

Specifications

Volume 3 of 3

UConn HEALTH

Building C Renovation
Farmington, CT

(UConn Project # 901737)

BID DOCUMENTS

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SECTION 250500

BASIC MATERIALS AND METHODS

PART 1 GENERAL

1.01 PROVISIONS INCLUDED

- A. Include General Conditions, Supplementary General Conditions Division 0 and applicable parts of Division 01 for conditions and Section 019113 Commissioning and requirements which may affect the work of this Section.
- B. Examine all other Sections of the specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.
- C. Coordinate work with that of all other Trades affecting, or affected by work of this Section. Cooperate with such Trades to ensure the steady progress of all work under the Contract.
- D. Refer to Section 23 0510, 3D Building information modeling , for additional coordination and record drawing scope that is required to be performed by the ATC Contractor.

1.02 DEFINITIONS

- A. Words in the singular shall also mean and include the plural, wherever the context so indicates and words in the plural shall mean the singular, wherever the context so indicates.
- B. Wherever the terms "shown on drawings" are used in the specifications, they shall mean "noted", "indicated", "scheduled", "detailed", or any other diagrammatic or written reference made on the drawings.
- C. Wherever the term "provide" is used in the specifications it will mean "furnish" and "install", "connect", "apply", "erect", "construct", or similar terms, unless otherwise indicated in the specifications.
- D. Wherever the term "material" is used in the specifications it will mean any product", "equipment", "device", "assembly", or "item" required under the Contract, as indicated by trade or brand name, manufacturer's name, standard specification reference or other description.
- E. The terms "approved", or "approval" shall mean the written approval of the Architect.
- F. The term "specification" shall mean all information contained in the bound or unbound volume, including all "Contract Documents" defined therein, except for the drawings.
- G. The terms "directed", "required", "permitted", "ordered", "designated", "prescribed" and similar words shall mean the direction, requirement, permission, order, designation or prescription of the Architect. The terms "approved", "acceptable", "satisfactory" and similar words shall mean approved by, acceptable or satisfactory to the Architect. The terms "necessary", "reasonable", "proper", "correct" and similar words shall mean necessary, reasonable, proper or correct in the judgment of the Architect.
- H. "Piping" includes in addition to pipe or mains, all fittings, flanges, unions, valves, strainers, drains, hangers and other accessories relative to such piping.

- I. Algorithm: A logical procedure for solving a recurrent mathematical problem; A prescribed set of well-defined rules or processes for the solution of a problem in a finite number of steps.
- J. Analog: A continuously varying signal value (e.g., temperature, current, velocity etc).
- K. BACnet: Building Automation Control Network Protocol, ASHRAE Standard 135.
- L. Baud: It is a signal change in a communication link. One signal change can represent one or more bits of information depending on type of transmission scheme. Simple peripheral communication is normally one bit per Baud. (e.g., Baud rate = 78,000 Baud/sec is 78,000 bits/sec, if one signal change = 1 bit).
- M. BIBB's: BACnet Interoperability Building Block.
- N. Binary: A two-state system where a high signal level represents an "ON" condition and an "OFF" condition is represented by a low signal level.
- O. "Concealed" means hidden from sight in chases, furred spaces, shafts, hung ceilings, embedded in construction or in crawl spaces.
- P. Deadband: A temperature range over which no heating or cooling is supplied, i.e., 22-25 degrees C (72-78 degrees F), as opposed to a single point change over or overlap).
- Q. Diagnostic Program: A software test program, which is used to detect and report system or peripheral malfunctions and failures. Generally, this system is performed at the initial startup of the system.
- R. Direct Digital Control (DDC): Microprocessor based control including Analog/Digital conversion and program logic. A control loop or subsystem in which digital and analog information is received and processed by a microprocessor, and digital control signals are generated based on control algorithms and transmitted to field devices in order to achieve a set of predefined conditions.
- S. Distributed Control System: A system in which the processing of system data is decentralized and control decisions can and are made at the subsystem level. System operational programs and information are provided to the remote subsystems and status is reported back to the Engineering Control Center. Upon the loss of communication with the Engineering Control center, the subsystems shall be capable of operating in a stand-alone mode using the last best available data.
- T. Download: The electronic transfer of programs and data files from a central computer or operation workstation with secondary memory devices to remote computers in a network (distributed) system.
- U. Electrical Control: A control circuit that operates on line or low voltage and uses a mechanical means, such as a temperature sensitive bimetal or bellows, to perform control functions, such as actuating a switch or positioning a potentiometer.
- V. Electronic Control: A control circuit that operates on low voltage and uses a solid-state components to amplify input signals and perform control functions, such as operating a relay or providing an output signal to position an actuator.

