SECTION 16010

GENERAL REQUIREMENTS FOR ELECTRICAL WORK

PART 1 - GENERAL

1.1 REFERENCES

A. Conditions of the Contract, Specifications, Change Orders, Addenda, Drawings and Division 1 General Requirements, apply to work of this section. Where paragraphs of this section conflict with similar paragraphs of Division 1, requirements of this section shall prevail.

B. As used in this section, "provide" means "furnish and install", "furnish" means "to purchase and deliver to the project site complete with every necessary appurtenance and support and to store in a secure area in accordance with manufacturers instructions", and "install" means "to unload at the delivery point at the site or retrieve from storage, move to point of installation and perform every operation necessary to establish secure mounting and correct operation at the proper location in the project".

1.2 EXAMINATION OF SITE

A. Before submitting a bid, the Electrical Contractor shall visit and carefully examine site to identify existing conditions and difficulties that may affect the work of this Section. No extra payment will be allowed for additional work caused by unfamiliarity with site conditions.

B. Before starting work in a particular area of the project, the Electrical Contractor shall examine the conditions under which work must be performed including preparatory work performed under other Sections of the Contract, or by the Owner and report conditions which might adversely affect the work in writing to the Architect. Do not proceed with work until defects have been corrected and conditions are satisfactory. Commencement of work shall be construed as complete acceptance of existing conditions and preparatory work.

1.3 SCOPE

A. The work to be accomplished under these specifications includes providing all labor, materials, equipment, consumable items, supervision, administrative tasks, tests and documentation required to install complete and fully operational electrical systems as described herein and shown on the Drawings. The Electrical Contractor shall completely coordinate the work of this section with the work of other trades.

B. The Electrical Contractor shall file plans, obtain permits and licenses, pay fees and obtain necessary inspections and approvals from authorities that have jurisdiction, as required to perform work in accordance with all legal requirements. The Electrical Contractor shall pay line extension charges, fees, utility back charges, and excess costs and perform work in accordance with utility company requirements.

C. The Work shall be complete from point of service to each outlet or device with all accessory construction and materials required to make each item of equipment or system complete and ready for operation. The work shall include but not be limited to the following. The Electrical Contractor shall provide:

1. Primary electrical service conduit, grounding materials and necessary hardware for utility company transformer. Arrange for and pay for utility company to provide primary wire and transformer.

2. Service lateral including service entrance conductors and raceways.

3. Meter enclosure, mounting rack, conduit, and associated hardware for utility company revenue metering at the pad mount transformer.

4. Empty conduit from riser pole to the building for telephone. Service cabling shall be provided by service provider under separate owner contract.

5. Empty conduit from riser pole to the building for cable television. Service cabling shall be provided by the service provider under separate owner contract.

6. Complete power and lighting distribution systems including service equipment, distribution panels, panelboards, transformers, overcurrent devices, raceway, cable and wire.

7. Branch circuits and devices for power and convenience receptacles.

8. All motor wiring, safety disconnects, and motor starters unless integral with equipment.

9. Complete interior lighting system including normal and emergency fixtures, exit signs, lamps, controls, trim and accessories.

10. Complete exterior lighting system consisting of building and site lighting fixtures, poles, controls, lamps and accessories.

11. Complete fire alarm and detection system including pull stations, heat detectors, area smoke detectors, duct smoke detectors, indicating appliances, water flow and tamper switch wiring, auxiliary contacts for equipment interlocking, magnetic door holders, access controlled door release, and other devices shown on the Drawings.

12. Complete emergency power system including generator, transfer switches, and associated equipment.

13. Variable frequency drives accept those provided with packaged air handling units furnished by Division 15.

14. Complete horizontal telephone and data systems infrastructure including devices, cable, raceway, racks, patch panels, terminations, etc. as defined in Section 16715

15. Complete vertical data systems infrastructure including devices, cable, raceway, racks, patch panels, terminations, etc. as defined in Section 16715

16. Control wiring not provided by Division 15000.

17. Complete grounding system.

18. All support material and hardware for raceway, cable tray and electrical equipment.

19. Branch circuits to control panels and devices furnished under other sections.

20. Termination of all cable and wire unless otherwise noted.

21. Building wall, floor and roof penetrations for raceway.

22. Complete vertical and horizontal cable television systems infrastructure including devices, cable, raceway, horizontal and vertical cable management, and terminations as defined on the Drawings.

23. The furnishing of access panels for installation in finished surfaces where access to electrical equipment is required by code or for maintenance.

24. A complete UL listed and certified installed building lighting protection system as described in Section 16670.

25. A complete GPS based synchronized wireless central clock system with transmitter, GPS receiver and clocks as indicated on the systems plans.

26. Complete Internet based CCTV camera system with 16 channel digital video recorder, fixed interior and exterior cameras, exterior Pan-Tilt-Zoom cameras and all required software for complete integration with access control system.

D. Install the following items furnished by others:

1. Motors

2. Control Panels

3. Wiring to magnetic door holders, access control doors, and motorized door openers.

1.4 RELATED WORK IN OTHER SECTIONS

A. The following work is not included in this Section and shall be performed under other sections:

1. Excavation and backfill.

2. Concrete work, including concrete housekeeping pads and other pads and blocks for vibrating and rotating equipment.

3. Cutting and patching of masonry, concrete, tile, and other parts of structure, with the exception of drilling for hangers and providing holes and openings in metal decks.

4. Installation of access panels in ceilings and wall construction.

5. Painting, except as specified herein.

6. Temporary water, heat, gas and sanitary facilities for use during construction and testing.

7. Control wiring specifically indicated as part of Division 15.

8. Commissioning: The contractor shall provide support for commissioning of mechanical systems, as defined by section 01810, "Commissioning Requirements."

B. The Electrical Contractor shall identify locations of penetrations, excavations, structural supports, etc. required for the completion of the Work of this Section to the General Contractor in a timely manner.

1.5 CODES, STANDARDS, AND AUTHORITIES

A. All work shall be performed strictly as required by rules, regulations, standards, codes, ordinances, and laws of local, state, and Federal governments, and other authorities that have lawful jurisdiction. Materials and equipment shall be manufactured, installed and tested as specified in latest editions of publications, standards, rulings, and determinations of:

1. Local and state building, plumbing, mechanical, electrical, fire and health department and public safety codes agencies.

2. National Fire Protection Association (NFPA)

3. Occupational Safety and Health Act (OSHA)

4. Factory Mutual Association (FM)

5. National Electrical Code (NEC)

6. National Electrical Safety Code (NESC).

7. The IFC International Building Code.

B. All materials and equipment shall be listed by Underwriters Laboratories (UL), and approved for intended service.

C. When requirements cited in this Paragraph conflict with each other or with Contract Documents, the most stringent requirements shall govern conduct of work. The Engineer may relax this requirement when such relaxation does not violate the ruling of authorities that have jurisdiction. Approval for such relaxation shall be obtained in writing.

1.6 WARRANTY

A. Refer to Division 1 General Requirements for Warranty Requirements.

1.7 CONTRACT DRAWINGS

A. Work to be performed under this section is shown on the electrical drawings listed in Division 1 General Requirements and in the Drawing Index.

B. The listing of electrical drawings does not limit responsibility of determining full extent of work required by contract documents. The Electrical Contractor shall refer to architectural, plumbing, HVAC, structural, and other drawings and other sections that indicate types of construction with which work of this section must be coordinated. The Electrical Contractor shall check with the General Contractor and other subcontractors to determine whether there will be any interference by such trades with the electrical work. If the Electrical Contractor fails to check with the General Contractor and subcontractors and the electrical work is later found to interfere with their work, then he shall make necessary changes, without additional cost to the Owner, to eliminate such interference.

C. Drawings are diagrammatic and indicate general arrangement of systems and work included in contract. Information and components shown on riser diagrams or called for in the specifications but not shown on plans, and vice versa, shall apply and shall be provided as though required expressly by both. It is not intended to specify or to show every offset, fitting, or component; however, contract documents require components and materials whether or not indicated or specified as necessary to make electrical installation complete and operational.

1.8 DISCREPANCIES IN DOCUMENTS

A. It shall be the responsibility of each bidder to examine the drawings and specifications carefully before submitting his bid, with particular attention to errors, omissions, conflicts with provisions of laws and codes imposed by authorities having jurisdiction, conflicts between portions of drawings, or between drawings and specifications, and ambiguous definition of the extent of coverage in the contract. Any such discrepancy discovered shall be brought to the immediate attention of the Architect for correction. Should any of the aforementioned errors, omissions, conflicts or ambiguities exist in either or both the drawings and specifications, the Electrical Contractor shall have the same explained and adjusted in writing before signing the contract or proceeding with work. Failure to notify the Architect in writing of such irregularities will cause the Architect's interpretation of the Contract Documents to be final. No additional compensation will be approved because of discrepancies thus resolved.

B. The drawings and these specifications are intended to comply with all the above mentioned rules and regulations. If discrepancies occur, the Electrical Contractor shall immediately notify the Architect in writing of said discrepancies and apply for an interpretation and, unless and interpretation is offered in writing by the Architect prior to the execution of the contract, the applicable rules and regulations shall be complied with as a part of the contract.

C. In case of difference between building codes, specifications, state laws, industry standards and the contract documents, the most stringent shall govern. Should the Electrical

Contractor perform any work that does not comply with the requirements of the applicable building codes, state laws, and industry standards, he shall bear all costs arising in correcting these deficiencies.

1.9 EQUIPMENT AND MATERIALS

A. All equipment and materials shall be new and of the quality specified. All materials shall be free from defects at the time of installation. Materials or equipment damaged in shipment or otherwise damaged during construction shall not be repaired at the jobsite, but shall be replaced with new materials.

B. All equipment installed on this project shall have local representation, local factory authorized service and a local stock of repair parts.

C. No equipment or material shall be installed in such a manner as to void a manufacturers warranty. The Electrical Contractor shall notify the Architect of any discrepancies between the Contract Documents and manufacturer's recommendations prior to execution of the work.

1.10 RECORD DRAWINGS

A. As work progresses, and for duration of the Contract, the Electrical Contractor shall maintain a complete and separate set of prints of Contract Drawings at job site at all times and record work completed and all changes from original Contract as described in Division 1. Drawings shall clearly and accurately include work installed as a modification or added to the original design.

B. Upon completion of work and prior to final request for payment, the Electrical Contractor shall submit a complete set of reproducible record drawings showing all systems as actually installed. Coordinate with Division 1 requirements for the format and quantity of Project Record Documents to be provided.

1.11 SHOP DRAWINGS

A. Refer to Division 1 for requirements relating to shop drawings and product submittals. After the Contract is awarded, but prior to proceeding with the Work, the Electrical Contractor shall obtain complete shop drawings, product data and samples when requested from manufacturers, suppliers, vendors, and Subcontractors for all materials and equipment specified herein, and submit data and details of such materials and equipment for review by the Architect and Engineer. Prior to submission of the shop drawings, product data and samples to the Architect and Engineer, the Electrical Contractor shall review and certify that the shop drawings, product data and samples are in compliance with the Contract Documents. Further, the Electrical Contractor shall check all materials and equipment after their arrival on the jobsite and verify their compliance with the Contract Documents.

B. Refer to Division 1 for specific submittal requirements and quantity of copies to be submitted.

C. The shop drawing submittal shall include all data necessary for interpretation as well as manufacturer's name and catalog number. Sizes, capacities, colors, etc., specified on the drawings shall be specifically noted or marked on the shop drawings.

D. Submittals shall contain only information specific to systems, equipment and materials required by Contract Documents for this Project. Do not submit catalogs that describe products, models, options or accessories, other than those required, unless irrelevant information is marked out or unless relevant information is highlighted clearly. Marks on submittals, whether by Contractor, Subcontractor, manufacturer, etc., shall not be made in red ink. Red is reserved for review process.

E. If the Electrical Contractor proposes an item of equipment other than that specified or detailed on the drawings which requires any redesign of the wiring or any other part of the mechanical, electrical or architectural layout, the required changes shall be made at the expense of the trade furnishing the changed equipment at no cost to the Owner.

F. Manufacturer's names are listed herein and on the drawings to establish a standard for quality and design. Where one manufacturer's name is mentioned, products of other manufacturers will be acceptable if, in the opinion of the Engineer the substitute material is of quality equal to or better than that of the material specified. Where two or more manufacturer's names are specified, material shall be by one of the named manufacturers only.

1.12 BULLETINS, MANUALS, AND INSTRUCTIONS

A. Refer to Division 1 for specific submittal requirements and quantity of copies to be submitted.

1.13 TEMPORARY LIGHT AND POWER

A. The Electrical Contractor shall furnish, install and remove the temporary electrical power and lighting systems and pay for all labor, materials, and equipment required therefore. All such temporary electrical work shall meet the requirements of the National Electrical Code, the local utility company, and OSHA.

B. The Electrical Contractor shall make all necessary arrangements with the local utility company as to where the temporary electric service can be obtained from.

C. The Electrical Contractor shall secure and pay for all required permits and back charges for work performed by others, and other expenses incidental to the installation of the temporary electric service.

D. The Electrical Contractor shall provide temporary electric light and power while the building is under construction and until the permanent feeders have been installed, tested and accepted by the Owner. Install and maintain a feeder or feeders of sufficient capacity for the requirements of each floor.

E. The temporary electric service shall be based on the following:

1. Rooms or spaces under 250 sq. ft. - one (1) 100 watt lamp.

2. Rooms or spaces over 250 sq. ft. and under 500 sq. ft. - two (2) 100 watt lamps.

3. Rooms or spaces over 500 sq. ft. - one (1) 200 watt lamp per every 1,000 sq. ft. or fraction thereof.

4. Sufficient wiring outlets and lamps shall be installed to insure proper lighting in stairwells, corridors, and passage areas.

5. Temporary power, in addition to the lighting requirements, shall be provided throughout the building for electrically operated tools on a minimum of 0.5 watts per sq. ft. Motors up to and including one hp only shall be provided for.

6. Outlets shall be located at convenient points so that extension cords of not over 50 ft. in length will reach all work requiring light or power.

F. All necessary wiring, transformers, meters, cables, panelboards, switches, and accessories required by the temporary light and power installation shall be provided by the Electrical Contractor.

G. The General Contractor shall pay the costs of all energy consumed by himself and by all of his subcontractors until final completion.

H. The Electrical Contractor shall furnish all lamps, both initial and replacement, used for the temporary lighting system.

I. The General Contractor and all subcontractors, individually, shall furnish all extension cords, portable lights and lamps therefore, sockets, motors, and accessories as required for their work.

J. The General Contractor and all subcontractors shall reimburse the Electrical Contractor for the following:

1. Any temporary wiring of a special nature, other than that specified above, required for their work.

2. Any temporary wiring of construction offices and buildings used by them, other than the office of the General Contractor and the Clerk of the Works.

K. All temporary wiring, service equipment, and accessories thereto shall be removed by the Electrical Contractor when directed by the General Contractor.

L. All lamps installed in permanent lighting fixtures and used as temporary lights during the construction period, shall be removed and replaced with new lamps.

1.14 SPACE, EQUIPMENT ARRANGEMENT AND ACCESS

A. The size of equipment shown on the drawings is based on the dimensions of a particular manufacturer. Where other manufacturers are acceptable, it is the responsibility of the Electrical Contractor to determine if the equipment he proposed will fit the space available. Shop drawings shall be prepared by the Contractor when required by the Architect, Engineer or Owner to indicate a suitable arrangement.

B. Locate all equipment which must be serviced, operated or maintained in fully accessible positions. Minor deviations from the drawings may be made to allow for better accessibility at no additional cost to the Owner, but changes shall not be made without review by the Engineer and Architect.

C. Minimum clearances in front of or around equipment shall conform to the latest applicable code requirements.

1.15 MARKING AND LABELING

A. All panelboards, indoor transformers, cabinets and other specified equipment shall be labeled with engraved laminated plastic plates, minimum 3/4" high with 3/8" engraved letters. Punch tapes with mastic backings are not acceptable.

B. All starters, disconnect switches and other specified equipment shall be marked with engraved laminated plastic plates, minimum 1/2" high with 1/4" engraved letters. Where individual switches or circuit breakers in power or distribution panelboards do not have cardholders, they shall be marked with 1/2" high labels.

C. All empty conduits shall have labels tied to the pull string at each end of each empty conduit, marked as to identification of each end. Junction boxes with circuits provided for future use shall be labeled with appropriate circuit designation.

D. Cardholders for panelboard shall be filled out with typewritten identification of each circuit, except that the word "spare" shall be written in soft pencil to identify all circuit breakers installed that are not used.

1.16 WIRING METHODS

A. Above Grade Wiring.

Wiring shall be installed as follows:

1. All service conductors shall be installed in rigid steel, rigid aluminum or intermediate metal conduit.

2. All conduit installed outdoors, all risers between floors and conduit exposed to physical damage shall be rigid steel, rigid aluminum or intermediate metal conduit.

3. All power distribution wiring and motor branch circuits shall be installed in electrical metallic tubing (EMT). All other branch circuit wiring shall be type MC cable.

4. All fire alarm system wiring shall be approved fire alarm type MC cable.

5. All control wiring including automatic temperature control wiring provided by Division 15000 shall be type MC cable.

B. Underground wiring

1. All wiring over 600 volts, service laterals and service entrance conductors and other conduit indicated on the drawings shall be rigid nonmetallic conduit. Rigid nonmetallic conduit shall be schedule 80 PVC and concrete encased where noted on drawings.

2. Site lighting branch circuits shall be direct buried rigid nonmetallic conduit.

END OF SECTION 16010

SECTION 16030

ELECTRICAL ACCEPTANCE TESTING

PART 1 -GENERAL

1.1 GENERAL

A. Provisions of Section 16010, General Requirements for Electrical Work apply to the work of this Section.

B. This Specification Section covers the field inspection, mechanical completeness, and electrical acceptance tests required for electrical apparatus, wire, cable and other miscellaneous equipment and material installed and wired by Contractor.

C. The Contractor shall prepare written procedures for the performance of all testing. The procedures shall include an itemization of all equipment, devices, cable and material requiring field testing, setting, adjustment or calibration and shall describe the required set points. The procedures shall be submitted to the Engineer for review prior to the commencement of any testing.

D. The Contractor shall maintain records for all tests and inspections, with complete data on all readings taken. Test results shall be recorded on standard test forms. All reports shall be dated and shall include the name of the person performing the test.

PART 2 - PRODUCTS

2.1 GENERAL

A. The equipment to be tested under this Section is generally provided under other Specification Sections.

PART 3 - EXECUTION

3.1 EXECUTION

A. Upon completion of the installation, the Contractor shall perform field tests on all equipment, materials and systems to insure that the entire installation is sound and that all circuits, including power, control, relaying, instrumentation and metering will function properly and as intended.

B. The Contractor shall furnish and maintain all tools, instruments, materials, test equipment, test connections and personnel, including supervision and labor required for testing, setting and adjusting of all electrical equipment.

C. All tests shall be performed with proper regard for the protection of equipment and the Contractor shall be responsible for adequate protection of all personnel during such tests.

D. No equipment shall be installed, operated or tested in such a manner as to void the manufacturer's warranty or guarantee. Should any test values or procedures as indicated in this Specification exceed the values or overrule the procedures recommended by the manufacturer for the equipment

involved, the manufacturer's recommendation, shall take precedence.

E. Prior to energizing or placing in service any electrical equipment, testing and checking shall be completed.

F. The witnessing or waiving of witnessing of any test shall not relieve the Contractor of its guarantees for material, equipment and workmanship.

G. The Contractor shall promptly advise the Engineer in writing concerning the failure of any equipment or material to pass the tests performed, or to properly function as intended, or to meet calibration accuracy required. After the defects have been corrected, the test(s) shall be repeated.

3.2 SWITCHBOARDS

A. Each switchboard line up shall be inspected for shipping and handling damage, mechanical completeness, and made ready for operation including the following:

1. Remove all shipping blocks and debris from all cubicles and clean cubicles as necessary. If appreciable dirt has accumulated, cubicles shall be vacuumed. Compressed air will not be permitted for cleaning.

2. Make visual inspection of the physical conditions of each bus and cable. Verify that proper cable tags and wire numbers have been installed.

3. Check all accessible bolted electrical connections for proper torque values.

4. Check ground bus for connection to plant ground grid at both ends. Check ground bus splices at all shipping breaks.

5. Manually exercise all circuit breakers to assure freedom of operation. Verify operation of shutters.

B. A one minute megger shall be performed on all bus work. Tests shall be performed for each phase to phase and all phases to ground. Circuit breakers shall be racked out. ALL ELECTRONIC RELAYING, INSTRUMENTS AND DEVICES WHICH MAY BE DAMAGED BY INSULATION RESISTANCE TESTING SHALL BE DISCONNECTED OR SUITABLY PROTECTED IN ACCORDANCE WITH THE MANUFACTURERS RECOMMENDATIONS.

Equipment Rating	Megger Voltage	Minimum Resistance
600 Volt	1000 V	100 Megohm

C. Contact resistance and dielectric testing shall be performed on all power circuit breakers as recommended by the manufacturer.

D. Verify proper phase sequence.

3.3 DRY TYPE TRANSFORMERS (GENERAL PURPOSE POWER AND LIGHTING)

A. Check primary and secondary connections for correctness.

B. Check secondary neutral for proper bonding to ground.

C. Perform one minute megger tests of the primary windings to ground with the secondary grounded and secondary windings to ground with the primary grounded.

D. After transformers are energized check secondary voltage and adjust taps as necessary.

3.4 ROTATING EQUIPMENT

A. All motors shall be subjected to a one minute megger test, resistance measured to ground with all phase leads tied together. Minimum insulation resistance values are as follows:

Equipment Rating (volts)	600 or less
Megger Rating (volts)	1000
Min Resistance (megohms)	10

If minimum resistance values are not obtained, the equipment shall be dried out as required, and the above test repeated.

