) TELEX ME-25/2 dual channel connection cable with each beltpack.

2.13 AUDITORIUM SOUND SYSTEM CABLE

- A. This Contractor shall furnish and install one (1) two (2) conductor, No. 10 AWG stranded plenum rated cable with a temperature range for dry locations of minus ten (10) degrees C to sixty (60) degrees C for each speaker zone. A cable that meets this Specification is WEST PENN Cat. No. 25210 or equal as manufactured by BELDEN, CONSOLIDATED WIRE, GENERAL CABLE, PAIGE, WINDY CITY or TAPPAN.
- B. This Contractor shall furnish and install one (1) stranded, No. 18 AWG, shielded, single twisted pair plenum rated cable with a temperature range for dry locations of minus ten (10) degrees C to sixty (60) degrees C for each microphone and MP3 outlet. A cable that meets this Specification is WEST PENN Cat. No. 25293B or equal as manufactured by BELDEN, CONSOLIDATED WIRE,

GENERAL CABLE, PAIGE, WINDY CITY or TAPPAN.

- C. This Contractor shall furnish and install field wiring for MP3 outlets as shown on the Drawings. Wiring shall be two (2) conductor, No. 20 AWG stranded and shielded cable. A cable that meets this Specification is WEST PENN Cat. No. 25292B or equal as manufactured by BELDEN, CONSOLIDATED WIRE, GENERAL CABLE, PAIGE, WINDY CITY or TAPPAN.
- D. This Contractor shall furnish and install digital audio cables where shown on the Drawings and specified herein. The cable shall be UL listed, plenum rated unshielded, four (4) twisted pairs, No. 23AWG, category 6, extended distance, high speed type with a flame retardant polyvinyl chloride jacket and a temperature range for minus (10) degrees C to sixty (60) degrees C. A digital audio cable, which meets this specification, is BERK-TEK cat. no. 10132983 (Gray) or equal as manufactured by AMP, AT&T, BELDEN, THE CABLE COMPANY, GENERAL CABLE, GENISIS, HITACHI, MOHAWK, NORTHERN TELECOM, PAIGE, or OPTICAL CABLE CORPORATION.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. All vertical low voltage field wiring shall be installed by this Contractor in 1/2-inch conduit and/or surface metal raceway as shown on the Drawings. Conduit fill shall not exceed the conduit space capacity.
- B. All horizontal low voltage field wiring to be installed in areas without a ceiling or in areas without an accessible ceiling shall be installed by this Contractor in 1/2-inch conduit.
- C. All horizontal low voltage field wiring to be installed in areas with accessible ceilings shall be installed by this Contractor bundled together and run exposed above the ceilings. Bundles shall be supported by "J" hooks mounted not more than four (4) feet on center. "J" hooks shall be dedicated to the wiring specified in this specification section.
- D. All horizontal low voltage field wiring shall be run at right angles to the building structure.
- E. All horizontal low voltage field wiring shall be installed below the roof/floor structural supports (joist, beams, girders, etc.). Wiring installed between the structural supports mentioned above and the roof or floor deck will not be acceptable.
- F. All horizontal low voltage field-wiring penetrations through new and/or existing walls shall be sleeved. Minimum sleeve size shall be 3/4 inch. All sleeves shall be bushed both sides.

- G. All low voltage field wiring for the auditorium sound reinforcement system shall be furnished and installed by this Contractor. All junction box covers shall be stenciled for distinct identification.
- H. All wiring connections shall be made by this Contractor as directed by the equipment manufacturer. Splices for circuits shall be made only in junction boxes and shall be crimp connected.
- I. All auditorium sound reinforcement system wiring shall be checked and tested by this Contractor to ensure the system is free from grounds, opens, and shorts.
- J. All work shall be under the supervision of a factory accredited sound engineer. It shall be the responsibility of the sound engineer and this contractor to check and inspect this installation to the Owner's and Architect/Engineer's approval.
- K. All stereo devices (i.e. those with left and right output) shall be connected to the mixers STEREO inputs.
- L. All shields of balanced audio connectors and lines must be connected.

3.02 RACK MOUNTED EQUIPMENT

- A. The auditorium sound reinforcement system's rack mounted equipment shall be installed by this Contractor with the proper adapters, rack mounting kits, brackets, and closure panels for unused spaces. All interconnecting wiring shall be labeled, bundled, secured, and terminated by this Contractor in a neat and professional manner.
- B. All rack mounted equipment AC power cords shall be plugged into the mounted power strip by this Contractor.
- C. All interconnecting patch cables within equipment rack shall factory manufactured.
- D. This Contractor shall turn over to the owner all existing wireless microphone rack mounted equipment, microphones and all associated accessories.

3.03 SPEAKER MOUNTING

- A. Surface mounted speakers shall be securely fastened to the building structure by this Contractor with threaded rod or bolts as appropriate for the application and in strict conformance with the manufacturer's recommendations.
- B. Flush ceiling mounted speaker assemblies shall be supported by this Contractor from the building structure with a minimum of two (2) steel wires. Ceiling baffles shall be finished flush with the ceiling. The speakers shall be secured to the grid with four (4) Caddy 515A lay-in/troffer support clips. Flush ceiling mounted speaker assemblies shall be tapped at 0.5 watts unless otherwise indicated.

- C. Suspended speakers shall be appropriately rigged to the building structure with a safety factor of 8:1. Speakers shall be suspended in strict conformance with the manufacturer's recommendation.
- 3.04 MICROPHONES
- A. This Contractor shall unpack microphone and assemble with cables and stands and connect ready for operation. Microphones shown for permanent installation shall be mounted by this Contractor in accordance with the Drawings in a manner appropriate for the location.
- 3.05 MICROPHONES OUTLETS
- A. This Contractor shall assemble microphone outlets and install, connect, and label as shown on Drawings.
- 3.06 AM/FM TUNER ANTENNA INSTALLATION
- A. The antenna shall be bracket mounted by this Contractor above the roof at a location approved by the Owner. The antenna cables shall be run by this Contractor to the equipment rack and connected ready for operation.
 - B. The antenna shall be grounded by this Contractor to the secondary building ground system with one (1) No. 10 AWG in 1/2 inch conduit.
- 3.07 WIRELESS MICROPHONE SYSTEM TESTING & ADJUSTMENT
- A. This Contractor shall test each transmitter and receiver for full coverage from the stage, with minimal interference.
- 3.08 SPEAKER TESTING AND ADJUSTMENT
- A. The main house speaker arrays shall be configured and tested to provide 95 decibels of pink noise with a "C" weighting when measured from the rear most seats in the house of the auditorium.

END OF SECTION

SECTION 16725

BLACK BOX THEATER SOUND REINFORCEMENT SYSTEM

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work covered under this Section shall include furnishing and installing a locally controlled complete and satisfactorily operating sound system in the Black Box Theater for the pick up, amplification, reproduction, and distribution of voice and/or music to associated loudspeakers within the black box theater.

1.03 QUALITY ASSURANCE

- A. All equipment described shall be the product of a manufacturer of established reputation and experience who shall have produced similar apparatus for a period of at least ten (10) years and shall be able to refer to similar installations now rendering satisfactory service.
- B. The black box theater sound reinforcement system shall be furnished by a factory authorized distributor certified to design, program, and service the system. The distributor must show evidence of successfully furnishing systems specified for at least five (5) years
- C. All equipment for this system shall be listed Underwriters Laboratories, Inc. (UL), bear the UL label, and shall be installed in accordance with all requirements of the National Electrical Code (NEC), state and local codes, and these Specifications.
- D. The entire black box theater sound reinforcement system installation shall be performed under the direct supervision of a factory trained service specialist.
- E. Shop drawing submittals are required per SECTION 16010 and shall include the following for review. Submittals not containing all of the information listed below will be rejected.
 - 1. A complete list of equipment shall be furnished indicating the specific quantities to be furnished by this Contractor. The catalog or model number for each module of the system shall be listed next to the quantities. This information shall be furnished in the front of the submittal.

2. A specific description of the system shall be furnished describing each module and how it shall function in the system.
3. A specific drawing shall be furnished of the sound equipment rack. Each module shall be shown in its proper location with its terminal designation shown.
4. A data sheet shall be furnished for each module and device. The information shall be highlighted that applies to the particular module or device to be furnished.
5. A detailed diagram showing how to connect each device shall be furnished indicating exact final connection information.
6. A detailed floor plan for the black box theater shall be furnished. The plan shall show the locations of all equipment, loudspeakers, and devices and their required interconnections. The interconnections shown shall indicate the number, size, and type of wires as described in this Specification. Loudspeakers shall be zoned as shown on the Drawings. The layout of all Black Box Theater sound system equipment, devices, and conduit routings shall closely follow that shown on the Drawings.

1.04 DOCUMENTATION

- A. This Contractor shall furnish to the Owner, one (1) set of "As Built" drawings depicting the complete field wiring system and component interconnections in the system equipment rack.
- B. This Contractor shall furnish to the Owner, four (4) sets of factory operation and maintenance manuals. These manuals shall include factory service manuals with complete parts lists, wiring and component schematics including circuit diagrams, and all other information necessary for the proper operation, service, and maintenance of the black box theater sound reinforcement system.

1.05 TRAINING

- A. This Contractor shall furnish eight (8) hours of technical service training to the Owner's technical staff using the factory service manuals previously specified.
- B. This Contractor shall furnish eight (8) hours of operating and programming training to the Owner's operating staff which shall be delivered in two (2) separate four (4) hours sessions to be scheduled at the Owner's convenience over the warranty period.
- C. All training specified herein shall be performed by a factory certified technician.

1.06 DESCRIPTION OF OPERATION

- A. This Contractor shall furnish and install a black box theater sound reinforcement system with all conduit, cable, outlets, devices, and equipment as shown on the Drawings and as herein specified to furnish a complete system.
- B. The black box theater sound reinforcement system shall provide for reception of AM or FM radio broadcasts, the amplification of music and voice, and the reproduction of recorded music or other program materials, and their distribution to all associated speakers within the black box theater.
- C. The black box theater sound reinforcement system shall accept both the input and output of an external tape recorder.
- D. Each black box sound reinforcement system shall accept a priority override signal to mute the system when the main building sound and intercommunications system activates the priority override function.

1.07 SYSTEM TEST AND ACCEPTANCE

- A. Prior to the final site visitation, this Contractor shall conduct an operating test of the complete black box theater sound reinforcement system. The system shall test free from grounds, shorts, and other faults. All connections shall be thoroughly checked for mechanical and electrical connections. All equipment shall be demonstrated to operate in accordance with the requirements set forth in these Specifications and as shown on the Drawings.
- B. This Contractor shall perform all tests in the presence of the Architect/Engineer. This Contractor shall furnish all personnel and test instruments for use in the test.
- C. When the work on the entire black box theater sound reinforcement system has been completed and is ready for final review, this Contractor shall demonstrate that the requirements of the Contract as it applies to this work have been carried out and that the system has been adjusted and operated in accordance therewith.

1.08 WARRANTY

- A. This Contractor shall deliver the work described herein in a first-class operating condition in every respect. This Contractor shall also warrant that the material, equipment, and workmanship furnished shall be entirely free from defects. Any materials, equipment, or workmanship in which defects may develop before or during the warranty period shall be repaired or replaced at the Contractor's own expense. Refer to SECTION 01740 for the start of the warranty period. The

Contractor shall further warrant that all material, equipment, and workmanship used in the installation, but not specifically mentioned in the Drawings and Specifications, is the best of their respective kinds and that the construction and installation was performed in accordance with the best accepted standard practices in all details.

PART 2 - PRODUCTS

2.01 EQUIPMENT RACK

- A. This Contractor shall furnish and install where shown on the Drawings, a wall mounted equipment rack for the black box theater sound reinforcement system as specified herein. The rack shall be ATLAS SOUNDOLIER Cat. No. WMA24-23 sectional, wall mounting type with a textured black finish providing a minimum of sixty-one (61) inches of vertical rack mounting space. The rack shall be complete with a continuous piano hinged front door with a cylinder lock and handle. The following equipment shall be furnished and installed by this Contractor in the rack:
1. One (1) TOA model no. D-901 twelve (12) input, eight (8) output, digital mixer. Mixer shall come complete with:
 - a. One (1) D936R four (4) stereo input module (tuner, CD, MP3 outlets).
 - b. One (1) D971E four (4) channel line output module (personal listening system, amplifier).
 - c. Four (4) D921E 2-channel input modules (microphone outlets).
 2. One (1) Crown model no. CDi 2/300 dual channel amplifier with three hundred (300) watts per channel at eight (8) ohms. Amplifier shall be suitable for rack mounting.
 3. One (1) TASCAM model no. CD- 200BT, rack mounted CD player with MP3 dock.
 4. One (1) ROLLS model no. RS81B Quartz PLL synthesized rack mounted stereo AM/FM tuner.
 5. One (1) SHURE "SLX" series UHF wireless microphone system complete with model no. SLX4 wireless receiver complete with rack mounting hardware and detachable antennas.
 6. One (1) ATLAS SOUND model No. AP-2410-15SAC power strip suitable for rack mounting.

2.02 WALL MOUNTED STEREO SPEAKERS

- A. This Contractor shall furnish and install where shown on the Drawings, two (2) JBL model no. "Control 29AV-1" enclosed wall mounted stereo speakers. The stereo speakers shall be 300 watt, 8 ohms. Each stereo speaker shall be complete with wall mounting bracket.

2.03 MICROPHONES

- A. This Contractor shall furnish to the Owner's representative, one (1) SHURE , model no. SLX2/SM58S dynamic cardioid wireless handheld microphone, and one (1) SHURE model no. WL183 lapel microphone with SLX1 transmitter. Each complete with an ON/OFF switch and batteries.
- B. This Contractor shall furnish to the Owner's representative, four (4) SHURE model no. SM58S dynamic cardioid microphones each complete with an ON/OFF switch. Each microphone shall be furnished by this Contractor complete with a twenty five (25) foot connector cord with CANNON XLR connectors.

2.04 MICROPHONE STANDS

- A. This Contractor shall furnish to the Owner's representative, four (4) ATLAS SOUNDOLIER model no. MS-20 microphone floor stands.
- B. This Contractor shall furnish to the Owner's representative, four (4) ATLAS SOUNDOLIER model no. PB15CH microphone booms.

2.05 MICROPHONE OUTLETS

- A. This Contractor shall furnish and install where shown on the Drawings, flush or surface wall mounted microphone outlets consisting of one (1) CANNON "XLR", complete with 3 pin XLR (female), series audio jack of the type required so as to be compatible with the type of microphone cable connector furnished, one (1) 3.5mm stereo audio jack (MP3), and a stainless steel coverplate. A microphone/MP3 outlet, which meets this Specification shall be as manufactured by CONQUEST AUDIO or approved equal.

2.06 AM/FM ANTENNA

- A. This Contractor shall furnish and install a PIXEL TECHNOLOGIES model no. AFHD-4 AM/FM and HD antenna complete with: L mounting bracket; weather boot; surge protector; 20dB attenuator; 10dB attenuator; AM/FM separator; U-bolts with washers and nuts; pole mount saddle brackets; F-female to twin-lead adaptor and push-on-F-female to DIN adaptor. This Contractor shall furnish and install a weatherhead, rigid steel conduit mast, and two (2) RG-6 plenum rated cables from the antennas to the tuner located in the sound and intercommunication system equipment rack. This Contractor shall ground the

antenna in accordance with the following specification.

2.07 BLACK BOX THEATER SOUND SYSTEM CABLE

- A. This Contractor shall furnish and install one (1) two (2) conductor, No. 12 AWG stranded plenum rated cable with a temperature range for dry locations of minus ten (10) degrees C to sixty (60) degrees C for each stereo speaker. A cable that meets this Specification is WEST PENN Cat. No. 25227B or equal as manufactured by BELDEN, CONSOLIDATED WIRE, GENERAL CABLE, PAIGE, WINDY CITY WIRE or TAPPAN.
- B. This Contractor shall furnish and install one (1) stranded, No. 20 AWG, shielded, single twisted pair plenum rated cable with a temperature range for dry locations of minus ten (10) degrees C to sixty (60) degrees C for each microphone outlet. A cable that meets this Specification is WEST PENN Cat. No. 25292B or equal as manufactured by BELDEN, CONSOLIDATED WIRE, GENERAL CABLE, PAIGE, WINDY CITY WIRE or TAPPAN.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. All vertical low voltage field wiring shall be installed by this Contractor in 1/2-inch conduit and/or surface metal raceway as shown on the Drawings. Conduit fill shall not exceed the conduit space capacity.
- B. All horizontal, low voltage field wiring to be installed in areas without a ceiling or in areas without an accessible ceiling shall be installed by this Contractor in 1/2-inch conduit.
- C. All horizontal, low voltage field wiring to be installed in areas with accessible ceilings shall be installed by this Contractor bundled together and run exposed above the ceilings. Bundles shall be supported by "J" hooks mounted not more than four (4) feet on center. "J" hooks shall be dedicated to the wiring specified in this specification section.
- D. All horizontal, low voltage field wiring shall be run at right angles to the building structure.
- E. All horizontal, low voltage field wiring shall be installed below the roof/floor structural supports (joists, beams, girders, etc.). Wiring installed between the structural supports mentioned above and the roof or floor deck will not be acceptable.

- F. All horizontal, low voltage field wiring penetrations through new and/or existing walls shall be sleeved. Minimum sleeve size shall be 3/4 inch. All sleeves shall be bushed both sides.
- G. All low voltage field wiring for the black box theater sound reinforcement system shall be furnished and installed by this Contractor. All junction box covers shall be stenciled for distinct identification.
- H. All wiring connections shall be made by this Contractor as directed by the equipment manufacturer. Splices for circuits shall be made only in junction boxes and shall be crimp connected.
- I. All black box theater sound reinforcement system wiring shall be checked and tested by this Contractor to ensure the system is free from grounds, opens, and shorts.
- J. All work shall be under the supervision of a factory accredited sound engineer. It shall be the responsibility of the sound engineer and this Contractor to check and inspect this installation to the Owner's and Architect/Engineer's approval.

3.02 RACK MOUNTED EQUIPMENT

- A. The black box theater sound system's rack mounted equipment shall be installed by this Contractor with the proper adapters, rack mounting kits, brackets, and closure panels for unused spaces. All interconnecting wiring shall be labeled, bundled, secured, and terminated by this Contractor in a neat and professional manner.
- B. All rack mounted equipment AC power cords shall be plugged into the mounted power strip by this Contractor.

3.03 SPEAKER

- A. Wall mounted stereo speakers shall be securely fastened to the building structure by this Contractor with threaded rod or bolts as appropriate for the application.

3.04 MICROPHONES

- A. This Contractor shall unpack microphone and assemble with cables and stands and connect ready for operation. Microphones shown for permanent installation shall be mounted by this Contractor in accordance with the Drawings in a manner appropriate for the location.

3.05 MICROPHONES OUTLETS

- A. This Contractor shall assemble microphone outlets and install, connect, and label as shown on Drawings.

3.06 ANTENNA INSTALLATION

- A. The antenna shall be bracket mounted by this Contractor above the roof at a location approved by the Owner. The antenna cables shall be run by this Contractor to the equipment rack and connected ready for operation.
- B. The antenna shall be grounded by this Contractor to the secondary building ground system with one (1) No. AWG in 1/2-inch conduit.

END OF SECTION

SECTION 16726

DRAMA CLASSROOM SOUND REINFORCEMENT SYSTEM

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work covered under this Section shall include furnishing and installing a locally controlled complete and satisfactorily operating sound system in the drama classroom for the pick up, amplification, reproduction, and distribution of voice and/or music to associated loudspeakers within the drama classroom.

1.03 QUALITY ASSURANCE

- A. All equipment described shall be the product of a manufacturer of established reputation and experience produced similar apparatus for a period of at least ten (10) years and shall be able to refer to similar installations now rendering satisfactory service.
- B. The drama classroom sound reinforcement system shall be furnished by a factory authorized distributor certified to design, program, and service the system. The distributor must show evidence of successfully furnishing systems specified for at least five (5) years
- C. All equipment for this system shall be listed Underwriters Laboratories, Inc. (UL), bear the UL label and shall be installed in accordance with all requirements of the National Electrical Code (NEC), state and local codes, and these Specifications.
- D. The entire drama classroom sound reinforcement system installation shall be performed under the direct supervision of a factory trained service specialist.
- E. Shop drawing submittals are required per SECTION 16010 and shall include the following for review. Submittals not containing all of the information listed below will be rejected.
 - 1. A complete list of equipment shall be furnished indicating the specific quantities to be furnished by this Contractor. The catalog or model number for each module of the system shall be listed next to the quantities. This information shall be furnished in the front of the submittal.