- W. Ethernet: A trademark for a system for exchanging messages between computers on a local area network using coaxial, fiber optic, or twisted-pair cables.
- X. "Exposed" means not installed underground or "concealed" as defined above.
- Y. "Invert Elevation" means the elevation of the inside bottom of the pipe.
- Z. "HVAC, Plumbing, and/or Fire Protection Contractor" shall refer to the Contractor or his Subcontractors responsible for furnishing and installation of all work indicated on the HVAC, Plumbing, and/or Fire Protection drawings and specifications, as applicable and or referenced to each Trade in the Architectural and/or Structural documents.
- AA. I/O Unit: The section of a digital control system through which information is received and transmitted. I/O refers to analog input (AI), digital input (DI), analog output (AO) and digital output (DO). Analog signals are continuous and represent temperature, pressure, flow rate etc, whereas digital signals convert electronic signals to digital pulses (values), represent motor status, filter status, on-off equipment etc.
- BB. I/P: Internet Protocol-global network, connecting workstations and other host computers, servers etc. to share the information.
- CC. Local Area Network (LAN): A communication bus that interconnects operator workstation and digital controllers for peer-to-peer communications, sharing resources and exchanging information.
- DD. NAC – Network Application Controller: This controller shall have all the functions of a Network Automation Controller but shall also have direct input/output capabilities for operating large equipment in a stand alone fashion.
- EE. NAN – Network Automation Node: A stand-alone, multi-tasking, multi-user, real-time digital processor complete with all hardware, software, and communications interfaces to manage network traffic between Tier 1 and Tier 2 controllers.
- FF. Network: A set of computers or other digital devices communicating with each other over a medium such as wire, coax, fiber optics cable etc.
- GG. "Mechanical Contractor" shall refer to the Fire Protection, Plumbing, HVAC and ATC Contractors, as applicable.
- HH. MS/TP: Master-slave/token-passing.
- II. Operating system (OS): Software, which controls the execution of computer application programs.
- JJ. Peer-to-Peer: A networking architecture that treats all network stations as equal partners.
- KK. PICS: BACnet Protocol Implementation Conformance Statement.
- LL. UAC: Unitary Application Controller, digital controller, dedicated to a specific piece of terminal equipment, such as VAV boxes, fan coil units, etc.
- MM. "Architect" shall refer to the Architect "ARC" (Joint Venture) and/or Engineer "Bard, Rao + Athanas Consulting Engineers, LLC" and/or Owner.

- NN. "Owner" shall refer to the designated representatives of the Project Owner, University of Connecticut Health Center.
- OO. "Construction Manager" shall refer to the Construction Manager (CM) "Turner Construction" for this project.
- PP. "Commissioning Agent (CA)" shall refer to project Commissioning Agent, SSRCx, employed by the Owner to witness demonstration or performance for all systems in accordance with the Commissioning plan. Refer to Section 019113.

1.03 CODES, STANDARDS AND REFERENCES

- A. All materials and workmanship shall comply with all applicable Codes, Specifications, Local and State Ordinances, Industry Standards and Utility Company Regulations, latest editions.
- B. In case of difference between Building Codes, State Laws, Local Ordinances, Industry Standards and Utility Company Regulations and the Contract Documents, the Mechanical Contractor, as applicable, shall promptly notify the Architect in writing of any such difference.
- C. In case of conflict between the Contract Documents and the requirements of any Code or Authorities having jurisdiction, the most stringent requirements of the aforementioned shall govern for budgetary purposes. However, no work will proceed until the Architect determines the correct method of installation.
- D. Should any Contractor, as applicable, perform any work that does not comply with the requirements of the applicable Building Codes, State Laws, Local Ordinances, Industry Standards and Utility Company Regulations, he shall bear all costs arising in correcting the deficiencies, as approved by the Architect.
- E. Applicable Codes and Standards shall include all State Laws, Local Ordinances, Utility Company Regulations and the applicable requirements of the following accepted Codes and Standards, without limiting the number, as follows:
1. National Electrical Code (NEC)
 2. Environmental Protection Agency (EPA)
 3. Connecticut Environmental Air Quality Protection Agency
 4. Connecticut Energy Code
 5. Connecticut Building Code/IBC (Latest Adopted Edition), including all adopted Connecticut Supplements
 6. Connecticut Fire Prevention Regulations and Elevator Regulations
 7. Local Ordinances, Regulations of the Local Building Department and Fire Department
 8. Guidelines for Construction and Equipment of hospital and Medical Facilities, as published by the Facilities Guidelines Institute, ISBC 978-0-87258-859-2.
 9. Recommendations of the National Fire Protection Association (NFPA), latest applicable edition adopted, in general and in particular:
 - a. Life Safety, NFPA 101
 - b. HVAC, NFPA 90A, 90B
 - c. Removal of Smoke and Grease Laden Vapors from Commercial Cooking Equipment, NFPA 96
 - d. Hospitals, NFPA 99