B. The following visual inspection shall be made on all motors:

1. Check bearings for free rotation.

2. Check all ventilation openings for blockages.

3. Check bearing lubrication and correct as necessary.

4. Check that frame is grounded.

5. Check motor leads for proper connection and color coding.

C. The Contractor shall check all motors for proper rotation by bumping motors. Coupled motors shall not be bumped. The Contractor shall correct motor connections as necessary.

3.5 WIRE AND CABLE

A. Control and Instrument Wiring - Control and instrument field wiring shall be visually inspected and tested for continuity to insure that all field wiring is installed in accordance with Contract Drawings and/or equipment manufacturers drawings. Verify all field conductors are properly identified with wire numbers.

B. Low Voltage Power Wiring - All 480V and 208V power wiring shall be subjected to one minute 1000V megger test. Minimum insulation resistance shall be 50 megohms. Megger tests shall be performed between each phase (A-B, B-C, and C-A) and three phases tie together to ground.

3.6 CALIBRATION

A. The Contractor shall check, calibrate and operate all protective relays, timers, meters, instruments and devices furnished under this Division, in accordance with manufacturers recommendations.

Equipment furnished under other Divisions will be calibrated by others.

3.7 FUNCTIONAL TESTING

A. Unless otherwise noted, the Contractor shall energize and operate all alarm and control circuits under simulated or actual system conditions to verify the correctness of wiring. All control circuits shall be checked in their entirety.

B. Control wiring, circuits and devices furnished and installed by Division 15 will be tested by Division 15.

3.9 GROUNDING

A. The Contractor shall measure the resistance to earth of the grounding system using the three terminal fall of potential method.

END OF SECTION 16030

SECTION 16050

INSTALLATION OF ELECTRICAL EQUIPMENT

PART 1 - GENERAL

1.1 GENERAL

A. The provisions of Section 16010 General Requirements for Electrical Work apply to the work of this section.

B. Included in the work of this section is the assembly, installation and wiring of all parts, subassemblies and shipping sections of electrical switchboards, panels, control panels, motors, disconnect switches, variable speed drives and similar equipment.

C. Testing shall be performed in accordance with Section 16030, Electrical Acceptance Testing.

PART 2 - PRODUCTS

2.1 GENERAL

A. Equipment to be installed under this section is generally furnished under other specification sections.

PART 3 - EXECUTION

3.1 GENERAL

A. All equipment shall be completely assembled, installed and connected and shall be fully prepared and made ready for operation. The Electrical Contractor may employ the use of any special tools furnished with the equipment specifically for installation purposes, but shall not use tools furnished with the equipment for maintenance purposes. The Electrical Contractor shall acquaint himself with and follow special instructions of the Manufacturer for the care, handling and installation of the equipment.

B. After installation, all operating parts shall be inspected to insure correct mechanical operation.

C. Internal wiring within any equipment which as been disconnected for shipping purposes shall be reconnected. Any wiring not installed by reason of shipping requirements shall also be installed. The Electrical Contractor may disconnect internal wiring as necessary for installation purposes, and shall reconnect all wiring so disconnected.

D. After installation, all equipment shall be left in clean conditions. In particular, all insulators, bushings, insulating materials, and other parts which are depended upon for their insulating qualities shall be thoroughly cleaned.

E. No overall painting of equipment will be required, but housing surfaces which have been soiled or marred shall be touched up or refinished with primer and color coat.

F. Drilling, tapping, cutting, or welding of equipment required for mounting or for conduit and cable entrances to suit particular conditions of installation shall be considered as part of electrical equipment installation.

G. All equipment shall be provided with engraved nameplates in accordance with Section 16010 and the drawings.

3.2 SUPPORTS

A. The Electrical Contractor shall size and provide all supports necessary for the installation of the electrical equipment.

B. Supports shall be designed for seismic forces in accordance with the 2003 International Building Code (IBC).

C. Channel framing shall be manufactured by Unistrut, Kindorf, B-Line or approved equal.

D. In dry, non-corrosive areas, channel framing shall be galvanized steel or aluminum and all nuts, bolts and hardware shall be carbon steel, cadmium plated or hot dipped galvanized.

E. In outdoor, wet or damp areas channel framing shall be aluminum or 304 stainless steel and nuts, bolts and hardware shall be 304 stainless steel.

F. In corrosive areas, channel framing shall be 316 stainless steel, PVC coated steel or PVC coated aluminum. Nuts, bolts and hardware shall be 316 stainless steel.

G. Supports shall be sized with a minimum safety factor of four or 200 lbs. whichever is greater.

H. Fastening to steel may be welded or bolted. Fastening to solid masonry or concrete shall be machine bolts with expansion shields. Fastening to hollow masonry shall be by toggle bolts.

1. Supports and hangers shall be connected to structural framing members and not to floor or roof sheathing, to metal roof deck, or to non-structural items. Where supports and hangers are connected to steel joists, connections shall be made at panel points (where steel joist individual framing members are interconnected) and not mid-span of individual joist members.

3.3 WIRING

A. All external connections to electrical equipment shall be completed by the Electrical Contractor. Wiring shall be neatly formed, trained and tied with nylon cable ties in all equipment.

B. All power conductors shall be color coded. All control wiring shall be identified with sleeve type wire markers with wire numbers matching those on the manufacturers schematic and connection diagrams.

C. All bus work shall be properly phased "A", "B", "C" left to right, front to back or top to bottom.

3.4 FREE STANDING ELECTRICAL EQUIPMENT

A. Switchgear, switchboards and other freestanding equipment shall be accurately aligned and leveled using shims when necessary to secure alignment between adjacent sections. After alignment has been completed, adjacent shipping sections shall be bolted together. Equipment shall be anchored by tack welding to channel embedded in the equipment pad or with anchor bolts.

B. Bus splices shall be thoroughly cleaned at contact surface then bolted together using torque values recommended by the manufacturer. Where insulated busses are provided, splices shall be insulated in accordance with manufacturers instructions.

C. Contactors, circuit breakers, fuses, motor thermal overloads, instruments, meters and the like which were removed for shipping or provided separately shall be installed by the Contractor.

3.5 PANELBOARDS AND DISTRIBUTION PANELS

A. The Contractor shall mount equipment at locations shown on the drawings, install all interiors, branch circuit protective devices, complete all external connections and install exterior trim.

B. The panelboard circuit directory card shall be completed in accordance with Section 16010.

C. Mount panelboards so that top of trim is at 6'-2" above finished floor. If panelboard is taller, than the highest circuit breaker shall not exceed 6'-6" above finished floor.

D. Mount panelboards plumb and rigid without distortion of box. Mount recessed panels uniformly flush with wall finish. Install panels securely mounted to building structure or to steel channel framing fastened to building structure.

E. For all recessed panelboards, stub four one inch conduits from panelboard to an accessible ceiling space for future access to panelboards.

F. Wiring in panel gutters to be trained neatly into groups, bundled and wrapped with wire ties.

G. Install electrical equipment to resist seismic forces determined in accordance with the 2003 International Building Code (IBC) and based on applicable seismic zone for project geographical location.

3.6 MOTOR SAFETY SWITCHES, LOCAL MOTOR STARTERS AND VARIABLE SPEED DRIVES

A. Equipment shall be installed at locations shown on the drawings. The Contractor shall provide all support material and framing required for proper support.

B. Enclosures installed on concrete surfaces or surfaces where condensation is likely to occur shall clear the mounting surface by at least 1/4 inch.

C. Conduit shall be bottom entry to all enclosures installed outdoors or in wet or damp areas.

3.7 TRANSFORMERS

A. Transformers shall be floor mounted at locations shown unless otherwise noted on the drawings. The Contractor shall provide all mounting accessories, support material and hardware.

B. Transformers shall be installed with adequate cooling space in accordance with the manufacturers recommendations, a minimum of 6" from wall.

C. Transformer neutral shall be grounded in accordance with NEC Article 250.

D. Provide flexible conduit, minimum 2-feet length, for final connections to transformer case.

E. Provide seismic restraints and vibration isolators.

3.8 MOTORS

A. Motors shall be set plumb and aligned with shafts or pulleys.

B. Motor connections shall be made with compression lugs installed on the motor leads and the motor branch circuit conductors, bolted together.

C. Motor connections shall be wrapped with varnished cambric tape, then insulated with Super 33 Scotch Vinyl electric tape or insulated with motor connection kits as manufactured by Raychem or 3M.

END OF SECTION 16050

SECTION 16060

INSTALLATION OF WIRE AND CABLE

PART 1 - GENERAL

1.1 GENERAL

A. The Provisions of Section 16010 General Requirements for Electrical Work apply to the Work of this Section.

1.2 CODES AND STANDARDS:

A. Products shall comply with the following codes and standards and shall be UL-listed and labeled where applicable.

IEEE 48	Standard Test Procedures and Requirements for High Voltage Alternating Current Cable Terminations.
UL 486A	Wire Connectors and Soldering Lugs for use with Copper Conductors.
UL 510	Electrical Insulating Tape

1.3 SUBMITTALS

A. Manufacturers product data sheets

PART 2 - PRODUCTS

2.1 WIRE AND CABLE

A. Wire and cable are specified in other Sections of Division 16000.

2.2 TERMINATIONS AND SPLICES

A. Power Wiring:

1. Terminal lugs, connectors and splices shall be tin plated, high conductivity copper compression type. They shall have chamfered barrels and be permanently identified with conductor sizes.

2. Terminal lugs for conductors No. 3/0 AWG and larger shall be long barrel NEMA two hole type.

3. Splices shall be long barrel butt type with a center stop in the splice barrel.

4. Hydraulic crimping tools with proper die sizes requiring full closure before reopening shall be used.

B. Lighting and branch circuits

1. Splices and taps in lighting and branch circuit wiring shall be 3M Hyflex connectors or equal.

C. Metal clad cable connectors.

1. For non-jacketed metal clad cable in dry locations, cable terminations shall be O.Z. Gedney Type PK for use with galvanized steel armor or Type PK-A for use with aluminum armor. Cable terminations shall be provided with locknuts and bushings.

PART 3 - EXECUTION

3.1 GENERAL

A. Conductors shall be carefully handled during installation to avoid damage of any kind. They shall be unreeled or uncoiled slowly in order to prevent damage to the insulation or sheath due to sudden bending. Repeated bending shall be avoided. Sharp kinks shall be avoided in unreeling, uncoiling and pulling.

B. Suitable precautions shall be made to protect all installed wiring against damage due to construction activities.

3.2 PREPARATION OF RACEWAYS

A. Raceways shall be substantially completed before any wiring is installed in them. Before any wiring is pulled into a conduit, the conduit shall be cleaned and tested for obstructions and cleared of foreign material that may be found.

3.3 PULLING INTO RACEWAYS

A. All possible care shall be taken in pulling of wiring into conduits or other raceways. The cable reels or coils shall be set up in such a way that the conductor may be trained into the raceway as directly as possible with a minimum number of changes of direction or amount of bending. Where several cables are contained in one conduit, all such cables shall be pulled in together.

B. The use of pulling lubricants shall be restricted to non-hardening type, approved by UL and the cable manufacturer.

C. Maximum allowable pull tension as specified by the cable manufacturer shall not be exceeded. Cables shall not be bent or pulled around sheaves less than the minimum radius recommended by the manufacturer.

3.4 SPLICES AND TERMINATIONS

A. All power and control wiring shall be continuous and shall not be spliced unless otherwise indicated on the Drawings.

B. Bolts, nuts and hardware used for terminations shall be silicone bronze. All terminations shall be properly torqued and provided with Belleville washers.

C. Where terminations are made on insulated buses, the terminations shall be insulated using the proper tape(s) and fillers for the voltage level of the cable.

D. Connections in motor terminal boxes shall be made by installing compression type lugs on the motor branch circuit conductors and the motor leads and bolting the lugs together then insulating with motor lead connection kits, Raychem, 3M or equal.

E. Control wiring terminated on terminal blocks provided with saddle clamps does not require terminal lugs. Where screw or stud type terminal blocks are provided, control wiring shall be terminated with insulated, crimp type locking forks, Thomas & Betts STA-KON or approved equal.

3.5 IDENTIFICATION

A. All power wiring conductors shall be color coded as follows:

Phase	208Y/120V	480Y/277V
Phase A	Black	Brown
Phase B	Red	Orange
Phase C	Blue	Yellow
Neutral	White	Gray
Ground	Green	Green

B. Each cable shall be permanently identified with cable numbers as indicated on the Drawings. Tags shall be provided at each end, in pull and splice boxes.

C. Each control conductor shall be identified with a preprinted, sleeve type wire marker. The wire numbers shall match those shown on the Drawings or on manufacturer's schematic and connection diagrams.

END OF SECTION 16060

SECTION 16070

GROUNDING

PART 1 - GENERAL

1.1 GENERAL

A. The provisions of Section 16010, General Requirements for Electrical Work apply to the work of this Section.

B. The Contractor shall provide a complete grounding system including grounding electrodes, electrode conductors, bonding jumpers, equipment grounding conductors, connections and other materials as may be required.

1.2 CODES AND STANDARDS:

A. Products shall comply with the following codes and standards and shall be UL listed and labeled.

NFPA 70	National Electrical Code
UL 467	Grounding and Bonding Equipment

PART 2 - PRODUCTS

2.1 GROUND RODS

A. Ground rods shall be 3/4 inch copper clad steel furnished in 10 foot lengths.

2.2 CONDUCTORS

A. Bare grounding conductors shall be soft drawn stranded copper, sized in accordance with NEC Article 250 unless otherwise noted on the Drawings.

B. Insulated grounding conductors shall be stranded copper with Type TW, THW or THHN/THWN insulation colored green.

2.3 CONNECTIONS

A. Welded connections shall be exothermic reaction type, Cadweld or approved equal. The Contractor shall provide all molds, crucibles, weld metal and necessary materials to complete all connections.

B. Lugs shall be long barrel, two hole compression type for No. 3/0 AWG wire and larger and short barrel, one hole compression type for grounding conductors No. 2/0 AWG and smaller.

PART 3 - EXECUTION

3.1 GROUNDING ELECTRODE SYSTEM

A. Grounding electrodes as shown on the Drawings and as required by code shall be provided. All electrodes shall be bonded together to from the grounding electrode system.

B. Ground rods shall be driven vertically with the upper end of the rod not less than 2-1/2 feet below finished grade. When rock is encountered, the rod may be driven at an angle not to exceed 45 degrees from the vertical.

C. Ground ring conductors shall be bare No. 4/0 AWG copper installed minimum 2-1/2 feet below finished grade.

D. Conductors encased in concrete footings, floor slabs or duct banks shall be bare copper, No. 4/0 AWG unless otherwise noted.

E. Building structural steel or metal framing shall be connected at all points indicated on the Drawings.

3.2 EQUIPMENT GROUNDING CONDUCTORS

A. A separate insulated green copper conductor shall be installed as an equipment grounding conductor in all raceway and with every feeder, branch circuit and control circuit. This shall be in addition to the grounded metallic conduit system.

B. All equipment grounding conductors shall be terminated at both ends.

3.3 GROUNDING ELECTRODE CONDUCTOR

A. The electrical service and all separately derived systems shall be grounded in accordance with NEC Article 250.

B. The grounding electrode conductor shall be copper, sized in accordance with NEC Article 250 or as shown on the Drawings.

3.4 CONNECTIONS

A. All conductors below grade or encased in concrete and all connections to building steel shall be exothermic weld.

B. Connections to equipment ground busses or pads shall be compression type lugs, bolted to the bus or pad.

C. Grounding connections shall be made to clean, dry surfaces. All scale, rust, paint, grease and other contamination shall be removed prior to making connections. Upon completion of welded connections all slag shall be removed.

3.5 RACEWAY, CABLE TRAY AND EQUIPMENT

A. All raceway, cable tray and non-current carrying metal equipment and enclosures shall be electrically continuous and bonded to the grounding system.

B. Where equipment is provided with a ground bus all equipment grounding conductors shall be terminated on the bus. The Contractor shall perform all drilling and tapping required and provide all hardware.

C. Switchgear, switchboard and motor control center ground buses shall be connected to the grounding electrode system at both ends with No. 4/0 AWG copper conductors.

3.6 BONDING TO OTHER SYSTEMS

A. An accessible means for connecting intersystem bonding and grounding conductors shall be provided.

B. Interior metal water piping, sprinkler piping, and natural gas piping shall be bonded in accordance with NEC ART 250-80.

END OF SECTION 16070

SECTION 16110

RACEWAY AND FITTINGS

PART 1 - GENERAL

1.1 GENERAL

A. Provisions of Section 16010 General Requirements for Electrical Work apply to the work of this Section.

1.2 CODES AND STANDARDS

A. Products shall comply with the following codes and standards and shall be UL-listed and labeled:

ANSI C80.1	Standard for Rigid Steel Conduit
NEMA RN-1	Polyvinyl-chloride Externally Coated Galvanized Rigid Steel Conduit and Electrical Metallic Tubing
NEMA TC-2	Electrical Plastic Tubing and Conduit
NEMA TC-3	PVC Fittings for use with Rigid PVC Conduit and Tubing
UL 1	Flexible Metal Conduit
UL 6	Rigid Metal Conduit
UL 360	Liquid Tight Flexible Steel Conduit
UL 514B	Fittings for Conduit and Outlet Boxes
UL651	Schedule 40 and 80 Rigid PVC Conduit
UL797	Electrical Metallic Tubing
UL870	Wireways, Auxiliary Gutters and Associated Fittings
UL1242	Intermediate Metal Conduit

PART 2 - PRODUCTS

2.1 CONDUIT

A. Rigid steel conduit shall be of mild steel piping with a uniform protective coating of hot dipped galvanizing inside and outside, including all threads. The conduit shall be furnished in nominal 10-foot lengths, with both ends threaded and one coupling (galvanized inside and out) applied to each length. The threads opposite the coupling end shall be protected by a plastic cap.

B. Rigid aluminum conduit, couplings and elbows shall be manufactured of a suitable copper-free aluminum alloy. Conduit lengths shall be seamless throughout and shall have hard, smooth and gum-free interior coatings to facilitate the pulling-in of conductors. It shall be furnished in nominal 10-foot lengths, with both ends threaded and a coupling applied to one end of each length. Threads on the coupling end shall be coated with a special lubricant so

that the coupling may be removed without difficulty. Threads on the end opposite the coupling shall be protected from damaged by a plastic cap.

C. Intermediate metal conduit shall be of steel piping with a uniform protective coating of hot dipped galvanizing inside and outside, including all threads. The conduit shall be furnished in nominal 10-foot lengths, both ends threaded and one coupling (galvanized inside and out) applied to each length. The threads opposite the coupling end shall be protected by a plastic cap.

D. Plastic coated rigid steel conduit shall have a 40 mil polyvinyl chloride coating fused to the exterior of the conduit and a urethane coating on the interior and over the threads. The conduit shall be hot dipped galvanized inside and out before the PVC coating is applied. All couplings and fittings shall be similarly coated and shall have overlapping sleeves for the sealing of all joints

E. Plastic coated conduit and fittings shall be "Plasti-Bond Red" as manufactured by Robroy Industries, or approved equal.

F. Rigid nonmetallic conduit shall be heavy wall Schedule 80 polyvinyl chloride 90 deg. C rated furnished in 10-20-, or 30-foot lengths unless noted otherwise on the Drawings. Plastic conduit shall be PV-DUIT as manufactured by Carlon, or approved equal.

G. Electrical metallic tubing shall be of zinc coated steel with an interior coating of lacquer or enamel.

H. Liquid tight flexible conduit shall be constructed with a flexible core of galvanized steel and an oil resistant PVC jacket to form a liquid tight raceway. The overall jacket shall be wrinkle free and suitable for use in temperatures from -40 deg. C to + 100 deg. C.

I. Flexible conduit shall be Anaconda "Sealtite" type UA or approved equal.

J. Flexible metal conduit shall be hot dipped galvanized interlocked strip steel.

2.2 CONDUIT FITTINGS

A. Bushings.

1. Insulated bushings for conduit sizes 1-1/4 inches and larger shall have metal bodies and threads, with molded-on high impact phenolic thermosetting insulation to prevent conductor insulation damage. Bushings shall be Type IBC insulated bushings as manufactured by O.Z./Gedney or an approved equal. Insulated bushings for conduit sizes 1 inch and smaller may be of plastic, O.Z./Gedney Type "A", or an approved equal.

2. Insulated grounding bushings shall be similar to the insulated bushings described above, except they shall have set screws to lock the bushings on the conduits and shall have mechanical type lugs attached. The lugs shall be sized to accept the ground wire sizes as set forth in the latest edition of the National Electrical Code, but in no case smaller than No. 8 AWG wire. Grounding bushings shall be Type BLG as manufactured by O.Z./ Gedney or an approved equal.

3. Male bushings shall be Thomas and Betts Corporation insulated throat chase nipples, or a product of equal construction. Bushings used only to pass conductors through metal partitions, etc. shall be O.Z./Gedney, Type "ABB".

4. Bushings for use with EMT shall be O.Z./Gedney type SBT or approved equals.

B. Conduit bodies for use with aluminum conduit shall be of copper free aluminum alloy. Those for use with steel conduit may be of galvanized, or cadmium plated cast iron, or of copper free aluminum alloy. All conduit fittings shall be provided with neoprene gaskets and sheet metal covers, except that cast covers shall be used for sized 1-1/2 inches and larger. Conduit connections shall be threaded and EMT connections shall be set screw. Cover screws shall be captive. All conduit fittings shall be Crouse Hinds, Appleton, Killark or approved equal.

C. Hubs. Water-tight conduit connections are required on all NEMA 3R, 4, and 4X enclosures and all electrical equipment located outdoors or in damp or wet areas. Where hubs or water-tight threaded connections are not provided as part of the enclosure, water-tight hubs shall be Myers "Scru-tite", or approved equal. All other terminations shall be double locknut and bushing.

D. Fittings for use with liquid-tight flexible conduit shall be zinc plated malleable iron O.Z./Gedney type 4Q or approved equal.

E. Locknuts. Locknuts shall be hot dipped galvanized steel or malleable iron. Standard locknuts shall be used for connections to NEMA 1 enclosures. Sealing locknuts with integral gasket shall be used for connections to NEMA 12 enclosures.