2. A specific description of the system shall be furnished describing each module and how it shall function in the system.
3. A specific drawing shall be furnished of the sound equipment rack. Each module shall be shown in its proper location with its terminal designation shown.
4. A data sheet shall be furnished for each module and device. The information shall be highlighted that applies to the particular module or device to be furnished.
5. A detailed diagram showing how to connect each device shall be furnished indicating exact final connection information.
6. A detailed floor plan for the drama classroom shall be furnished. The plan shall show the locations of all equipment, loudspeakers, and devices and their required interconnections. The interconnections shown shall indicate the number, size, and type of wires as described in this Specification. Loudspeakers shall be zoned as shown on the Drawings. The layout of all drama classroom sound system equipment, devices, and conduit routings shall closely follow that shown on the Drawings.

1.04 DOCUMENTATION

- A. This Contractor shall furnish to the Contractor, one (1) set of "As Built" drawings depicting the complete field wiring system and component interconnections in the system equipment rack.
- B. This Contractor shall furnish to the Owner, four (4) sets of factory operation and maintenance manuals. These manuals shall include factory service manuals with complete parts lists, wiring and component schematics including circuit diagrams, and all other information necessary for the proper operation, service, and maintenance of the drama classroom Theater sound reinforcement system.

1.05 TRAINING

- A. This Contractor shall furnish eight (8) hours of technical service training to the Owner's technical staff using the factory service manuals previously specified.
- B. This Contractor shall furnish eight (8) hours of operating and programming training to the Owner's operating staff which shall be delivered in two (2) separate four (4) hours sessions to be scheduled at the Owner's convenience over the warranty period.
- C. All training specified herein shall be performed by a factory certified technician.

1.06 DESCRIPTION OF OPERATION

- A. This Contractor shall furnish and install a drama classroom sound reinforcement system with all conduit, cable, outlets, devices, and equipment as shown on the Drawings and as herein specified to furnish a complete system.
- B. The drama classroom sound reinforcement system shall provide for reception of AM or FM radio broadcasts, the amplification of music and voice, and the reproduction of recorded music or other program materials, and their distribution to all associated speakers within the drama classroom.
- C. The drama classroom sound reinforcement system shall accept both the input and output of an external tape recorder.
- D. Each drama classroom sound reinforcement system shall accept a priority override signal to mute the system when the main building Sound and Intercommunications System activates the priority override function.

1.07 SYSTEM TEST AND ACCEPTANCE

- A. Prior to the final site visitation this Contractor shall conduct an operating test of the complete drama classroom sound reinforcement system. The system shall test free from grounds, shorts, and other faults. All connections shall be thoroughly checked for mechanical and electrical connections. All equipment shall be demonstrated to operate in accordance with the requirements set forth in these Specifications and as shown on the Drawings.
- B. This Contractor shall perform all tests in the presence of the Architect/Engineer. This Contractor shall furnish all personnel and test instruments for use in the test.
- C. When the work on the entire drama classroom sound reinforcement system has been completed and is ready for final review, this Contractor shall demonstrate that the requirements of the Contract as it applies to this work have been carried out and that the system has been adjusted and operated in accordance therewith.

1.08 WARRANTY

- A. This Contractor shall deliver the work described herein in a first-class operating condition in every respect. This Contractor shall also warrant that the material, equipment, and workmanship furnished shall be entirely free from defects. Any materials, equipment, or workmanship in which defects may develop before or during the warranty period shall be repaired or replaced at the Contractor's own expense. Refer to SECTION 01740 for the start of the warranty period. The Contractor shall further warrant that all material, equipment, and workmanship used in the installation, but not specifically mentioned in the Drawings and Specifications, is the best of their respective kinds and that the construction and

installation was performed in accordance with the best accepted standard practices in all details.

PART 2 - PRODUCTS

2.01 EQUIPMENT RACK

A. This Contractor shall furnish and install where shown on the Drawings, a wall mounted equipment rack for the drama classroom sound reinforcement system as specified herein. The rack shall be ATLAS SOUNDOLIER Cat. No. WMA24-23 sectional, wall mounting type with a textured black finish providing a minimum of sixty-one (61) inches of vertical rack mounting space. The rack shall be complete with a continuous piano hinged front door with a cylinder lock and handle. The following equipment shall be furnished and installed by this Contractor in the rack:

1. One (1) TOA Model No. D-901 twelve (12) input, eight (8) output, digital mixer. Mixer shall come complete with:
 - a. One (1) D936R four (4) stereo input module (tuner, CD, MP3 outlets).
 - b. One (1) D971E four (4) channel line output module (personal listening system, amplifier).
 - c. Four (4) D921E 2-channel input modules (microphone outlets).
2. One (1) Crown Model No. CDi 2/300 dual channel amplifier with three hundred (300) watts per channel at eight (8) ohms. Amplifier shall be suitable for rack mounting.
3. One (1) TASCAM Model No. CD- 200BT, rack mounted CD player with MP3 dock.
4. One (1) ROLLS Model No. RS81B Quartz PLL synthesized rack mounted stereo AM/FM tuner.
5. One (1) SHURE "SLX" series UHF wireless microphone system complete with Model No. SLX4 wireless receiver complete with rack mounting hardware and detachable antennas.
6. One (1) ATLAS SOUND Model No. AP-2410-15S AC power strip suitable for rack mounting.

2.02 WALL MOUNTED STEREO SPEAKERS

A. This Contractor shall furnish and install where shown on the Drawings, two (2)

JBL Model No "Control 29AV-1" enclosed wall mounted stereo speakers. The stereo speakers shall be 300 watt, 8 ohms. Each stereo speaker shall be complete with wall mounting bracket.

2.03 MICROPHONES

- A. This Contractor shall furnish to the Owner's representative, one (1) SHURE Model No. SLX2/SM58S dynamic cardioid wireless handheld microphone, and one (1) SHURE Model No WL183 lapel microphone with SLX1 transmitter. Each complete with an ON/OFF switch and batteries.
- B. This Contractor shall furnish to the Owner's representative, four (4) SHURE Model No. SM58S dynamic cardioid microphones each complete with an ON/OFF switch. Each microphone shall be furnished by this Contractor complete with a twenty five (25) foot connector cord with CANNON XLR connectors.

2.04 MICROPHONE STANDS

- A. This Contractor shall furnish to the Owner's representative, four (4) ATLAS SOUNDOLIER Model No. MS-20 microphone floor stands.
- B. This Contractor shall furnish to the Owner's representative, four (4) ATLAS SOUNDOLIER Model No. PB15CH microphone booms.

2.05 MICROPHONE OUTLETS

- A. This Contractor shall furnish and install where shown on the Drawings, flush or surface wall mounted microphone outlets consisting of one (1) CANNON "XLR", complete with 3 pin XLR (female), series audio jack of the type required so as to be compatible with the type of microphone cable connector furnished, one (1) 3.5mm stereo audio jack (MP3), and a stainless steel coverplate. A microphone/MP3 outlet, which meets this Specification shall be as manufactured by CONQUEST AUDIO or approved equal.

2.06 AM/FM ANTENNA

- A. This Contractor shall furnish and install a PIXEL TECHNOLOGIES Model No. AFHD-4 AM/FM and HD antenna complete with: L mounting bracket; weather boot; surge protector; 20dB attenuator; 10dB attenuator; AM/FM separator; U-bolts with washers and nuts; pole mount saddle brackets; F-female to twin-lead adaptor and push-on-F-female to DIN adaptor. This Contractor shall furnish and install a weatherhead, rigid steel conduit mast, and two (2) RG-6 plenum rated cables from the antennas to the tuner located in the sound and intercommunication system equipment rack. This Contractor shall ground the antenna in accordance with the following specification.

2.07 DRAMA CLASSROOM SOUND SYSTEM CABLE

- A. This Contractor shall furnish and install one (1) two (2) conductor, No. 12 AWG stranded plenum rated cable with a temperature range for dry locations of minus ten (10) degrees C to sixty (60) degrees C for each stereo speaker. A cable that meets this Specification is WEST PENN Cat. No. 25227B or equal as manufactured by BELDEN, CONSOLIDATED WIRE, GENERAL CABLE, PAIGE, WINDY CITY WIRE or TAPPAN.
- B. This Contractor shall furnish and install one (1) stranded, No. 20 AWG, shielded, single twisted pair plenum rated cable with a temperature range for dry locations of minus ten (10) degrees C to sixty (60) degrees C for each microphone outlet. A cable that meets this Specification is WEST PENN Cat. No. 25292B or equal as manufactured by BELDEN, CONSOLIDATED WIRE, GENERAL CABLE, PAIGE, WINDY CITY WIRE or TAPPAN.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. All vertical low voltage field wiring shall be installed by this Contractor in 1/2-inch conduit and/or surface metal raceway as shown on the Drawings. Conduit fill shall not exceed the conduit space capacity.
- B. All horizontal, low voltage field wiring to be installed in areas without a ceiling or in areas without an accessible ceiling shall be installed by this Contractor in 1/2-inch conduit.
- C. All horizontal, low voltage field wiring to be installed in areas with accessible ceilings shall be installed by this Contractor bundled together and run exposed above the ceilings. Bundles shall be supported by "J" hooks mounted not more than four (4) feet on center. "J" hooks shall be dedicated to the wiring specified in this specification section.
- D. All horizontal, low voltage field wiring shall be run at right angles to the building structure.
- E. All horizontal, low voltage field wiring shall be installed below the roof/floor structural supports (joists, beams, girders, etc.). Wiring installed between the structural supports mentioned above and the roof or floor deck will not be acceptable.
- F. All horizontal, low voltage field wiring penetrations through new and/or existing walls shall be sleeved. Minimum sleeve size shall be 3/4 inch. All sleeves shall be bushed both sides. Cables pulled through sleeves without bushings, cut

bushings, or wrapped with tape will not be accepted and shall be replaced by the Contractor.

- G. All low voltage field wiring for the drama classroom sound reinforcement system shall be furnished and installed by this Contractor. All junction box covers shall be stenciled for distinct identification.
- H. All wiring connections shall be made by this Contractor as directed by the equipment manufacturer. Splices for circuits shall be made only in junction boxes and shall be crimp connected.
- I. All drama classroom sound reinforcement system wiring shall be checked and tested by this Contractor to ensure that the system is free from grounds, opens, and shorts.
- J. All work shall be under the supervision of a factory accredited sound engineer. It shall be the responsibility of the sound engineer and this Contractor to check and inspect this installation to the Owner's and Architect/Engineer's approval.

3.02 RACK MOUNTED EQUIPMENT

- A. The drama classroom sound system's rack mounted equipment shall be installed by this Contractor with the proper adapters, rack mounting kits, brackets, and closure panels for unused spaces. All interconnecting wiring shall be labeled, bundled, secured, and terminated by this Contractor in a neat and professional manner.
- B. All rack mounted equipment AC power cords shall be plugged into the mounted power strip by this Contractor.

3.03 SPEAKER

- A. Wall mounted stereo speakers shall be securely fastened to the building structure by this Contractor with threaded rod or bolts as appropriate for the application.

3.04 MICROPHONES

- A. This Contractor shall unpack microphone and assemble with cables and stands and connect ready for operation. Microphones shown for permanent installation shall be mounted by this Contractor in accordance with the Drawings in a manner appropriate for the location.

3.05 MICROPHONES OUTLETS

- A. This Contractor shall assemble microphone outlets and install, connect, and label as shown on Drawings.

3.06 ANTENNA INSTALLATION

- A. The antenna shall be bracket mounted by this Contractor above the roof at a location approved by the Owner. The antenna cables shall be run by this Contractor to the equipment rack and connected ready for operation.
- B. The antenna shall be grounded by this Contractor to the secondary building ground system with one (1) No. 10 AWG in 1/2-inch conduit.

END OF SECTION

SECTION 16730

GYMNASIUM SOUND REINFORCEMENT SYSTEM (High and Secondary Schools)

PART 1 - GENERAL

1.01 REQUIREMENT

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work covered under this Section shall include furnishing and installing a locally controlled complete and satisfactorily operating system for the pick up, amplification, reproduction, and distribution of voice and/or music to loudspeakers within the gymnasium as shown on the Drawings and herein specified.

1.03 QUALITY ASSURANCE

- A. All equipment described shall be the product of a manufacturer of established reputation and experience producing similar apparatus for a period of at least ten (10) years and shall be able to refer to similar installations now rendering satisfactory service.
- B. The gymnasium sound reinforcement system shall be furnished by a factory authorized distributor certified to design, program, and service the system. The distributor must show evidence of successfully furnishing systems specified for at least five (5) years.
- C. All equipment for this system shall be listed by Underwriters Laboratories, Inc. (UL), bear the UL label, and shall be installed in accordance with all requirements of the National Electrical Code (NEC), state and local codes, and these Specifications.
- D. The entire gymnasium sound reinforcement system installation shall be performed under the direct supervision of a factory trained service specialist.
- E. Shop drawing submittals are required per SECTION 16010 and shall include the following for review:
 - 1. A complete list of equipment shall be furnished indicating the specific quantities to be furnished by the manufacturer. The catalog or model number for each module of the system shall be listed next to the quantities. This information shall be furnished in the front of the

submittal.

2. A specific description of the system shall be furnished describing each module and how it shall function in the system.
3. A detailed floor plan of the gymnasium area shall be furnished showing the locations of all equipment, loudspeakers, and devices and their required interconnections. The interconnections shown shall indicate the number, size, and type of cable as described in this Specification. The layout of all gymnasium sound reinforcement system equipment, devices, and conduit routings shall closely follow that shown on the Drawings.
4. A specific drawing of the gymnasium sound reinforcement system rack shall be made by the equipment supplier. Each module shall be shown in its proper location with its terminal designation shown.
5. A data sheet shall be furnished for each module and device. The information shall be highlighted that applies to the particular module or device to be furnished.
6. A detailed diagram showing how to connect each device shall be furnished indicating exact final connection information.
7. A detailed drawing showing how to mount the gymnasium speakers shall be furnished, including necessary hardware and mounting devices.

1.04 DOCUMENTATION

- A. This Contractor shall furnish to the Owner, one (1) set of "As Built" drawings depicting the complete field wiring system and component interconnections in the gymnasium sound reinforcement system equipment rack.
- B. This Contractor shall furnish to the Owner, four (4) sets of factory operation and maintenance manuals. These manuals shall include factory service manuals with complete parts lists, wiring and component schematics including circuit diagrams, and all other information necessary for the proper operation, service, and maintenance of the gymnasium sound reinforcement system.

1.05 TRAINING

- A. This Contractor shall furnish eight (8) hours of technical service training to the Owner's technical staff using the factory operation manuals previously specified.
- B. This Contractor shall furnish eight (8) hours of operating and programming training to the Owner's operating staff which shall be delivered in two (2) separate four (4) hour sessions to be scheduled at the Owner's convenience

over the warranty period.

C. All training specified herein shall be performed by a factory certified technician.

1.06 DESCRIPTION OF OPERATION

A. This Contractor shall furnish and install a gymnasium sound reinforcement system with all cable and equipment as shown on the Drawings and as herein specified to furnish a complete system.

B. The gymnasium sound reinforcement system shall provide for the reception of AM or FM radio broadcasts, the amplification of music and/or voice, and the reproduction of recorded music or other program materials, and their distribution to all associated loudspeakers.

C. The gymnasium sound reinforcement system shall provide a personal listening system for use by hearing impaired listeners.

D. Each gymnasium sound reinforcement system shall accept a priority override signal to mute the system when the main building Sound and Intercommunications System activates the priority override function.

1.07 SYSTEM TEST AND ACCEPTANCE

A. Prior to the final site visitation, this Contractor shall conduct an operating test of the complete gymnasium sound reinforcement system. The system shall test free from grounds, shorts, and other faults. All connections shall be thoroughly checked for mechanical and electrical connections. All equipment shall be demonstrated to operate in accordance with the requirements set forth in these Specifications and as shown on the Drawings.

B. This Contractor shall perform all tests in the presence of the Architect/Engineer. This Contractor shall furnish all personnel and test instruments for use in the test.

C. When the work on the entire gymnasium sound reinforcement system has been completed and is ready for final review, this Contractor shall demonstrate that the requirements of the Contract as it applies to this work have been carried out and that the system has been adjusted and operated in accordance therewith.

1.08 WARRANTY

A. This Contractor shall deliver the work described herein in a first-class operating condition in every respect. This Contractor shall also warrant that the material, equipment, and workmanship furnished shall be entirely free from defects. Any materials, equipment, or workmanship in which defects may develop before or during the warranty period shall be repaired or replaced at the Contractor's own expense. Refer to SECTION 01740 for the start of the warranty period. The

Contractor shall further warrant that all material, equipment, and workmanship used in the installation, but not specifically mentioned in the Drawings and Specifications, is the best of their respective kinds and that the construction and installation was performed in accordance with the best accepted standard practices in all details.

PART 2 - PRODUCTS

2.01 EQUIPMENT RACK

- A. This Contractor shall furnish and install where shown on the Drawings, a wall mounted equipment rack for the gymnasium sound reinforcement system as specified herein. The rack shall be ATLAS SOUND Cat. No. WMA35-23 sectional wall mounting type with a textured black finish providing a minimum of thirty five (35) vertical rack units of mounting space. The rack shall be complete with a continuous piano hinged front door with a cylinder lock and handle. The gymnasium sound system equipment rack shall have a sign mounted to the front stating, "Personal Listening Devices Stored Here". The sign shall be 1/16 inch thick laminated plastic with 3/16 inch high white letters on a black background. The following equipment shall be furnished and installed by this Contractor in the rack:
1. Two (2) four channel power amplifiers with a minimum rating of 600 watts continuous sine wave per channel into a eight (8) ohm output. A power amplifier that will meet this Specification is CROWN Model No. CDi 4/600.
 2. One (1) TOA Model No. D-901 twelve (12) input, eight (8) output, digital mixer. Mixer shall come complete with:
 - a. One (1) D936R four (4) stereo input module (tuner, CD, MP3 outlets).
 - b. One (1) D971E four (4) channel line output module (personal listening system, amplifier).
 - c. Four (4) D921E 2-channel input modules (microphone outlets).
 3. One (1) ROLLS Model No. RS81B Quartz PLL synthesized rack mounted stereo AM/FM tuner.
 4. One (1) TASCAM Model No. CD-200BT, rack mounted CD player with MP3 dock.
 5. One (1) WILLIAMS SOUND Model No. FM T55 personal listening system

base station transmitter complete with WILLIAMS SOUND Model No. RPK 005 rack mounting kit and ANT 025 antenna.

6. This Contractor shall furnish and install in the charging stations, thirty two (32) WILLIAMS SOUND Model No. No. PPA R37, seventeen (17) channel personal listening system receivers each complete with WILLIAMS SOUND Model No. EAR 013 single ear bud, rechargeable batteries, and belt clip.
7. This Contractor shall furnish to the Owner's representative, eight (8) WILLIAMS SOUND Model NKL 001 neckloops.
8. This Contractor shall furnish and install, three (3) WILLIAMS SOUND Model No. CHG 3512 twelve (12) unit charging cases for the personal listening system receivers complete with three (3) ATLAS SOUND Model No. VTD1-16 rack sliding shelves.
9. One (1) SHURE "SLX" series UHF wireless microphone system complete with Model No. SLX4 wireless receiver complete with rack mounting hardware and detachable antennas.
10. One (1) ATLAS SOUND Model No. RAC-9 AC power strip suitable for rack mounting.

2.02 SPEAKER SYSTEMS

- A. This Contractor shall furnish and install where shown on the Drawings, secured/suspended mounted speaker assemblies consisting of Electrovoice Model No. SX100+e HE (black), 200W speakers, Electrovoice Model no. Mb-100-LB, Electrovoice Model No. Mb 200 installation kit and Electrovoice Model No. Mb 300 horizontal array kit (as required). Speakers shall use Neutrik connectors NL4FX).