10. Recommendations of ASHRAE (American Society of Heating, Refrigeration and Air Conditioning Engineers), including:
 - a. ASHRAE 90.1
 - b. ANSI/ASHRAE 62-Ventilation for Acceptable Indoor Air Quality
 - c. ANSI/ASHRAE 15-Safety Code for Mechanical Refrigeration
 - d. ANSI/ASHRAE 110-Method of Testing Performance of Laboratory Fume Hoods
 - e. ANSI/ASHRAE 55-Thermal Environmental Conditions for Human Occupancy
 - f. ANSI/ASHRAE 170 – Ventilation of Health Care Facilities
11. Americans with Disabilities Act, ADA
12. CDC Guidelines for Preventing the Transmission of Mycobacterium Tuberculosis in Health Care Facilities 2005.
13. Guidelines for Infection Control in Health Care Facilities Recommendations of CDC and the Healthcare Infection control Practices Advisory Committee (HICPAC).
14. U.S. Department of Health and Human Services for disease Control and Prevention (CDC).

F. In these specifications, references made to the following Industry Standards and Code Bodies are intended to indicate the accepted volume or publication of the Standard. All equipment, materials and details of installation shall comply with the requirements and latest revisions of the following Bodies, as applicable:

- | | | |
|-----|--------|---|
| 1. | AMCA | Air Moving and Conditioning Association |
| 2. | ANSI | American National Standards Institute |
| 3. | ARI | American Refrigeration Institute |
| 4. | ASHRAE | American Society of Heating, Refrigeration and Air Conditioning Engineers |
| 5. | ASME | American Society of Mechanical Engineers |
| 6. | ASTM | American Society of Testing Materials |
| 7. | AWS | American Welding Society |
| 8. | CS | Commercial Standards, U.S. Department of Commerce |
| 9. | FM | Factory Mutual |
| 10. | FS | Federal Specification, U.S. Government |
| 11. | MSS | Manufacturers Standardization Society of the Valve and Fittings Industry |
| 12. | NEMA | National Electrical Manufacturers Association |
| 13. | SMACNA | Sheet Metal and Air Conditioning Contractor's National Association |
| 14. | UL | Underwriters' Laboratories, Inc. |
| 15. | IRI | Industrial Risk Insurer's |
| 16. | CDA | Copper Development Association |
| 17. | CISPI | Cast Iron Soil Pipe Institute |
| 18. | NSF | National Sanitation Foundation |
| 19. | CGA | Compressed Gas Association |
| 20. | OSHA | Occupational Safety and Health Act |

G. Each Contractor for the work under his charge, shall give all necessary notices, obtain and pay for all permits, pay all governmental taxes, fees and other costs in connection with his work; file for necessary approvals with the jurisdiction under which the work is to be performed. Each Contractor shall obtain all required Certificates of Inspection for his work and deliver same to the Architect before request for acceptance of his portion of work and before final payment is made.

- H. All equipment shall be installed per manufacturer's recommendations and requirements. The Contractor shall notify the Engineer in writing when they intend to deviate from manufacturer's installation guidelines. The Engineer shall advise if the installation is acceptable prior to installation.