2.3 JUNCTION BOXES

A. Pull and junction boxes shall be of code gauge metal with continuously welded joints or of cast metal if called for on the Drawings. All junction boxes shall have gasketed screw covers. Boxes for use with aluminum conduits shall be of aluminum. Sheet steel boxes shall be galvanized after fabrications. Screws for galvanized steel box covers shall be made of brass. Screws for aluminum box cover shall be stainless steel.

Unless otherwise shown on drawings, all boxes installed indoors shall be rated NEMA 1 and all boxes installed outdoors shall be rated NEMA 3R.

2.4 OUTLET BOXES

A. Outlet boxes for concealed work shall be pressed steel boxes, galvanized and not less than #12 gauge. Each ceiling outlet designated for a lighting fixture shall have a fixture support secured in place with bolts and nuts. Ceiling boxes shall be octagonal with lugs and screws for back plates.

B. Outlet boxes installed outdoors, in concrete or exposed, shall be cast iron alloy or copper free aluminum with gasketed covers.

C. Provide outlet box accessories as required for each installation, including box supports, mounting ears and brackets, wallboard hangers, box extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, which are compatible with outlet boxes being used and to fulfill installation requirements for individual wiring situations.

D. Outlet boxes provided as part of raceway systems for telecommunications or video systems shall not be less than 4" x 4" x 2.5" size.

2.5 WIREWAY

A. Wireway shall be lay-in type, code gauge steel with dark gray enamel finish inside and out.

B. Covers shall be hinged with captive screw fasteners for NEMA 1 & NEMA 3R wireway.

2.6 SUPPORTS

A. The Electrical Contractor shall size and provide all supports necessary for the installation of all raceway.

B. Supports shall be designed for seismic forces in accordance with The BOCA National Building Code.

C. Channel framing shall be manufactured by Unistrut, Kindorf, B-Line or approved equal.

D. In dry, non-corrosive areas, channel framing and angle shall be galvanized steel or aluminum and all nuts, bolts and hardware shall be carbon steel, cadmium plated or hot dipped galvanized. Beam clamps shall be galvanized steel or malleable iron.

E. In outdoor, wet or damp areas channel framing and angle shall be aluminum or 304 stainless steel and nuts, bolts and hardware shall be 304 stainless steel. Beam clamps shall be hot dipped galvanized steel or malleable iron.

F. In corrosive areas, channel framing shall be 316 stainless steel, PVC coated steel or PVC coated aluminum. Nuts, bolts and hardware shall be 316 stainless steel. Beam clamps shall be PVC coated.

G. Supports shall be sized with a minimum safety factor of four or 200 lbs. whichever is greater.

PART 3 - EXECUTION

3.1 GENERAL

A. Wiring methods are specified in Section 16010 General Requirements for Electrical Work.

3.2 INSTALLATION

A. Conduit, EMT, boxes & enclosures shall be installed so that they are mechanically secure, electrically continuous and neat in appearance.

B. Exposed runs shall be installed to conform to the shape of the surface over which they are run. Where they are run over a plane surface, they shall be straight and true. All exposed conduits shall be run parallel and perpendicular to building column lines and walls. Diagonal run will not be permitted. Conduit runs in groups shall be supported by means of common members made of channel framing. Group mounting is not required where the group consists of only two conduits. Fastening to solid masonry or concrete shall be machine bolts with expansion shields. Fastening to hollow masonry shall be with toggle bolts.

C. Unless otherwise approved, spacing between conduit supports shall not exceed ten feet. Conduits shall not be supported from structural members marked Removable on the structural drawings. Conduit hangers and supports shall be fastened to buildings and structural members only and not to any equipment or piping. Separate conduits a minimum 6 inches from flues, steam and hot water lines. Install conduit above mechanical piping wherever possible.

D. All conduit supports other than structural members shall be galvanized. The use of perforated strap or plumber straps will not be permitted.

E. Conduit up to 1-1/2 inches may shall be supported by one hole malleable iron straps with clamp backs. Conduit 2 inches and larger shall be supported by two hole straps.

F. Conduit runs shall not exceed 100 feet between boxes, fittings or devices.

G. All conduit crossing building or structure expansion joints shall be provided with approved expansion fittings.

3.3 BENDS

A. Field bends shall be made with approved bending tools. All field-formed bends shall be of maximum radius permitted by the design and construction conditions.

B. Where a group of exposed conduits change direction, the bends shall have a common center in order to maintain the uniformity and neat appearance of the group, having regard for the minimum bending radius of the largest conduit in the group.

C. Bends shall be uniform radius and free from cracks, crimps or other damage to the conduit or its coating and shall not unduly flatten the conduit section.

3.4 JOINTS AND TERMINATIONS

A. All joints in rigid conduit shall be threaded, using standard couplings. The use of running threads, threadless or split couplings is prohibited. When reaming out of conduit ends to remove burrs and rough edges, care shall be exercised to avoid excessive reaming which results in the weakening of the conduit wall at the end.

B. All joints shall be made up wrench tight and with a minimum of wrench work in order to avoid wrench cuts.

C. All cut threads shall be thoroughly painted with a coating of a rust inhibiting primer.

D. EMT couplings and fittings shall be compression type up to 1-1/4 inch and double set screw type 1-1/2 inch and larger.

E. All conduit terminations in panels, enclosures, outlet boxes and equipment shall be provided with bushings.

3.5 FLEXIBLE CONDUIT

A. Flexible conduit shall be use to terminate all, lighting, motors, unit lanterns, transformers, pilot devices and vibrating equipment.

B. Liquitite flexible conduit and fittings shall be used outdoors and in all damp or wet areas, or where exposed to grease or oil.

C. Connections to lighting fixtures shall be maximum length of 6 feet. All other flexible connections shall be maximum 18 inches.

3.6 PENETRATIONS

A. All penetrations through concrete slabs, masonry walls or roofs shall be provided with sleeves.

B. All sleeves shall be sealed to maintain the integrity of the structure. Fire resistant walls and floors shall be sealed with approved material, and shall maintain the original fire rating. All seals below grade shall be watertight, O.Z./Gedney type WSK or approved equal.

END OF SECTION 16110

SECTION 16200

600 VOLT WIRE

PART 1 - GENERAL

1.1 GENERAL

A. The provisions of Section 16010, General Requirements for Electrical Work apply to the Work of this Section.

1.2 CODES AND STANDARDS

A. Products shall comply with the following codes and standards and shall be UL-listed and labeled:

ASTM B-3	Soft or Annealed Copper Wire
ASTM B-8	Concentric Lay Stranded Copper Conductors
NEMA WC-5	Thermoplastic Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
UL 44	Rubber Insulated Wires and Cables
UL 83	Thermoplastic Insulated Wires and Cables

1.3 SUBMITTALS

A. Manufacturer's product data sheets.

PART 2 - PRODUCTS

2.1 GENERAL

A. All conductors shall be annealed copper in accordance with ASTM B-3.

B. The jacket of all wire shall be printed with the following information:

1. Manufacturer
2. Size
3. Insulation type
4. Maximum voltage
5. UL label

C. All insulation shall be rated 600 volt.

2.2 POWER WIRING

A. Service lateral conductors shall be type XHHW.

B. Feeders and motor branch circuits shall be type THHN/THWN.

C. All power wiring shall be stranded, Class B strand in accordance with ASTM B-8, minimum size #12 AWG.

2.3 BRANCH CIRCUITS

A. All lighting and convenience receptacle branch circuit wiring shall be type THHN/THWN.

B. Branch circuit wiring shall be solid or stranded conductor, minimum size #12 AWG.

2.4 CONTROL WIRING

A. Wiring for control circuits shall be THHN/THWN.

B. Control wiring shall be stranded, Class B strand in accordance with ASTM B-8, minimum size #14 AWG.

2.5 FIXTURE WIRE

A. Where high temperature fixture wire is required it shall be silicone rubber type SF-2.

PART 3 - EXECUTION

3.1 GENERAL

A. All wire shall be installed in accordance with Section 16060, Installation of Wire and Cable.

END OF SECTION 16200

SECTION 16400

SWITCHBOARDS

PART 1 - GENERAL

1.1 GENERAL

A. Provisions of Section 16010 "General Requirements for Electrical Work" apply to the Work of this Section.

B. This Section includes low-voltage service and power distribution switchboards and associated auxiliary equipment rated 600 V and less.

1.2 CODES AND STANDARDS

A. Products shall comply with the following codes and standards and shall be UL-listed and labeled:

NEMA PB-2	Deadfront Distribution Switchboards
UL 489	Molded Case Circuit Breakers
UL 869	Service Equipment
UL 891	Deadfront Switchboards

1.3 SUBMITTALS

A. Manufacturer's product data sheets for each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, digital power monitor and other components to be provided.

B. Dimensioned outline drawings, sections, elevations and details, including required clearances and service access required.

C. Schedule of features, characteristics, ratings, factory settings of individual protective devices, details for conduit entry/exit openings, cable terminal sizes, control wiring diagrams and manufacturers Installation Procedures and Recommendations.

1.4 MANUFACTURERS

A. Subject to compliance with the requirements of this Section:

Eaton Corporation; Cutler-Hammer Products
General Electric Co.; Electrical Distribution & Controls
Siemens Energy & Automation, Inc.
Square D Co.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver in sections or lengths that can be moved through all doors and pathways entering room switchboard is to be installed in.

B. Store indoors in clean dry space with uniform temperature to prevent condensation. Protect from exposure to dirt, fumes, water, corrosive substances, and physical damage. Store and handle equipment in accordance with manufacturers instructions.

C. If stored in areas subjected to weather, cover switchboards to provide protection from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside switchboards; install electric heating (250 W per section) to prevent condensation.

D. Handle switchboards in accordance with NEMA Satndard PB2.1 "General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards." Use factory installed lifting provisions.

1.6 EXTRA MATERIALS

A. Touch-Up Paint: 1 half-pint container.

PART 2 - PRODUCTS

2.1 GENERAL

A. Switchboards shall be metal enclosed and of the sizes, ratings and arrangement shown on the Drawings.

B. Switchboards shall be provided complete with all overcurrent devices, accessories, engraved labels and trim.

C. The short circuit ratings of the assembled switchboards are shown on the Drawings. The short circuit rating of every overcurrent device in the panel shall meet or exceed the switchboard rating. Unless otherwise noted on the Drawings, series rated combinations will not be permitted.

2.2 ENCLOSURE

A. The switchboard shall consist of one or more free standing vertical sections bolted together to form a rigid assembly. Provide barriers between adjacent switchboard sections.

B. Vertical sections shall be constructed of bolted formed steel channels with code gauge steel side and backplates, and bolt on front trim. All exterior and interior steel surfaces shall be finished in ANSI-61 gray over a rust inhibiting primer.

C. The enclosure shall be rated NEMA 1.

D. Vertical sections shall be rear aligned, suitable for installation against a wall. All connections and terminations shall be completely front accessible, with no rear or side access required.

2.3 BUS

A. The Main Phase Buses, Neutral Bus, and Equipment Ground bus shall be a full–capacity, silver plated, copper of 98% conductivity with copper feeder circuit-breaker line connections, rated as shown on the Drawings and sized in accordance with UL 891.

B. A continuous hard drawn, copper ground bus with 98% conductivity shall be provided for the entire length of the switchboard. Ground Bus shall ¼" by 2" minimum size, and provided with pressure connector terminations for feeder and branch-circuit ground connections. For busway feeders extend insulated equipment grounding cable to busway ground connection and support cable at manufacturers recommended intervals in vertical run.

C. Neutral Bus shall rated 100% of Phase Bus ratings and be equipped with pressure connectors for outgoing circuit neutral cables.

D. The Main Phase Buses, Neutral Bus, and Equipment Ground bus shall be capable of future expansion by means of bolt holes or other approved methods.

E. Buses shall have adequate support and bracing for short circuit currents indicated on drawings.

2.4 OVERCURRENT DEVICES

A. The main disconnecting device shall be individually fixed mounted, 100 percent rated, solid state, molded case circuit breaker. The circuit breaker shall be true RMS sensing and have the following adjustable functions.

- o Long-Time Pick-Up
- o Long-Time Delay
- o Short-Time Pick-Up
- o Short-Time Delay
- o Instantaneous Pick-Up
- o Ground Fault Pick-Up
- o Ground Fault Delay

B. Distribution overcurrent devices shall be trip-free thermal magnetic molded case circuit breakers sized as indicated on the Drawings. Each overcurrent device shall be removable from the front without disturbing adjacent units.

C. All connections shall be rated for 75°C copper conductors.

2.5 METERING

A. The switchboard shall be provided with a multifunction microprocessor digital panel meter. The meter shall be capable of displaying voltage between each phase and neutral, current in each phase, Megawatts, Megavars, frequency, power factor, and KVA demand.

B. Monitor to be flush mounted in switchboard instrument compartment door.

2.6 SERVICE ENTRANCE EQUIPMENT

A. Service entrance equipment shall be UL-listed and labeled as "Suitable for Service Entrance".

2.7 LUGS

A. Cable connections to main lugs and main disconnecting device shall be compression type lugs.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Switchboards shall be installed in accordance with Section 16050, Installation of Electrical Equipment & NEMA PB 2.1.

B. The Contractor shall provide a 4" high, chamfered-edge concrete housekeeping pad extending a min. of 6" beyond the footprint of the switchboard in all directions.

3.2 IDENTIFICATION

A. Label switchboards in accordance with Section 16010, General Requirements For Electrical Work.

3.3 FIELD QUALITY INSPECTION

A. Make visual inspection for defects and physical damage, labeling and nameplate compliance with record drawings. Check switchboard mounting, area clearances, alignment and fit of components.

B. Exercise and perform operational tests of all mechanical components and other operable devices in accordance with manufacturer's instruction manual. Check tightness of all bolted electrical connections with calibrated tourque wrench. Refer to manufacturer's instructions for proper tourque values.

3.4 TESTING

A. Test insulation resistance for each switchboard bus, component, connecting supply, feeder and control circuit.

B. Test continuity of feeder.

3.4 CLEANING

F. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION 16400

SECTION 16415

MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 GENERAL

A. The provisions of Section 16010, General Requirements for Electrical Work apply to the Work of this Section.

B. The work of this section includes locally installed, enclosed combination magnetic motor starters and manual motor starters.

1.2 CODES AND STANDARDS

A. Products shall comply with the following codes and standards and shall be UL listed and labeled.

NEMA ICS-2	Industrial Control Devices, Controllers and Assemblies.
UL 508	Industrial Control Equipment.

1.3 SUBMITTALS

A. Manufacturers Product Data Sheets

B. Dimensioned Outline Drawings.

C. Control wiring diagrams.

1.4 MANUFACTURERS

Subject to compliance with the specification requirements.

Allen-Bradley
Cutler-Hammer
Furnas Electric
General Electric
Square D

PART 2 - PRODUCTS

2.1 MAGNETIC MOTOR STARTERS

A. Unless otherwise noted, magnetic motor starters shall be NEMA rated full voltage type. The disconnecting means shall be circuit breaker type, non-fused or fused switch as shown on the Drawings. Minimum starter size shall be NEMA 1.

B. All components including the disconnecting means shall be installed in a single enclosure rated NEMA 1 for indoor locations and NEMA 3R for wet, damp and outdoor locations.

C. The disconnecting means shall be provided with an external operating handle which is interlocked to prevent opening the door when the handle is in the ON position and prevent closing the disconnect when the door is opened. The interlock shall be de-featable. The handle shall be pad-lockable in the OFF position.

D. Circuit breakers shall be adjustable magnetic trip, motor circuit protector type.

E. The short circuit rating of the assembly shall have a rating equal to the branch circuit breaker rating feeding the assembly.

F. Each motor starter shall be provided with a control power transformer to provide 120 VAC control power. The transformer shall be provided with two primary fuses and one secondary fuse. The transformer shall be extra capacity with a minimum rating of 100 VA.

G. Overload relays shall be three pole, trip free, manually reset Class 20, solid state with an external reset mechanism.

H. Contactor coils shall be provided with surge suppressors.

I. Sufficient auxiliary contacts shall be provided for all interlocks. A minimum of one normally opened and one normally closed spare contacts shall be provided.

J. Door mounted pilot devices shall be heavy duty oil tight. Pilot lights shall be transformer type. A HAND-OFF-AUTO maintained contact selector switch, red RUN and green READY pilot lights shall be provided on each enclosure.

K. All control wiring shall be brought to terminal blocks for connection of field cabling. Minimum wire size shall be #14 AWG.

L. Connections for motor leads shall be suitable for copper conductors applied at their 75 degree C rating.

2.2 MANUAL MOTOR STARTERS

A. Single phase fractional HP manual motor starters shall be toggle operated, enclosed, one or two pole switches as required by the installation.

B. Unless otherwise noted, the enclosure shall be NEMA 1 for indoor locations and NEMA 3R for outdoor, wet and damp locations. A handle guard shall be provided to allow the toggle operator to be padlocked in the OFF position.

C. Starters shall be provided with trip free melting alloy overloads.

PART 3 - EXECUTION

3.1 Equipment shall be installed in accordance with Section 16050, Installation of Electrical Equipment.

3.2 The Contractor shall verify motor nameplate amperes and motor service factors and shall set all solid state relays for magnetic motor starters and provide all overload heater elements for manual motor starters. Overload heater elements shall be sized in accordance with motor nameplate amperes.

END OF SECTION 16415

SECTION 16420

VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 GENERAL

A. The provisions of Section 16010, General Requirements for Electrical Work, apply to the work of this section.

B. The equipment shall be completely assembled, wired and tested at the manufacturer's factory or in a factory authorized distributor's facility.

C. The manufacturer shall have a local service representative to provide start-up and warranty service.

D. The manufacturer shall review speed, load and torque data provided for the driven equipment and verify that the drive(s) will provide sufficient starting torque and will function properly over the entire intended speed range.

E. Acceptable manufacturers are:

ABB
Allen-Bradley
Eaton
Magnetek/Yaskawa
Toshiba/Houston
Danfoss

1.2 CODES AND STANDARDS

A. Products shall comply with the following codes and standards and shall be UL listed and labeled.

IEEE Std 519	Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.

1.3 SUBMITTALS

A. Outline drawings showing overall dimensions, weight, mounting details, spacing requirements, and cooling requirements.

B. Assembly drawing identifying all components and their location in the panel.

C. Schematic diagram showing control wiring.

D. Terminal block drawing showing connection points for all customer wiring.

E. Catalog cuts and descriptive information for the drive, drive accessories and options.

PART 2 - PRODUCTS

2.1 GENERAL

A. Variable frequency drives shall be pulse width modulated (PWM) with diode bridge rectifiers, transistorized inverters and microprocessor based digital control.

B. Each drive shall have a rating in horsepower (HP) equal to or greater than the motor name plate horsepower and each drive shall have a continuous output current rating equal to or greater than the motor full load amperes (FLA).

C. Each drive shall be provided with a DC bus choke to reduce harmonics back to the powerline and to improve power factor.

D. All components shall be assembled in a single NEMA 1, metallic, self ventilated enclosure.

E. Drives shall be designed for continuous duty in a 40 °C ambient temperature.

F. Drives may be variable or constant torque in accordance with the load requirements.

G. Power supply shall be 480 or 208 volts as required by the application, (+/-10%), 3 phase, 60 Hz, (+/-2 Hz) on a solidly grounded system.

H. Drives shall be provided with a minimum 3% impedance AC line reactor.

I. Drives shall have the capability of communicating with the facility BAS system as provided by Division 15. Coordinate required system communications protocol with mechanical contractor.

2.2 CONTROLLER SPECIFICATIONS

A. Output Frequency: 0 to 60 Hz.

B. Frequency Accuracy: + 0.5%

C. Overload Rating: 115% for one minute

D. Efficiency: 95% minimum

E. Displacement Power Factor: 0.95 nominal

2.3 CONTROL

A. The drive shall be capable of local and remote control.

1. A door mounted HAND/OFF/AUTO (H/O/A) selector switch to select between manual (HAND) and remote (AUTO) run control shall be provided. The RUN control circuit shall be obtained from a control power transformer installed in the drive cabinet. Transformer shall have additional 100 VA capacity for customer use. A remote RUN contact to start and stop the drive in the AUTO mode will be provided by others. No external sources of control power shall be required.

2. Door mounted manual speed adjust control shall be provided. This may be incorporated as a function in the keypad or a separate door potentiometer may be provided. The manual speed adjust control shall function when the H/O/A switch is in the HAND position.

3. Remote speed adjustment shall be 4-20 mA DC. and shall control the drive when the H/0/A switch is in the AUTO position.

4. A door mounted maintained contact EMERGENCY STOP push button and emergency stop relay shall be provided. The relay shall initiate an external drive fault condition and be wired directly to and de-energize the output contactor.

5. Each drive shall be furnished with a door mounted operators keypad and alphanumeric display. The keypad shall be capable of programming, setting and adjusting all drive parameters. The display shall indicate drive status, speed, and fault conditions.

6. The drive shall be provided with current transformers and a door mounted percent load meter.

7. One set of Form C dry contacts rated 120 VAC shall be provided for customer use for each of the following functions:

   - Drive RUN
   - Drive FAULT

8. A 4-20 mA output shall be provided for the following functions:

   - Output LOAD
   - Output FREQUENCY

9. Provide red door mounted transformer type pilot lights for the following functions:

   - Power ON
   - Drive RUN
   - Drive BYPASS

2.4 OPERATIONAL FUNCTIONS

A. The drive shall include the following user adjustable functions.

1. Maximum Frequency

2. Minimum Frequency
3. Three (3) Frequency Skips with adjustable band width
4. Acceleration Time
5. Deceleration Time
6. Torque Boost
7. Volts/Hertz
8. Preset Speeds

2.5 PROTECTIVE FEATURES

A. The drive shall include the following protective features:

1. External Signal Trip
2. Phase sequence
3. Phase loss
4. Undervoltage
5. Overvoltage
6. Overcurrent
7. Overtemperature

B. Current limiting input line fuses shall be provided and sized by the manufacturer for proper drive protection.

C. The drive shall include adjustable electronic overload protection to provide motor running overload protection in accordance with NEC Article 430 Part C.