2.03 MICROPHONES

- A. This Contractor shall furnish to the Owner's representative, four (4) SHURE Model No. SM58S dynamic cardioid microphones. Each complete with an ON/OFF switch. Each microphone shall be furnished by this Contractor complete with a twenty five (25) foot connector cord with CANNON XLR connectors.
- B. This Contractor shall furnish to the Owner's representative, one (1) SHURE Model No. SLX2/SM58 dynamic cardioid wireless handheld microphone, and one (1) SHURE Model No WL183 lapel microphone with SLX1 transmitter, each complete with an ON/OFF switch and batteries.

2.04 MICROPHONE STANDS

- A. This Contractor shall furnish to the Owner's representative, two (2) ATLAS SOUND Model No. MS-20 microphone floor stands.
- B. This Contractor shall furnish to the Owner's representative, two (2) ATLAS SOUND Model No. DS-2 microphone desk stands.

2.05 MICROPHONE OUTLETS

- A. This Contractor shall furnish and install where shown on the Drawings, flush or surface wall mounted microphone outlets consisting of one (1) CANNON "XLR", complete with 3 pin XLR (female), series audio jack of the type required so as to be compatible with the type of microphone cable connector furnished, one (1) 3.5mm stereo audio jack (MP3), and a stainless steel coverplate. A microphone/MP3 outlet, which meets this Specification shall be as manufactured by CONQUEST AUDIO or approved equal.
- B. This Contractor shall furnish and install where shown on the Drawings, flush floor mounted microphone outlets consisting of a CANNON "XLR" complete with a 3 pin XLR (female) series audio jack, of the type required so as to be compatible with the type of microphone cable connector furnished, and one (1) 3.5mm stereo audio jack (MP3) mounted in a THOMAS AND BETTS (STEEL CITY) floor box with one (1) NEMA 5-20R duplex receptacle and two (2) Cat. 6 RJ-45 ports as hereinbefore specified, non-skid top, and tamperproof screws.

2.06 GYMNASIUM SOUND SYSTEM CABLE

- A. This Contractor shall furnish and install speaker cable consisting of one (1) twisted pair, No. 12 AWG unshielded with a temperature range for dry locations of minus ten (10) degrees C to seventy-five (75) degrees C. A cable that meets this Specification is WEST PENN Cat. No. 25227B or equal as manufactured by BELDEN, CONSOLIDATED WIRE, GENERAL CABLE, PAIGE, WINDY CITY WIRE or TAPPAN.
- B. This Contractor shall furnish and install field wiring for microphone outlets as shown on the Drawings. Wiring shall be two (2) conductor, No. 20 AWG stranded and shielded cable. A cable that meets this Specification is WEST PENN Cat. No. 25292B or equal as manufactured by BELDEN, CONSOLIDATED WIRE, GENERAL CABLE, PAIGE, WINDY CITY WIRE or TAPPAN.
- C. This Contractor shall furnish and install field wiring for MP3 outlets as shown on the Drawings. Wiring shall be two (2) conductor, No. 20 AWG stranded and shielded cable. A cable that meets this Specification is WEST PENN Cat. No. 25292B or equal as manufactured by BELDEN, CONSOLIDATED WIRE, GENERAL CABLE, PAIGE, WINDY CITY WIRE or TAPPAN.

2.07 AM/FM ANTENNA

- A. This Contractor shall furnish and install a PIXEL TECHNOLOGIES Model No. AFHD-4 AM/FM and HD antenna complete with: L mounting bracket; weather boot; surge protector; 20dB attenuator; 10dB attenuator; AM/FM separator; U-bolts with washers and nuts; pole mount saddle brackets; F-female to twin-lead adaptor and push-on-F-female to DIN adaptor. This Contractor shall furnish and install a weatherhead, rigid steel conduit mast, and two (2) RG-6 plenum rated cables from the antennas to the tuner located in the sound and intercommunication system equipment rack. This Contractor shall ground the antenna in accordance with the following specification.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. All wiring for the gymnasium sound reinforcement system shall be installed by this Contractor in minimum 1/2-inch conduit as hereinbefore specified. All junction box covers shall be stenciled by this Contractor for distinct identification. All conduit, device mounting boxes, junction boxes, and enclosures shall be securely fastened with appropriate fittings to ensure a positive ground throughout the entire system.
- B. All low voltage wiring connections shall be made by this Contractor as directed by the manufacturer. Splices for circuits shall be made only in junction boxes and shall be crimp connected.
- C. All low voltage wiring shall be checked and tested by this Contractor to ensure the system is free from grounds, opens, and shorts.
- D. All work shall be under the direct supervision of an accredited factory sound engineer. It shall be the responsibility of the sound engineer and this Contractor to check and inspect this installation to the Architect/Engineer's approval.

3.02 RACK MOUNTED EQUIPMENT

- A. The gymnasium sound system's rack mounted equipment shall be furnished and installed by this Contractor with the proper adapters, rack mounting kits, brackets, and closure panels for unused space. All interconnecting wiring shall be labeled, bundled, secured, and terminated by this Contractor in a neat and professional manner.
- B. All rack mounted equipment AC power cords shall be plugged into the rack mounted power strip.

3.03 SPEAKERS

- A. The speaker systems shall be securely mounted to the building structure by this Contractor at the locations shown and as detailed on the Drawings. All bracing shall be painted to match the surrounding structure. This Contractor shall coordinate the exact hanging angles with the system supplier and the Owner prior to the installation.

3.04 MICROPHONES

- A. This Contractor shall unpack and assemble microphones complete with all cables, connectors, and stands and connect ready for operation.

3.05 MICROPHONE OUTLETS

- A. This Contractor shall assemble microphone outlets and install, connect, and label as shown on the Drawings.

3.06 CABLES

- A. All wiring and cable for the gymnasium sound reinforcement system shall be pulled continuously through conduits without splices or abrasions and shall be terminated at their appropriate devices as shown on the Drawings, specified herein, and as directed by the system supplier. All cables shall be labeled. Input and output cabling shall not be installed in the same raceway.

3.07 ANTENNA INSTALLATION

- A. The antenna shall be bracket mounted by this Contractor above the roof at a location approved by the Owner. The antenna cables shall be run by this Contractor to the equipment rack and connected ready for operation.
- B. The antenna shall be grounded by this Contractor to the secondary building ground system with one (1) No. 10 AWG in ½ inch conduit.

END OF SECTION

SECTION 16735

BAND, CHORAL, ORCHESTRA AND GENERAL MUSIC ROOMS SOUND REINFORCEMENT SYSTEMS

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work covered under this Section shall include furnishing and installing a locally controlled complete and satisfactorily operating sound system in each of the band, choral, orchestra and general music rooms for the pick up, amplification, reproduction, and distribution of voice and/or music to associated loudspeakers within each room.
- B. Existing band, choral, orchestra and general music rooms sound reinforcement systems equipment may be reused as noted on the Drawings. This Contractor shall exercise extreme care not to damage the equipment while following the instructions on the Drawings. The equipment to be reused shall be protected from construction before, during, and after work has been completed.

1.03 QUALITY ASSURANCE

- A. All equipment described shall be the product of a manufacturer of established reputation and experience who has produced similar apparatus for a period of at least ten (10) years and shall be able to refer to similar installations now rendering satisfactory service.
- B. The band, choral, orchestra and general music rooms sound reinforcement systems shall be furnished by a factory authorized distributor certified to design, program, and service the system. The distributor must show evidence of successfully furnishing systems specified for at least five (5) years.
- C. All equipment for the band, choral, orchestra and general music rooms sound reinforcement systems shall be listed Underwriters Laboratories, Inc. (UL) bear the UL label and shall be installed in accordance with all requirements of the National Electrical Code (NEC), state and local codes, and these Specifications.
- D. Each of the band, choral, orchestra and general music rooms sound reinforcement systems installation shall be performed under the direct supervision of a factory trained service specialist.

- E. Shop drawing submittals are required per SECTION 16010 and shall include the following for review. Submittals not containing all of the information listed below will be rejected.
1. A complete list of equipment for each band, choral, orchestra and general music rooms sound reinforcement system shall be furnished indicating the specific quantities to be furnished by this Contractor. The catalog or model number for each module of each system shall be listed next to the quantities. This information shall be furnished in the front of the submittal.
 2. A specific description of each of the band, choral, orchestra and general music rooms sound reinforcement systems shall be furnished describing each module and how it shall function within each system.
 3. A specific drawing shall be furnished of each band, choral, orchestra and general music sound reinforcement system equipment rack. Each module rooms shall be shown in its proper location with its terminal designation shown.
 4. A data sheet shall be furnished for each module and device. The information shall be highlighted that applies to the particular module or device to be furnished.
 5. A detailed diagram showing how to connect each device shall be furnished indicating exact final connection information.
 6. A detailed floor plan for each band, choral, orchestra and general music Room shall be furnished. The plans shall show the locations of all equipment, loudspeakers, and devices and their required interconnections. The interconnections shown shall indicate the number, size, and type of wires as described in this Specification. Loudspeakers shall be zoned as shown on the Drawings. The layout of all band, choral, orchestra and general music rooms sound reinforcement system equipment, devices, and conduit routings shall closely follow that shown on the Drawings.

1.04 DOCUMENTATION

- A. This Contractor shall furnish to the Owner, one (1) set of "As Built" drawings for each band, choral, orchestra and general music Room sound reinforcement system depicting the complete field wiring system and component interconnections in each system equipment rack.
- B. This Contractor shall furnish to the Owner, four (4) sets of factory operation and maintenance manuals. These manuals shall include factory service manuals

with complete parts lists, wiring and component schematics including circuit diagrams, and all other information necessary for the proper operation, service, and maintenance of each band, choral, orchestra and general music Room sound reinforcement system.

1.05 TRAINING

- A. This Contractor shall furnish eight (8) hours (total for all rooms) of technical service training to the Owner's technical staff using the factory service manuals previously specified.
- B. This Contractor shall furnish eight (8) hours (total for all rooms) of operating and programming training to the Owner's operating staff which shall be delivered in two (2) separate four (4) hours sessions to be scheduled at the Owner's convenience over the warranty period.
- C. All training specified herein shall be performed by a factory certified technician.

1.06 DESCRIPTION OF OPERATION

- A. This Contractor shall furnish and install band, choral, and general music rooms sound reinforcement systems with all orchestra conduit, cable, outlets, devices, and equipment as shown on the Drawings and as herein specified to furnish complete systems.
- B. Each band, choral, orchestra and general music rooms sound reinforcement system shall provide for reception of AM or FM radio broadcasts, the amplification of music and voice, and the reproduction of recorded music or other program materials, and their distribution to all associated speakers within each band, choral, and orchestra Room.
- C. Each band, choral, orchestra and general music Room sound reinforcement system shall accept both the input and output of an external tape recorder.
- D. Each band, choral, orchestra and general music Room sound reinforcement system shall accept a priority override signal to mute the system when the main building Sound and Intercommunications System activates the priority override function.

1.07 SYSTEM TEST AND ACCEPTANCE

- A. Prior to the final site visitation this Contractor shall conduct an operating test of each complete band, choral, orchestra and general music rooms sound reinforcement system. Each system shall test free from grounds, shorts, and other faults. All connections shall be thoroughly checked for mechanical and electrical connections. All equipment shall be demonstrated to operate in

accordance with the requirements set forth in these Specifications and as shown on the Drawings.

- B. This Contractor shall perform all tests in the presence of the Architect/Engineer. This Contractor shall furnish all personnel and test instruments for use in the test.
- C. When the work on each band, choral, orchestra and general music Room sound reinforcement system has been completed and is ready for final review, this Contractor shall demonstrate that the requirements of the Contract, as it applies to this work, have been carried out and that the system has been adjusted and operated in accordance therewith.

1.08 WARRANTY

- A. This Contractor shall deliver the work described herein in a first-class operating condition in every respect. This Contractor shall also warrant that the material, equipment, and workmanship furnished shall be entirely free from defects. Any materials, equipment, or workmanship in which defects may develop before or during the warranty period shall be repaired or replaced at the Contractor's own expense. Refer to SECTION 01740 for the start of the warranty period. The Contractor shall further warrant that all material, equipment, and workmanship used in the installation, but not specifically mentioned in the Drawings and Specifications, is the best of their respective kinds and that the construction and installation was performed in accordance with the best accepted standard practices in all details.

PART 2 - PRODUCTS

2.01 EQUIPMENT RACKS

- A. This Contractor shall furnish and install in each band, choral, orchestra and general music Room where shown on the Drawings, a wall mounted equipment rack for the room's sound reinforcement system as specified herein. Each rack shall be ATLAS SOUND Cat. No. WMA24-23 sectional, wall mounting type with a textured black finish providing a minimum of sixty-one (61) inches of vertical rack mounting space. Each rack shall be complete with a continuous piano hinged front door with a cylinder lock and handle. The following equipment shall be furnished and installed by this Contractor in each rack:
 - 1. One (1) TOA Model No. D-901 twelve (12) input, eight (8) output, digital mixer. Mixer shall come complete with:
 - a. One (1) D936R four (4) stereo input module (tuner, CD, MP3 outlets).

- b. One (1) D971E four (4) channel line output module (personal listening system, amplifier).
 - c. Four (4) D921E 2-channel input modules (microphone outlets).
2. One (1) CROWN Model No. CDi 2/300 dual channel amplifier with three hundred (300) watts per channel at eight (8) ohms. Amplifier shall be suitable.
3. One (1) TASCAM Model No. SS-CDR250N rack mounted MP3/CD recorder workstation complete with minimum 8GB SDHC Card (Sweetwater SD card 8GB Top Tier SDHC Card or equal).
4. One (1) ROLLS Model No. RS81B Quartz PLL synthesized rack mounted stereo AM/FM tuner.
5. One (1) ATLAS SOUND Model No. AP-2410-15S AC power strip suitable for rack mounting.
6. One (1) SHURE "SLX" series UHF wireless microphone system complete with Model No. SLX4 wireless receiver complete with rack mounting hardware and detachable antennas.
7. One (1) Atlas Sound Make Storage Drawer - recessed 4RU with 14 inch extension (SD4-14).

2.02 WALL MOUNTED STEREO SPEAKERS

- A. This Contractor shall furnish and install where shown on the Drawings, two (2) JBL Model No "C29AV-1" enclosed wall mounted stereo speakers. The stereo speakers shall be 300 watt, 8 ohms. Each stereo speaker shall be complete with wall mounting bracket.

2.03 MICROPHONES

- A. This Contractor shall furnish to the Owner's representative, four (4) SHURE Model No. SM58S dynamic cardioid microphones for each band, choral, orchestra and general music Room sound reinforcement system (total of **CONSULTANT SHALL EDIT**). Each microphone shall be furnished by this Contractor complete with a twenty five (25) foot connector cord with CANNON XLR connectors.
- B. This Contractor shall furnish to the Owner's representative, one (1) SHURE Model No. SLX2/SM58 dynamic cardioid wireless handheld microphone and one (1) SHURE Model No WL183 lapel microphone with SLX1 transmitter for each

band, choral, orchestra and general music Room sound reinforcement system.
Each shall be complete with an ON/OFF switch and batteries

- C. This Contractor shall furnish and install in the choral Room, three (3) SHURE Model No. CVO-B/C hanging microphones at locations shown on the Drawings.

2.04 MICROPHONE STANDS

- A. This Contractor shall furnish to the Owner's representative, four (4) ATLAS SOUNDOLIER Model No. MS-20 microphone floor stands for each band, choral, orchestra and general music Room sound reinforcement system (total of **CONSULTANT SHALL EDIT**).
- B. This Contractor shall furnish to the Owner's representative, four (4) ATLAS SOUNDOLIER Model No. PB15CH microphone booms for each band, choral, orchestra and general music Room sound reinforcement systems (total of **CONSULTANT SHALL EDIT**).

2.05 MICROPHONE OUTLETS

- A. This Contractor shall furnish and install where shown on the Drawings, flush or surface wall mounted microphone outlets consisting of one (1) CANNON "XLR", complete with 3 pin XLR (female), series audio jack of the type required so as to be compatible with the type of microphone cable connector furnished, one (1) 3.5mm stereo audio jack (MP3), and a stainless steel coverplate. A microphone/MP3 outlet, which meets this Specification shall be as manufactured by CONQUEST AUDIO or approved equal.

2.06 AM/FM ANTENNA

- A. This Contractor shall furnish and install a PIXEL TECHNOLOGIES Model No. AFHD-4 AM/FM and HD antenna complete with: L mounting bracket; weather boot; surge protector; 20dB attenuator; 10dB attenuator; AM/FM separator; U-bolts with washers and nuts; pole mount saddle brackets; F-female to twin-lead adaptor and push-on-F-female to DIN adaptor. This Contractor shall furnish and install a weatherhead, rigid steel conduit mast, and two (2) RG-6 plenum rated cables from the antennas to the tuner located in the sound and intercommunication system equipment rack. This Contractor shall ground the antenna in accordance with the following specification.

2.07 BAND, CHORAL, ORCHESTRA AND GENERAL MUSIC ROOMS SOUND SYSTEM CABLE

- A. This Contractor shall furnish and install one (1) two (2) conductor, No. 12 AWG stranded plenum rated cable with a temperature range for dry locations of minus ten (10) degrees C to sixty (60) degrees C for each stereo speaker. A cable that meets this Specification is WEST PENN Cat. No. 25227B or equal as

manufactured by BELDEN, CONSOLIDATED WIRE, GENERAL CABLE, PAIGE, WINDY CITY WIRE or TAPPAN.

- B. This Contractor shall furnish and install one (1) stranded, No. 20 AWG, shielded, single twisted pair plenum rated cable with a temperature range for dry locations of minus ten (10) degrees C to sixty (60) degrees C for each microphone outlet. A cable that meets this Specification is WEST PENN Cat. No. 25292B or equal as manufactured by BELDEN, CONSOLIDATED WIRE, GENERAL CABLE, PAIGE, WINDY CITY WIRE or TAPPAN.

2.08 CEILING MOUNTED PROJECTOR LOCATIONS

- A. This Contractor shall furnish and install one(1) two (2) conductor No. 12 AWG stranded, plenum rated cable from the audio out port of the ceiling mounted projector to an audio in port for each band, choral, orchestra and general music Room sound reinforcement systems shown on the drawings.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. All vertical, low voltage field wiring shall be installed by this Contractor in 1/2-inch conduit and/or surface metal raceway as shown on the Drawings. Conduit fill shall not exceed the conduit space capacity.
- B. All horizontal, low voltage field wiring to be installed in areas without a ceiling or in areas without an accessible ceiling shall be installed by this Contractor in 1/2-inch conduit.
- C. All horizontal low voltage field wiring to be installed in areas with accessible ceilings shall be installed by this Contractor bundled together and run exposed above the ceilings. Bundles shall be supported by "J" hooks mounted not more than four (4) feet on center. "J" hooks shall be dedicated to the wiring specified in this specification section.
- D. All horizontal, low voltage field wiring shall be run at right angles to the building structure.
- E. All horizontal low voltage field wiring shall be installed below the roof/floor structural supports (joist, beams, girders, etc.). Wiring installed between the structural supports mentioned above and the roof or floor deck will not be acceptable.
- F. All horizontal low voltage field wiring penetrations through new and/or existing walls shall be sleeved. Minimum sleeve size shall be 3/4 inch. All sleeves shall be bushed both sides.

- G. All low voltage field wiring for the band, choral, orchestra and general music Room sound reinforcement systems shall be furnished and installed by this Contractor. All junction box covers shall be stenciled for distinct identification.
- H. This Contractor as directed by the equipment manufacturer shall make all wiring connections. Splices for circuits shall be made only in junction boxes and shall be crimp connected.
- I. All band, choral, orchestra and general music Room sound reinforcement systems wiring shall be checked and tested by this Contractor to ensure the system is free from grounds, opens, and shorts.
- J. All work shall be under the supervision of a factory accredited sound engineer. It shall be the responsibility of the sound engineer and this Contractor to check and inspect this installation to the Owner's and Architect/Engineer's approval.

3.02 RACK MOUNTED EQUIPMENT

- A. Each band, choral, orchestra and general music Room sound reinforcement system's rack choral mounted equipment shall be installed by this Contractor with the proper adapters, rack mounting kits, brackets, and closure panels for unused spaces. All interconnecting wiring shall be labeled, bundled, secured, and terminated by this Contractor in a neat and professional manner.
- B. All rack mounted equipment AC power cords shall be plugged into the mounted power strip by this Contractor.

3.03 SPEAKER

- A. Wall mounted stereo speakers shall be securely fastened to the building structure by this Contractor with threaded rod or bolts as appropriate for the application.
- B. This Contractor shall furnish and install a NEMA 5-20R duplex receptacle (as hereinbefore specified) at each stereo speaker location whether shown on the Drawings or not. Duplex receptacles shall be on their own circuit.

3.04 MICROPHONES

- A. This Contractor shall unpack microphone and assemble with cables and stands and connect ready for operation. Microphones shown for permanent installation shall be mounted by this Contractor in accordance with the Drawings in a manner appropriate for the location.

3.05 MICROPHONES OUTLETS

- A. This Contractor shall assemble microphone outlets and install, connect, and label as shown on Drawings.

3.06 ANTENNA INSTALLATION

- A. The antenna shall be bracket mounted by this Contractor above the roof at a location approved by the Owner. The antenna cables shall be run by this Contractor to the equipment rack and connected ready for operation.
- B. The antenna shall be grounded by this Contractor to the secondary building ground system with one (1) No. 10 AWG in 1/2 inch conduit.

END OF SECTION

SECTION 16740

ATHLETIC FIELDS SOUND REINFORCEMENT SYSTEMS

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work covered under this Section shall include furnishing and installing a separate locally controlled complete and satisfactorily operating athletic field sound reinforcement system for the pick up, amplification, reproduction, and distribution of voice and/or music to associated loudspeakers for each of the following: baseball field; football stadium; softball field; and track and field area.

1.03 QUALITY ASSURANCE

- A. All equipment described shall be the product of a manufacturer of established reputation and experience producing similar apparatus for a period of at least ten (10) years and shall be able to refer to similar installations now rendering satisfactory service.
- B. The athletic fields sound reinforcement systems shall be furnished by a factory authorized distributor certified to design, program, and service the system. The distributor must show evidence of successfully furnishing systems specified for at least five (5) years.
- C. All equipment for the athletic fields sound reinforcement systems shall be listed by Underwriters Laboratories, Inc. (UL), bear the UL label, and shall be installed in accordance with all requirements of the National Electrical Code (NEC), state and local codes, and these Specifications.
- D. Each athletic field sound reinforcement system installation shall be performed under the direct supervision of a factory trained service specialist.
- E. Shop drawing submittals are required per SECTION 16010 and shall include the following for review:
 - 1. A complete list of equipment for each athletic field area shall be furnished indicating the specific quantities for each area to be furnished by the manufacturer. The catalog or model number for each module of each system shall be listed next to the quantities. This information shall be furnished in the front of the submittal.

2. A specific description of each athletic field sound reinforcement system shall be furnished describing each module and how it shall function in the associated system.
3. A detailed plan of each athletic field area shall be furnished showing the locations of all equipment, loudspeakers, and devices and their required interconnections. The interconnections shown shall indicate the number, size, and type of wires as described in this Specification. The layout of all equipment, devices, and conduit routings shall closely follow that shown on the Drawings.
4. A specific drawing of each athletic field sound reinforcement system rack shall be made by the equipment supplier. Each module shall be shown in its proper location with its terminal designation shown.
5. A data sheet shall be furnished for each module and device. The information shall be highlighted that applies to the particular module or device to be furnished.
6. A detailed diagram showing how to connect each device shall be furnished indicating exact final connection information.
7. A detailed drawing showing how to mount the football, baseball, softball, and track and field speakers, shall be furnished, including necessary hardware and mounting devices.

1.04 DOCUMENTATION

- A. This Contractor shall furnish to the Owner, one (1) set of "As Built" drawings for each athletic field area depicting the complete wiring system and component interconnections in each system equipment rack.
- B. This Contractor shall furnish to the Owner, four (4) sets of factory operation and maintenance manuals for each athletic field sound reinforcement system. These manuals shall include factory service manuals with complete parts lists, wiring and component schematics including circuit diagrams, and all other information necessary for the proper operation and service maintenance of the system.

1.05 TRAINING

- A. This Contractor shall furnish eight (8) hours (total for all athletic fields) of technical service training to the Owner's technical staff using the factory service manuals previously specified.
- B. This Contractor shall furnish eight (8) hours (total for all athletic fields) of operating and programming training to the Owner's operating staff which shall be delivered in two (2) separate four (4) hour sessions to be scheduled at the

Owner's convenience over the warranty period.

- C. All training specified herein shall be performed by a factory certified technician.

1.06 DESCRIPTION OF OPERATION

- A. This Contractor shall furnish and install athletic fields sound reinforcement systems with all conduit, wiring, outlets, and equipment as shown on the Drawings and as herein specified to furnish complete systems.
- B. Each athletic field sound reinforcement system shall provide for the amplification of music and voice, and the reproduction of recorded music or other program materials, and their distribution to all associated speakers.
- C. Each Athletic Field sound reinforcement system shall provide a personal listening system for use by hearing impaired listeners.

1.07 SYSTEM TEST AND ACCEPTANCE

- A. Prior to the final site visitation this Contractor shall conduct an operating test of each complete Athletic Field sound reinforcement system. Each system shall test free from grounds, shorts, and other faults. All connections shall be thoroughly checked for mechanical and electrical connections. All equipment shall be demonstrated to operate in accordance with the requirements set forth in these Specifications and as shown on the Drawings.
- B. This Contractor shall perform all tests in the presence of the Architect/Engineer. This Contractor shall furnish all personnel and test instruments for use in the test.
- C. When the work on each Athletic Field sound reinforcement system has been completed and is ready for final review, this Contractor shall demonstrate that the requirements of the Contract as it applies to this work have been carried out and that each system has been adjusted and operated in accordance therewith.

1.08 WARRANTY

- A. This Contractor shall deliver the work described herein in a first-class operating condition in every respect. This Contractor shall also warrant that the material, equipment, and workmanship furnished shall be entirely free from defects. Any materials, equipment, or workmanship in which defects may develop before or during the warranty period shall be repaired or replaced at the Contractor's own expense. Refer to SECTION 01740 for the start of the warranty period. The Contractor shall further warrant that all material, equipment, and workmanship used in the installation, but not specifically mentioned in the Drawings and Specifications, is the best of their respective kinds and that the construction and installation was performed in accordance with the best accepted standard practices in all details.

PART 2 - PRODUCTS

2.01 BASEBALL FIELD SOUND REINFORCEMENT SYSTEM

A. EQUIPMENT RACK

1. This Contractor shall furnish and install a sectional wall mounted Baseball Field sound reinforcement system equipment rack as shown on the Drawings and as specified herein. The rack shall be ATLAS SOUND cat. no. WMA24-23 sectional, wall mounting type with a textured black finish providing a minimum of forty-two (42) inches of vertical rack mounting space. The rack shall be complete with a continuous piano hinged front door with a cylinder lock and handle. The baseball field sound system equipment rack shall have a sign mounted to the front stating, "Personal Listening Devices Stored Here". The sign shall be 1/16 inch thick laminated plastic with 3/16 inch high white letters on a black background. The following equipment shall be furnished and installed by this Contractor in the rack:
 - a. One (1) dual channel power amplifier suitable for rack mounting with a minimum rating of 300 watts continuous sine wave per channel into an eight (8) ohm output. A power amplifier that will meet this specification is CROWN Model No. CDi 2/300.
 - b. One (1) TOA model no. D-901 twelve (12) input, eight (8) output, digital mixer. Mixer shall come complete with:
 - One (1) D936R four (4) stereo input module (for tuner/CD/MP3)
 - One (1) D971E four (4) channel line output module
 - Four (4) D921E 2 -channel input modules (mic/MP3 outlets)
 - c. One (1) ROLLS model no. RS81B Quartz PLL synthesized rack mounted stereo AM/FM tuner.
 - d. One (1) TASCAM model no. CD-200BT, rack mounted CD player with MP3 dock.
 - e. One (1) WILLIAMS SOUND model no. FM T55 personal listening system base station transmitter complete with WILLIAMS SOUND model no. RPK 005 rack mounting kit and ANT 025 antenna.
 - f. The Contractor shall furnish and install in the charging stations,

twelve (12) WILLIAMS SOUND model no. No. PPA R37, seventeen (17) channel personal listening system receivers each complete with WILLIAMS SOUND model no. EAR 013 single earbud, rechargeable batteries, and belt clip.

- g. This Contractor shall furnish to the Owner's representative, four (4) WILLIAMS SOUND model NKL 001 neckloops.
- h. The Contractor shall furnish and install one (1) WILLIAMS SOUND model no. CHG 3512 twelve (12) unit charging case for the personal listening system receivers complete with one (1) ATLAS SOUND model no. VTD1-16 rack sliding shelf.
- i. One (1) ATLAS SOUND model no. AP-S15L AC power supply module suitable for rack mounting.
- j. One (1) ATLAS SOUND model no. AP-2410-15S AC power strip.
- k. One (1) SHURE "SLX" series UHF wireless microphone system complete with model no. SLX4 wireless receiver complete with rack mounting hardware and detachable antennas.
- l. One (1) Atlas Sound Make Storage Drawer-recessed- 4RU with 14 inch extension (SD4-14).

B. Speaker Systems:

- 1. This Contractor shall furnish and install two (2), horn type loudspeakers 200 watts, 70.0 volts with a frequency response of 85 Hz - 16 kHz and shall include a driver. A horn type loudspeaker that will meet this Specification is COMMUNITY model no. R.5-66TZ or equal as manufactured by JBL.

C. Microphones:

- 1. This Contractor shall furnish to the Owner's representative, one (1) SHURE model no. SM58S dynamic cardioid microphone complete with an ON/OFF switch. The microphone shall be furnished by this Contractor complete with a twenty five (25) foot connector cord with CANNON XLR connectors.
- 2. This Contractor shall furnish to the Owner's representative, one (1) SHURE model no. SLX2/SM58 dynamic cardioid wireless handheld microphone, and one (1) SHURE model no. WL183 lapel microphone with SLX1 transmitter. Each shall be complete with an ON/OFF switch and batteries

D. Microphone Stand:

1. This Contractor shall furnish to the Owner's representative, one (1) ATLAS SOUND model no. DS-2 microphone desk stand.
- E. Microphone Outlets:
1. This Contractor shall furnish and install where shown on the Drawings, flush or surface wall mounted microphone outlets consisting of one (1) CANNON "XLR", complete with 3 pin XLR (female), series audio jack of the type required so as to be compatible with the type of microphone cable connector furnished, one (1) 3.5mmstereo audio jack (MP3), and a stainless steel coverplate. A microphone/MP3 outlet, which meets this Specification shall be as manufactured by CONQUEST AUDIO or approved equal.
- F. Baseball Field System Cable:
1. This Contractor shall furnish and install speaker cable consisting of one (1) twisted pair, no. 12 AWG unshielded with a temperature range for dry locations of minus twenty-five (25) degrees C to one hundred five (105) degrees C and seventy-five (75) degrees C for wet locations. A cable that meets this Specification is WEST PENN Cat. No. AQ227 or equal as manufactured by BELDEN, CONSOLIDATED WIRE, GENERAL CABLE, PAIGE, WINDY CITY WIRE or TAPPAN.
 2. This Contractor shall furnish and install field wiring for microphone outlets as shown on the Drawings. Wiring shall be two (2) conductor, No. 20 AWG stranded and shielded cable. A cable that meets this Specification is WEST PENN Cat. No. 25292B or equal as manufactured by BELDEN, CONSOLIDATED WIRE, GENERAL CABLE, PAIGE, WINDY CITY WIRE or TAPPAN.
 3. This Contractor shall furnish and install field wiring for MP3 outlets as shown on the Drawings. Wiring shall be two (2) conductor, no. 20 AWG stranded and shielded cable. A cable that meets this Specification is WEST PENN Cat. No. 25292B or equal as manufactured by BELDEN, CONSOLIDATED WIRE, GENERAL CABLE, PAIGE, WINDY CITY WIRE or TAPPAN.

2.02 FOOTBALL FIELD SOUND REINFORCEMENT SYSTEM

- A. Equipment Rack:
1. This Contractor shall furnish and install a floor mounted equipment rack for the football field sound reinforcement system as shown on the Drawings and as specified herein. The rack(s) shall be ATLAS SOUND cat. no. 140-18 providing standard nineteen (19) inch rack mounting space. The rack(s) shall be complete with a hinged front door with cylinder lock and handle, and a flush spring-hinged rear door with

cylinder lock (front and rear locks shall be keyed differently) and handle. The football field sound system equipment rack shall have a sign mounted to the front stating, "Personal Listening Devices Stored Here". The sign shall be 1/16 inch thick laminated plastic with 3/16 inch high white letters on a black background. The following equipment shall be furnished and installed by this Contractor in the rack:

- a. One (1) dual channel power amplifier (home) suitable for rack mounting with a minimum rating of 2100 watts continuous sine wave per channel into a four (4) ohm output. A power amplifier, which will meet this specification, is CROWN model no. CDi 6000.
- b. One (1) dual channel power amplifier (visitor) suitable for rack mounting with a minimum rating of 1200 watts continuous sine wave per channel into a four (4) ohm output. A power amplifier, which will meet this specification, is CROWN model no. CDi 4000.
- c. One (1) TOA model no. D-901 twelve (12) input, eight (8) output, digital mixer. Mixer shall come complete with:
 - One (1) D936R four (4) stereo input module (for tuner/CD/MP3)
 - One (1) D971E four (4) channel line output module
 - Four (4) D921E 2 -channel input modules (mic/MP3 outlets)
- d. One (1) PYLE model no. ROLLS model no. RS81B rack mounted stereo AM/FM tuner.
- e. One (1) TASCAM model no. CD-200BT, rack mounted CD player with MP3 dock.
- f. One (1) WILLIAMS SOUND model no. FM T55 personal listening system base station transmitter complete with WILLIAMS SOUND model no. RPK 005 rack mounting kit and ANT 025 antenna.
- g. The Contractor shall furnish and install in the charging stations, thirty six (36) WILLIAMS SOUND model no. PPA R37, seventeen (17) channel personal listening system receivers each complete with WILLIAMS SOUND model no. EAR 013 single earbud, rechargeable batteries, and belt clip.
- h. This Contractor shall furnish to the Owner's representative, nine (9) WILLIAMS SOUND model NKL 001 neckloops.
- i. The Contractor shall furnish and install three (3) WILLIAMS

SOUND model no. CHG 3512 twelve (12) unit charging cases for the personal listening system receivers complete with three (3) ATLAS SOUND model no. VTD1-16 rack sliding shelves.

- j. One (1) ATLAS SOUND model no. AP-S15L AC power supply module suitable for rack mounting.
- k. One (1) ATLAS SOUND model no. AP-2410-15S AC power strip.
- l. One (1) SHURE "SLX" series UHF wireless microphone system complete with model no. SLX4 wireless receiver complete with rack mounting hardware and detachable antennas.
- m. One (1) Atlas Sound Make Storage Drawer- recessed – 4RU with 14 inch extension (SD4-14).

B. Speaker Systems:

- 1. This Contractor shall furnish and install two (2), horn type loudspeakers (Home) 800 watts @ 4 ohm, with a frequency response of 85 Hz - 16 kHz and shall include a driver. A horn type loudspeaker that will meet this Specification is COMMUNITY model no. R.2-474Z complete with COMMUNITY model no. R2YOKE or equal as manufactured by JBL.
- 2. This Contractor shall furnish and install one (1), 3-way loudspeaker system (visitor) with a frequency response of 70 Hz - 4 kHz and shall include a driver. A speaker, which will meet this Specification, is COMMUNITY model no. R2-52Z complete with COMMUNITY model no. R2YOKE mounting yoke kit or equal as manufactured by JBL.

C. Microphones:

- 1. This Contractor shall furnish to the Owner's representative, four (4) SHURE model no. SM58S dynamic cardioid microphones. Each complete with an ON/OFF switch. Each microphone shall be furnished by this Contractor complete with a twenty five (25) foot connector cord with CANNON XLR connectors.
- 2. This Contractor shall furnish to the Owner's representative, one (1) SHURE model no. SLX2/SM58 dynamic cardioid wireless handheld microphone, and one (1) SHURE model no. WL183 lapel microphone with SLX1 transmitter. Each complete with an ON/OFF switch and batteries.

D. Microphone Stands:

- 1. This Contractor shall furnish to the Owner's representative, two (2) ATLAS SOUND model no. DS-2 microphone desk stands.

2. This Contractor shall furnish to the Owner's representative, two (2) ATLAS SOUND model no. MS-20 microphone floor stands.

E. Microphone Outlets:

1. This Contractor shall furnish and install where shown on the Drawings, flush or surface wall mounted microphone outlets consisting of one (1) CANNON "XLR", complete with 3 pin XLR (female), series audio jack of the type required so as to be compatible with the type of microphone cable connector furnished, one (1) 3.5mm stereo audio jack (MP3), and a stainless steel coverplate. A microphone/MP3 outlet, which meets this Specification shall be as manufactured by CONQUEST AUDIO or approved equal.

F. Football Field System Cable:

1. This Contractor shall furnish and install speaker cable consisting of one (1) twisted pair, no. 12 AWG unshielded with a temperature range for dry locations of minus twenty-five (25) degrees C to one hundred five (105) degrees C and seventy-five (75) degrees C for wet locations. A cable that meets this Specification is WEST PENN Cat. No. AQ227 or equal as manufactured by BELDEN, CONSOLIDATED WIRE, GENERAL CABLE, PAIGE, WINDY CITY WIRE or TAPPAN.
2. This Contractor shall furnish and install field wiring for microphone outlets as shown on the Drawings. Wiring shall be two (2) conductor, no. 20 AWG stranded and shielded cable. A cable that meets this Specification is WEST PENN cat. no. 25292B or equal as manufactured by BELDEN, CONSOLIDATED WIRE, GENERAL CABLE, PAIGE, WINDY CITY WIRE or TAPPAN.
3. This Contractor shall furnish and install field wiring for MP3 outlets as shown on the Drawings. Wiring shall be two (2) conductor, no. 20 AWG stranded and shielded cable. A cable that meets this Specification is WEST PENN cat. no. 25292B or equal as manufactured by BELDEN, CONSOLIDATED WIRE, GENERAL CABLE, PAIGE, WINDY CITY WIRE or TAPPAN.

2.03 SOFTBALL FIELD SOUND REINFORCEMENT SYSTEM

A. EQUIPMENT RACK

1. This Contractor shall furnish and install a sectional wall mounted softball field sound reinforcement system equipment rack as shown on the Drawings and as specified herein. The rack shall be ATLAS SOUND cat. no. WMA24-23 sectional, wall mounting type with a textured black finish providing a minimum of forty-two (42) inches of vertical rack mounting

space. The rack shall be complete with a continuous piano hinged front door with a cylinder lock and handle. The softball field sound system equipment rack shall have a sign mounted to the front stating, "Personal Listening Devices Stored Here". The sign shall be 1/16 inch thick laminated plastic with 3/16 inch high white letters on a black background. The following equipment shall be furnished and installed by this Contractor in the rack:

- a. One (1) dual channel power amplifier suitable for rack mounting with a minimum rating of 300 watts continuous sine wave per channel into a eight (8) ohm output. A power amplifier that will meet this specification is CROWN model no. CDi 2/300.
- b. One (1) TOA model no. D-901 twelve (12) input, eight (8) output, digital mixer. Mixer shall come complete with:
 - One (1) D936R four (4) stereo input module (for tuner/CD/MP3)
 - One (1) D971E four (4) channel line output module
 - Four (4) D921E 2 -channel input modules (mic/MP3 outlets)
- c. One (1) ROLLS model no. RS81B rack mounted stereo AM/FM tuner.
- d. One (1) TASCAM model no. CD-200BT, rack mounted CD player with bluetooth.
- e. One (1) WILLIAMS SOUND model no. FM T55 personal listening system base station transmitter complete with WILLIAMS SOUND model no. RPK 005 rack mounting kit and ANT 025 antenna.
- f. The Contractor shall furnish and install in the charging stations, twelve (12) WILLIAMS SOUND model no. No. PPA R37, seventeen (17) channel personal listening system receivers each complete with WILLIAMS SOUND model no. EAR 013 single earbud, rechargeable batteries, and belt clip.
- g. This Contractor shall furnish to the Owner's representative, four (4) WILLIAMS SOUND model NKL 001 neckloops.
- h. The Contractor shall furnish and install (1) WILLIAMS SOUND model no. CHG 3512 twelve (12) charging case for the personal listening system receivers complete with one (1) ATLAS SOUND model no. VTD1-16 rack sliding shelf.