2.6 DISCONNECT

A. A circuit breaker type disconnect shall be provided as a means of disconnecting the incoming 3 phase power. All power in the enclosure shall be de-energized when the disconnect is opened.

B. The external operating handle shall be pad lockable in the OFF position.

2.7 CONTACTORS

A. A NEMA or IEC rated output contactor shall be provided. Contactor coil shall be interlocked with the emergency stop relay.

B. Surge suppressors shall be provided on all contactor coils.

2.8 ENCLOSURE

A. The drive and all components shall be installed in a single NEMA 1 metallic, gasketed enclosure.

B. The enclosure shall be suitable for top or bottom conduit entry.

C. Cabinet ventilation shall be arranged such that two or more drive cabinets may be placed next to each other.

D. Cabinet shall be front access only and suitable for mounting against a wall.

E. The cabinet shall be provided with a copper equipment ground bus. A bonding jumper shall be provided between the enclosure and the door.

2.9 WIRING

A. Power and control wiring shall be segregated from wiring sensitive to noise.

B. Control wiring shall be No. 14 AWG stranded or larger.

C. Signal leads shall be No. 16 AWG shielded, 600volt insulation.

D. Easily accessible and labeled terminal strips shall be provided for signal leads and control field connections.

E. Each wire or cable termination, except for printed circuit board connections, shall be clearly and permanently identified with wire numbers at both ends.

F. Connections to equipment located on the doors and hinged frames shall be flexible, looped and arranged to prohibit chafing on the edges of the door or frame or interference in any way with the operation of other equipment.

PART 3 - EXECUTION

3.1 Drives shall be installed in accordance with manufacturers written instructions and Section 16050, Installation of Electrical Equipment.

3.2 The drive manufacturer shall provide start-up service assistance for drive set-up, adjustment and field checking and testing.

END OF SECTION 16420

SECTION 16450

TRANSIENT VOLTAGE SURGE SUPPRESSION

PART 1 - GENERAL

1.1 GENERAL

A. The provisions of Section 16010, General Requirements for Electrical Work, apply to the Work of this Section.

B. This section describes the materials and installation requirements for surge protection devices for the protection of AC electrical circuits from the effects of lightning induced currents, substation switching transients and internally generated transients resulting from inductive and/or capacitive load switching.

C. TVSS shall be provided with a ten year warranty.

1.2 CODES AND STANDARDS

A. Products shall comply with the following codes and standards and shall be UL-listed and labeled:

NFPA 70	National Electrical Code
NFPA 780	Standard for the Installation of Lightning Protection Systems
UL 1449	Transient Voltage Surge Suppression
ANSI/IEEE C62.41	8x20 Single Impulse Current Test

1.3 SUBMITTALS

A. Manufacturer's product data sheets, shop drawings and system layout drawings shall be submitted for approval prior to installation. Layout drawings shall include locations of all devices and required connections. Product data shall include manufacturer's written recommendations for installation.

1.4 MANUFACTURERS

A. Subject to compliance with the Specification requirements:

Square D
Cutler Hammer
Siemens
General Electric
Erico/Critec

PART 2 - PRODUCTS

2.1 GENERAL

A. TVSS modules may be provided remote mounted or integral to the switchboard the device is directly protecting. However, if the manufacturer, supplier or contractor decides to provide this as a remote mounted assembly, all components including but not limited to breakers, wiring, and conduit required by this installation shall be provided by the contractor at no additional cost to the owner. Remote mounted assembly shall be provided in a NEMA 1 enclosure or as indicated by the drawings.

B. TVSS system shall be UL Listed.

C. Service entrance TVSS system shall be suitable for use in service entrance locations.

D. TVSS shall be Metal Oxide Varistor (MOV) based, however, silicon avalanche diode (SAD) and combination MOV and SAD systems will be considered if submitted.

E. TVSS protection shall be for all modes of protection, Line-to-Line/Line-to-Neutral, Line-to-Ground, and Ground-to-Neutral. The maximum surge current capability shall be at least 250kA for service entrance TVSS units. Maximum surge capability shall be measured as the sum of the Line-to-Neutral value plus the Line-to-Ground value.

F. The UL 1449 clamping voltage ratings shall be as follows:

Voltage	Line-to-Neutral	Line-to-Ground	Neutral-to-Ground	Line-to-Line
480Y/277V	800V	800V	900V	1200V

G. The ANSI/IEEE C62.41 (1991) Category C3 bi-wave clamping voltage ratings shall be as follows:

Voltage	Line-to-Neutral	Line-to-Ground	Neutral-to-Ground	Line-to-Line
480Y/277V	975V	975V	975V	1925V

H. Unit shall be capable of protecting against and surviving 14,000 ANSI/IEEE C62.41 Category C transients without failure.

I. Each TVSS shall be designed to withstand a maximum continuous operating voltage (MCOV) of not less than 125% of nominal RMS voltage.

J. TVSS shall be provided with onboard visual and audible diagnostic monitoring. Indicator lights/LED's shall provide fulltime visual diagnostic monitoring of the operational status of each phase of the surge current diversion module and shall differentiate full operation, reduced system operation and system failure. An audible alarm shall be provided to indicate a fault condition.

PART 3 - EXECUTION

3.1 INSTALLATION AND TESTING

A. Remote mounted TVSS units shall be mounted as close to the switchboard they are protecting as possible and shall use short, straight wiring runs with minimum slack, no extra turns and no loops to minimize circuit inductance and shall not exceed manufacturer's recommended maximum distance of installation.

END OF SECTION 16450

SECTION 16470

PANELBOARDS

PART 1 - GENERAL

1.1 GENERAL

A. The provisions of Section 16010, General Requirements for Electrical Work, apply to the Work of this Section.

1.2 CODES AND STANDARDS

A. Products shall comply with the following codes and standards and shall be UL-listed and labeled:

NEMA AB-1	Molded Case Circuit Breakers
NEMA PB-1	Panelboards
UL 50	Enclosures for Electrical Equipment
UL 67	Panelboards
UL 489	Molded Case Circuit Breakers and Circuit Breaker Enclosures
UL 943	Ground Fault Circuit Interrupters

1.3 SUBMITTALS

A. Manufacturer's product data sheets.

B. Circuit breaker schedules exactly as shown on the drawings.

C. Dimensioned plans, elevations, sections and details.

1.4 MANUFACTURERS

A. Subject to compliance with the Specification requirements:

Cutler-Hammer
General Electric
Siemens
Square D

PART 2 - PRODUCTS

2.1 GENERAL

A. Panelboards, including lighting and appliance panelboards and power distribution panelboards, shall be of the sizes, rating and arrangement shown on the Drawings.

B. Panelboards shall be provided complete with all overcurrent devices, accessories and trim.

C. All panelboards shall be provided with safety barriers for dead front construction.

D. The required short circuit ratings of assembled panelboards are shown on the Drawings. The short circuit rating of every overcurrent device in the panel shall meet or exceed the panel rating. Unless otherwise noted on the Drawings, series rated combinations will not be permitted.

E. Provide feed-through or sub-feed lugs as indicated on panel schedules.

2.2 CABINETS

A. Boxes shall be code gauge galvanized sheet steel flush or surface mounted as indicated on panel schedules. NEMA type 1 enclosure unless otherwise noted on the drawings.

B. Trim shall be code gauge steel, ANSI-61 gray finish, stainless steel flush type lock/latch handle. All locks shall be keyed alike. Front trim to be hinged to box so that panelboard gutter space can be accessed without removing the trim.

C. Directory frames shall be metal frame with plastic covers.

2.3 BUS

A. All bus work shall be 1000 amp/sq.in. copper.

B. Unless otherwise noted on the Drawings, neutral busses shall be 100% rated with adequate connections for all outgoing neutral conductors.

C. Panelboards shall be provided with copper ground busses.

D. Bus shall be designed for sequence phase connection to allow the installation of one, two or three pole branch circuit breakers in any position.

2.4 OVERCURRENT DEVICES

A. Overcurrent devices shall be trip-free molded case, bolt-on, thermal magnetic circuit breakers.

B. Main circuit breakers shall be individually mounted and bolted to bus assembly. Back-fed branch mounted circuit breakers are prohibited.

C. Front faces of all circuit breakers shall be flush. Trip indication shall be clearly shown by the handle position between the ON and OFF positions.

D. Ground fault circuit breakers shall require no more panel space than standard breakers.

E. Where circuit breakers are used for switching of lighting, circuits type "SWD" circuit breakers shall be provided.

F. All connections shall be rated for 75°C copper conductors.

PART 3 - EXECUTION

3.1 PANELBOARDS

A. Label panelboards and directory in accordance with Section 16010, General Requirements for Electrical Work.

B. Panelboards shall be installed in accordance with Section 16050, Installation of Electrical Equipment.

END OF SECTION 16470

SECTION 16490

SAFETY SWITCHES

PART 1 - GENERAL

1.1 GENERAL

A. The provisions of Section 16010, General Requirements for Electrical Work, apply to the Work of this Section.

1.2 CODES AND STANDARDS

A. Products shall comply with the following codes and standards and shall be UL-listed and labeled:

NEMA KS-1	Enclosed Switches
UL 98	Enclosed and Deadfront Switches

1.3 SUBMITTALS

A. Manufacturer's product data sheets.

1.4 MANUFACTURERS

A. Subject to compliance with the specification requirements:

Cutler-Hammer
General Electric
Siemens
Square D

PART 2 - PRODUCTS

2.1 Safety switches shall be 600 VAC, NEMA heavy duty, horsepower rated visible blade type. Switches shall be non-fused or fused as indicated on the Drawings.

2.2 The switch operating mechanism shall be spring activated quick make - quick break.

2.3 The external operating handle shall indicate the switch position, ON in the up position, OFF in the down position and shall be pad-lockable in the OFF position. A de-featable interlock shall be provided to prevent opening the cover when the switch is ON and prevent closing the switch contacts when the cover is opened.

2.4 Switches shall be provided with arc suppressors and line terminal shields.

2.5 Single speed motors shall be provided with three pole switches. Two speed motors shall be provided with six pole switches.

2.6 Switches shall be provided with a factory supplied ground kit.

2.7 Fused switches shall be provided with class RK1 fuses.

2.8 Safety switches installed indoors shall be provided with NEMA 1 enclosures. Safety switches installed outdoors or in wet areas shall be provided with NEMA 3R enclosures.

PART 3 - EXECUTION

3.1 Safety switches shall be installed in accordance with Section 16050, Installation of Electrical Equipment.

END OF SECTION 16490

SECTION 16500

LIGHTING FIXTURES

PART 1 - GENERAL

1.1 GENERAL

A. Provisions of Section 16010, General Requirements for Electrical Work, Section 16060, Installation of Wire and Cable, and Section 16110, Raceway and Fittings, apply to the work of this section.

1.2 CODES AND STANDARDS

A. Products shall comply with the following codes and standards and shall be UL-listed and labeled:

CBM Labels	Certified Ballast Manufacturers Assoc.
NEC Art. 410	National Electrical Code
FCC, Part 18	RFI and EMI
ANSI C62.41	Line Transient Protection
UL 1570	Fluorescent Lighting Fixtures
UL 1572	HID Lighting Fixtures
UL 1571	Incandescent Lighting Fixtures
UL 924	Emergency Lighting and Power Equipment
UL 1088	Temporary Lighting

1.3 SUBMITTALS

A. Submit manufacturer's product data, photometrics, and installation instructions for each type of light fixture specified. Fixture submittals will be in booklet form with separate sheet for each fixture assembled in "luminaire type" alphabetical order, with proposed fixture and accessories clearly indicated on each sheet.

B. Submit on a separate sheet for each HID and fluorescent fixture type specified, the ballast manufacturer, type and technical data for that ballast.

C. Submit on a separate sheet for each light fixture specified, the proposed lamp and manufacturers data for that lamp.

1.4 MANUFACTURERS

A. Provide products of the manufacturers specified on the contract drawings and as listed under Part 2 of this section.

PART 2 - PRODUCTS

2.1 GENERAL

A. Light fixtures shall be provided with housings, trims, ballasts, lamp holders, sockets, reflectors, wiring and other components required, as a factory-assembled unit for a complete installation.

B. Provide electrical wiring within light fixtures suitable for connecting to branch circuit wiring in accordance with N.E.C. Article 410, Paragraph 24.

C. Deliver interior lighting fixtures in factory fabricated containers and wrapping, which properly protect fixtures from damage.

D. Store interior lighting fixtures in original packaging. Store inside well-ventilated area protected from weather, moisture, soiling, humidity, extreme temperatures, laid flat and on skids to keep off floors and ground.

E. Fixtures installed in ceilings, suspended from ceilings or on walls shall have a plastic film covering protecting lens, louver and lamps from dust, dirt and debris. Plastic film shall not be removed until construction is completed.

2.2 FLUORESCENT FIXTURES

A. General: Provide fluorescent fixtures of sizes, types and ratings indicated and specified in the Lighting Fixture Schedule on the Contract Drawings.

B. Fluorescent-Lamp Ballasts: Provide low-energy solid state fluorescent lamp ballasts, operating lamps with a frequency of >20KHz and capable of operating lamp types indicated. Ballasts shall be high power factor >0.90, Class A sound rating. Ballasts shall have lamp current crest factor of 1.7 or less and total harmonic distortion less than 10%. Ballasts shall be UL listed, Class P, and meet FCC 47CFR Part 18 Non-Consumer and meet applicable ANSI standard.

1. Ballasts that operate T8 lamps shall have the following requirements:

   a. Listed as an acceptable High Efficiency T8 ballast per the Efficiency Maine Business Program.

2. Ballasts that operate T5, T4, compact fluorescent and smaller diameter lamps shall have the following requirements:

   a. Ballasts shall have an end of lamp life sensing circuit capable of shutting the lamp down to prevent lamp glass from cracking and lamp base sockets from melting.
   b. Ballast factor shall be 0.80 - 1.15.

c. Ballasts for T4 compact fluorescent lamps shall be Programmed Rapid Start type to operate lamps in series. Ballast shall digitally control lamp starting to maintain manufactures rated lamp life under any lamp starting cycles.
d. Listed as an acceptable High Efficiency T5 ballast per the Efficiency Maine Business Program.

3. Dimming Ballasts:

a. Ballasts shall be programmed rapid start to operate lamps in series. Ballast shall digitally control lamp starting to maintain manufacturers rated lamp life under any lamp starting cycles.
b. Ballasts shall have anti-flash circuitry such that lamp will start in any light level mode without flashing to full light output.
c. Ballasts shall be compatible with a wide range of 0-10VDC controls.
d. T8 dimming range shall be 100% -5% with a ballast factor range of 0.96 to 0.06.

4. Manufacturers: Subject to compliance with the requirements, provide ballasts by one of the following:

a. Osram Sylvania Inc.
b. Advance
c. Magnetek
d. Lutron
e. General Electric

2.3 HIGH INTENSITY DISCHARGE FIXTURES

A. Provide HID lamp ballasts, of ratings, types and makes as recommended by lamp manufacturer, which properly mates and matches lamps to electrical supply by providing appropriate voltages and impedances for which lamps are designed. Design ballast to operate lamp within the lamp's power trapezoid requirements.

B. All HID fixtures shall have a minimum efficacy of 60 lumens/watt.

2.4 LAMPS

A. Provide fluorescent lamps of types as indicated on the contract drawings.

B. T8 Lamp Type:

1. Listed as an acceptable High Efficiency T8 lamp per the Efficiency Maine Business Program.

2. Lamp color temperature shall be 3500K unless otherwise noted.

C. Compact Fluorescent (T4) Lamp Type:

1. Lamp shall have an average rated life of 12,000 hours, and a minimum 82 CRI.

2. Lamps shall have 4 pin bases for operation on electronic ballasts.

3. Lamp color temperature shall be 3500K unless otherwise noted.

4. Listed as an acceptable High Efficiency T5 lamp per the Efficiency Maine Business Program.

E. Exterior HID Lamp Type:

1. 250 Watt Metal halide lamps shall be clear with an average rated life of 15,000 hours, a lamp color temperature of 3700k, a minimum 65 CRI, and min. initial lumen value of 23,000.

2. 175 Watt Metal halide lamps shall be clear with an average rated life of 15,000 hours, a lamp color temperature of 3700k, a minimum 62 CRI, and initial lumen value of 16,000.

3. 100 Watt Metal halide lamps shall be clear with an average rated life of 16,000 hours, a lamp color temperature of 3000k, a minimum 85 CRI, and initial lumen value of 8600.

5. 70 Watt Metal halide lamps shall be clear with an average rated life of 16,000 hours, a lamp color temperature of 3000k, a minimum 85 CRI, and initial lumen value of 5900.

F. ANSI Standards. Lamps shall comply with applicable ANSI standards.

G. Lamps shall be manufactured by Osram Sylvania, Philips Lighting Co. or approved equal.

PART 3 - EXECUTION

3.1 GENERAL

A. Examine all areas and conditions under which lighting fixtures are to be installed and structure which will support lighting fixtures. Notify the Contractor in writing of any conditions which are detrimental to proper installation and completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

B. Coordinate light fixture installations with other trades. Fluorescent light fixtures should be installed at least two feet away from smoke detectors. Coordinate all lighting fixtures with mechanical piping and duct work to allow for proper clearance.

3.2 INSTALLATION

A. Install all lighting fixtures at locations and heights indicated, in accordance with the architectural reflected ceiling plans.

B. All recessed lighting fixtures installed in ceiling which require a fire resistance rating shall be installed in accordance with the IBC International Building Code.

C. Provide fixtures and/or fixture outlet boxes with hangers, channel or other method of fastening and supporting fixtures required for proper installation.

D. Tighten connectors and terminals, including screws and bolts in accordance with equipment manufacturer's published torque tightening values for equipment connectors. All screws and bolts shall have washers.

3.3 SPLICES AND TERMINATIONS

A. Twist on wire connectors shall be installed which utilize square-wire spring grips and thermo plastic shells. Install connectors to meet the manufacturer's torquing requirements. Install wire connectors of size required as not to exceed the manufacturers UL-listed CSA recognized wire combinations.

3.4 FIELD QUALITY CONTROL

A. At date of substantial completion, all lamps which are not functioning, have color deficiencies, or are noticeably dimmed shall be replaced with new lamps as determined by the Engineer.

B. All lamps used for temporary lighting in new light fixtures shall be replaced with new lamps.

C. All light fixtures shall be cleaned of dirt and debris upon completion of construction. All finger prints and smudges shall be cleaned.

D. All installed fixtures during remainder of construction shall be protected in accordance with Section 2.1 Paragraph E of this specification section.

E. All light fixtures shall be grounded in accordance with article 250 and 410 of the NEC. Tighten connections to comply with tightening torques specified in UL 486A to assure permanent and effective grounds.

F. All light fixtures damaged in shipping or during installation shall be replaced with new fixtures at no cost to the Owner.

G. Furnish stock or replacement lamps amounting to 15%, but no less than six lamps, of each type and size lamp used in each type of lighting fixture. Deliver replacement stock as directed to Owner's storage space.

END OF SECTION 16500

SECTION 16540

INTERIOR TRANSFORMERS

PART 1 - GENERAL

1.1 GENERAL

A. The provisions of Section 16010, General Requirements for Electrical Work, apply to the Work of this Section.

1.2 CODES AND STANDARDS

A. Products shall comply with the following codes and standards and shall be UL-listed and labeled:

ANSI C89.2	Dry Type Transformer for General Applications
UL 1561	Dry Type General Purpose and Power Transformers

1.3 SUBMITTALS

A. Manufacturer's product data sheets indicating weights, dimensions, voltage, KVA, impedance ratings, efficiency at 25, 50, 75, and 100 percent load, rated temperature rise, sound level rating and insulation system.

1.4 MANUFACTURERS

A. Subject to compliance with the Specification requirements.

Cutler-Hammer
General Electric
Siemens
Square D

PART 2 - PRODUCTS

2.1 GENERAL

A. Interior transformers shall be of the sizes, and ratings shown on the Drawings.

B. Transformers shall be general purpose dry type, self-cooled. Transformers 9kVA and smaller shall be non-ventilated, unless otherwise noted on the Drawings. Transformers 15kVA and larger shall be ventilated. Ventilated transformers installed outdoors shall be provided with NEMA 3R enclosures.

C. Transformer sound levels shall meet NEMA/ANSI standard requirements, measured in accordance with ANSI standards. Provide integral vibration and noise dampening supports.

D. Transformers 15kVA and larger shall have 220 degrees C insulation system with temperature rise not exceeding 115 degrees C under full-rated load in maximum ambient of 40 degrees C. Transformers less than 15kVA shall have 180 degrees C insulation with a 115 degrees C temperature rise.

E. Provide transformers with 6 full capacity taps, 2 at 2-1/2% above rated primary voltage and 4 at 2-1/2% below rated primary voltage.

PART 3 - EXECUTION

3.1 INSTALLATION AND TESTING

A. Transformers shall be tested in accordance with Section 16030, Electrical Acceptance Testing.

B. Transformers shall be installed in accordance with Section 16050, Installation of Electrical Equipment.

END OF SECTION 16540

SECTION 16540

INTERIOR TRANSFORMERS

PART 1 - GENERAL

1.1 GENERAL

A. The provisions of Section 16010, General Requirements for Electrical Work, apply to the Work of this Section.

1.2 CODES AND STANDARDS

A. Products shall comply with the following codes and standards and shall be UL-listed and labeled:

ANSI C89.2	Dry Type Transformer for General Applications
UL 1561	Dry Type General Purpose and Power Transformers

1.3 SUBMITTALS

A. Manufacturer's product data sheets indicating weights, dimensions, voltage, KVA, impedance ratings, efficiency at 25, 50, 75, and 100 percent load, rated temperature rise, sound level rating and insulation system.