- i. One (1) ATLAS SOUND model No. AP-S15L AC power supply module suitable for rack mounting.
 - j. One (1) ATLAS SOUND model no. AP-2410-15S AC power strip.
 - k. One (1) SHURE "SLX" series UHF wireless microphone system complete with model no. SLX4 wireless receiver complete with rack mounting hardware and detachable antennas.
 - l. One (1) Atlas Sound Make Storage Drawer- recessed- 4RU with 14 inch extension (SD4-14).
- B. Speaker Systems:
- 1. This Contractor shall furnish and install two (2) horn type loudspeakers 200 watts, 70.0 volts with a frequency response of 85 Hz - 16 kHz and shall include a driver. A horn type loudspeaker that will meet this Specification is COMMUNITY model no. R.5-66TZ or equal as manufactured by JBL.
- C. Microphones:
- 1. This Contractor shall furnish to the Owner's representative, one (1) SHURE Model No. SM58S dynamic cardioid microphones complete with an ON/OFF switch. The microphone shall be furnished by this Contractor complete with a twenty five (25) foot connector cord with CANNON XLR connectors.
 - 2. This Contractor shall furnish to the Owner's representative, one (1) SHURE Model No. SLX2/SM58 dynamic cardioid wireless handheld microphone, and one (1) SHURE model no. WL183 lapel microphone with SLX1 transmitter. Each complete with an ON/OFF switch and batteries
- D. Microphone Stand:
- 1. This Contractor shall furnish to the Owner's representative, one (1) ATLAS SOUND model no. DS-2 microphone desk stand.
- E. Microphone Outlets:
- 1. This Contractor shall furnish and install where shown on the Drawings, flush or surface wall mounted microphone outlets consisting of one (1) CANNON "XLR", complete with 3 pin XLR (female), series audio jack of the type required so as to be compatible with the type of microphone cable connector furnished, one (1) 3.5mmstereo audio jack (MP3), and a stainless steel coverplate. A microphone/MP3 outlet, which meets this

Specification shall be as manufactured by CONQUEST AUDIO or approved equal.

F. Softball Field System Cable:

1. This Contractor shall furnish and install speaker cable consisting of one (1) twisted pair, No. 12 AWG unshielded with a temperature range for dry locations of minus twenty-five (25) degrees C to one hundred five (105) degrees C and seventy-five (75) degrees C for wet locations. A cable that meets this Specification is WEST PENN Cat. No. AQ227 or equal as manufactured by BELDEN, CONSOLIDATED WIRE, GENERAL CABLE, PAIGE, WINDY CITY WIRE or TAPPAN.
2. This Contractor shall furnish and install field wiring for microphone outlets as shown on the Drawings. Wiring shall be two (2) conductor, No. 20 AWG stranded and shielded cable. A cable that meets this Specification is WEST PENN Cat. No. 25292B or equal as manufactured by BELDEN, CONSOLIDATED WIRE, GENERAL CABLE, PAIGE, WINDY CITY WIRE or TAPPAN.
3. This Contractor shall furnish and install field wiring for MP3 outlets as shown on the Drawings. Wiring shall be two (2) conductor, No. 20 AWG stranded and shielded cable. A cable that meets this Specification is WEST PENN Cat. No. 25292B or equal as manufactured by BELDEN, CONSOLIDATED WIRE, GENERAL CABLE, PAIGE, WINDY CITY WIRE or TAPPAN.

2.04 TRACK AND FIELD AREA SOUND REINFORCEMENT SYSTEM

A. EQUIPMENT RACK

1. This Contractor shall furnish and install a sectional wall mounted Track and Field Area sound reinforcement system equipment rack as shown on the Drawings and as specified herein. The rack shall be ATLAS SOUND Cat. No. WMA24-23 sectional, wall mounting type with a textured black finish providing a minimum of forty-two (42) inches of vertical rack mounting space. The rack shall be complete with a continuous piano hinged front door with a cylinder lock and handle. The track and field sound system equipment rack shall have a sign mounted to the front stating, "Personal Listening Devices Stored Here". The sign shall be 1/16 inch thick laminated plastic with 3/16 inch high white letters on a black background. The following equipment shall be furnished and installed by this Contractor in the rack:
 - a. Two (2) dual channel power amplifier suitable for rack mounting with a minimum rating of 600 watts continuous sine wave per channel into a four (4) ohm output. A power amplifier that will meet this specification is CROWN model no. CDi 2/600.

- b. One (1) TOA model no. D-901 twelve (12) input, eight (8) output, digital mixer. Mixer shall come complete with:
 - One (1) D936R four (4) stereo input module (for tuner/CD/MP3)
 - One (1) D971E four (4) channel line output module
 - Four (4) D921E 2 -channel input modules (mic/MP3 outlets)
 - c. One (1) ROLLS model no. RS81B rack mounted stereo AM/FM tuner.
 - d. One (1) TASCAM Model No. CD-200BT, rack mounted CD player with bluetooth.
 - e. One (1) WILLIAMS SOUND model No. FM T55 personal listening system base station transmitter complete with WILLIAMS SOUND model No. RPK 005 rack mounting kit and ANT 025 antenna.
 - f. The Contractor shall furnish and install in the charging stations, twelve (12) WILLIAMS SOUND model no. PPA R37, seventeen (17) channel personal listening system receivers each complete with WILLIAMS SOUND model no. EAR 013 single earbud, rechargeable batteries, and belt clip.
 - g. This Contractor shall furnish to the Owner's representative, four (4) WILLIAMS SOUND model NKL 001 neckloops.
 - h. The Contractor shall furnish and install, one (1) WILLIAMS SOUND model no. CHG 3512 twelve (12) unit charging case for the personal listening system receivers complete with one (1) ATLAS SOUND model no. VTD1-16 rack sliding shelf.
 - i. One (1) ATLAS SOUND model no. AP-S15L AC power supply module suitable for rack mounting.
 - j. One (1) ATLAS SOUND model no. AP-2410-15S power strip.
 - k. One (1) SHURE "SLX" series UHF wireless microphone system complete with model no. SLX4 wireless receiver complete with rack mounting hardware and detachable antennas.
 - l. One (1) Atlas Sound Make Storage Drawer-recessed- 4RU with 14 inch extension (SD4-14).
- B. Speaker Systems:

1. This Contractor shall furnish and install two (2), horn type loudspeakers 200 watts, 70.0 volts with a frequency response of 85 Hz - 16 kHz and shall include a driver. A horn type loudspeaker that will meet this Specification is COMMUNITY model no. R.5-66TZ or equal as manufactured by JBL.
- C. Microphones:
1. This Contractor shall furnish to the Owner's representative, one (1) SHURE model no. SM58S dynamic cardioid microphone complete with an ON/OFF switch. The microphone shall be furnished by this Contractor complete with a twenty five (25) foot connector cord with CANNON XLR connectors.
 2. This Contractor shall furnish to the Owner's representative, one (1) SHURE model no. SLX2/SM58 dynamic cardioid wireless handheld microphone, and one (1) SHURE model no. WL183 lapel microphone with SLX1 transmitter. Each shall be complete with an ON/OFF switch and batteries
- D. Microphone Stand:
1. This Contractor shall furnish to the Owner's representative, one (1) ATLAS SOUND model no. DS-2 microphone desk stand.
- E. Microphone Outlets:
1. This Contractor shall furnish and install where shown on the Drawings, flush or surface wall mounted microphone outlets consisting of one (1) CANNON "XLR", complete with 3 pin XLR (female), series audio jack of the type required so as to be compatible with the type of microphone cable connector furnished, one (1) 3.5mmstereo audio jack (MP3), and a stainless steel coverplate. A microphone/MP3 outlet, which meets this Specification shall be as manufactured by CONQUEST AUDIO or approved equal.
- F. Track and Field System Cable:
1. This Contractor shall furnish and install speaker cable consisting of one (1) twisted pair, No. 12 AWG unshielded with a temperature range for dry locations of minus twenty-five (25) degrees C to one hundred five (105) degrees C and seventy-five (75) degrees C for wet locations. A cable that meets this Specification is WEST PENN Cat. No. AQ227 or equal as manufactured by BELDEN, CONSOLIDATED WIRE, GENERAL CABLE, PAIGE, WINDY CITY WIRE or TAPPAN.

2. This Contractor shall furnish and install field wiring for microphone outlets as shown on the Drawings. Wiring shall be two (2) conductor, no. 20 AWG stranded and shielded cable. A cable that meets this Specification is WEST PENN Cat. No. 25292B or equal as manufactured by BELDEN, CONSOLIDATED WIRE, GENERAL CABLE, PAIGE, WINDY CITY WIRE or TAPPAN.
3. This Contractor shall furnish and install field wiring for MP3 outlets as shown on the Drawings. Wiring shall be two (2) conductor, no. 20 AWG stranded and shielded cable. A cable that meets this Specification is WEST PENN Cat. No. 25292B or equal as manufactured by BELDEN, CONSOLIDATED WIRE, GENERAL CABLE, PAIGE, WINDY CITY WIRE or TAPPAN.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. All wiring for the athletic fields sound reinforcement systems shall be installed by this Contractor in ½-inch conduit. All junction box covers shall be stenciled for distinct identification. All conduit, device mounting boxes, junction boxes, and enclosures shall be securely fastened with appropriate fittings to ensure a positive ground throughout each entire system.
- B. All wiring connections shall be made by this Contractor as directed by the equipment manufacturer. Splices for circuits shall be made only in junction boxes and shall be crimp connected.
- C. All wiring shall be checked and tested by this Contractor to ensure each system is free from grounds, opens, and shorts.
- D. All work shall be under the supervision of a factory accredited sound engineer. It shall be the responsibility of the sound engineer and this Contractor to check and inspect this installation to the Architect/Engineer's approval.

3.02 RACK MOUNTED EQUIPMENT

- A. Each athletic field sound reinforcement systems' rack mounted equipment shall be installed by this Contractor with the proper adapters, rack mounting kits, brackets, and closure panels for unused spaces. All interconnecting wiring shall be labeled, bundled, secured, and terminated by this Contractor in a neat and professional manner.
- B. All rack mounted equipment AC power cords shall be plugged into the rack mounted power strip by this Contractor.

3.03 SPEAKER MOUNTING

- A. This Contractor shall assemble and install all speakers as detailed on the Drawings.

3.04 MICROPHONES

- A. This Contractor shall unpack and assemble microphones complete with all cables, connectors, and stands and connect ready for operation.

3.05 MICROPHONE OUTLETS

- A. This Contractor shall assemble microphone outlets and install, connect, and label as shown on the Drawings.

3.06 CABLES

- A. All wiring and cable for the athletic fields sound reinforcement systems shall be pulled continuously through conduits without splices or abrasions and shall be terminated at their appropriate devices as shown on the Drawings, specified herein, and as directed by the system supplier. All cables shall be labeled. Input and output cabling shall not be installed in the same raceway.
- B. Unless otherwise indicated on the Drawings, all athletic fields sound reinforcement systems cable shall be installed in heavywall schedule 40 PVC conduit, minimum size 3/4, as hereinbefore specified.

END OF SECTION

SECTION 16745

DANCE AND ROOMS SOUND REINFORCEMENT SYSTEMS

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work covered under this Section shall include furnishing and installing a locally controlled complete and satisfactorily operating sound system in each of the dance and gymnastics rooms for the pick up, amplification, reproduction, and distribution of voice and/or music to associated loudspeakers within each room.
- B. Existing dance and gymnastics rooms sound reinforcement systems equipment may be reused as noted on the Drawings. This Contractor shall exercise extreme care not to damage the equipment while following the instructions on the Drawings. The equipment to be reused shall be protected from construction before, during, and after work has been completed.

1.03 QUALITY ASSURANCE

- A. All equipment described shall be the product of a manufacturer of established reputation and experience who has produced similar apparatus for a period of at least ten (10) years and shall be able to refer to similar installations now rendering satisfactory service.
- B. The dance and gymnastics rooms sound reinforcement systems shall be furnished by a factory authorized distributor certified to design, program, and service the system. The distributor must show evidence of successfully furnishing systems specified for at least five (5) years.
- C. All equipment for the dance and gymnastics rooms sound reinforcement systems shall be listed Underwriters Laboratories, Inc. (UL), bear the UL label and shall be installed in accordance with all requirements of the National Electrical Code (NEC), state and local codes, and these Specifications.
- D. Each of the dance and gymnastics rooms sound reinforcement systems installation shall be performed under the direct supervision of a factory trained service specialist.
- E. Shop drawing submittals are required per SECTION 16010 and shall include the following for review. Submittals not containing all of the information listed below

will be rejected.

1. A complete list of equipment for each dance and gymnastics rooms sound reinforcement system shall be furnished indicating the specific quantities to be furnished by this Contractor. The catalog or model number for each module of each system shall be listed next to the quantities. This information shall be furnished in the front of the submittal.
2. A specific description of each of the dance and gymnastics rooms sound reinforcement systems shall be furnished describing each module and how it shall function within each system.
3. A specific drawing shall be furnished of each dance and gymnastics rooms sound reinforcement system equipment rack. Each module shall be shown in its proper location with its terminal designation shown.
4. A data sheet shall be furnished for each module and device. The information shall be highlighted that applies to the particular module or device to be furnished.
5. A detailed diagram showing how to connect each device shall be furnished indicating exact final connection information.
6. A detailed floor plan for each dance and gymnastics room shall be furnished. The plans shall show the locations of all equipment, loudspeakers, and devices and their required interconnections. The interconnections shown shall indicate the number, size, and type of wires as described in this Specification. Loudspeakers shall be zoned as shown on the Drawings. The layout of all dance and gymnastics rooms sound reinforcement system equipment, devices, and conduit routings shall closely follow that shown on the Drawings.

1.04 DOCUMENTATION

- A. This Contractor shall furnish to the Owner, one (1) set of "As Built" drawings for each dance and gymnastics room sound reinforcement system depicting the complete field wiring system and component interconnections in each system equipment rack.
- B. This Contractor shall furnish to the Owner, four (4) sets of factory operation and maintenance manuals. These manuals shall include factory service manuals with complete parts lists, wiring and component schematics including circuit diagrams, and all other information necessary for the proper operation, service, and maintenance of each dance and gymnastics room sound reinforcement system.

1.05 TRAINING

- A. This Contractor shall furnish eight (8) hours (total for all rooms) of technical service training to the Owner's technical staff using the factory service manuals previously specified.
- B. This Contractor shall furnish eight (8) hours (total for all rooms) of operating and programming training to the Owner's operating staff which shall be delivered in two (2) separate four (4) hours sessions to be scheduled at the Owner's convenience over the warranty period.
- C. All training specified herein shall be performed by a factory certified technician.

1.06 DESCRIPTION OF OPERATION

- A. This Contractor shall furnish and install dance and gymnastics rooms sound reinforcement systems with all conduit, cable, outlets, devices, and equipment as shown on the Drawings and as herein specified to furnish complete systems.
- B. Each dance and gymnastics rooms sound reinforcement system shall provide for reception of AM or FM radio broadcasts, the amplification of music and voice, and the reproduction of recorded music or other program materials, and their distribution to all associated speakers within each dance and gymnastics Room.
- C. Each dance and gymnastics room sound reinforcement system shall accept both the input and output of an external tape recorder.
- D. Each dance and gymnastics sound reinforcement system shall accept a priority override signal to mute the system when the main building Sound and Intercommunications System activates the priority override function.

1.07 SYSTEM TEST AND ACCEPTANCE

- A. Prior to the final site visitation this Contractor shall conduct an operating test of each complete dance and gymnastics rooms sound reinforcement system. Each system shall test free from grounds, shorts, and other faults. All connections shall be thoroughly checked for mechanical and electrical connections. All equipment shall be demonstrated to operate in accordance with the requirements set forth in these Specifications and as shown on the Drawings.
- B. This Contractor shall perform all tests in the presence of the Architect/Engineer. This Contractor shall furnish all personnel and test instruments for use in the test.
- C. When the work on each dance and gymnastics room sound reinforcement system has been completed and is ready for final review, this Contractor shall

demonstrate that the requirements of the Contract as it applies to this work have been carried out and that the system has been adjusted and operated in accordance therewith.

1.08 WARRANTY

- A. This Contractor shall deliver the work described herein in a first-class operating condition in every respect. This Contractor shall also warrant that the material, equipment, and workmanship furnished shall be entirely free from defects. Any materials, equipment, or workmanship in which defects may develop before or during the warranty period shall be repaired or replaced at the Contractor's own expense. Refer to SECTION 01740 for the start of the warranty period. The Contractor shall further warrant that all material, equipment, and workmanship used in the installation, but not specifically mentioned in the Drawings and Specifications, is the best of their respective kinds and that the construction and installation was performed in accordance with the best accepted standard practices in all details.

PART 2 - PRODUCTS

2.01 EQUIPMENT RACKS

- A. This Contractor shall furnish and install in each dance and gymnastics room where shown on the Drawings, a wall mounted equipment rack for the room's sound reinforcement system as specified herein. Each rack shall be ATLAS SOUND Cat. No. WMA24-23 sectional, wall mounting type with a textured black finish providing a minimum of sixty-one (61) inches of vertical rack mounting space. Each rack shall be complete with a continuous piano hinged front door with a cylinder lock and handle. The following equipment shall be furnished and installed by this Contractor in each rack:
1. One (1) TOA Model No. D-901 twelve (12) input, eight (8) output, digital mixer. Mixer shall come complete with:
 - a. One (1) D936R four (4) stereo input module (tuner, CD, MP3 outlets).
 - b. One (1) D971E four (4) channel line output module (personal listening system, amplifier).
 - c. Four (4) D921E 2-channel input modules (microphone/MP3 outlets).

2. One (1) CROWN Model No. CDi 2/300 dual channel amplifier with three hundred (300) watts per channel at eight (8) ohms. Amplifier shall be suitable for rack mounting.
3. One (1) ROLLS Model No. RS81B Quartz PLL Synthesized. rack mounted stereo AM/FM tuner.
4. One (1) TASCAM Model No. CD-200BT, rack mounted CD player with MP3 dock.
5. One (1) ATLAS SOUND Model No. AP-2410-15S AC power strip suitable for rack mounting.

2.02 WALL MOUNTED STEREO SPEAKERS

- A. This Contractor shall furnish and install where shown on the Drawings, two (2) JBL Model No "Control 29AV-1" enclosed wall mounted stereo speakers. The stereo speakers shall be 300 watt, 8 ohms. Each stereo speaker shall be complete with wall mounting bracket.

2.03 MICROPHONES

- A. This Contractor shall furnish to the Owner's representative, two (2) SHURE Model No. SM58S dynamic cardioid microphones for each dance and gymnastics room sound reinforcement system (total of **CONSULTANT SHALL EDIT**). Each microphone shall be furnished by this Contractor complete with a twenty five (25) foot connector cord with CANNON XLR connectors

2.04 MICROPHONE STANDS

- A. This Contractor shall furnish to the Owner's representative, two (2) ATLAS SOUND Model No. MS-20 microphone floor stands for each dance and gymnastics room sound reinforcement system (total of **CONSULTANT SHALL EDIT**).

2.05 MICROPHONE OUTLETS

- A. This Contractor shall furnish and install where shown on the Drawings, flush or surface wall mounted microphone outlets consisting of one (1) CANNON "XLR", complete with 3 pin XLR (female), series audio jack of the type required so as to be compatible with the type of microphone cable connector furnished, one (1) 3.5mm stereo audio jack (MP3), and a stainless steel coverplate. A microphone/MP3 outlet, which meets this Specification shall be as manufactured by CONQUEST AUDIO or approved equal.

2.06 AM/FM ANTENNA

- A. This Contractor shall furnish and install a PIXEL TECHNOLOGIES Model No. AFHD-4 AM/FM and HD antenna complete with: L mounting bracket; weather boot; surge protector; 20dB attenuator; 10dB attenuator; AM/FM separator; U-bolts with washers and nuts; pole mount saddle brackets; F-female to twin-lead adaptor and push-on-F-female to DIN adaptor. This Contractor shall furnish and install a weatherhead, rigid steel conduit mast, and two (2) RG-6 plenum rated cables from the antennas to the tuner located in the sound and intercommunication system equipment rack. This Contractor shall ground the antenna in accordance with the following specification.