1.4 MANUFACTURERS

A. Subject to compliance with the Specification requirements.

Cutler-Hammer
General Electric
Siemens
Square D

PART 2 - PRODUCTS

2.1 GENERAL

A. Interior transformers shall be of the sizes, and ratings shown on the Drawings.

B. Transformers shall be general purpose dry type, self-cooled. Transformers 9kVA and smaller shall be non-ventilated, unless otherwise noted on the Drawings. Transformers 15kVA and larger shall be ventilated. Ventilated transformers installed outdoors shall be provided with NEMA 3R enclosures.

C. Transformer sound levels shall meet NEMA/ANSI standard requirements, measured in accordance with ANSI standards. Provide integral vibration and noise dampening supports.

D. Transformers 15kVA and larger shall have 220 degrees C insulation system with temperature rise not exceeding 115 degrees C under full-rated load in maximum ambient of 40 degrees C. Transformers less than 15kVA shall have 180 degrees C insulation with a 115 degrees C temperature rise.

E. Provide transformers with 6 full capacity taps, 2 at 2-1/2% above rated primary voltage and 4 at 2-1/2% below rated primary voltage.

PART 3 - EXECUTION

3.1 INSTALLATION AND TESTING

A. Transformers shall be tested in accordance with Section 16030, Electrical Acceptance Testing.

B. Transformers shall be installed in accordance with Section 16050, Installation of Electrical Equipment.

END OF SECTION 16540

SECTION 16625

EMERGENCY GENERATION SYSTEMS

PART 1 - GENERAL

1.1 GENERAL

A. The provisions of Division 1 and Section 16010, General Requirements for Electrical Work, apply to the work of this section.

1.2 CODES AND STANDARDS

A. Products shall comply with the following codes and standards and shall be UL-listed and labeled:

UL 1008	Standard for Automatic Transfer Switches
NFPA 110	Standard for Emergency and Standby Power Systems
NEMA ICS 2-447	Standard for Automatic Transfer Switches

1.3 QUALITY ASSURANCE

A. Emergency power supply system: Level 1, Type 10, Class 24 as classified by NFPA 110.

1.4 WARRANTY

A. Engine generator: five years or 1500 hour period from the start-up date.

1.5 SUBMITTALS

A. Manufacturer's product data sheets indicating dimensions, voltage and current ratings.

1.6 MANUFACTURERS

A. Subject to compliance with the specification requirements.
Onan
Caterpillar
Generac

PART 2 - PRODUCTS

2.1 DIESEL ENGINE GENERATOR SET

A. Four-cycle, 1800 RPM, diesel engine generator set with low reactance brushless generator, torque-matched excitation, automatic voltage regulator, set-mounted control panel, and high ambient cooling system (50 degree C).

B. Ratings:

1. 300 kW / 333 kVA @ 0.9 PF standby
2. 480Y / 277V, 3-phase, 4-wire, 60 HZ

C. Performance:

1. Voltage regulation shall be +/- 0.5% of rated voltage for any constant load between no load and rated load.

2. A zero-droop, electronic governor shall be provided.

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.

4. Motor starting capability shall be a minimum of 313 surge kW/1210 surge kVA. The generator set shall be capable of sustaining a minimum of 90% of rated no load voltage with the specified kVA load at near zero power factor applied to the generator set.

5. Low exhaust emissions. The engine shall be certified to U.S. EPA non-road source emission standard 40 CFR 89, Tier 3.

D. AC Generator

1. The AC generator shall be synchronous, four-pole, 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(s). All insulation system components shall meet NEMA MG1 standard temperature limits for Class H insulation system. Actual temperature rise measured by resistance method at full load shall not exceed 125 degrees C.

2. A permanent magnet generator (PMG) shall provide excitation power to the automatic voltage regulator for immunity from voltage distortion caused by non-linear SCR controlled loads on the generator. The PMG shall sustain main field excitation power for optimum motor starting and to sustain short circuit current for selective operation and coordination of system overcurrent devices.

   The automatic voltage regulator shall be temperature-compensated, solid-state design. The voltage regulator shall be equipped with three-phase RMS sensing. The regulator shall control buildup of AC generator voltage to provide a linear rise and limit overshoot. The regulator shall include an under-frequency, rolloff torque-matching characteristic, which shall reduce output voltage in proportion to frequency below a threshold of 58 Hz. The torque-matching characteristic shall include differential rate of frequency change compensation to use maximum available engine torque and provide optimal transient load response. Regulators which use a fixed volts-per-hertz characteristic are not acceptable.

E. Engine Generator Set Control

1. The control shall have automatic remote start capability from a panel-mounted, three-position (Stop, Run, Remote) switch.

2. Provide cycle cranking of 15 SEC (ON)/15 SEC (OFF) for three attempts (75 SEC). If engine fails to start lockout the engine and indicate overcrank on alarm status panel.

3. The control shall shut down and lockout upon: Failing to start (overcrank), overspeed, low lubricating oil pressure, high engine temperature, or operation of a remote manual stop station. A panel-mounted switch shall reset the engine monitor and test all the lamps. Lamp indications on the control panel shall include:

Overcrank shutdown	- red
Overspeed shutdown	- red
Low oil pressure shutdown	- red
High engine temperature shutdown	- red
High engine temperature pre-alarm	- yellow
Low engine oil pressure pre-alarm	- yellow
Low coolant temperature	- yellow
Low fuel	- yellow
Run	- green
Not in automatic start	- flashing red
Auxiliary (2 each)	-red (Customer identified)

4. Each condition above shall be provided with an individual 0.5 Amp relay signal and common external alarm contact.

5. The NEMA 1 enclosed control panel shall be mounted on the generator set with vibration isolators. A front control panel illumination lamp with ON/OFF switch shall be provided. Control panel-mounted indicating meters and devices shall include: engine oil pressure gauge, coolant temperature gauge, battery charging meter to indicate satisfactory performance of prime mover-driven battery charging means (DC voltmeter), and running time meter (hours). A control panel mounted generator exercise timer shall also be provided.

6. An AC meter package shall also be provided consisting of a voltage adjusting rheostat, locking screwdriver type, to adjust voltage +/- 5% from rated value; analog AC voltmeter, dual range, 90-degree scale 2% accuracy; analog AC ammeter, dual range, 90-degree scale, 2% accuracy; analog frequency/RPM meter, 45-65 Hz, 1350-1950 RPM, 90-degree scale, +/- 0.6 Hz accuracy. Seven position phase selector switch with OFF position to allow meter display of current and voltage in each generator phase.

F. Engine

1. The engine shall be 4-cycle, 1800 RPM, direct injunction diesel, turbocharged and charge air cooled, with forge steel crankshaft and connecting rods. Minimum engine displacement shall be 661+/- cubic inches, with 6 cylinders. The cylinder block shall be cast iron and have four valves per cylinder. Two cycle engines are not acceptable.

2. An electronic governor shall provide isochronous frequency regulation.

3. The engine shall be cooled by a unit-mounted closed loop radiator system rated for full rated load operation in 122 degrees F (50 degrees C) room-ambient condition with the ambient temperature as measured at the generator air inlet. Radiators shall be provided with a duct adapter flange. The cooling system shall be filled with 50/50 ethylene glycol/water mixture by the equipment supplier. Rotating parts shall be guarded against accidental contact.

4. Engine Accessory Equipment: The engine-generator set shall include the engine accessories as follows:

   a. A 24v electric starter capable of three complete cranking attempts without overheating.

   b. Positive displacement, mechanical, full-pressure, lubrication oil pump. Full-flow lubrication oil filters with replaceable spin-on canister elements and dipstick oil level indicator.

   c. An engine-driven mechanical, positive displacement fuel pump. Fuel / water separator. Fuel filter with replaceable spin-on canister element. Replaceable dry element air cleaner with restriction indicator. Flexible supply and return fuel lines.

   d. Engine-mounted battery charging alternator, 35 ampere, and solid-state voltage regulator.

5. Low exhaust emissions. The engine shall be certified to U.S. EPA non-road source emission standard 40 CFR 89, Tier 3.

G. Base

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 battery hold-down clamps within the rails. Provisions for stub up of electrical conduits shall be within the footprint of the set. Vibration isolators, standard quantity and type of the manufacturer, shall be integral between generator set and base.

2. Provide dual wall sub-base tank with fuel capacity for 24 hours of operation at full

load.

H. Generator Set Auxiliary Equipment and Accessories

1. Generator main circuit breakers: Set-mounted and wired, UL-listed, molded case thermal-magnetic type, rated at 400 amps, 3-pole, 480 volts and 100 amps, 3-pole, 480 volts for standby and life safety transfer switches respectively. Field circuit breakers shall not be acceptable for generator overcurrent protection.

2. Coolant heater: Engine mounted, thermostatically controlled, water jacket heater. The heater shall be sized as recommended by the equipment supplier. Heater voltage shall be 208Volts, single phase.

3. Lube Oil Heater (If required): Engine mounted, thermostatically controlled, lube oil heater. The heater shall be sized as recommended by the equipment supplier. Heater voltage shall be 208Volts, single phase.

4. Starting and control batteries: Starting batteries, lead acid, maintenance-free type, 24 volt DC, sized as recommended by the generator set manufacturer, shall be supplied for the generator set with battery cables and connectors.

5. Battery charger: A 10-amp voltage-regulated battery charger shall be provided for the engine-generator set. Input AC voltage to be 120V and DC output voltage to be 24 VDC. Chargers shall be equipped with float, taper and equalize charge settings. Operational monitors shall provide visual output along with individual form C contacts rated at 4 amps, 120 VAC, 30 VDC for remote indication of:

Loss of AC power	- red light
Low battery voltage	- red light
High battery voltage	- red light
Power ON	- green light (no relay contact)

6. Exhaust muffler: An exhaust muffler shall be provided for the engine; size and type as recommended by the generator set manufacturer. The mufflers shall be critical grade. Exhaust system shall be installed according to the generator set manufacturer's recommendations and applicable codes and standards.

7. UL-listed in-skid fuel tank: A fuel tank capable of providing fuel for 24 hours at full load shall be provided and factory-installed in the generator set skid base with overflow / rupture basin. The tank shall be made of aluminized steel and shall incorporate an integral fuel pump with 20-foot lift. The day tank control shall be provided with the following functions and indications: On/Off/Emergency Run Switch; Test / Reset Switch; Indicator lamps and shutdowns, as follows:

Power available
High Fuel Alarm and Shutdown
Low Fuel Alarm
Low Fuel Shutdown

Overflow to Basin Alarm and Shutdown
Pump Running

8. Remote Annunciator: Provide and install a remote alarm annunciator. It shall be located in Communications 237 adjacent to fire alarm system annunciator. The remote annunciator shall provide all the indications and audible alarms called for by NFPA Standard 110 as provided on the engine-generator set control panel; and in addition shall provide indications for high battery voltage, low battery voltage, normal battery voltage, battery charger malfunction. Alarm silence and lamp test switches shall be provided.

9. Outdoor Weather Protective Housing: Generator shall be provided with a sound attenuated, outdoor weather protective housing, factory assembled to generator set base and radiator cowling. Sound Pressure at 7 meters shall not exceed 73db(A). Housing shall provide ample airflow for generator set operation. Motorized louvers shall be provided on the air inlet and outlets to protect from ice and snow accumulation. It shall be wind rated to 150mph. The housing shall have hinged side access doors and rear control door. All doors shall be lockable. All sheet metal shall be primed for corrosion protection and finish painted with a color selected by architect. Provision shall be made to maintain the temperature in the energy converter enclosure at not less than 32 degrees F or battery heaters shall be provided to maintain the battery temperature at a minimum of 50 degrees F and shall automatically shut off when the battery temperature reaches 90 degrees F. All prime mover heaters shall be automatically deactivated while the prime mover is running. All factory installed AC powered features shall be pre-wired into a 208Y/120V, 60A, main breaker load center.

2.2 TRANSFER SWITCHES

A. Transfer switches shall be automatic and rated 480 Volt, 3 pole.

B. The transfer switch enclosures shall be rated NEMA 1.

C. The main contacts shall be heavy duty silver allow with separate arcing surfaces and multiple leaf arc chutes to cool and quench the arcs. Contacts are to be rated for 100% continuous duty.

D. All contacts, coils, springs, and control elements shall be conveniently removable from the front of the transfer switch without major disassembly or disconnection of power conductors.

E. Mechanical and electrical interlocking shall be provided to prevent source-to-source connection through the power or control wiring.

F. A microprocessor-based control module shall be provided. Indication shall be provided on the control module to indicate the following conditions:

1. Source 1 OK

2. Source 2 OK
3. Generator Set Signal
4. Transfer Timing
5. Transfer Complete
6. Retransfer Timing
7. Retransfer Complete
8. Timing for Stop

G. Control module shall have the capability of delaying transfer and retransfer of load through the use of solid-state adjustable time delay relays. Initial set-up: Life Safety Branch transfer switch shall have 0 time delay on transfer. Standby Branch transfer switch shall have 20 second time delay on transfer.

H. Meters shall be provided on the enclosure front. They shall be 2.5", 2% accuracy. A phase selector switch shall also be provided. Meters shall be provided for:

1. Voltage
2. Current
3. Frequency

PART 3 - EXECUTION

3.1 Emergency generator neutral shall not be grounded at the generator.

END OF SECTION 16625

SECTION 16670

LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes lightning protection for buildings and building elements.

1.3 DEFINITIONS

A. LPI: Lightning Protection Institute.

B. NRTL: National recognized testing laboratory.

1.4 SUBMITTALS

A. Product Data: For air terminals and mounting accessories.

B. Shop Drawings: Detail lightning protection system, including air-terminal locations, conductor routing and connections, and bonding and grounding provisions. Include indications for use of raceway, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.

C. Qualification data for firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include data on listing or certification by an NRTL or LPI.

D. Certification, signed by Contractor, that roof adhesive for air terminals is approved by manufacturers of both the terminal assembly and the single-ply membrane roofing material.

E. Field inspection reports indicating compliance with specified requirements.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:

1. Engage an installer with a minimum of 5 years of documented experience.

2. Installation to be supervised and inspected by a LPI certified Master Installer actively working in the lightning protection industry; provide Owner/Architect with proof of certification during inspection.

3. Installation to be preformed by LPI certified journeyman installers.

4. Installer to be listed with Underwriters Laboratories and capable of furnishing a UL Master Label.

B. Listing and Labeling: As defined in NFPA 780, "Definitions" Article.

1.6 COORDINATION

A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.

B. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and Installer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

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

1. Automatic Lightning Protection.
2. ERICO International Corporation.
3. Harger Lightning Protection, Inc.
4. Heary Bros. Lightning Protection Co. Inc.
5. Independent Protection Co.
6. Robbins Lightning Inc.
7. Thompson Lightning Protection, Inc.

2.2 LIGHTNING PROTECTION SYSTEM COMPONENTS

A. Comply with UL 96.

B. Roof-Mounting Air Terminals: NFPA Class I solid copper unless otherwise indicated.

1. Single-Membrane, Roof-Mounting Air Terminals: Designed for single-membrane roof materials.

C. Stack-Mounting Air Terminals: Solid copper.

D. Ground Rods, Ground Loop Conductors, and Concrete-Encased Electrodes: Comply with Division 26 Section "Grounding and Bonding for Electrical Systems" and with standards referenced in this Section.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install lightning protection components and systems according to UL 96A, LPI 175, and NFPA 780.

B. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends and narrow loops.

C. Conceal the following conductors:

1. System conductors.
2. Down conductors.
3. Interior conductors.
4. Conductors within normal view from exterior locations at grade within 200 feet (60 m) of building.
5. Notify Architect at least 48 hours in advance of inspection before concealing lightning protection components.

D. Cable Connections: Use approved exothermic-welded connections for all conductor splices and connections between conductors and other components except those above single-ply membrane roofing.

E. Air Terminals on Single-Ply Membrane Roofing: Comply with adhesive manufacturer's written instructions.

F. Bond extremities of vertical metal bodies exceeding 60 feet (18 m) in length to lightning protection components.

G. A counterpoise installation based on requirements in Division 16 Section "Grounding" may be used as a ground loop required by NFPA 780, provided counterpoise conductor meets or exceeds minimum requirements in NFPA 780.

1. Bond ground terminals to counterpoise conductor.
2. Bond grounded metal bodies on building within 12 feet (3.6 m) of ground to counterpoise conductor.
3. Bond grounded metal bodies on building within 12 feet (3.6 m) of roof to counterpoise conductor.

H. Bond lightning protection components with intermediate-level interconnection loop conductors to grounded metal bodies of building at 60-foot (18-m) intervals.

3.2 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

B. Use conductors with protective coatings where conditions would cause deterioration or corrosion of conductors.

3.3 FIELD QUALITY CONTROL

A. UL Inspection: Provide inspections as required to obtain a UL Master Label for system.

B. Provide an inspection by an inspector certified by LPI to obtain an LPI certification.

END OF SECTION 16670

SECTION 16700

FIRE ALARM SYSTEMS

PART 1 - GENERAL

1.1 GENERAL

A. Provisions of Section 16010, General Requirements for Electrical Work, apply to the work of this Section.

B. The work of this section includes providing a complete microprocessor based, addressable, analog fire alarm system including all initiating and notification devices, communications, controls, software, programming, accessories, raceway, wiring, terminations, documentation, testing and start-up services.

1.2 CODES AND STANDARDS

A. The Fire Alarm System shall comply with the following codes and standards:

NFPA 13	Sprinkler Systems
NFPA 70	National Electric Code
NFPA 72	National Fire Alarm Code
NFPA 90A	Air Conditioning and Ventilating Systems
ADA	Americans Disabilities Act
NFPA 101	Life Safety Code

Other Applicable NFPA Standards
Local Jurisdictional Adopted Codes and Standards

B. All equipment shall be UL listed.

1.3 SUBMITTALS

A. Manufacturer's product data sheets and installation instructions.

B. Complete system one line and wiring diagrams including floor plans showing all devices and their corresponding address. Wiring diagrams to show all field and factory wiring, include diagrams for equipment and for system with all terminals and interconnections identified.

C. Standby battery calculations.

D. System operation description covering this specific project include method of operation and supervision of each type of circuit and sequence of operations for all manually and automatically initiated system inputs and outputs. Generic descriptions from manufacturer shall not be acceptable and submittal will be rejected.

E. Provide quality assurance certification signed by the manufacturer of the fire alarm system components certifying that their products comply with indicated requirements.

F. Submit an identical submission as described above to the Authority Having Jurisdiction for their approval before any work associated with fire alarm system is started. Upon receipt of comments from the Authority, submit them to Architect for review.

G. Record of field tests of the system.

H. Closeout Submittals:

1. Operation and maintenance data for inclusion in Operating and Maintenance Manual specified in Section 16010. Include data for each type of product, including features and operating sequences (both automatic and manual). Include recommendations for spare parts to be stocked on site. Provide names, telephone numbers and addresses of local service organizations that carry stock of repair parts for the system.

2. Provide an additional set of operating instructions for mounting at the Fire Alarm Control Panel.

1.4 MANUFACTURERS

A. Subject to compliance with the specification requirements:

Edwards Systems Technology
Fire Control Instruments (FCI)
Gamewell
Notifier
Simplex

B. Installer shall be regularly engaged in the installation of fire alarm systems and shall be factory authorized by the manufacturer to provide sales and service.

PART 2 - PRODUCTS

2.1 SYSTEM OPERATION

A. The fire alarm system shall provide general evacuation notification as shown on the Drawings and described herein.

B. Operation of a flow switch, manual pull station or area smoke detector shall initiate a general evacuation alarm, initiate equipment interlocks as described on drawings and register an alarm condition at the control panel.

C. Notification devices shall be provided with separate audio and visual circuits such that alarms may be silenced and visual alarms continue to operate until the system is reset.

D. All initiating, notification and tamper circuits shall be supervised.

E. Removal of an addressable initiating device shall cause a trouble signal to appear at the Control Panel.

2.2 FIRE ALARM CONTROL PANEL

A. Main Control Panel: Modular type panel installed in a flush steel cabinet with hinged door and cylinder lock for microprocessor based system. Switches and other controls shall not be accessible without the use of a key. The control panel shall be a neat, compact, factory-wired assembly containing all parts and equipment required to provide specified operating and supervisory functions of the system. Panel cabinet shall be finished on the inside and outside with factory-applied enamel finish. Provide audible trouble signal. Provide indication of: Power on, battery power on, and alarm, trouble and supervisory acknowledge switches. Provide permanent engraved rigid plastic or metal identification plates, or silk-screened labels attached to the rear face of the panel viewing window, for all lamps and switches. System power shall be 120 volts AC services, transformed through a two winding isolation transformer and rectified to 24 volts DC for operation of all system initiating, actuating, signal sounding (indicating appliance), trouble signal and fire alarm tripping circuits. The system shall be provided with sufficient battery capacity to operate the entire system upon loss of normal AC power in the normal supervisory mode for a period of 24 hours with 5 minutes of alarm output at the end of this period. Permanently label all switches. Panel shall be provided with the following features:

1. Trouble silencing switch which transfers audible trouble signals (including remote trouble devices, if provided) to an indicating lamp. For non-self-resetting type switch, upon correction of the trouble condition, audible signals will again sound until the switch is returned to its normal position.

2. Evacuation alarm silencing switch which when activated will silence all alarm indicating appliances without resetting the panel, and cause operation of system trouble signals. Subsequent alarm(s) from additional device(s) not originally in alarm shall cause activation of the evacuation alarms even with the alarm silencing switch in the "silenced" position.

3. Reset switch when activated will restore the system to normal standby status after the cause of the alarm has been corrected, and all activated initiating devices reset. Operation of reset switch shall restore activated smoke detectors to normal standby status.

4. Lamp test switch.

5. Drill switch which will enable test of alarm devices and restoration to normal without tripping the system.

6. CPU with nonvolatile memory for user defined operating parameters. The system shall be field programmable and configurable from a panel key pad. The system shall remain active and provide fire detection while the program is being edited. The system shall operate in real time for event date and time annotation.

7. Menu driven alpha-numeric liquid crystal display which indicates events stored in the system log, the status of all points, alarm and diagnostic messages.