2.07 DANCE AND GYMNASTICS ROOMS SOUND SYSTEM CABLE

- A. This Contractor shall furnish and install one (1) two (2) conductor, No. 12 AWG stranded plenum rated cable with a temperature range for dry locations of minus ten (10) degrees C to sixty (60) degrees C for each stereo speaker. A cable that meets this Specification is WEST PENN Cat. No. 25227B or equal as manufactured by BELDEN, CONSOLIDATED WIRE, GENERAL CABLE, WINDY CITY WIRE, PAIGE, or TAPPAN.
- B. This Contractor shall furnish and install field wiring for microphone outlets as shown on the Drawings. Wiring shall be two (2) conductor, No. 20 AWG stranded and shielded cable. A cable that meets this Specification is WEST PENN Cat. No. 25292B or equal as manufactured by BELDEN, CONSOLIDATED WIRE, GENERAL CABLE, WINDY CITY WIRE, PAIGE, or TAPPAN.
- C. This Contractor shall furnish and install field wiring for MP3 outlets as shown on the Drawings. Wiring shall be two (2) conductor, No. 20 AWG stranded and shielded cable. A cable that meets this Specification is WEST PENN Cat. No. 25292B or equal as manufactured by BELDEN, CONSOLIDATED WIRE, GENERAL CABLE, WINDY CITY WIRE, PAIGE, or TAPPAN.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. All vertical, low voltage field wiring shall be installed by this Contractor in 1/2-inch conduit and/or surface metal raceway as shown on the Drawings. Conduit fill shall not exceed the conduit space capacity.
- B. All horizontal, low voltage field wiring to be installed in areas without a ceiling or in areas without an accessible ceiling shall be installed by this Contractor in 1/2-

inch conduit.

- C. All horizontal low voltage field wiring to be installed in areas with accessible ceilings shall be installed by this Contractor bundled together and run exposed above the ceilings. Bundles shall be supported by "J" hooks mounted not more than four (4) feet on center. "J" hooks shall be dedicated to the wiring specified in this specification section.
- D. All horizontal, low voltage field wiring shall be run at right angles to the building structure.
- E. All horizontal low voltage field wiring shall be installed below the roof/floor structural supports (joist, beams, girders, etc.). Wiring installed between the structural supports mentioned above and the roof or floor deck will not be acceptable.
- F. All horizontal low voltage field wiring penetrations through new and/or existing walls shall be sleeved. Minimum sleeve size shall be 3/4 inch. All sleeves shall be bushed both sides.
- G. All low voltage field wiring for the dance and gymnastics rooms sound reinforcement systems shall be furnished and installed by this Contractor. All junction box covers shall be stenciled for distinct identification.
- H. All wiring connections shall be made by this Contractor as directed by the equipment manufacturer. Splices for circuits shall be made only in junction boxes and shall be crimp connected.
- I. All dance and gymnastics rooms sound reinforcement systems wiring shall be checked and tested by this Contractor to ensure the system is free from grounds, opens, and shorts.
- J. All work shall be under the supervision of a factory accredited sound engineer. It shall be the responsibility of the sound engineer and this Contractor to check and inspect this installation to the Owner's and Architect/Engineer's approval.

3.02 RACK MOUNTED EQUIPMENT

- A. Each dance and gymnastics room sound reinforcement system's rack mounted equipment shall be installed by this Contractor with the proper adapters, rack mounting kits, brackets, and closure panels for unused spaces. All interconnecting wiring shall be labeled, bundled, secured, and terminated by this Contractor in a neat and professional manner.
- B. All rack mounted equipment AC power cords shall be plugged into the mounted power strip by this Contractor.

3.03 SPEAKERS

- A. Wall mounted stereo speakers shall be securely fastened to the building structure by this Contractor with threaded rod or bolts as appropriate for the application.

3.04 MICROPHONES

- A. This Contractor shall unpack microphone and assemble with cables and stands and connect ready for operation. Microphones shown for permanent installation shall be mounted by this Contractor in accordance with the Drawings in a manner appropriate for the location.

3.05 MICROPHONES OUTLETS

- A. This Contractor shall assemble microphone outlets and install, connect, and label as shown on Drawings.

3.06 ANTENNA INSTALLATION

- A. The antenna shall be bracket mounted by this Contractor above the roof at a location approved by the Owner. The antenna cables shall be run by this Contractor to the equipment rack and connected ready for operation.
- B. The antenna shall be grounded by this Contractor to the secondary building ground system with one (1) No. 10 AWG in 1/2 inch conduit.

END OF SECTION

SECTION 16750

TELECOMMUNICATIONS SYSTEM

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work covered under this Section shall include furnishing and installing a complete telecommunications system as shown on the Drawings and as herein specified for the distribution of telephone and/or networked data signals.
- B. The telephone service into the building shall be provided by COX COMMUNICATIONS. It shall be the responsibility of this Contractor to coordinate with the telephone utility company to ensure timely delivery of permanent telephone service.
- C. The electronic telephone switch and all telephone instruments shall be furnished and installed by the Owner.
- D. The existing telecommunications service and system shall remain in operation during the construction period until the new service and system has been installed and tested, ready for operation. After the new service and system has been placed in operation, the existing service and system shall be removed as shown on the Drawings.

1.03 QUALITY ASSURANCE

- A. All equipment and materials for this system shall be listed by Underwriter's Laboratories, Inc. (UL), bear the UL label, and shall be installed in accordance with all requirements of the National Electrical Code (NEC), all state and local codes, and these Specifications.
- B. Equipment shall be constructed in accordance with National Electrical Manufacturer's Association (NEMA) standards.
- C. All work relating to the telephone service entrance shall comply with the requirements of the telephone utility company.
- D. Shop drawing submittals are required per Section 16010 and shall include the following for review. Submittals not containing all of the information listed below

will be rejected.

1. Manufacturer's shop drawings for the networking main and sub-distribution frames including the equipment mounting rack and all associated accessories, components, and equipment to be installed therein.
 2. Manufacturer's data sheets for the telecommunications outlets and the telecommunications cable.
 3. A detailed set of floor plans for the complete building shall be furnished showing the locations of all equipment and devices and their required interconnections. The interconnections shown shall indicate the number, size, and type of wires as described in this Specification. The layout of all telecommunications system equipment, devices, and conduit routings shall closely follow that shown on the Drawings.
- E. This Contractor shall be prepared, upon request by the Owner, to provide proof of the ability to provide the above listed drawings in a mechanical form.
- F. This Contractor shall be an AMP, HUBBELL, P&S ACTIVATE, LEVITON, PANDUIT, ORTRONICS, and BICSI certified installer of copper and fiber optic cabling systems and have a fully equipped and trained service organization that will have a response time of thirty six (36) hours or less to the job site. This Contractor shall have a minimum of one (1) certified installer on site during construction of this project. This Contractor must show evidence of successfully furnishing systems specified for at least five (5) years. This Contractor shall be prepared to show proof of such certification upon request by the Owner. This Contractor shall also be prepared to offer to the Owner upon request, a fifteen (15) year manufacturer's warranty covering defects in material and workmanship in the passive components of the telecommunications wiring system (outlets, patch panels, etc.).
- G. Prior to final inspection, this Contractor shall furnish two (2) complete as-built sets of drawings prepared by mechanical drafting methods.

1.04 SYSTEM TEST AND ACCEPTANCE

- A. Prior to the final site visitation, and acceptance of each construction phased spaces, this Contractor shall conduct an operating test of all telecommunications system cabling. The cabling shall test free from grounds, shorts, and other faults. All connections shall be checked for mechanical and electrical connection. Phased space test results shall be furnished to the Owner in bound binders prior to acceptance.
- B. This Contractor shall perform the following tests certifying each telecommunications outlet Cat 6 cable. Test results shall be tabulated listing each outlet (by number), the cable, and the test results.

<u>TEST</u>	<u>FREQUENCY</u>	<u>REQUIREMENTS</u>
1. Impedance	1 MHz	100 ohms \pm 15%
	10 MHz	
	25 MHz	
	100 MHz	
	250 MHz	
2. Attenuation	1 MHz	2 dB max. per 100m
	10 MHz	6 dB max. per 100m
	25 MHz	9.5 dB max. per 100m
	100 MHz	19.8 dB max. per 100m
	250 MHz	32.8 dB max. per 100m
3. Crosstalk (Next)	1 MHz	min. 62 dB
	10 MHz	min. 47 dB
	25 MHz	min. 41 dB
	100 MHz	min. 44.3 dB
4. PS-Next (min)	100 MHz	42.3 dB
5. EL-FEXT (min)	100 MHz	27.8 dB
6. PS-ELFEXT (min)	100 MHz	24.8 dB
7. Return Loss (min)	100 MHz	20.1 dB
8. Delay Skew (max)	100 MHz	45 nS
9. Mutual Capacitance: less than 46 pf per meter		
10. Cable Length: less than 100 meters		
C.	Each fiber optic cable shall have a FOIRL specification, bi-directional testing at both 850 nm and 1300 nm with 3 db light signal loss per km and 2000/500 MHz-km bandwidth at 850/1300nm.	
D.	This Contractor shall perform all tests in the presence of the Architect/Engineer. This Contractor shall furnish all personnel and test instruments required for use in the test.	
E.	This Contractor shall be prepared, upon request by the Owner, to show current ownership of all instruments and equipment necessary to perform all of the tests listed above.	

1.05 TRAINING

- A. This Contractor shall furnish to the Owner's designated representatives project specific cable plant layout orientation (4 hours).

1.06 WARRANTY

- A. This Contractor shall deliver the work described herein in a first class operating condition in every respect. This Contractor shall also warrant that the material and workmanship shall be entirely free from defects. Any materials, equipment, or workmanship in which defects may develop before or during the warranty period shall be repaired or replaced at the Contractor's own expense. Refer to SECTION 01740 for the start of the warranty period. The Contractor shall further warrant that all material, equipment, and workmanship used in the installation, but not specifically mentioned in the Drawings and Specifications, is the best of their respective kinds and that the construction and installation was performed in accordance with the best accepted standard practices in all details.

PART 2 - PRODUCTS

2.01 CONDUITS

- A. This Contractor shall furnish and install underground telephone service entrance conduit(s) as shown on the Drawings and as hereinbefore specified.
- B. This Contractor shall furnish and install telephone distribution conduits, minimum 1/2 inch, only as shown on the Drawings and as hereinbefore specified.
- C. This Contractor shall furnish and install all fiber optic cable in conduit for the entire run. Minimum conduit size for fiber optic cable shall be 1/2 inch.

2.02 TELECOMMUNICATIONS EQUIPMENT LOCATIONS

- A. This Contractor shall furnish and install where shown on the Drawings, wall mounted main and sub-distribution telecommunications equipment locations consisting of fire resistant 3/4 inch thick plywood backboards and networking hubs as hereinafter described and as detailed on the Drawings.

2.03 TELECOMMUNICATIONS OUTLETS

- A. This Contractor shall furnish and install where shown on the Drawings, wall mounted telecommunications outlets each consisting of: one (1) ORTRONICS part no. OR-403STJ14 single-gang faceplate; one (1) ORTRONICS part no. OR-TJ600-00 (black) single category 6, RJ-45 (568A/B) TrackJack insert; two (2) ORTRONICS part no. OR-63700005 single RJ-25C TrackJack inserts; and

one (1) ORTRONICS part no. OR-42100002 blank TrackJack insert mounted in a single-gang outlet box. The equivalent outlets as manufactured by AMP, HUBBELL, P&S ACTIVATE, LEVITON or PANDUIT will also be considered provided they are fully equal to the type specified herein.

- B. This Contractor shall furnish and install where shown on the Drawings, wall mounted data only outlets each consisting of: one (1) ORTRONICS part no. part no. OR-403STJ13 single-gang faceplate; two (2) ORTRONICS part no. OR-TJ600-00 (black) single category 6, RJ-45 (568A/B) TrackJack inserts mounted in a single-gang outlet box. The equivalent outlets as manufactured by AMP, HUBBELL, P&S ACTIVATE, LEVITON or PANDUIT will also be considered provided they are fully equal to the type specified herein.
- C. This Contractor shall furnish and install where shown on the Drawings, flush floor telecommunications outlets consisting of a telecommunications jack assembly mounted in a flush floor outlet box as described on the Drawings and elsewhere in these Specifications.
- D. This Contractor shall furnish, and install were detailed on the drawings, telecommunications and data only outlets in the surface raceway manufactured by ORTRONICS or EQUAL AS MANUFACTURED BY PASS AND SEYMOUR ACTIVATE SERIES, or PANDUIT.
- E. This Contractor shall furnish and install where shown on the Drawings, wall mounted telephone outlets consisting of a four (4) inch square flush outlet box with plaster cover and a single gang stainless steel coverplate with a 3/8 inch diameter bushed opening.

2.04 NETWORKING MAIN DISTRIBUTION FRAME (MDF)

- A. This Contractor shall furnish and install where shown on the Drawings, a floor mounted networking main distribution frame as detailed on the Drawings. Components shall be as shown or equivalent as manufactured by ADC, AMP, HUBBELL, P&S ACTIVATES, LEVITON or PANDUIT.
 - 1. Furnish and install ORTRONICS part no. OR-19-72-T2SD heavy duty EIA compliant nineteen (19) inch wide, seven (7) foot tall equipment racks (of the quantity detailed on the Drawings) each consisting of fifteen (15) inch self-supporting bases; two (2) three (3) inch wide side channels; top angle; and assembly hardware (or Hubbell No. HPW84RR19ML). All components shall have a brushed aluminum finish. Side channels shall be drilled and tapped on both sides.
 - 2. Furnish and install ORTRONICS part no. OR-DVMS704 vertical cable management modules (CM-2) with cover including all required mounting hardware in the locations and of the quantity detailed on the Drawings (or VCM-3 by Superior).

3. Furnish and install Middle Atlantic no. U2MS cable management shelves (CM-3) including all required mounting hardware in the locations and of the quantity detailed on the Drawings.
4. Furnish and install ORTRONICS part no. OR-DVMS706 vertical cable management modules (CM-4) with cover including all required mounting hardware in the locations and of the quantity detailed on the Drawings (or VCM-6 by Superior).
5. Furnish and install light interface unit(s). The unit(s) shall be rack mounted type with a strain bracket for securing cables. A light interface unit, which meets this specification, shall be CORNING part no. CCH-01U with two (2) part no. CCH-CP12-E4 chamber connector panels and part no. 95-050-99-X type "LC" multimode bulkhead interconnects of the quantity indicated. Other acceptable manufacturers are RADIANT COMMUNICATIONS, FONS, ORTRONICS and PASS and SEYMOUR ACTIVATE.
6. Furnish and install ORTRONICS part no. OR-PHD66U96 ninety-six (96) port, RJ-45 (568A/B) type patch panel(s) suitable for rack mounting in the quantity required to crossconnect all of the telecommunications and/or data only outlet RJ-45 ports.
7. Furnish and install ORTRONICS part no. OR-PHD66AU48 forty-eight (48) port RJ-45 (568A/B) type patch panel(s) suitable for rack mounting in the quantity required to cross connect all of the wireless access point wiring. Label patch panel as "MAIN DISTRIBUTION WIRELESS ACCESS POINT PATCH PANEL (MD-WAPP)."
8. Furnish and install ORTRONICS part no. OR-PHD66U48 forty-eight (48) port RJ-45 (568A) type patch panel(s) suitable for rack mounting in the quantity required to cross connect all of the CCTV wiring. Label patch panel as "CCTV CAMERAS".
9. Furnish and install ORTRONICS part no. PHD66U24 twenty-four port RJ-45 (568A) type patch panel(s) suitable for rack mounting in the quantity required to cross connect all of the two way communication wiring. Label patch panel as "TWO WAY COMMUNICATION".
10. Furnish and install ORTRONICS part. no. OR-110ABC5E100 one hundred (100) pair rack mounted 110 punchdown blocks including all necessary mounting hardware in the locations detailed on the Drawings, in the quantity required to terminate all of the 100 pair distribution cables and 4 pair station cables from the RJ-25C ports.
11. Furnish and install Siemon part. no. S66M1-25 twenty-five (25) pair "66"

clip connecting blocks mounted by this Contractor on a blank rack mounting panel including all necessary mounting hardware in the locations and of the quantity detailed on the Drawings (or approved equal).

12. The networking main distribution frame shall include one (1) rack mounted 110-volt power strip/surge suppressor in each floor-mounted rack. Each power strip/surge suppressor shall consist of eight (8) front mounted outlets, and eight (8) foot long AC power cord. The rack mounted 110-volt power strip/surge suppressor shall be AMERICAN POWER CONVERSION (APC) part no. AP7900.
13. The networking main distribution frame shall have a nameplate of 1/16-inch thick laminated plastic with 3/16-inch high white engraved letters on a black background. The nameplate shall identify the frame as indicated on the Drawings and shall be mounted on the front top of the frame.

2.05 NETWORKING SUB-DISTRIBUTION FRAME(S) (SDF)

- A. This Contractor shall furnish and install where shown on the Drawings, a floor mounted networking sub-distribution frame as detailed on the Drawings. Components shall be as shown or equivalent as manufactured by AMP, HUBBELL, P&S ACTIVATE, LEVITON or PANDUIT.
 1. Furnish and install ORTRONICS part no. OR-19-72-T2SD heavy duty EIA compliant nineteen (19) inch wide, seven (7) foot tall equipment rack consisting of fifteen (15) inch self-supporting base; two (2) three (3) inch wide side channels; top angle; and assembly hardware. All components shall have a brushed aluminum finish. Side channels shall be drilled and tapped on both sides (or Hubbell No. HPW84RR19ML).
 2. Furnish and install ORTRONICS part no. OR-DVMS704 vertical cable management modules (CM-2) with cover including all required mounting hardware in the locations and of the quantity detailed on the Drawings (or VCM-3 by Superior).
 3. Furnish and install ORTRONICS part no. OR-DVMS706 vertical cable management modules (CM-4) with cover including all required mounting hardware in the locations and of the quantity detailed on the Drawings (or VCM-6 by Superior).
 4. Furnish and install light interface unit(s). The unit(s) shall be rack mounted type with a strain bracket for securing cables. A light interface unit, which meets this specification, shall be CORNING part no. CCH-01U with Two (2) part no. CCH-CP12-E4 chamber connector panel and part no. 95-050-99-X type "LC" multimode bulkhead interconnects of the quantity indicated. Other acceptable manufacturers are RADIANT

COMMUNICATIONS, FONS, ORTRONICS and PASS and SEYMOUR ACTIVATE.

5. Furnish and install ORTRONICS part no. OR-PHD66U96 ninety-six (96) port, RJ-45 (568A) type patch panel(s) suitable for rack mounting in the quantity required to cross connect all of the telecommunications and/or data only outlet RJ-45 ports.
6. Furnish and install ORTRONICS part no. OR-PHD66AU48 forty-eight (48) port RJ-45 (568A) type patch panel(s) suitable for rack mounting in the quantity required to cross connect all of the wireless access point wiring. Label patch panel as "SUB DISTRIBUTION WIRELESS ACCESS POINT PATCH PANEL (SD-WAPP)."
7. Furnish and install ORTRONICS part no. OR-PHD66U48 forty-eight (48) port RJ-45 (568A) type patch panel(s) suitable for rack mounting in the quantity required to cross connect all of the CCTV wiring. Label patch panel as "CCTV CAMERAS".
8. Furnish and install ORTRONICS part. no. OR-PHD66U24 twenty-four (24) port RJ-45 (568A) type patch panel(s) suitable for rack mounting in the quantity required to cross connect all of the two way communication wiring. Label patch panel as "TWO WAY COMMUNICATIONS".
9. Furnish and install ORTRONICS part no. OR-110ABC5E100 one hundred (100) pair rack mounted 110 punchdown blocks including all necessary mounting hardware in the locations detailed on the Drawings, in the quantity required to terminate all of the 100 pair distribution cables and 4 pair station cables from the RJ-25C ports.
10. The networking sub-distribution frame shall include one (1) rack mounted 110-volt power strip/surge suppressor in each floor-mounted rack. Each power strip/surge suppressor shall consist of eight (8) front mounted outlets, and eight (8) foot long AC power cord. The rack mounted 110-volt power strip/surge suppressor shall be AMERICAN POWER CONVERSION (APC) part no. AP7900.
11. The networking sub-distribution frame shall have a nameplate of 1/16 inch thick laminated plastic with 3/16 inch high white engraved letters on a black background. The nameplate shall identify the frame as indicated on the Drawings and shall be mounted on the front top of the frame.