8. Serial port to connect a 24 volt Alarm Printer and RS-232-C connection or similar for remote maintenance terminal.

9. Alarm verification, drift compensation and maintenance alert for smoke detectors. Provide dry contact for Owners use.

10. Dual rate battery charger with volt and ammeters.

11. Maintenance free sealed recombinant, lead-acid batteries.

12. Transient voltage surge protection.

13. Signaling Line Circuits shall be Class A, Style 6 with a minimum of 3 circuits. Notification Appliance Circuits shall be Class B, with isolation by floor.

2.3 DEVICES

A. Manual Pull Stations

1. Dual action, key reset, addressable suitable for semiflush or surface mounting. The device shall be painted red with the word FIRE in white raised letters.

B. Area Smoke Detectors

1. Spot type photoelectric analog addressable with integral communications and device identification. Flashing LED indicator for normal operation with steady illumination on alarm. The smoke detector shall measure the analog level of smoke and report the level to the Control Panel.

C. Duct Smoke Detectors

1. Similar to Area Smoke Detectors. Duct smoke detectors shall be furnished by the Electrical Contractor, installed in the ductwork by the Mechanical Contractor and wired by the Electrical Contractor. Control wiring of motor shutdown is by the Electrical Contractor. All duct detectors shall initiate a supervisory signal to the fire alarm control panel and be provided with 120V rated form C contacts that open/close upon sensing of smoke or detector failure. Contacts will be used to shut down the associated air handler/heat recovery ventilator fan when detectors are installed in the supply or return ducts of the air handlers/heat recovery ventilator. An additional set of form C contacts shall be provided for Owners use. Each duct smoke detector shall be provided with a Remote Test / Indicating device.

D. Heat Detectors

1. Heat Detectors shall be analog, addressable, fixed temperature type, 135°F generally.

Heat detectors installed in the elevator shaft and machine rooms shall have a lower rating than the sprinkler head. The detector shall have state of the art thermistor sensing circuitry. The detector shall be provided with flashing LED indicator for normal operation with steady illumination on alarm.

E. Notification Appliances

1. 24 Volt Xenon Flasher and electronic horns per ADA guidelines. Minimum intensity 15/75 cd unless otherwise shown on Drawings. Minimum sound levels shall generally be 75dBA unless otherwise noted.

F. Interlocks

1. Provide addressable relay modules for all interlocks shown on Drawings with contacts rated 120 VAC.

G. Digital Communicator

1. The fire alarm system shall be provided with a digital communicator to transmit system alarm information to the owner's central monitoring service. Monitoring services shall be provided under separate contract.

H. Door Hold-Opens

1. Interlock wiring of the door hold-opens, where required, is by the Electrical Contractor. Door holder shall release upon detection of smoke on either side of smoke barrier doors and upon fire alarm initiation.

PART 3 – EXECUTION

3.1 INSTALLATION

A. The Contractor shall provide all equipment and materials required for a fully operational system. The Contractor shall prepare layout drawings showing device locations, raceway size, wiring runs, conduit fill and terminations.

B. All wiring shall be approved fire alarm type MC cable.

C. All junction boxes and fittings shall be color coded red. Junction Box Covers shall be labeled Fire Alarm System.

D. Coordinate device locations with other trades to assure proper installation of devices. Coordinate with other trades where work pertains to fire alarm system, (i.e. air handling unit control, fire suppression system).

E. The Contractor shall clean all dirt and debris from the inside of the fire alarm control panels, devices, etc. and clean the outside of aforementioned equipment after the completion of the

installation. During construction, devices and equipment shall have protective coverings to limit amount of dirt and debris.

F. The manufacturer shall provide on-site supervision of the installation to assure system is installed to meet manufacturers installation requirements.

3.2 TESTING

A. System Acceptance:

1. Testing and inspection of the fire alarm system shall be in accordance with chapter 10 of NFPA 72.

2. A pretest shall be held with the installer and the manufacturer's technical representative present. In addition to the requirements listed below, the pretest shall demonstrate that each smoke detector is operative and produces the intended response. Each smoke detector shall be tested in accordance with the manufacturer's recommendations to initiate an alarm at its installed location. After certification of a complete pretest, the installing contractor shall provide the authority having jurisdiction with written documentation from the manufacturer's authorized representative of the outcome of the test and then shall re-inspect in the presence of the authority having jurisdiction and the manufacturer's authorized technical representative. A complete test shall be conducted as follows: the installing contractor, in the presence of a representative of the authority having jurisdiction, shall manually operate every manual fire alarm station, manually operate or electrically short out every fixed temperature thermodetector, actuate every smoke detector with smoke in accordance with the manufacturer's recommendations to demonstrate that smoke can enter the chamber and initiate an alarm, activate all automatic extinguishing system switches and activate every water sprinkler/standpipe flow switch by a flow of water.

2. Each manual fire alarm station, thermodetector, smoke detector, extinguishing system switching circuits, flow switch circuit and each alarm horn/strobe circuit shall be opened in at least two locations to test for the correctness of the supervisory circuitry. All communications shall be tested completely.

3. The fire alarm system may be placed in operation prior to acceptance if in the opinion of the authority having jurisdiction, it will enhance public safety or provide property protection during the final phases of construction. In this case all devices will be thoroughly cleaned or replaced prior to the system acceptance test. The system will not be placed in operation without the written permission of the authority having jurisdiction. Under no circumstances will this be considered a final acceptance test.

B. The manufacturer's representative shall provide on-site training for the Owner's representatives upon completion of acceptance testing. A 3 hour in depth maintenance and operation training session shall be provided for the maintenance staff. Provide for 2 shifts.

3.3 MAINTENANCE SERVICE

A. Maintenance Service Contract: Provide maintenance of fire alarm systems and equipment for a period of 12 months, using factory authorized service representatives.

B. Basic Services: Systematic, routine maintenance visits on a quarterly basis at times scheduled with the owner. In addition, respond to service calls within 24 hours of notification of system trouble. Adjust and replace defective parts and components with original manufacturer's replacement parts, components and supplies.

C. Additional Services: Perform services within the above 12-month period not classified as routine maintenance or as warranty work when authorized in writing. Compensation for additional services must be agreed upon in writing prior to performing services.

D. Renewal of Maintenance Service Contract: No later than 60 days prior to the expiration of the maintenance services contract, deliver to the owner a proposal to provide contract maintenance and repair services for an additional one year term. Owner will be under no obligation to accept maintenance service contract renewal proposal.

END OF SECTION 16700

SECTION 16715

COMMUNICATIONS TECHNOLOGY INFRASTRUCTURE

PART 1 - GENERAL

1.01 REGULATIONS AND CODE COMPLIANCE

A. The General Provisions of the Contract, including, General Provisions for Electrical Work (Section 16010 Construction Specifications Institute - Master Format), General and Supplementary General Conditions, and Division 1 General Requirements, apply to work specified in this section.

B. All work shall be performed strictly as required by rules, regulations, standards, codes, ordinances, and laws of local, state, and Federal governments, and other authorities that have lawful jurisdiction. Materials and equipment shall be manufactured, installed and tested as specified in latest editions of publications, standards, rulings, and determinations of:

a. Local and state building, plumbing, mechanical, electrical, fire and health department and public safety codes agencies.
b. National Fire Protection Association (NFPA).
c. Occupational Safety and Health Act (OSHA).
d. National Electrical Code (NEC).
e. National Electrical Safety Code (NESC).
f. The ICC National Building Code.

1.02 SCOPE

A. The work to be accomplished under these specifications includes providing all labor, materials, equipment, consumable items, supervision, administrative tasks, tests and documentation required to install complete and fully operational communications systems as described herein and shown on the Drawings. The Communications Subcontractor shall completely coordinate the work of this section with the work of other trades.

B. The Communications Subcontractor shall file plans, obtain permits and licenses, pay fees and obtain necessary inspections and approvals from authorities that have jurisdiction, as required to perform work in accordance with all legal requirements.

C. The Work shall be complete from point of service to each outlet or device including termination of all cable and wire with all accessory construction and materials required to make each item of equipment or system complete and ready for operation. The Communications Subcontractor shall provide complete cabling infrastructure for Phone, Data Systems, CATV, and other systems as indicated on the drawings, including but not limited to the following:

1. Category 5e Data Station Cabling
2. Category 5e Voice Station Cabling
3. Category 3 Voice Riser Backbone Cabling
4. Category 5e RJ-45 Style Jacks
5. Category 5e RJ-45/110 Style Patch Panels
6. Category 5e Patch Cords

7. Category 5e 110-style Voice Termination Blocks
8. Multi Mode Fiber Optic Riser Cables
9. Multi Mode Fiber Optic Connectors
10. Fiber Optic Patch Panels
11. Coaxial cable for CATV
12. Splitters, directional couplers, and patch panels for CATV
13. Data Equipment Racks
14. Horizontal and Vertical Cable Managers
15. Head End Server Equipment Racks
16. Cabling Distribution Support

D. It is the intent of the specification that one manufacturer, where practical, be selected for each particular classification of material.

1.03 TECHNICAL REFERENCES

A. ANSI/TIA/EIA 568-B.1, -B.2, -B.3: "Commercial Building Telecommunications Wiring Standards", including all subsequent changes, modifications, addenda to these standards that are in effect at the time of bidding.

B. ANSI/TIA/EIA 569A: "Commercial Building Standard for Telecommunications Pathways and Spaces".

C. ANSI/TIA/EIA 606: "The Administration Standard for the Telecommunications Infrastructures".

D. ANSI/TIA/EIA 607: "Grounding / Bonding".

1.04 SUBMITTALS

A. After the Contract is awarded, but prior to proceeding with the Work, the Contractor shall obtain complete shop drawings, and product data from manufacturers, suppliers, vendors, and contractors for all materials and equipment specified herein, and submit data and details of such materials and equipment for review by the Architect. Prior to submission of the shop drawings, and product data to the Architect, the Contractor shall review and certify that the shop drawings, product data and samples are in compliance with the Contract Documents. Further, the Contractor shall check all materials and equipment after their arrival on the jobsite and verify their compliance with the Contract Documents. A minimum period of ten working days, exclusive of transmittal time will be required in the Architect's office each time shop drawings, product data and/or samples are submitted or resubmitted for review. This time period shall be considered by the Contractor when scheduling his Work.

B. The Contractor shall submit to the Architect three (3) copies of shop drawings. All copies shall be neatly bound in folders. Additional copies required for distribution shall be the responsibility of the Contractor after reviewed copies are returned to him with the Architect's review comments and notes.

C. The shop drawing submittal shall include all data necessary for interpretation as well as manufacturer's name and catalog number. Sizes, capacities, colors, etc., specified on the drawings shall be specifically noted or marked on the shop drawings.

D. Submittals shall contain only information specific to systems, equipment and materials required by Contract Documents for this Project. Do not submit cut sheets that describe products, models, options or accessories, other than those required, unless irrelevant information is marked out or unless relevant information is highlighted clearly. Illegible copies of catalog pages will not be accepted. Marks on submittals, whether by Contractor, Subcontractor, manufacturer, etc., shall not be made in red ink. Red is reserved for review process.

E. All specification sheets, drawings and diagrams shall be submitted within 30 days from the date the Contractor signs the Contract. The Architect's review of such drawings shall not relieve the Contractor of responsibility for deviations from the Contract, Drawings or Specifications, unless he has in writing called the attention of the Architect to such deviations at the time of the submission. The Architect's review shall not relieve the Contractor from responsibility for errors or omissions in such drawings.

1.05 CLOSE-OUT SUBMITTALS

A. Technical Documentation; Submit for approval one draft of the complete Technical Documentation for the systems defined in this specification. This documentation shall include the following:
   a. Table of contents.
   b. Communications Systems installer Name, Contact Name, Address, Telephone Number, Fax Number, and email address.
   c. Manufacturers' certificate of warranty for the complete (or each and every of the various subsystems) Communications System. Clear documentation of effective warranty periods. All warranties shall be filled out in the Owner's name.
   d. Proposed Service Contract.
   e. Maintenance Documentation including the following:
      i. Information necessary for the Owner's technical staff to perform routine and/or corrective maintenance.
      ii. List of all equipment by manufacturer.
      iii. List of all spare parts.
   f. Original copies of manufacturers installation and operation instructions arranged alphabetically by manufacturer.

B. Technical Diagrams and Drawings:
   a. Provide a simplified single line drawing showing functional relationships and interconnection of all equipment. These drawings should be sufficient to provide information that a technician who is unfamiliar with the installation be able to efficiently troubleshoot and service the system.
   b. A complete set of technical diagrams and drawings shall be mounted on the wall either behind a plastic cover or in a durable file holder (as determined by the owner) in each telecommunications and equipment room.

1.06 TRAINING

A. Conduct a training program for the Owner's staff.

B. Training program shall include:
   a. Proper termination technique for Cat5e jacks and patch panels.
   b. Circuit tracing techniques.
   c. Review of technical manuals and diagrams.
   d. Training on any electronic systems installed.

1.07 SPARE PARTS

A. Provide the following spare parts:
   a. Single gang 2-port faceplate. Quantity of 5.
   b. Cat5e Data outlet jacks. Quantity of 10.
   c. Cat5e Voice outlet jacks. Quantity of 10.
   d. Cat5e 24-port patch panel. Quantity of 1.
   e. Cat5e cable. Quantity of 1000 feet of each color for voice and data.
   f. F-connector video jacks compatible with voice/data faceplates. Quantity of 10.
   g. RG-6U coaxial cable. Quantity of 1000 feet.

1.08 ALTERNATES

A. Manufacturer's names are listed herein and on the drawings to establish a standard for quality and design. Where one manufacturer's name is mentioned, products of other manufacturers will be acceptable if, in the opinion of the Architect, the substitute material is of quality equal to or better than that of the material specified.

B. Detailed specifications and, if the Architect determines it is necessary, samples of proposed alternate products shall be provided to the Architect for review prior to purchase or installation of proposed alternates.

C. Cost for removal and replacement of any unapproved alternates pertaining to the items specified in this section is the sole responsibility of the Communications Cabling Contractor.

PART 2 – PRODUCTS

2.01 DEMARCATION AND TELECOMMUNICATION ROOM REQUIREMENTS

A. Two 4-foot by 8-foot by ¾-inch plywood backboard with 2 coats of fire resistant light or white colored paint shall be provided and installed by the General Contractor at the demarcation point as shown on the architectural drawings.

B. A 6-AWG green insulated ground wire shall be directly terminated from the building entrance terminal to the main building ground.

C. Labeling shall follow the guidelines set forth in ANSI/TIA/EIA-606 -Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.

2.02 EQUIPMENT RACKS

A. Provide floor mount equipment racks in the SERVER/MIDRANGE 114, COMP. 141, and all telecommunications rooms as shown on the drawings.

B. Cable management racks are to accommodate 19-inch mounting width. High capacity 6.5-inch deep aluminum vertical channels to allow for safe management of large bundles of cabling. Vertical channels tapped 12/24 on front and back. Top bars are to have parallel and perpendicular attachment points for cable trays, as well as built-in bend radius protection.

C. The Server/Midrange Room 114 shall have on 36" wide server rack, which shall be a 4-post open design. Front and rear shall have channels tapped 12-24. Server rack shall be Chatsworth Quadra Rack Server Frame or approved alternate. Rack shall have two heavy duty fixed shelves with a minimum load rating of 200lbs per shelf.

D. Each rack or cabinet shall have at least one rack mount power strip, which meets the surge protection requirements of UL 1449 with a minimum of 8-15Amp outlets. Additional power requirements will be noted on drawings.

E. All racks and cabinets shall be bounded to the ground bar (provided by EC) with minimum of 6 AWG green insulated copper wire.

2.03 CABLE MANAGEMENT

A. Vertical cable management shall be integrated into freestanding racks.

B. Horizontal cable management shall be spaced to efficiently accommodate patch cables on front of rack without overcrowding.

C. Velcro cable ties to be used to maintain neat cable routing on and around racks without over tightening and crimping cable jackets.

D. Devices shall be installed on conduit as necessary to insure that minimum bend radius requirements are maintained.

2.04 CABLE TRAY WITHIN TELECOMMUNICATIONS ROOMS

A. All Telecommunications rooms (IDFs and the MDF) shall have cable tray, installed 9' AFF, on the wall adjacent to the racks and continuously along the path horizontal and backbone cabling enters and leaves the room. Tray shall only be installed along the perimeter of the room, and/or on the shortest route to attach to floor standing racks.

B. Cable tray to be ladder style manufactured of tubular steel and painted black (Hubbell HLS1012B).

C. Tray shall be 12" wide with 9" rung spacing.

D. Acceptable support methods for wall mount applications include triangular support brackets (Hubbell HLTSB12B), and Wall angle support brackets (Hubbell HLS0612).

E. Cable tray shall be firmly mounted to Racks using a mounting kit (Hubbell HLMPK19B).

F. Install tray system with hardware, splice connectors, support components, and accessories furnished by the manufacturer.

G. A cable drop out shall be used for all vertical transitions to maintain recommended bend radius in cables (Hubbell HLCD12).

H. Cable tray shall be grounded to the building ground system.

2.05 INNERDUCT

A. Innerduct with a minimum diameter of 1-1/4in shall be used for routing of fiber optic cables.

B. Innerduct shall have proper fire ratings for the environment which is to be routed through (i.e. un-rated in metallic conduit, riser and/or plenum as required by code and AHJ).

C. A spare pull line shall be left in all innerduct to facilitate future cable pulls.

2.06 CABLE FROM DEMARCATION POINT TO MAIN DISTRIBUTION FRAME (MDF)

A. Cable from the Telecommunications Service Entrance in TEL/DATA 171 to MDF-1 in SERVER/MIDRANGE 114 shall have 100 pairs with 24AWG solid conductors and be riser rated, Category 3 or higher. Cable from the Telecommunications Service Entrance to MDF-2 in COMP 141 shall have 25 pairs with 24AWG solid conductors and be riser rated, Category 3 or higher.

B. Cable shall be terminated on the protected side of the entrance terminal(s), provided by the owners' service provider, to rack mount 110 blocks in each MDF.

C. 4-foot by 8-foot by ¾-inch plywood backboards with 2 coats of fire resistant white colored paint shall be provided by the general contractor as shown on the architectural drawings.

D. Cable shall be terminated by the communications cabling contractor to rack mounted 110 block(s) in MDF-1 in SERVER/MIDRANGE 114 and MDF-2 in COMP 141.

E. Connection to the owners phone system shall be provided by the phone system installer under separate contract.

2.07 FIBER OPTIC BACKBONE (DATA)- INSIDE PLANT

A. All computer network cabling between telecommunications rooms shall be 12 strand Multimode Fiber Optic cables.

B. Multimode Fiber Optic Backbone cabling shall have a core to cladding ratio of 50/125µ and be "Laser Optimized" for Gigabit and 10 Gigabit transmission speeds using VCSEL light sources.

C. Inside plant fiber optic cable shall be tight-buffered design with a 900µ coating on each strand.

D. Fiber Optic Backbone cables shall be routed through innerduct provided by Telecommunications Cabling Contractor.

2.08 CAT5e CABLE (DATA AND PHONE)

A. Cat5e cable shall be Riser rated (CMR)

B. All horizontal cabling shall be Cat5e unless specifically indicated otherwise.

C. See Appendix A for pre-approved manufacturers.

2.09 PATCH PANELS (DATA)

A. Patch Panels shall meet a minimum of Cat5e performance and be of the same manufacturer as workstation jacks.

B. Patch panels shall follow the T568B wiring scheme.

C. See Appendix A for pre-approved manufacturers.

D. A rear cable support bar shall be provided for each patch panel.

E. Spare patch panel capacity equal to at least 20% of the installed ports shall be installed for each telecommunications rack.

F. Minimum number of ports per patch panel shall be 24.

2.10 OPTICAL FIBER PATCH PANELS

A. Optical Fiber Patch Panels in each IDF shall be rack mountable capable of terminating a minimum of 24 fibers. Optical Fiber Patch Panels in the MDF shall be rack mountable capable of terminating a minimum of 48 fibers. There shall be integrated cable management on both the cable entrance side and the jumper side of the panel. Enclosure shall be black in color.

B. Optical fiber patch panel shall be loaded with LC adapter panels capable of supporting all fiber strands entering and leaving the closet. Adapters shall have either ceramic or metallic sleeves. Any unused panel space shall have blank fillers installed.

2.11 CONDUITS

A. Conduit fill ratios should follow the guidelines set forth in ANSI/TIA/EIA-569-A.

B. Where conduit is required a minimum trade size of ¾" shall be used regardless of number or size of conductors.

C. Conduit system shall accommodate minimum bend radius of 4-times the diameter of copper cables and 10-times the diameter of fiber optic cables. No condulets shall be used to change direction of the conduit run.

2.12 FACEPLATES/JACKS

A. Jacks shall be rated Category 5e, and follow the T568B wiring scheme.

B. See Appendix A for pre-approved manufacturers.

C. Jacks designated for Data shall be Blue and those designated for phone shall be Office White. Colored icons or bezels fixed to each jack are suitable substitutions for a colored jack.

D. Faceplates shall be Office White in color, resistant to tampering, and not be a "front loading" design.

2.13 FIBER CONNECTORS

A. Fiber connectors shall be type LC. Epoxy or adhesive shall be used to fix the fiber within the ferrule.

B. Connectors with only a mechanical/pressure type method of fixing the fiber to the connector are NOT acceptable. Fusion splicing of fiber strands to pre-terminated pigtails is acceptable providing that the splices are well protected and fixed within the enclosure.

C. Care shall be taken to insure that all fiber optic connectors are protected by a dust boot to avoid damage after termination and testing.

2.14 COAXIAL VIDEO CABLING SYSTEM

A. General
   1 All passive components including cable shall be 1 GHz rated.
   2 Wiring for Video Distribution System shall be coaxial broadcast quality riser rated 75-ohm cable.

B. Backbone cable shall be RG-11U.

C. Drop cable shall be either RG-6U or RG-11U, as required to meet the parameters of this specification.

   1 CommScope 5726 RG-6/U, utilize shielding of aluminum bonded to both sides of a polypropylene or polyester tape with 60% aluminum braid and meet or exceed the following maximum attenuation specifications:

Frequency	Max. Attenuation dB/100 feet
1 MHz	.26
10 MHz	.81
50 MHz	1.46

100 MHz	2.05
200 MHz	2.83
400 MHz	4.05
700 MHz	5.60
900 MHz	6.23
1000 MHz	6.80

2 CommScope 5913 RG11, utilize shielding of aluminum bonded to both sides of a polypropylene or polyester tape with 60% aluminum braid and meet or exceed the following maximum attenuation specifications:

Frequency	Max. Attenuation dB/100 feet
1 MHz	.22
10 MHz	.49
50 MHz	.98
100 MHz	1.29
200 MHz	1.84
400 MHz	2.68
700 MHz	3.67
900 MHz	4.25
1000 MHz	4.52

D. "F" Style Connectors:
1 "F" connectors shall be crimp-on style, twist-on connectors are not acceptable.
2 "F" connectors shall be pass-through modular style connectors. Pass-through connectors requiring the use of additional adapters shall not be accepted. Provide angled connectors as required to accommodate workbox depth and width.

E. BNC Style Connectors
1. BNC connectors shall be crimp-on style, twist-on connectors are not acceptable.
2. BNC connectors shall be pass-through modular style connectors. Pass-through connectors requiring the use of additional adapters shall not be accepted. Provide angled connectors as required to accommodate workbox depth and width.

2.15 VIDEO SPLITTERS, DIRECTIONAL COUPLERS AND WALL TAPS

A. The contractor is responsible for the selection of the appropriate tap values for splitters, directional couplers, and wall taps to insure balanced signal strength throughout the installation. The system shall be designed to provide a minimum of 3dB and a maximum of 10 dB of signal strength at each wall tap without requiring the systems provider to install amplifiers outside telecommunications closets. Amplifiers and head end equipment to be provided under separate contract.

B. All splitters, directional couplers and wall taps shall be designed to perform at frequencies up to 1GHz. Basis of design is Blonder Tongue solder back series.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION GUIDELINES

A. Design is based on ANSI/EIA/TIA-568-B.1, .2, and .3 Standard.

B. Additional guidelines can be found in the BiCSi Telecommunications Distribution Methods Manual, 10th Edition.

3.02 ROUTING

A. All phone and data horizontal cables to be home run from workstation outlet to telecommunications room.

B. Route cables, in large groups, down the main cable pathways, until a direct path to the point of access to the workstation outlet can be taken. At that point, route the cables, above all building systems, to the outlet location in accordance with standard installation practices, as described herein. Cable pathways should follow walkways within the building and generally minimize the number of bends as is practicably possible.

C. Individual bundles of cables are not to exceed 12 cables with at least 2" of separation to adjacent bundles.

D. When not in conduit or tray, support cables to the deck and/or beams, at least every five feet throughout the length of the installed run. Use J-hooks to group the cables in bundles of no more than 12 and keep them away from electric wires, fixtures and the other systems installed in the building. Multiple bundles can be run in parallel but must be separated by at least 2-inches. Ensure that hangers, ties, and other methods of securing cable do not compress cable or damage insulation.

E. Attach to beams with minimal disruption of any fireproofing. The contractor will be responsible to restore ALL fireproofing to appropriate levels, including penetrations of fire rated walls and disruption of any protective coatings on building structures.

F. Make cable routes with 90 degree sweeps whenever possible; do not install cables randomly or diagonally across rooms or through the building.

G. Cables installed partially or fully within communications rooms are to be routed through and secured in cable tray whenever possible. Cables placed in cable tray are to be tie wrapped with hook and loop (Velcro) every 24in to keep them neatly bundled and not permitted to shift from one side of the tray to the other as they are routed in the tray.

H. Recommended bend radius shall be maintained whenever cables enter or leave conduits, cable trays, or other raceways.

I. Route station cables to fixed wall locations through EMT to back box provided by electrical.

Be sure to provide a bushing on any exposed conduit ends which cable is to be routed through to insure that cable jacket is not damaged during installation or over time.

J. Whenever cable is routed through rough openings (such as through steel studs) be sure to provide bushings or protective grommets to insure that cable jacket is not damaged either during installation or over time.

K. Cable routing should avoid areas of potential high temperatures. Areas of concern are hot water pipes, areas adjacent to roofs, and south facing eves.

3.03 COAXIAL CABLING SYSTEM

A. Cabling for CATV system shall be installed as a broadband distribution system with trunk lines originating in the MDF to each IDF. From each IDF the signal shall be split to each device as indicated on the drawings.

B. CATV cabling system shall be engineered by the installer to have the appropriate tap values and splitters to allow 3 to 10dB of signal strength at each drop without the use of amplifiers outside any telecommunications room. Amplifiers and video head end equipment is to be provided under separate contract.

C. Home run cabling or RG-11 shall be provided between each telecommunications closet and AV/telecom room #1024 for the CATV backbone.

D. Each TV location shown on the drawings shall have a coaxial cable drop at 18" AFF unless noted otherwise.

3.04 GROUNDING

A. All equipment racks, enclosures, cable tray, equipment, and patch panels shall be properly grounded. Minimum 6-AWG green ground wire shall be used.

B. Ground bars in each telecommunications room to be provided by division 16.

3.05 TIE WRAPS

A. Tie wraps shall be used to maintain clear and organized cable management throughout the installation. Care should be taken not to over-tighten tie wraps.

B. Hook and loop (i.e. Velcro™) tie wraps shall be used exclusively in and around racks and enclosures to enable moves, adds, and changes in the future.

3.06 LABELING

A. Unless otherwise indicated by the owner follow guidelines set forth in TIA/EIA-606-A Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.

a. Labeling scheme shall define each cable run based on originating location on the rack and patch panel.

b. Labeling on the cable, patch panel, and faceplate/jack should follow the following pattern:
    i. SN-ANN
        1. SN = Telecommunications Room (alpha/numeric)
        2. A = Panel Identifier (alpha)
        3. NN = Port Number (numeric)
c. Patch panels shall be designated A through Z based on vertical position on the rack with the highest panel labeled A. If more than a single rack is present in a closet the designation shall continue from the top of the leftmost rack to the bottom of the rack on the right.
d. The patch panel shall be identified by a clear mechanically produced label affixed on the top center of each panel. Handwritten labels are unacceptable.
e. Example – a run originating in IDF B from patch panel E and in the 16th port would be designated B-E16.

B. Cables shall be labeled within 12-inches of each end identical to the label on the faceplate and patch panel.

C. Labels shall be mechanically reproduced and resistant to smudging and rubbing off. Handwritten labeling is unacceptable.

D. The labeling requirements apply to all voice, data, CCTV, and CATV (backbone only for CATV) cable runs.

3.07 TESTING CAT5e

A. All Cat5e cables shall be proven to pass the complete TIA/EIA-568-B standard.

B. Test all cables from telecommunications closet/head end to station jack (Permanent Link).

C. Test results shall be provided for each link in both printed and electronically in Microsoft Excel format provided on a CD.

D. Labeling of all test results shall match the labeling on faceplate and patch panel.

3.08 TESTING FIBER OPTIC CABLES

A. All Fiber Optic Strands shall be tested with a light loss meter from each end at 850 and 1300nm.
    a. Mandrel wrap method shall be used.

B. Repair or replace any strands with a link loss in either direction of 5dB or greater at either 850 or 1300nm wavelengths.

C. Test results shall be provided for each link in both printed and electronically in Microsoft Excel format provided on a CD.

D. Labeling of all test results shall match the labeling on faceplate and patch panel.

3.09 DOCUMENTATION/AS-BUILTS/RECORDS

A. The Cable Installation shall be documented according to the TIA/EIA 606-A Standard.

B. Four (4) complete sets of as builts shall be provided.

C. As builts shall be provided in AutoCAD format not hand drawn.

3.10 SUPPORT

A. Each vendor is to maintain a fully equipped service organization capable of providing full maintenance and service of the installed system(s) within 24 hours. This facility shall be available for inspection by the engineer. Provide the street address and staffing levels of all service locations that may provide support to this project.

B. Each vendor is to maintain the necessary spare parts in the proper proportion as recommended by the manufacturer to maintain and service the equipment being installed.

3.11 WARRANTY

A. Product and Applications Assurance Warranty documentation for the infrastructure system shall be for 15 years to the system design parameters. Provide complete documentation regarding the manufacturer's warranty at the time of the proposal. Include a sample of the warranty that would be provided to the customer when the installation is complete and documentation of the support procedure for warranty issues. Provide an application assurance manual documenting the vendor-supported applications and application guidelines.

B. Vendor/installer must be authorized to provide warranty services, components, and systems on behalf of the manufacturer.

C. This warranty is in addition to, not in lieu of, all other warranties in the contract documents, and all other rights and remedies available to the owner under the contract and under the law.

Appendix A

The following list contains acceptable manufacturers based on broad categories.

Copper Connectivity (patch panels, jacks, faceplates)

Hubbell
NORDX/CDT
Panduit
Siemon
Superior Modular
Krone

Copper Cable (UTP)

Belden
Commscope
General Cable
Hitachi

NORDX/CDT	Krone
Berk-Tek	

Fiber Optic Connectors/Enclosures

Alcoa Fujikura	NORDX/CDT
Corning Cable Systems	Panduit
Hubbell	Krone

Fiber Optic Cable

Alcoa Fujikura	General Cable
Avaya	Hitachi
Corning Cable Systems	NORDX/CDT

Racks and Enclosures

Hubbell	Chatsworth
Panduit	APW
Rack Technologies	X-Mark

END OF SECTION 16715

SECTION 16800

PRESENTATION SYSTEMS

SOUND AND VIDEO

PART 1 - GENERAL

1 - RELATED DOCUMENTS

A - Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B - Section 16780 Voice-Data-CATV transport systems.

C - Lighting Controls as shown on Electrical Drawings.

2 - SUMMARY

A - The Multimedia Systems for the MTA Headquarters shall provide a high quality and flexible infrastructure for the presentation of live and recorded material.

B - The Multimedia system in the Authority Room shall be utilized primarily for public meetings. The Board table requires a clear view of the same material being presented to the audience. The layout of the Authority Room requires the use of two projectors and screens on opposite sides of the room to insure visibility. Microphones shall be provided for seating at the Board table, Lectern, and wirelessly.

C - The conference rooms (#229 and 230) shall be used primarily for training and presentations to large groups of MTA employees. The multimedia systems shall be configured to work independently when the rooms are divided, or as a single system when the rooms are combined.

D - The executive conference room (#345) shall be used for small group meetings and presentations. A projector shall be ceiling mounted on a lift that fully conceals the projector when not in use and focused on the screen (specified in the architectural section). No sound system is required. An interface shall be integrated into the conference table to accommodate power, monitor, and data connectors.

E - The systems specified herein shall be operable without expert technical support on site. This Section includes the following:

1 Digital Projection systems

2 Sound reinforcement and program amplification systems

3 Audio speaker systems.

4 Integrated AV control and switching systems.

5 AV source Equipment including
- a. PC (s)
- b. DVD/VCR
- c. Visual Presenter

6 Video Conferencing system.

7 Assistive listening system(s).

8 Wireless microphone system.

9 AV Cabling for above systems.

10 Wireless portable and wall mount controllers,

11 Cabinets and AV racks.

F - The contractor is responsible for providing a complete and functional system as outlined by the performance requirements. Any required components are the responsibility of the contractor even if they are not listed here. Such items may include but are not limited to power supplies, signal converters, patch bays, etc.

G - Related Sections include the following:
1 Division 1 "Systems Demonstration and Training" for all systems and equipment in this section.
2 Division 16 Sections for electrical service and connections including lighting controls, metal device boxes for switches and conduit, where required, for low-voltage control wiring.

3 - SUBMITTALS

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

B - Shop Drawings: Show layouts and types of equipment. Include the following:
1 Location of wiring connections.
2 Connections to supporting structure for pendant- and recess-mounted screens.
3 Layout of AV rack(s)
4 Layout of Podium
5 Location of all AV cabling jacks.
6 Wiring Diagrams: For connection of AV equipment in AV control closets.

C - Operation and Maintenance Data:
1 For all systems and equipment in this section

4 - QUALITY ASSURANCE

A - Acceptable alternates for products specified shall be determined by the Architect.

B - Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

5 - CABLING INSTALLATION

A - All cabling work shall be performed strictly as required by rules, regulations, standards, codes, ordinances, and laws of local, state, and Federal governments, and other authorities that have lawful jurisdiction. Materials and equipment shall be manufactured, installed and tested as specified in latest editions of publications, standards, rulings, and determinations of:

1 Local and state building, plumbing, mechanical, electrical, fire and health department and public safety codes agencies.
2 National Fire Protection Association (NFPA).
3 Occupational Safety and Health Act (OSHA).
4 National Electrical Code (NEC).
5 National Electrical Safety Code (NESC).
6 The ICC National Building Code.

6 - DELIVERY, STORAGE, AND HANDLING

A - Do not deliver AV equipment until building is enclosed and other construction within spaces where equipment will be installed is substantially complete and ready for AV system installation.

B - Store un-installed equipment in manufacturer's protective packaging and according to manufacturer's written instructions including temperature and humidity.

7 - COORDINATION

A - Coordinate layout and installation of projection screens with adjacent construction, including ceiling framing, light fixtures, HVAC equipment, fire-suppression system, and partitions.

PART 2 - PRODUCTS

1 - MANUFACTURERS

A - In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1 Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified. Acceptance of alternate products is to be determined by the Contracting Officer. It is the responsibility of the bidder to provide detailed information on proposed substitutions to substantiate the replacement products suitability for the project.

2 In the event that a specified product is discontinued prior to installation a substitute of equivalent or higher performance shall be submitted to the architect for approval.

2 - DIGITAL PROJECTORS

A - Digital Projectors for Authority Room (quantity of 2) shall have the following minimum performance capabilities:

1 Native XGA resolution (1024x768).
2 Capable of 4000 ANSI lumen output.
3 Video Compatibility with NTSC, NTSC4.43, PAL, PAL60, PAL-M, PAL-N, SECAM, HDTV: 1080p, 1080i, 720p and SDTV: 480p, 480i (with optional cable), Y/Cb/Cr component (with optional cable).
4 Eco-mode to extend lamp life to 2000 hours or more.
5 Inputs: 1 5-BNC, 1 DVI-D, 1 RGB, 1 S-Video, 1 Video, 1 RJ45 Network, 3 RCA Audio, 2 Stereo Mini Audio, 1 Remote, 1 PC Control, 2 PC Card slots, 2 option card slots: 1 USB A
6 External controls: RS232 (AMX/Crestron compatibility), IR, USB, Network (LAN).
7 Maximum of 35dB acoustic noise level.
8 2-year parts and labor warranty.
9 Lens with power zoom and focus capabilities. Lens provided shall fill the screen from the mounting position indicated on the drawings.
10 Ceiling mount hardware to securely hold the projector in position without any movement caused by air handling systems.
11 Projectors shall be NEC NP2000 or approved alternate.

B - Digital Projector for each meeting room and the executive conference room (3 total) shall have the following minimum performance capabilities:

1 Native XGA resolution (1024x768).
2 Capable of 3500 ANSI lumen output.
3 Video Compatibility with NTSC, NTSC4.43, PAL, PAL60, PAL-M, PAL-N, SECAM, HDTV: 1080p, 1080i, 720p and SDTV: 480p, 480i (with optional cable), Y/Cb/Cr component (with optional cable).
4 Eco-mode to extend lamp life to 3000 hours. Normal mode lamp life of 2000 hours.
5 Inputs: 1 DVI-D, 1 5-BNC, 1 RGB, 1 S-Video, 1 Video, 2 PC Card, 2 L/R RCA Audio, 3 Stereo Mini Audio, 1 USB A, 1 Remote
6 External controls: RS232 (AMX/Crestron compatibility), IR, USB, Network (LAN).
7 Maximum of 35dB acoustic noise level.
8 2-year parts and labor warranty.
9 Lens with power zoom and auto focus capabilities sized to fill the screen from the mounting position indicated on the drawings.
10 Ceiling mount hardware to securely hold the projector in position without any movement caused by air handling systems. Note: this space has a drop ceiling with structural support above. Space above the ceiling is an air handling plenum.
11 Projector shall be NEC NP1000 or approved alternate.

3 - PROJECTOR LIFT

A - Projector lifts for the Authority Room No. 310, and Conference Room No. 345 shall fully conceal the projector when not in use.

B - Operation of the lifts shall be coordinated with the operation of the motorized screens (see architectural specifications) so that only one switch needs to be operated for both functions.

C - Lifts shall include enclosure to allow installation in plenum rated ceiling space.

D - Lifts shall be Draper Phantom or approved alternate.

4 - SOUND SYSTEMS

GENERAL: The primary purpose of the sound system in each space is for reinforcement of the spoken voice of the presenter. Primary importance is given to providing even sound pressure levels at frequencies up to 10kHz throughout the space to give the best possible intelligibility of the speaker. Secondary purpose of the sound system shall be to provide high quality audio from source equipment including DVD and CD players.

A - Overhead speakers (Authority Room Acoustical Tile ceiling areas and Meeting Rooms)
1 Overhead speakers shall be flush mounted in the ceiling at locations shown on the drawings.
2 Utilize the approved mounting system provided by the speaker manufacturer.
3 Speakers shall have 6.5" woofer and 1" dome tweeter.
4 Sensitivity shall be 90.5 dB (1 Watt at 1 Meter)
5 Use 70 Volt transformer for ceiling speakers.
6 Frequency response shall be at or above –3dB for the range between 63Hz – 22kHz.
7 The coverage angle shall be 125 degrees (–6dB @ 10kHz).
8 The speakers shall be white in color.
9 Speakers shall be Soundtube CM600I or approved alternate.

B - Overhead speakers (Authority Room Vaulted Ceiling area)
1 Speakers shall be surface mounted to the bottom of the three beams at locations shown on the drawings.
2 Utilize the approved mounting system provided by the speaker manufacturer.
3 Speakers shall have 5.25" woofer and .75" tweeter.
4 Use 70 Volt transformer tap.
5 Useable frequency response shall extend from 80Hz to 15kHz.
6 The coverage angle shall be 130 degrees (–6dB @ 10kHz).
7 Include ceiling mount adapter kit.
8 Speakers shall be White in color.
9 Speakers shall be JBL Control 25T-WH or approved alternate.

C - Amplification
1 Amplifier for Authority room and each meeting room speaker system shall be located in the respective AV control rack.
2 Amplifier shall take the audio signal from the automatic matrix switcher.
3 Output power shall be a minimum of 80 watts at 70v for each of 3 channels.
4 Frequency response shall be flat through the audio band (20Hz – 20kHz).
5 Amplifier shall be Crestron QM-AMP3X80SR or approved alternate.

5 - AUDIO AND VIDEO CONTROL SYSTEMS:

A - AV System Control -Authority Room and Conference Room(s) (2 total)
1 2-Series engine | Dual-bus architecture
2 Cresnet port - master/slave selectable
3 10/100 Ethernet | SSL encryption
4 e-Control 2 and RoomView enabled | SNMP support
5 3 Com ports (RS-232/422/485)
6 8 IR/serial ports
7 8 Versiport I/O ports
8 8 Low-voltage relay ports
9 Single-space EIA rack-mountable
10 Controller in Authority Room shall be configured and connected by AV contractor to operate scene selections on Lutron Grafik Eye 3000 series lighting controller via Grafik Eye GRX-RS232 control interface. Coordinate lighting scene selection with electrical contractor.
11 AV control system(s) Shall be Crestron CP2E or approved alternate.

B - RS-232 Expansion Modules (as needed to connect required number of RS-232 devices)
1 (2) RS-232/422/485 COM ports per module.
2 Communication with the control system via a single Cresnet connection.
3 Rack mount in Equipment cabinet with ST-RMK kit.
4 COM port expansion Modules shall be Crestron ST-COM.

C - Power Supplies
1 Power supplies shall be included as necessary to drive associated devices.
2 It is the responsibility of the installer to correctly size the power supplies.

D - Wireless Router
1 802.11a/b/g wireless router shall be installed in AV control rack in Authority room for interface between WiFi touchpanel and the AV controller.
2 Router shall be configured to accommodate WPA encryption.
3 Router shall be password protected to limit access by unauthorized users.

6 - AV Control system User Interface

A - Authority Room:
1 8.4" active matrix touch screen display
2 WiFi 802.11 a/b/g wireless transceiver.
3 Bluetooth Technology integrated.
4 Embedded Windows XP PC with built in Windows Media Player, RealPlayer, Internet Explorer, Adobe® Acrobat® Reader, and Microsoft Word, Excel, and PowerPoint® document viewers.
5 Isys graphics engine | 800 x 600 resolution
6 Built-in amplified speakers and microphone
7 5-way thumbpad and 4 "Softkey" buttons.
8 Li-Ion battery pack and integrated charger.
9 Shall be Crestron TPMC-8X or approved alternate.

B - Conference rooms (2)

1 Each half of the divisible conference room shall each have independent control system user interfaces, which will be configured and programmed to allow 1 interface to take control of the complete system when the rooms are combined. Consult with Owner to determine which touchpanel will be the master when rooms are combined.

2 6.4" active matrix touchscreen display

3 Isys graphics engine | 640 x 480 resolution.

4 High-performance video with gamma correction

5 Built-in amplified speakers and microphone.

6 5 engravable hard buttons.

7 Built-in light sensor.

8 Stylish flush mount design.

9 Cresnet communications.

10 Shall be Crestron TPS-3100L or approved alternate.

7 - MATRIX SWITCHING

A - Matrix Switcher for Authority Room

1 12 X 8 Matrix Switcher.

2 Inputs: Video on female BNC connectors; audio on captive screw connectors

3 Outputs: Video on female BNC connectors; audio on captive screw connectors

4 Compatible with RGBHV, RGBS, RGsB, HDTV, component video, S-video, composite video, and unbalanced/balanced stereo audio

5 RS-232 and RS-422 serial control port — Using serial commands, Matrix Switcher can be controlled and configured via the included Windows-based control software, or integrated into third-party control systems.