2.06 NETWORKING SPORTS FIELD SUB-DISTRIBUTION FRAME(S) (SDF) - **HIGH SCHOOLS ONLY**

- A. This Contractor shall furnish and install where shown on the Drawings, wall mounted networking sports field sub-distribution frame(s) arranged as detailed

on the Drawings. Components shall be as shown or equivalent as manufactured by AMP, HUBBELL, P&S ACTIVATES, LEVITON or PANDUIT.

1. Furnish and install ORTRONICS part no. OR-19-35-T25DHYDTB heavy duty EIA compliant nineteen (19) inch wide, 35 inch tall equipment rack. Side channels shall be drilled and tapped on both sides.
2. Furnish and install light interface unit(s). The unit(s) shall be rack mounted type with a strain bracket for securing cables. A light interface unit, which meets this specification, shall be CORNING part no. CCH-01U with two (2) part no. CCH-CP12-E4 chamber connector panel and part no. 95-050-99-X type "LC" multimode bulkhead interconnects of the quantity indicated. Other acceptable manufacturers are RADIANT COMMUNICATIONS, FONS, ORTRONICS and PASS and SEYMOUR ACTIVATE
3. Furnish and install ORTRONICS part no. OR-PHD66U24 twenty four (24) port, RJ-45 (568A/B) type patch panel suitable for rack mounting in the quantity required to cross connect all of the telecommunications and/or data only outlet RJ-45 ports.
4. Furnish and install ORTRONICS part no. OR-PHD6AU24 twenty four (24) port, RJ-45 (568A/B) type patch panel suitable for rack mounting to cross connect all future wireless access point wiring. Label patch panel as "SUB DISTRIBUTION WIRELESS ACCESS POINT PATCH PANEL (SD-WAPP)."
5. Furnish and install ORTRONICS part no. OR-110ABC5E100 one hundred (100) pair rack mounted 110 punchdown block with legs including all necessary mounting hardware in the quantity required to terminate all of the 25 pair outside plant distribution cables and 4 pair station cables from the RJ-25C ports.
6. The networking sub-distribution frame shall include one (1) rack mounted 110-volt power strip/surge suppressor in each floor-mounted rack. Each power strip/surge suppressor shall consist of eight (8) front mounted outlets, and eight (8) foot long AC power cord. The rack mounted 110-volt power strip/surge suppressor shall be AMERICAN POWER CONVERSION (APC) part no. AP7900.
7. The networking sub-distribution frame shall have a nameplate of 1/16 inch thick laminated plastic with 3/16 inch high white engraved letters on a black background. The nameplate shall identify the frame as indicated on the Drawings and shall be mounted on the front top of the frame.

2.07 CABLE

- A. This Contractor shall furnish and install telecommunications distribution cables as shown on the Drawings and specified herein. The cable shall be UL listed, plenum rated, unshielded, twenty-five (25) twisted pairs, no. 24 AWG, category 3, UTP/100 type with a flame retardant polyvinyl chloride jacket and a temperature range for dry locations of minus ten (10) degrees C to sixty (60) degrees C. A telecommunications distribution cable, which meets this specification, is BERK-TEK Cat. No. 10032111 or equal as manufactured by AMP, AT&T, BELDEN, THE CABLE COMPANY, GENERAL CABLE, GENISIS, HITACHI, MOHAWK, NORTHERN TELECOM, PAIGE, SUPERIOR ESSEX or OPTICAL CABLE CORPORATION.
- B. This Contractor shall furnish and install telecommunications and data only station cables where shown on the Drawings and specified herein. The cable shall be UL listed, plenum rated, unshielded, four (4) twisted pairs, no. 23 AWG, category 6, extended distance, high speed data type with a flame retardant polyvinyl chloride jacket and a temperature range for dry locations of minus ten (10) degrees C to sixty (60) degrees C. A telecommunications cable, which meets this specification, is BERK-TEK Cat. no. 10132983 (Gray) or equal as manufactured by AMP, AT&T, BELDEN, THE CABLE COMPANY, GENERAL CABLE, GENISIS, HITACHI, MOHAWK, NORTHERN TELECOM, PAIGE, SUPERIOR ESSEX or OPTICAL CABLE CORPORATION.
- C. This Contractor shall furnish and install wireless access point station cable where shown on the Drawings and specified herein. The cable shall be UL listed, plenum rated, unshielded, four (4) twisted pairs, no. 23 AWG, category 6A, extended distance, high speed data type with a flame retardant polyvinyl chloride jacket and a temperature range for dry locations of minus ten (10) degrees C to sixty (60) degrees C. A telecommunications cable which meets this specification is SUPERIOR ESSEX Cat No. 6A-246-6B (Yellow) or equal as manufactured by AMP, AT&T, BELDEN, BERK-TEK, THE CABLE COMPANY, GENERAL CABLE, GENISIS, HITACHI, MOHAWK, NORTHERN TELECOM, PAIGE, or OPTICAL CABLE CORPORATION.
- D. This Contractor shall furnish and install outside plant telecommunications distribution cables (flooded) as shown on the Drawings and specified herein. The cable shall be UL listed, shielded, twenty five (25) twisted pairs, no. 24 AWG, category 3, UTP/25 type with a temperature range for wet locations and a UV resistant jacket. An outside plant telecommunications distribution cable, which meets this specification is PAIGE Cat. No. 700190 or equal as manufactured by AMP, AT&T, BELDEN, BERK TEK, THE CABLE COMPANY, GENERAL CABLE, GENISIS, HITACHI, MOHAWK, NORTHERN TELECOM, SUPERIOR ESSEX or OPTICAL CABLE CORPORATION.
- E. This Contractor shall furnish and install outside plant telecommunications and

data only cables (flooded) as shown on the Drawings and specified herein. The cable shall be UL listed, unshielded, four (4) twisted pairs, no. 23 AWG, category 6, extended distance, high speed data type with a temperature range for wet locations and a UV resistant jacket. An outside plant telecommunications and data only cable, which meets this specification is BERK TEK Cat. no. 10139885 or equal as manufactured by AMP, AT&T, BELDEN, THE CABLE COMPANY, GENERAL CABLE, GENISIS, HITACHI, MOHAWK, NORTHERN TELECOM, PAIGE, SUPERIOR ESSEX or OPTICAL CABLE CORPORATION.

- F. This Contractor shall furnish and install indoor, plenum rated, fiber optic distribution cables, from Main Distribution Frame (MDF) to Sub Distribution Frame(s) (SDF), in conduit as shown on the Drawings and as specified herein. The cables shall be UL listed, twenty four (24) strand, tight buffer, 50/125 laser optimized type with a thermoplastic jacket and a temperature range for dry locations of minus forty (40) degrees C to eighty-five (85) degrees C. A fiber optic distribution cable which meets this specification, is BERK-TEK part no. PDP024XB3010-X5 or equal as manufactured by AMP, BELDEN, CORNING, GENERAL CABLE, MOHAWK, OPTICAL CABLE CORP., PAIGE, SIECOR, SUMITOMO ELECTRIC, or WEST PENN.
- G. This Contractor shall furnish and install outside plant (flooded), indoor/outdoor, plenum rated, fiber optic distribution cables in conduit as shown on the Drawings and as specified herein. The cables shall be UL listed, twenty four (24) strand, loose tube, 50/125 laser optimized type with dry gel filled tubes and a temperature range for wet or dry locations of minus forty (40) degrees C to seventy-five (75) degrees C. A fiber optic distribution cable, which meets this specification, is BERK-TEK part no. OPRZK12B024XB3010/X5 or equal as manufactured by AMP, BELDEN, CORNING, GENERAL CABLE, MOHAWK, OPTICAL CABLE CORP., PAIGE, SIECOR, SUMITOMO ELECTRIC, or WEST PENN.
- H. This Contractor shall furnish and install two way communication cables where shown on the Drawings and specified herein. The cable shall be UL listed, plenum rated, unshielded, four (4) twisted pairs, no. 23 AWG, category 6, extended distance, high speed data type with a flame retardant polyvinyl chloride jacket and a temperature range for dry locations of minus ten (10) degrees C to sixty (60) degrees C. A telecommunications cable, which meets this specification, is BERK-TEK Cat. No. 10136748 (Green) or equal as manufactured by AMP, BELDEN, CORNING, GENERAL CABLE, MOHAWK, OPTICAL CABLE CORP., PAIGE, SIECOR, SUMITOMO ELECTRIC, SUPERIOR ESSEX or WEST PENN.
- I. Telecommunication's system service entrance cables shall be furnished and installed by the telephone utility company. It shall be the responsibility of this Contractor to coordinate with the telephone utility to ensure timely delivery of permanent telephone service.

2.08 LIGHTNING PROTECTION

- A. This Contractor shall furnish and install for all outside plant telecommunications distribution, telecommunications and data only cables, lightning protection unit(s). The unit(s) shall be located as shown on the drawings and shall be installed no greater than fifty (50) feet from the exterior of the building(s). A lightning protection unit which meets this Specification:
1. For telecommunications distribution cables - CIRCA TELECOM Model No. 1880ECA1-25 or approved equal.
 2. For telecommunications and data only cables --CIRCA TELECOM Model No. 1880ENA1/NSC-12 or approved equal.

2.09 TELEPHONE RINGER BELL/CHIME

- A. This Contractor shall furnish and install in the kitchen area, one (1) wall mounted bell/chime ringer. The bell/chime ringer shall be connected to telephone ringing voltage circuit of the kitchen manager's telephone located in the kitchen office. This Contractor shall run ringer/chime plenum rated, Cat 6 cable to the main/sub communications closet feeding the kitchen and connect to the patch panel in the MDF/SDF. Label patch panel "Bell/Chime Ringer". A bell/chime that meets this specification is: Viking Model No. LPR-1 or equal. Coordinate exact mounting location with Owner.

2.10 TWO WAY COMMUNICATION SYSTEM

- A. This Contractor shall furnish and install where shown on the drawings, wall mounted IP Video Help Station in elevator lobby/lobbies. Two way communication that meets this specification is TALKAPHONE Model No. VOIP-200H3; Flush Mount Configuration or VOIP-201H3; Surface Mount Configuration. Coordinate exact mounting location with Owner.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. All fiber optic cable shall be installed in conduit as hereinbefore specified for the entire run. Minimum conduit size for the fiber optic cable shall be $\frac{3}{4}$ " inch.
- B. All vertical wiring for the telecommunications system shall be installed by this Contractor in conduit and/or surface metal raceway as shown on the Drawings.
- C. All horizontal wiring for the telecommunications system to be installed in areas without a ceiling or in areas without an accessible ceiling shall be installed by this

Contractor in 1/2-inch conduit. Conduit is not required in areas designated on the Drawings as "Electric/Communications" rooms or closets.

- D. All horizontal wiring for the telecommunications system to be installed in areas with accessible ceilings shall be installed by this Contractor bundled together and run exposed above the ceiling. Bundles shall be supported by "J" hooks mounted not more than four (4) feet on center. "J" hooks to be dedicated to the wiring specified in this Specification section. Provide eight to ten feet service loop within one foot of point of entry for any cabling supported by "J" hooks.
- E. All horizontal wiring for the telecommunications system shall be run at right angles to the building structure.
- F. All horizontal wiring for the telecommunications system shall be installed below the roof/floor structural supports (joists, beams, girders, etc.). Wiring installed between the structural supports mentioned above and the roof or floor deck will not be acceptable.
- G. All horizontal wiring penetrations for the telecommunications system through new and/or existing walls shall be sleeved. Minimum sleeve size shall be 3/4 inch. All sleeves shall be bushed both sides. Cables pulled through sleeves without bushings, cut bushings, wrapped with tape will not be accepted and shall be replaced by the Contractor.
- H. All wiring for the telecommunication system in millwork or casework only shall be installed in flexible metal conduit complete with an additional 200-pound pull string.
- I. All wiring for the telecommunications system shall be furnished and installed by this Contractor as hereinbefore specified and as showed on the Drawings. All junction box covers shall be stenciled for distinct identification.
- J. All wiring connections shall be made by this Contractor as detailed on the Drawings. Cables shall be run free of splices from the equipment enclosures to the telecommunications outlets.
- K. All wiring shall be checked and tested by this Contractor to ensure the system is free from grounds, opens, and shorts.
- L. All wiring installed outside the footprint of a building shall be outside plant (flooded), indoor/outdoor, type cables.
- M. All fiber optic outside plant (flooded), indoor/outdoor, type cables shall be installed in min. 3/4" conduit below finished grade with a single no. 10 AWG bare copper conductor. Copper conductor shall run the entire length of the conduit.

3.02 TELECOMMUNICATIONS OUTLETS

- A. This Contractor shall assemble telecommunications outlets and install, connect, and label as shown on the Drawings.

3.03 RACK MOUNTED EQUIPMENT

- A. The networking main distribution frame and the networking sub-distribution frame(s) shall be furnished and installed by this Contractor in the equipment rack(s) as detailed on the Drawings using the proper adapters, rack mounting kits, and brackets. All of this required mounting hardware shall be furnished and installed by this Contractor. All internal wiring shall be labeled, bundled, secured using the cable management modules, and terminated by this Contractor in a neat and professional manner.
- B. All frame mounted equipment AC power cords shall be plugged into the adjacent duplex receptacle by the Owner.

3.04 WIRELESS ACCESS POINT WIRING

- A. All wiring for the wireless access point system shall be terminated in the main and sub distribution frames on the designated wireless access point patch panel(s) as shown on the Drawings and as herein specified.
- B. All wiring for the future wireless access points located in the classrooms, office areas, etc., shall be terminated to a single Cat. 6A, RJ-45, 568A, OR-TJ6A-44, trackjack insert module (yellow) as detailed on the drawings.

3.05 TWO WAY COMMUNICATION

- A. All wiring for the two way communication help station shall be terminated in the main and sub distribution frames on the designated two way communication patch panel as shown on the drawings and herein specified.
- B. All wiring for the two way communication help station shall be terminated with a RJ-45 (568A) connector (s). This Contractor shall leave twenty five (25) feet of slack in the wiring for two way communication help station installation. Label junction box with the two way communication help station designation.

3.06 OWNER FURNISHED EQUIPMENT

- A. The networking electronic hub equipment and wireless access points shall be furnished and installed by the Owner.

3.07 ON-SITE AS-BUILT DRAWINGS

- A. The Contractor shall provide one (1) set of the telecommunications system supplier's as-built drawings for permanent use on-site. The Contractor shall: laminate each page of these drawings; provide a rigid means for mounting such as 1/4 inch thick x two (2) inch wide x width of the drawings through-bolted wood along the left edge of the drawings; furnish and install hanging hooks on the back of the Communications Room door; and hang the bound set of drawings.

END OF SECTION

SECTION 16760

CABLE TELEVISION/BROADBAND DISTRIBUTION SYSTEM

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work covered under this Section shall include furnishing and installing a complete bi-directional cable television/broadband distribution system to distribute both analog and digital RF carriers up to a frequency of 860 MHz, utilizing 860 MHz passive and 860 MHz active components and hardware, as shown on the Drawings and herein specified for the distribution of cable television and/or broadband data signals.
- B. The cable television/broadband distribution system shall deliver the following minimum performance requirements:
- Sub-split, (return): inbound: 5MHz – 36MHz (took out all periods after bullets in this list)
 - Outbound, (forward): 44 MHz – 860 MHz
 - Drop cable outlet level: + 10dBmv, +/- 5dB
 - Minimal distribution system carrier to noise ratio (CNR): 49 dB
 - Composite Second Order, (no comma) (CSO), distortion: 53 dBc or greater
 - Composite Triple Beat, (CTB), distortion: 53dBc or greater, 49 dBc or greater(HRC & IRC carrier systems)
 - No more than +/- 3.0 dB difference between adjacent channel video carriers
 - Maximum outlet spectral bandwidth tilt: +/- 10dB on any visual carrier on system up to 300MHz with a +/- 1 dB of separation for every additional 100MHz of total system bandwidth
 - RF channel aural carrier level: -15dB below RF channel visual carrier
 - HUM: maximum of 3% of visual signal level
 - RF leakage: per FCC, part 76
- C. Cable television service into the building shall be provided by COX COMMUNICATION. It shall be the responsibility of this Contractor to coordinate with the cable television utility to ensure timely delivery of permanent cable television service.
- D. The cable television head end equipment rack exists and shall be relocated by

- the Owner.
- E. The cable television head-end equipment and cabinet shall be furnished by the Owner and installed by this Contractor as directed by the Owner.
 - F. The existing cable television/broadband distribution system shall remain in operation throughout the construction period until the new system has been installed and tested, ready for operation. After the new system has become operational, the existing system shall be removed as shown on the Drawings.

1.03 QUALITY ASSURANCE

- A. All active devices for this system shall be listed by Underwriters Laboratories, Inc. (UL), bear the UL label, and shall be installed in accordance with all requirements of the National Electrical Code (NEC), all state and local codes, and these Specifications.
- B. Equipment shall be constructed with National Electrical Manufacturer's Association (NEMA) standards.
- C. All work relating to the cable television service entrance shall comply with the requirements of the cable television utility company.
- D. Shop drawing submittals are required per SECTION 16010 and shall include the following for review. Submittals not containing all of the information listed below will be rejected.
 - 1. Manufacturer's shop drawings for the main and sub-distribution equipment location layouts and equipment.
 - 2. Manufacturer's data sheets for all system components including cables.
 - 3. A detailed set of engineered floor plans for the complete bi-directional system for building shall be furnished showing the locations of all equipment and devices and their required interconnections. The shop drawings shall including the cable path from each wall outlet to its respective main or sub-distribution location. The interconnections shown shall indicate the device designation number, size, type of devices and wires as described in this Specification. The layout of all cable television/broadband distribution system equipment and devices shall include the engineered Db levels at each designated wall outlet as described below in this specification section and shall closely follow that shown on the Drawings.
- E. Prior to final inspection, this Contractor shall furnish two (2) complete sets of as-built drawings prepared by mechanical drafting methods. The Drawings shall include: the measured Db level at each outlet on Channel 2 and Channel 9; and the exact locations and descriptions of all outlets, tap equipment, and the like and the location and number of all spare ports.

- F. The entire cable television/broadband distribution system installation with the exception of pulling of cable shall be performed by a factory certified installer having a minimum record of five (5) years of successful installations. The installer must show evidence of successfully furnishing systems specified for at least five (5) years. The installer of the cable television/broadband distribution system shall be named within fourteen (14) days of the bid opening. The contractor shall be prepared, upon the Owner's request, to provide proof of factory certifications.

1.04 SYSTEM TEST

- A. Prior to the final acceptance of each phase of construction and at total completion of project, this Contractor shall conduct an operating test of the complete system. The system must test free from grounds, shorts, and other faults. The system shall provide ten (10) dBmV (+/- 5 dBmV) at each outlet when a signal of 50 DBMV is applied from the headend cable. This Contractor shall inform the Owner of any slope injected into the system during testing. All connections shall be thoroughly checked for mechanical and electrical connections. All equipment shall be demonstrated by this Contractor to operate in accordance with the requirements set forth in these Specifications and shown on the Drawings.
- B. This Contractor shall perform all tests in the presence of the Architect/Engineer. This Contractor shall furnish all personnel and test instruments required for use in the test, including signal generator and amplifier. This contractor is not permitted to use building CATV headend equipment for testing purposes.
- C. The maximum deviation of drop signals between 50 and 860 MHz (slope) shall not exceed fifteen (15) dBmV. This Contractor shall furnish to the Owner, in the final test documents, the exact slope setting used. Upon request of the Owner, this Contractor shall test the bi-directional system at a maximum of five (5) locations, selected by the owner, to show compliance.

1.05 WARRANTY

- A. This Contractor shall deliver the work described herein in a first class operating condition in every respect. This Contractor shall also warrant that the material, equipment, and workmanship shall be entirely free from defects. Any materials, equipment, or workmanship in which defects may develop before or during the warranty period shall be repaired or replaced at the Contractor's own expense. Refer to SECTION 01740 for the start of the warranty period. The Contractor shall further warrant that all material, equipment, and workmanship used in the installation, but not specifically mentioned in the Drawings and Specifications, is the best of their respective kinds and that the construction and installation was performed in accordance with the best accepted standard practices in all details.