6 Rack-mountable metal enclosure

7 Complete system operation shall be made transparent to the end-user with all signal routing occurring under the command of the control system touch panel(s).

8 Audio for devices other than microphones shall route through Matrix switcher with output to dedicated Audio mixer.

9 Matrix switcher shall be Extron CrossPoint 300 128 HVA or approved alternate.

B - Matrix Switcher for conference rooms (1 Switcher to be shared between combinable conference rooms)

1 12 X 8 Matrix Switcher.

2 Inputs: Video on female BNC connectors.

3 Outputs: Video on female BNC connectors.

4 Compatible with RGBHV, RGBS, RGsB, HDTV, component video, S-video, composite video.

5 RS-232 and RS-422 serial control port — Using serial commands, Matrix Switcher can be controlled and configured via the included Windows-based control software, or integrated into third-party control systems.

6 Rack-mountable metal enclosure

7 Complete system operation shall be made transparent to the end-user with all signal routing occurring under the command of the control system touch panels.

8 Audio for devices other than microphones shall route through Matrix switcher with output to dedicated Audio mixer.

9 Matrix switcher shall be Extron CrossPoint 300 128 HVA or approved alternate.

8 - AUDIO MIXERS

A - Microphone inputs on audio mixers shall be automatic, only activating microphones being addressed.

B - Mixer shall have noise cancellation on each microphone input.

C - Mixer shall be capable of full duplex sound

D - Audio Mixers for Authority Room (inputs include: Authority Room head table mics, shall be two (2) ClearOne XAP 800 audio managers linked to operate as a single unit.

E - Audio from devices such as DVD players or computers shall be routed through the Extron switcher (see above) before being routed to the Audio mixer.

F - Audio Mixer for Authority Room wireless microphones shall be Shure SCM410 linked to an AUX input on one of the ClearOne XAP 800 audio manager units in the same rack.

G - Audio Mixer for Combinable Conference Rooms (inputs include: wireless microphones, wired microphones, and input devices) shall be ClearOne XAP 800 audio manager.

9 - IR EMITTERS

A - Install IR emitters and cabling from the AV control unit (CP2E or MC2W) to each DVD, VCR, and CATV tuner/cable box in the Authority room and Conference room.

10 - SCREEN CONTROL CABLING

A - Install two 2-conductor cables from the AV control unit (CP2E or MC2W) to each screen for relay control.

11 - LIGHTING CONTROL

A - Install cabling and program Authority room AV controller to integrate with RS-232 control system for Authority Room lighting.

B - See Lighting drawings for specifications on lighting control system.

12 - AV SOURCE EQUIPMENT

A - All source equipment shall be connected to the Matrix switching device in the respective closet where the source device is located.

B - DVD/VCR
1 There shall be Three (3) DVD/VCR players.
a. 1 in Authority Room AV control closet
b. 1 for each of the two Conference rooms
2 DVD/VCR shall be capable of playing CD audio, MP3 audio, and viewing of images encoded in JPEG format.
3 DVD/VCR shall have Component video outputs for DVD source material.

C - CATV controllers
1 Install CATV boxes (provided by Owner) in each AV control closet.
2 Install IR repeater in wall near touch panel mounting location and connect to flasher positioned on CATV box to allow control of cable box with IR remote supplied by CATV provider.
3 Integrate Cable box as a selectable source within the AV control system.

D - Visual Presenter
1 The Visual Presenter (Document Camera) shall be provided to allow display of printed materials on the projection displays in the Authority Room or Conference Rooms
2 The camera shall be color and have native XGA resolution of 1024 x 768.
3 The lens shall have 12x optical zoom.
4 Selectable auto/manual focus.
5 Selectable auto/manual white balance.
6 Digital image freeze.
7 Image rotation, selectable by 90, 180, 270, or 360 degrees.
8 Presenter shall have both bottom back lighting and side fluorescent lamps.
9 Shall incorporate RS-232 control interface.
10 USB interface
11 Integrate image output to the video conferencing system (see below).
12 Visual presenter shall be Samsung SDP-900 or approved alternate.

13 - MICROPHONES

A - Lectern shall have a holder for Shure SLX2/SM58 hand held microphone on an 18-inch Gooseneck.

B - Authority room table shall have (9) 12-inch gooseneck microphones on movable base between every other seating position at the table.
1 Wide dynamic range and frequency response for accurate sound reproduction across the audio spectrum.
2 Shock mount that provides over 20dB isolation from surface vibration noise.
3 Locking flange for permanently securing to the lectern.
4 Snap fit foam windscreen.
5 Shure MX412D/C (table mount).

C - Wireless microphone system

1 The wireless system shall operate in the UHF band between 524 MHz and 865 MHz.

2 Effective range of the system shall be 100 meters under optimal conditions.

3 Each system shall allow selection from 960 operating frequencies.

4 Optimal frequencies shall be selected automatically, insuring that systems run at the highest level of performance and that multiple systems in simultaneous use do not interfere with each other.

5 An infrared signal beamed from the receiver shall be used to synchronize the frequency between the transmitter and the receiver.

6 Each transmitter shall be powered by two AA batteries. Transmitters shall have a power on–off/mute switch, as well as a timed back-lit LCD showing frequency group and channel, locked/unlocked status, and battery strength.

7 Available transmitters shall include a bodypack for use lavalier, headset or instrument microphones, and a hand held transmitter for voices.

8 The bodypack shall include a 3–position switch and the hand held transmitter shall include a 2–position switch to compensate for higher- or lower-gain devices.

9 Both transmitters shall feature an easily accessible infrared port for system synchronization.

10 The receiver shall have a multi-function display showing group, channel, frequency, transmitter battery strength, and locked/unlocked status.

11 The system shall use diversity technology to improve reception, minimize signal dropouts, and achieve the best possible signal-to-noise ratio. The receiver shall include an audio level meter and an infrared port for system synchronization.

12 The system shall be the Shure SLX Wireless (note that quantities of receivers and transmitters are not equal).

a. Quantity of 4 SLX4 Receivers rack mounted in the Authority Room AV closet.

b. Quantity of 4 SLX4 Receivers rack mounted in the Conference Room AV closet.

c. Quantity of 2 SLX 2/SM58 hand held Transmitters.

d. Quantity of 4 SLX1 Bodypack Transmitters.

e. Quantity of 4 WL185 Lavalier Microphones.

13 All Transmitters shall be provided with rechargeable NiMH AA batteries and charging stations.

14 - ASSISTIVE LISTENING SYSTEM

A - Portable Transmitters

1 Provide 3 Portable transmitters.

2 Range of up to 150'.

3 Capable of broadcasting on 57 channels.

4 80dB signal to noise ratio

5 LCD display for verification of channel selection and battery status

6 Easy access mute switch

7 Uses 2 AA batteries wither alkaline of NiMH.

8 Include 2 NiMH batteries per transmitter.

9 Adjustable microphone sensitivity Switch.

10 Includes collar style microphone.

11 The portable transmitter shall incorporate automatic battery charging circuitry for recharging of NiMH batteries, with the ability to charge via a wall transformer or drop in charging case.

12 A limited lifetime warranty shall be provided.

13 Product shall be the Listen LT-700 or approved alternate.

B - Stationary Transmitter.
1 Provide 1 stationary transmitter mounted in the Authority Room AV control rack and connected to the main audio system for the lecture hall.
2 Range of up to 3000'.
3 Capable of broadcasting on 57 channels.
4 80dB signal to noise ratio
5 LCD display for verification of channel selection.
6 Mix Level control.
7 VU meter display of output level.
8 Include remote antennas mounted to the top of the AV control rack.
9 A limited lifetime warranty shall be provided.
10 Product shall be the Listen LT-800 or approved alternate.

C - Receivers
1 Provide 12 receivers.
2 Range of up to 150'.
3 Capable of receiving on 57 channels.
4 LCD display for verification of channel selection and battery status
5 Uses 2 AA batteries wither alkaline of NiMH.
6 Includes 2 NiMH batteries.
7 Adjustable squelch in 20 steps mutes audio on loss of RF signal.
8 Includes ear speaker.
9 The receiver shall incorporate automatic battery charging circuitry for recharging of NiMH batteries, with the ability to charge via a wall transformer or drop in charging case.
10 A limited lifetime warranty shall be provided.
11 Product shall be the Listen LR-400 or approved alternate.

D - Storage and Charging Case.
1 Case shall be capable of holding and recharging up to 16 receivers and or transmitters.
2 All units may be recharged simultaneously.
3 Additional storage space shall be available to hold microphones, headsets, and miscellaneous cables.
4 Case shall be lockable

15 - RACKS AND CABINETS

A - Racks in Authority Room AV control Closet room and Conference room AV closet shall be minimum of 77" high, 36" deep, and accommodate 19" rack mount equipment.

B - Racks shall be black in color.

C - Include cantilevered shelves for any equipment that does not include rack mount system.

D - Rails shall be installed on both the front and rear of each cabinet.

E - Install Rack mount power strips with enough outlets to accommodate equipment which requires 120V power plus 20% additional capacity for future use.

F - Sides and doors are not required in order to provide best possible ventilation.

16 - AV WALL PLATES

A - AV wall plates with the following connections shall be mounted as shown on the drawings in each conference room (2) the Authority Room, Authority Room Lectern (with detachable cable whip to floor outlet) and at each end of the Authority Room head table..

1 Composite video input,
2 S-Video input,
3 Stereo audio input (both RCA jacks and 1/8" mini stereo connector)
4 DB15 RGBHV pass-through.
5 XLR Microphone input.

B - Each wall plate shall be wired to the matrix switching device for the room it is located in.

C - Signals shall be amplified to insure adequate signal strength back to the control equipment.

D - The Executive Conference room shall have a Surface mount enclosure for AC power, monitor, and network connectivity flush mounted into the conference table. Coordinate installation with Electrical contractor and location with the Architect.

1 Device shall include accessories to provide:
   a. 1 AC receptacle.
   b. 1 Monitor cable (DB15 RGBHV).
   c. 1 Cat5e patch cord.

2 Device shall be Extron Cable Cubby 200 with required accessories or approved alternate.

3 Provide amplification for the monitor link to the projector.

17 - AV CABLING

A - AV control cabling shall originate in the AV control room for each space.

B - Cabling above ceilings shall be plenum rated or routed through conduits, which meet the National Electric Code requirements for routing cables through air plenum spaces.

C - Cresnet control system cabling shall be Crestron Cresnet-P cabling.
1 Cabling shall be plenum rated.
2 2 conductor 22awg control strands, plus 2 conductor 18awg power conductors.
3 Control conductors shall be shielded.
4 Control conductors shall have 100-ohm impedance.
5 Cable jacket shall be teal with yellow stripe.

D - Microphone cabling and connectivity
1 XLR connectors shall be installed in stainless steel faceplates or desktop mounting system as shown on the drawings.

2 Cabling for microphones shall be home run to the matrix switcher installed in the AV control rack.

3 Cabling for microphones shall be shielded stranded #22AWG with stranded drain wire.

18 - VIDEO CONFERENCING EQUIPMENT

A - Video Conferencing system General

1 The Video Conferencing system shall integrate the dedicated Audio and Video inputs to the facilities video and audio presentation systems.

2 In each room (Authority room, Conference rooms 1 and 2) the digital projector and room audio systems shall be utilized for the presentation of remote images and audio.

3 The system shall be configured to connect either through an IP connection or via ISDN as selected by the user.

B - Videoconferencing system.

1 Shall incorporate
- a. Integrated 5" LCD display
- b. Precision HD Camera
- c. Microphone
- d. Digital Natural Audio Module
- e. Integrated cabling
- f. Cart

2 Shall be ITU H.323 and H.320 compliant

3 Shall allow up to 6 video inputs including:
- a. 1 x HD Main Camera or
- b. 1 x MiniDin, S-video: main camera
- c. 1 x MiniDin, S-video: auxiliary/document camera
- d. 1 x RCA/Phono, composite: document camera/aux
- e. 1 x RCA/Phono, composite: VCR
- f. 1 x DVI-I: PC

4 Video Outputs: 6
- a. 1 x MiniDin, S-video: main monitor
- b. 1 x MiniDin, S-video: dual monitor
- c. 1 x RCA/Phono, composite: main monitor or VCR
- d. 1 x RCA/Phono, composite: dual monitor or VCR
- e. 2 x DVI-I/XGA: main and dual monitor XGA OUTPUT

5 Serial Data Port: 2 DB9 Connectors control port for integration with AV control system.

6 View presentations and presenter simultaneously with DuoVideo and H.239 Dual Stream

7 Audio Features:
- a. Audio add-in over ISDN or POTS
- b. Full-duplex digital audio
- c. Instant Adaptation Echo Cancellation
- d. Automatic Gain Control (AGC) – Voice activated
- e. Automatic Noise Suppression (ANS)
- f. Ability to turn off Echo Cancellation when external audio equipment is used
- g. Audio Mixer (Mic, VCR, line-in)
- h. Built-in tonal speaker test
- i. Real-time audio level meter for local and far-end microphones

j. Microphone and VCR input audio mixing
k. Ability to talk over VCR audio

8 Audio Inputs: 4 Connectors
a. Audio input to the videoconferencing system shall be through the AV control system.
b. Any Microphone jack location shall be able to be patched into the videoconferencing system.
c. 3 x microphone, 24V phantom powered, XLR connector, each with separate echo cancellers
d. 1 x RCA/Phono, Line Level: separate echo canceller
e. 1 x RCA/Phono, Line Level: auxiliary (or VCR/DVD Stereo L)
f. 1 x RCA/Phono, Line Level: VCR/DVD (Stereo R)

9 Audio Outputs: 3 Connectors
a. 1 x RCA/Phono, S/PDIF (mono/stereo) or Analogue Line Level: main audio or Analogue Stereo L
b. 1 x RCA/Phono, Line Level: auxiliary (or Analogue Stereo R or VCR Stereo L)
c. 1 x RCA/Phono, Line Level: VCR (mono or Stereo R)

10 Network Interfaces:
a. SIP Support (Session Initiation Protocol)
b. IP (LAN, DSL, cable modem)
c. Single 10/100 Ethernet port (10 Mbps/100Mbps/Auto)
d. ISDN QBRI (Basic Rate Interface) Module

C - Videoconferencing Camera
1 7 x zoom 1/3" CMOS +10°/-20° tilt +/- 90° pan
2 42° vertical field of view
3 72° total vertical field of view
4 70° horizontal field of view
5 250° total horizontal field of view
6 Focus distance 0.3m–infinity
7 1280 x 720 pixels progressive @ 30fps
8 Automatic or manual focus/brightness/white balance
9 Far-end camera control
10 15 near and far-end camera presets
11 Voice-activated camera positioning
12 Daisy-chain support (Visca protocol camera)

D - Videoconferencing system shall be Tandberg Maestro MXP or approved alternate.

E - Pricing for Videoconferencing system shall be provided as an add alternate to the base AV systems bid.

PART 3 - EXECUTION

1 - INSTALLATION

A - General: All equipment shall be mounted according to manufacturers recommendations, using the specific brackets and assemblies required to insure that equipment is securely and safely fastened in place.

B - All cabling shall be routed in conduit to the device it is connecting unless specifically noted otherwise. Conduit shall be provided and installed by the Electrical Contractor.

C - All voice, data, and AV cables to be home run from Device to the AV control room unless otherwise noted on plans.

D - No splices are allowed in any voice or data cables.

E - When not in conduit or tray, support cables to the deck and/or beams, with no more than five feet between each cable support throughout the length of the installed run. Use J-hooks to group the cables in bundles. Ensure that hangers, ties, and other methods of securing cable do not compress cable or damage insulation.

F - Tie wraps shall be used to maintain clear and organized cable management throughout the installation. Care should be taken not to over-tighten tie wraps. Hook and loop tie wraps shall be used exclusively in and around racks and enclosures to enable moves, adds, and changes in the future.

G - Attach to beams with minimal disruption to any fireproofing. The installer will be responsible to restore ALL fireproofing to appropriate levels, including penetrations of fire rated walls and disruption of any protective coatings on building structures.

H - Support wires for other systems including the ceilings may not be used to support the cabling.

I - Make cable routes with 90 degree sweeps whenever possible; do not install cables randomly or diagonally across rooms or through the building(s).

J - Manufacturer recommended minimum bend radius shall be maintained whenever cables enter or leave conduits, boxes, cable trays, racks, or other raceways.

K - Route station cables to fixed wall locations through EMT to back box provided by electrical. Be sure to provide a bushing on any exposed conduit ends which cable is to be routed through to insure that cable jacket is not damaged during installation or over time.

L - Whenever cable is routed through rough openings (such as through steel studs) be sure to provide bushings or protective grommets to insure that cable jacket is not damaged either during installation or over time.

M - Install plastic bushings on all exposed conduit ends.

N - Cable routing shall avoid areas of potential high temperatures. Areas of concern are hot water pipes, areas adjacent to roofs, and south facing eves.

O - Projection Screen Installation:

1 Projection screens shall be installed by the General Contractor at locations indicated.

2 AV system installer shall connect low-voltage controls according to NFPA 70 and manufacturers written instructions.

a. Wiring Method: Install wiring in raceway except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Use UL-listed plenum cable in environmental air spaces, including plenum ceilings. Conceal raceway and cables except in unfinished spaces.

3 Test electrically operated units to verify that screen controls, limit switches, closure, and other operating components are in optimum functioning condition.

4 Connect screen control cabling to AV control system relays in AV control rack.

2 - LABELING

A - All AV cabling shall be clearly labeled within 12-inches of each end of the cable.

B - Labeling scheme shall define each cable run based on originating location on the device to which it is connected in the AV closet.

C - Labels shall be mechanically reproduced and resistant to smudging and rubbing off. Handwritten labeling is unacceptable.

D - The labeling requirements apply to all AV cable runs.

3 - PROGRAMMING

A - Programming of the AV control systems shall be reviewed by the AV systems consultant on this project.

B - The control system shall be configured to simplify the operation of all AV devices.

1 Often the AV system will be operated by individuals who are unfamiliar with this particular system.

2 Start-up, shut-down, and operation of all devices shall be automated.

3 Any source device shall be capable of being displayed through any output device throughout a given room or in any combination in the combinable meeting rooms.

4 Operation of touch panels shall include clear instructions, for any functions a presenter would need to perform.

C - Remote support

1 All systems shall be controllable from a remote room over the IT network.

2 The means to reach tech support from any of the AV control panels shall be clearly defined.

3 Tech support request shall be available through both control screens and via telephone.

4 Tech support phone number shall be mechanically reproduced, clearly labeled and mounted at the lectern, AV control room, and each control panel in the meeting rooms.

5 Terms for remote tech support shall be provided as an add alternate to the base price for AV systems.

4 - PROTECTING AND CLEANING

A - After installation, protect all Multimedia Equipment from damage during construction. If damage occurs despite such protection, remove and replace damaged components or entire unit as required to provide units in their original, undamaged condition.

B - Before scheduling the final inspection, remove all tools, equipment, surplus materials, and rubbish. Restore or refinish surfaces that are damaged due to work of this contract to original condition. Remove grease, dirt, stains, foreign materials, and labels from finished surfaces. Thoroughly clean building interiors. Pick up all construction debris from the site. At time of final inspection, project shall be thoroughly clean and ready for use.

C - All Multimedia devices shall be cleaned immediately prior to the overall project completion.
1 Projector screens shall be inspected and cleaned as necessary.
2 AV control cabinets shall be cleaned
3 The Lectern shall be cleaned both internally and externally.
4 Clean all projector lenses and insure that filters for any AV equipment are clean immediately prior to overall project completion.

5 - CALLIBRATION

A - All projectors shall be calibrated according to ISF standards.

6 - OPERATION AND MAINTENANCE DATA

A - See Division 1 for Operations and Maintenance requirements.

7 - SYSTEM DEMONSTRATION AND TRAINING

A - The work of this section consists of demonstrating systems and equipment to operating personnel. It also includes training of personnel. See Division 1 for training requirements.

B - Video Recording
1 Record all of the above sessions with high-resolution equipment.
2 The instructor's voice shall be clearly audible and understandable on the disc.
3 Videodiscs with poor video or audio quality will be rejected and the training recorded again.

DEVICE CONNECTION OUTLINE

Authority Room

Input Devices
Wireless Mobile control touchscreen
Mics wired to head table (9)
RF mics for lectern and lavaliere (4 receivers)
DVD (component + Audio)
VCR (composite + Audio)
PC in Rack (Monitor + Audio)
Two Input locations for:
-RGB on DB-15, Audio (Dual RCA AND 1/8" jack), S-vid, Composite Video
CATV box (S-Vid + Audio) (provided by owner)

Control, Routing and amplification
12X8 HVA mixer
Wireless mic mixer
Audio Mixers
Audio Amplifier
Power Supplies
ST-COM expansion modules

Output Devices
Dual projectors (display same or separate sources)
Speakers in drop ceiling and on beams in center

RS 232 Connections
Projector 1
Projector 2
Lighting (Lutron)
XAP-800 Audio Matrix
HVA Matrix Switcher

Combinable Meeting Rooms

Input Devices
Wall mount controllers (need to determine master?)
RF mics for lectern and lavaliere (4 receivers)
DVD (component + Audio)
VCR (composite + Audio)
CATV box (S-Vid + Audio) (provided by owner)
Two Input locations for:
-RGB on DB-15, Audio (Dual RCA AND 1/8" jack), S-vid, Composite Video

Control, Routing and amplification
12X8 HVA mixer
Wireless mic mixer
Audio Mixers
Audio Amplifier
Power Supplies
ST-COM expansion modules

Output Devices
Dual projectors (display same or separate sources)
Speakers in drop ceiling

RS 232 Connections
Projector 1
Projector 2
XAP-800 Audio Matrix
HVA Matrix Switcher

Executive Conference room

Overhead projector
Monitor, Network, and power access in table
No Audio
Amplifier for Monitor signal to projector.

Videoconferencing system

Add alternate.

END OF SECTION 16800