PART 2 - PRODUCTS**2.01 MANUFACTURER**

- A. The cable television/broadband distribution system equipment shall be manufactured by BLONDER-TONGUE, PPC., PICO MACOM, INC., TONER CABLE EQUIPMENT, INC.

2.02 EQUIPMENT LOCATIONS

- A. This Contractor shall furnish and install where shown on the Drawings, wall mounted main and sub-distribution equipment locations consisting of fire resistant 3/4 inch thick plywood backboards and the distribution equipment as detailed on the Drawings.

2.03 MODULAR TAP DEVICES

- A. This Contractor shall furnish and install modular tap units in each CATV equipment location as shown on the drawings, in the quantity required to terminate all of the CATV wall outlets. The modular tap units shall consist of the following:
1. Modular tap unit shall have a die cast aluminum housing with six (6) tap cavities for the installation of six (6) plug in tap plates to provide service for up to 48 CATV wall outlets. The housing shall have a cable entry fitting at each end so it can be fed from one end using a terminator plate in the last position or fed from one end with the other end being an output. The modular tap unit shall have a bandwidth of 5 to 1,000 MHz. The modular tap unit shall be TONER CABLE EQUIPMENT, INC., "TOTAL TAP" MODEL No. TXMT-6H with GILBERT ENGINEERING CO., PART No. GF-625-CH KS to F female adaptors.
 2. Plug-in tap plates shall have 8 ports each for insertion into the modular tap unit. The tap values of the 8 port plug-in tap plates shall range from 11.5 dB to 26 dB at 5 to 1,000 MHz and shall be selected by this Contractor to meet the test requirements hereinbefore described. The 8 port plug-in tap plates shall be TONER CABLE EQUIPMENT, INC., Model No. TXMT108 series; terminator plates Model No. TXMT108-T series; blank plates Model No. TXMT-B for insertion into unused cavities of the modular tap unit housing; and Equalizer plates Model No. TXMT-EQ series.

2.04 AMPLIFIERS

- A. This Contractor shall furnish and install bi-directional, self-attenuating amplifiers

as required to complete the system. Amplifiers shall be BLONDER-TONGUE series "5800" and shall have all necessary internal components for a complete bi-directional system. Amplifiers shall only be installed in CATV main and sub-distribution equipment locations.

2.05 CONNECTORS

- A. This Contractor shall furnish and install CATV compression type, color coded cable connectors to complete the system. Connectors shall be specifically designed for plenum rated cable. The connectors shall be PPC Model No. EX6, and EX11 as appropriate for RG-6 and RG-11 coaxial cables.
- B. The connectors shall be compressed by the appropriate compression tool. The compression tool shall be PPC Model No. VT300 for RG-6 and RG-11 cable.

2.06 CABLE TELEVISION/BROADBAND DISTRIBUTION WALL OUTLETS

- A. This Contractor shall furnish and install where shown on the Drawings, wall outlets consisting of "F" type connectors complete with stainless steel outlet coverplates. The cable television/broadband wall outlets shall be TONER CABLE EQUIPMENT, INC., Model No. F-81-NW.

2.07 TERMINATORS

- A. This Contractor shall furnish and install terminators on all unused female "F" connector jacks throughout the system. The terminator shall be PICO MACOM, INC., Model No. F-59T.

2.08 CABLE

- A. This Contractor shall furnish and install all cable television/broadband distribution system zone cables as shown on the Drawings. The cables shall be UL listed, plenum type, coaxial RG-6/U, No. 18 AWG, seventy-five (75) degree C solid bare copper with a maximum resistance of 6.5 ohms per 1,000 feet, foam polyethylene insulation with a tape barrier, and a bifoil (100% coverage) plus an aluminum braid (65% coverage) shield. The television/broadband distribution system zone cable shall be WEST PENN Cat. No. 25841 or equal as manufactured by BELDEN, PAIGE, GENERAL CABLE, or THE CABLE COMPANY.
- B. This Contractor shall furnish and install all cable television/broadband distribution system trunk cables as shown on the Drawings. The cables shall be UL listed, plenum type, coaxial RG-11/U, No. 14 AWG, one hundred twenty-five (125) degree C solid bare copper with a maximum resistance of 6.5 ohms per 1,000 feet, foam polyethylene insulation with a tape barrier, and a bifoil (100% coverage) plus an aluminum braid (65% coverage) shield. The television/broadband distribution system trunk cable shall be WEST PENN Cat. No. 25821 or equal as manufactured by BELDEN, GENERAL CABLE, PAIGE, or

THE CABLE COMPANY.

- C. This Contractor shall furnish and install all outside plant (flooded) cable television/broadband distribution system trunk cables as shown on the Drawings. The cables shall be UL listed, plenum type, coaxial RG-11/U, No. 14 AWG, one hundred twenty-five (125) degree C solid bare copper with a maximum resistance of 11.0 ohms per 1,000 feet, foam polyethylene insulation with a tape barrier, and a bifoil (100% coverage) plus an aluminum braid (61% coverage) shield and flooding. The outside plant (flooded) television/broadband distribution system trunk cable shall be WEST PENN Cat. No. 1110 or equal as manufactured by BELDEN, GENERAL CABLE, PAIGE, or THE CABLE COMPANY.
- D. Cable television system service entrance cables shall be furnished and installed by the cable television utility company. It shall be the responsibility of this Contractor to coordinate with the cable television utility to ensure timely delivery of permanent cable television service.

2.09 MISCELLANEOUS EQUIPMENT

- A. This Contractor shall furnish the following items of equipment for installation by the Owner in the headend equipment rack. There shall be no substitutions for this equipment.
 - 1. One (1) BLONDER TONGUE Model No. AP-60-860A w/ option 17, Digital-to-Analog Processor, QAM in > Analog RF Out, with tuning range of channels T7-T13.
 - 2. One (1) BLONDER TONGUE Model No. HDE-CSV-QAM/IP, High Definition MPEG-2 Encoder Module, QAM out.
 - a. One (1) BLONDER TONGUE Model No. HDE-3MCH, 3 Module Rack Mount Chassis.
 - 3. One (1) C2G Model No. 29131, F-Type RG6 Coaxial Video Cable, 3ft.
 - 4. One (1) ANVIL CASE "Forge II" model number RJ1-AFX2RM-14RR carrying case. 20 inches wide x 4.5 inches high x 19.25 inches deep with handle, removable front and rear, and interior 2ru rack mount rails on the handle.

2.10 LABELING

- A. This Contractor shall label all cable television/broadband distribution wall outlets as shown on the drawings.
- B. This Contractor shall label all cable television/broadband distribution system zone and trunk cables at each main and sub distribution equipment location.

1. Each zone cable shall be clearly labeled with the correct corresponding wall outlet designation. Each zone cable shall be labeled using a labeling machine with minimum ¼" high letters. Each label shall be wrapped around the zone cable and securely fastened.
1. Each trunk cable shall be clearly labeled with the correct corresponding main or sub distribution equipment location. Each trunk cable shall be labeled using a labeling machine with minimum ¼" high letters. Each label shall be wrapped around the trunk cable and securely fastened.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. All cable television/broadband distribution system homerun cables shall be routed from each CATV outlet to the main or sub distribution equipment location indicated through the corridors. Routing homerun cables through adjacent spaces is not acceptable.
- B. All vertical cable television/broadband distribution system cable shall be installed by this Contractor in conduit and/or surface metal raceway as shown on the Drawings.
- C. All horizontal cable television/broadband distribution system cable to be installed in areas without a ceiling or in areas without an accessible ceiling shall be installed by this Contractor in 3/4-inch conduit. Conduit is not required in areas designated on the Drawings as "Electric/Communications" rooms or closets.
- D. All horizontal cable television/broadband distribution system cable to be installed in areas with accessible ceilings shall be installed by this Contractor bundled together and run exposed above the ceilings. Bundles shall be supported by "J" hooks mounted not more than four (4) feet on center. "J" hooks to be dedicated to the wiring specified in this specification section. Provide eight to ten feet service loop within one foot of point of entry for any cabling supported by "J" hooks.
- E. All horizontal cable television/broadband distribution system cable shall be run at right angles to the building structure.
- F. All horizontal cable television/broadband distribution system penetrations through new and/or existing walls shall be sleeved. Minimum sleeve size shall be 3/4 inch. All sleeves shall be bushed both sides. Cables pulled through sleeves without bushings, cut bushings, wrapped with tape will not be accepted and shall be replaced by the Contractor.

- G. All cable television/broadband distribution system cable shall be terminated and labeled by this Contractor as shown on the Drawings. Cables shall not be nicked, strained, or damaged during the pulling operation. Cables shall be run free of splices from the equipment enclosures to the outlets. All junction box covers shall be stenciled for distinct identification.
- H. All cables shall be checked and tested by this Contractor to ensure the system is free from grounds, opens, and shorts.
- I. This Contractor shall notify the Owner when the service entrance conduit system is complete, ready for installation of the service entrance cable.
- J. All work shall be under the direct supervision of a factory accredited engineer. It shall be the responsibility of the Contractor to check and inspect this installation to the Architect/Engineer's approval.
- K. This Contractor shall demonstrate, to the Owner's technical staff, the ability to properly terminate RG-6 and RG-11 connectors prior to commencement of work.
- L. This Contractor shall demonstrate the capabilities of the upstream modulator for up to five (5) locations. The Owner shall select locations. Signal shall be demonstrated to flow back to the headend equipment and then through the entire system for distribution.
- M. All wiring installed outside the footprint of a building shall be outside plant (flooded), indoor/outdoor, type cables.

3.02 WALL MOUNTED EQUIPMENT

- A. Cable television/broadband distribution system equipment shown on the Drawings or otherwise required to be mounted at a main or sub-distribution equipment location shall be furnished and installed by this Contractor with the proper adapters, mounting kits, and brackets.
- B. All equipment enclosure mounted equipment AC power cords shall be plugged into the associated duplex receptacle by this Contractor.
- C. All modular tap devices shall be properly grounded to the main building grounding system with minimum #12 A.W.G. grounding conductor.

3.03 CABLE TELEVISION/BROADBAND DISTRIBUTION OUTLETS

- A. This Contractor shall install, connect, and label all cable television/broadband wall outlets, as shown on the Drawings.

3.04 ON-SITE AS-BUILT DRAWINGS

- A. The Contractor shall provide one (1) set of the cable television/broadband

distribution system supplier's as-built drawings for permanent use on-site. The Contractor shall: laminate each page of these drawings; provide a rigid means for mounting such as 1/4-inch thick x two (2) inch wide x width of the drawings through-bolted wood along the left edge of the drawings; furnish and install hanging hooks on the back of the Communications Room door; and hang the bound set of drawings.

END OF SECTION

SECTION 16770

MULTI-MEDIA PRESENTATION CONTROL SYSTEM

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SCOPE

- A. The work covered under this Section shall include furnishing and installing an HD Base T.2. UTP multi-media presentation control system as shown on the Drawings and herein specified for the distribution of audio/visual signals from cable television and/or broadband data signals.

1.03 QUALITY ASSURANCE

- A. All active devices for this system shall be listed by Underwriters Laboratories, Inc. (UL1863), bear the UL label, and shall be installed in accordance with all requirements of the National Electrical Code (NEC), all state and local codes, and these Specifications.
- B. All active products shall be HDCP 2.2.compliant for all 4K and HDR applications.
- C. Equipment shall be constructed with National Electrical Manufacturer's Association (NEMA) standards.
- D. Shop drawing submittals are required per SECTION 16010 and shall include the following for review. Submittals not containing all of the information listed below will be rejected.
 - 1. Manufacturer's data sheets for all system components including cables.
 - 2. A detailed set of engineered floor plans for the complete multi-media presentation control system for the building shall be furnished showing the locations of all equipment and devices and their required interconnections. The shop drawings shall include the cable path from each wall outlet to its respective ceiling outlet location. The interconnections shown shall indicate the device configuration, number, size, type of devices and wires as described in this Specification and detailed on the Drawings. The device locations and wiring shall closely follow that shown on the Drawings.

1.04 SYSTEM TEST

- A. Prior to the final acceptance of each phase of construction and at total completion of project, this Contractor shall conduct an operating test of the complete system. The system must test free from grounds, shorts, and other faults. All connections shall be thoroughly checked for mechanical and electrical connections.

1.05 WARRANTY

- A. This Contractor shall deliver the work described herein in a first-class operating condition in every respect. This Contractor shall also warrant that the material, equipment, and workmanship shall be entirely free from defects. Any materials, equipment, or workmanship in which defects may develop before or during the warranty period shall be repaired or replaced at the Contractors own expense. Refer to SECTION 01740 for the start of the warranty period. The contractor shall further warrant that all material, equipment, and workmanship used in the installation, but not specifically mentioned in the Drawings and Specifications, is the best of their respective kinds and that the construction and installation was performed in accordance with the best accepted standard practices in all details.

PART 2 - PRODUCTS

2.01 MANUFACTURER

- A. The multi-media presentation control system equipment shall be manufactured by HUBBELL PREMISE WIRING, EXTRON, PEERLESS or approved equals.

2.02 MULTI-MEDIA PRESENTATION CONTROL SYSTEM

- A. MULTI-MEDIA PRESENTATION CONTROL SYSTEM RECEIVER(S)
 - 1. This Contractor shall furnish and install where shown on the Drawings, wall/ceiling mounted multi-media HDBaseT receiver(s) HUBBELL Model No. ISFHDR4BK or part of the HUBBELL ISFHD4BK kit. One receiver for each multi-media presentation control system outlet shown. Each receiver shall be capable of video signals over one solid, unshielded, twisted-pair (UTP) cable, allowing video display devices to be located a maximum of 328 feet away from a digital source. Additionally, it shall support bidirectional RS232, IR, and USB control signals. The HDBase system shall feature LEDs to indicate that power and signal are working properly.
- B. MULTI-MEDIA PRESENTATION CONTROL SYSTEM OUTLET

1. This Contractor shall furnish and install where shown on the Drawings, wall mounted multi-media control system outlet. The system outlet shall come complete with one (1) 3.5mm mini-jack connector; one (1) HDMI connector and one (1) USB 2.0 connector. A multi-media control system outlet that meets this specification is HUBBELL Model No. ISFHDT4BK or part of the HUBBELL ISFHDT4BK kit. Where shown on the Drawing to be flush mounted, the devices shall be installed in a two gang, extra deep (min 3" depth) device box, refer to floor plans and details. Transmitter (source device) and receiver (display device) each will be mounted in a One Gang Standard Decora Style opening with stainless steel face plate. The two-gang box and decora opening is required for power receptacle on both ends (transmitter and receiver).
2. Transmitter/receiver power; front or rear 5V DC input (HUBBELL Model No. AVPS152BK Power Supply) on each device (both ends).
DC power wire length: up to 50 ft. with 16AWG
Power supply features: tamper-resistant receptacle with 5V DC output USB charging, DC power and AC power in a standard single gang electrical opening. Designed to provide DC power to support active AV components by eliminating the need for external power supplies, it also provides a high speed USB charging port for charging personal electronics. A DC power supply switch is provided to turn off DC power for servicing troubleshooting. The tamper-resistant Style Line® decorator AC outlets provide additional power for AV components and displays. USB port is rated for a minimum 10,000 insertions.
Power supply electrical ratings: 15A, 125V AC; input voltage: 125v AC. 60Hz; output voltage: 2A, 5V 125V circuit feed-through 20A, 125V.

Transmitter/receiver cover plate; wall plates and boxes, metallic plates, 2-Gang, 2-GFCI openings, standard size, stainless steel (HUBBELL Model No. SS262).

C. MULTI-MEDIA PRESENTATION CONTROL SYSTEM CABLE

1. This Contractor shall furnish and install all multi-media presentation control system cables as shown on the Drawings. The cable shall be UL listed, plenum rated, unshielded, four (4) twisted pairs, No. 23 AWG, category 6, extended distance, high speed data type with a flame retardant polyvinyl chloride jacket and a temperature range for dry locations of minus ten (10) degrees C to sixty (60) degrees C. A multimedia cable, which meets this Specification, is Superior Essex Model No. 77-240-2B (blue) or equal as manufactured by AMP, AT&T, BELDON, BERK-TEK, THE CABLE COMPANY, GENERAL CABLE, GENISIS, HITACHI, MOHAWK, NORTHERN TELECOM, OPTICAL CABLE CORP., WINDY CITY WIRE or PAIGE.
2. This Contractor shall furnish and install field wiring for multi-media

presentation control sound system cables as shown on the Drawings. Wiring shall be two (2) conductor, No. 16 AWG stranded and shielded cable. A cable that meets this Specification is WEST PENN Cat. No.25294B or equal as manufactured by BELDEN, CONSOLIDATED WIRE, GENERAL CABLE, WINDY CITY WIRE, PAIGE, or TAPPAN.

D. MULTI-MEDIA PRESENTATION CONTROL SYSTEM PATCH CABLES

1. This Contractor shall furnish and install all multi-media presentation control system patch cables as shown on the Drawings. The cables shall be UL listed, plenum type, and shall consist of the following.
 - a. One (1) HDMI patch cable - BTX Technologies Cat. No. BTX-HDMM06 or approved equal. Maximum 6 feet length.
 - b. All multi-media system patch cables shall be complete with factory terminated male connectors. Field terminated connectors shall not be acceptable.

2.03 MULTI – MEDIA CEILING INTERFACE ADAPTOR AND PROJECTOR UNIVERSAL MOUNTING BRACKET

- A. This contractor shall furnish and install at each ceiling mounted projector location shown on the Drawings, one (1) lightweight, adjustable, suspended ceiling plate complete with turn buckles, fasteners, escutcheon ring and 1-1/2" diameter extension column. A multi-media ceiling interface adaptor that meets this specification is PEERLESS Model No. CMJ500R1 or approved equal. Refer to floor plans for ceiling mounted projector locations.
- B. This Contractor shall furnish and install at each ceiling mounted projector location shown on the Drawings, one (1) lightweight, adjustable, universal multi-media projector mounting bracket. A universal multi-media projector mounting bracket that meets this specification is PEERLESS Model No. PRG-UNV or approved equal. Refer to floor plans for ceiling mounted projector locations.
- C. This Contractor shall furnish and install where shown on the Drawings, one (1) ceiling mounted projector vibration isolator and (1) 6" extension pole. A ceiling mounted projector vibration isolator that meets this specification is PEERLESS Model No. ACC845 or approved equal. Refer to floor plans for locations.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. All vertical multi-media presentation control system cables shall be installed by this Contractor in conduit and/or surface metal raceway as shown on the

Drawings.

- B. All horizontal multi-media presentation control system cables to be installed in areas with accessible ceilings shall be installed by this Contractor bundled together and run exposed above the ceilings. Bundles shall be supported by "J" hooks mounted not more than four (4) feet on center. "J" hooks shall be dedicated to the wiring specified in this specification section.
- C. All horizontal multi-media presentation control system cables shall be run at right angles to the building structure.
- D. All multi-media presentation control system cables shall be terminated and labeled by this Contractor as shown on the Drawings. Cables shall not be nicked, strained, or damaged during the pulling operation. Cables shall be run free of splices. All junction box covers shall be stenciled for distinct identification.
- E. All cables shall be checked and tested by this Contractor to ensure the system is free from grounds, opens, and shorts.
- F. The exact length of the extension column shall be field determined by this contractor prior to installation.
- G. This Contractor shall install, Owner furnished, wall/ceiling mounted LCD projector(s). This Contractor shall make all final connections and leave a complete, tested and operational multi-media system.
- H. This Contractor shall select a classroom, approved by the owner, to serve as a mock-up/prototype for all LCD projector wall/ceiling mounted installations. This Contractor shall install a typical ceiling mount and LCD projector (LCD projector furnished by Owner) to determine the focal length/location and extension column length required. Prior to continuing with the installation(s), coordinate with Owner's representative for review and approval of installation.
- I. For all the wall mounted locations, Hubbell ISFHD4BK extender kit shall be installed in 2-gang box; Hubbell Cat. No. HBL 2444D2AIV.

3.02 ON-SITE AS-BUILT DRAWINGS

- A. The Contractor shall provide one (1) set of the multi-media system supplier's as-built drawings for permanent use on-site. The Contractor shall: laminate each page of these drawings; provide a rigid means for mounting such as 1/4-inch thick x two (2) inch wide x width of the drawings through-bolted wood along the left edge of the drawings; furnish and install hanging hooks on the back of the Communications Room door; and hang the bound set of drawings.

END OF SECTION