1.04 SUBMITTALS

- A. Submit detailed shop drawings or brochures for approval of equipment and material proposed to be used on this project. Furnish the number of copies required by General Conditions.
- B. Documents submitted shall show the following:
 - 1. Principal dimensions and details of construction.
 - 2. Operating and maintenance clearances.
 - 3. Weights of principal parts and total weights with information required for the design of supports and foundations.
 - 4. Sizes and location of piping and connections.
 - 5. Performance data, including pump and fan curves; sound data including sound power dB levels in 1/3 octave bands.
 - 6. Data on electric motors, including brake horsepower of driven equipment, nameplate ratings and classes, sound data, starting and running full load currents, required starter size and recommended overload heater ratings.
 - 7. Approval stamp of Underwriters' and other authorities having jurisdiction of Contract Drawings requiring such approval.
 - 8. Certified performance guarantees.
 - 9. Calculations and details for refrigeration for field assembled systems including description of specialties and pressure drops, layout of piping with lengths fittings, and refrigerant specialties, and capacity curves for evaporator and compressor showing balance points.
 - 10. Minimum scale for sheet metal plans and piping plans shall be ¼ inch equal 1 foot.
- C. Submit brochures that contain only that information which is relative to the particular equipment or materials to be furnished. Do not submit catalogs that describe several different items other than those items to be used unless irrelevant information is marked out and relevant material is clearly marked.
- D. Specifications Compliance Statement
 - 1. The manufacturer shall submit a point by point statement of compliance with the specifications.
 - 2. The statement of compliance shall consist of a list of all paragraphs (line by line).
 - 3. Where the proposed system complies fully, such shall be indicated by placing the word "comply" opposite the paragraph number.
 - 4. Where the proposed system does not comply, or accomplishes the stated function in a manner different from that described, a full description of the deviation shall be provided.
 - 5. Where a full description of a deviation is not provided, it shall be assumed that the proposed system does not comply with the paragraph in question.
 - 6. Submissions which do not include a point by point statement of compliance as specified shall be disqualified.
- E. Shop drawing data shall include, but not be limited to, the following:
 - 1. Manufacturer's model and catalog data.
 - 2. Complete connection diagrams for all Trades.

3. Dimensions, capacities, ratings, materials, finishes, etc.
- F. Each shop drawing is required to bear the review stamp of the Contractor associated with installing the equipment and/or processing the document, as well as the Construction Manager's review stamp.
- G. Shop drawings shall include, but shall not be limited to, the following:
1. Automatic temperature control system complete with catalogue cuts and bill of materials, wiring and piping diagrams, system schematics, and detailed written description of sequences of operation. Hardware and software including interfaces with all Mechanical/Electrical systems.
 2. Hangers, supports, expansion compensators, guides, anchor details.
 3. Additional samples and shop drawing submittals, as requested by the Architect.
 4. Valve and pipe identification charts, tags, markers.
 5. Nameplates.
 6. Coordination Drawings and record "as-built" drawings by CAD.

1.05 GUARANTEE

- A. Attention is directed to provisions of the General Conditions and Supplementary General Conditions regarding guarantees and warranties for work under this Contract.
- B. Manufacturers shall provide their standard guarantees for work under this Contract, unless specified otherwise. However, such guarantees shall be in addition to and not in lieu of all other liabilities which the manufacturer and CM may have by Law or by other provisions of the Contract Documents. In any case, such guarantees and warranties shall commence when the Owner accepts the various systems, as applicable and as determined by the Architect.
1. The guarantees and warranties will remain in effect for a minimum period of (1) year thereafter except where longer periods are specifically stated and specified.
 2. Should the Contractor elect to operate any equipment prior to substantial completion, the operation of said equipment will not modify the commencement of the manufacturer's standard guarantees post substantial completion. The Contractor shall assume all maintenance for equipment operated during the interim period prior to substantial completion. For any equipment that may be operated prior to substantial completion, the Contractor shall provide a maintenance plan as part of the submittal process. Maintenance plan shall include a listing of tasks and a schedule for performing those tasks. Said maintenance plan must be approved by the Owner and Architect prior to operation of equipment.
 3. All warranties for all equipment shall begin at the time that the equipment is TURNED OVER TO AND ACCEPTED BY THE Owner. The use of equipment by the Contractor for the purposes of completion of the building, testing and evaluation of the system prior to turnover to the Owner, or partial completion of systems shall, in no way, be construed as "accepted by the Owner". The Contractor shall include in his cost the value of extending the warrantee period to ensure that the warrantee period begins when the equipment is Owner accepted and ends according to the Contract.
- C. All materials, items of equipment and workmanship furnished under HVAC, shall carry the warranty against all defects in material and workmanship. Any fault due to defective or improper material, equipment, workmanship or design which may develop shall be made good, forthwith, by and at the expense of the Contractor responsible, including all other damage done to areas, materials and other systems resulting from this failure.

- D. Each Contractor shall guarantee that all elements of the systems provided under his Contract, are of sufficient capacity to meet the specified performance requirements as set forth herein or as indicated on the drawings.
- E. Upon receipt of notice from the Owner of failure of any part of the systems or equipment during the guarantee period, the affected part or parts shall be replaced by the responsible Contractor.
- F. Each Contractor shall furnish, before the final payment is made, a written guarantee covering the above requirements.

1.06 COMMISSIONING

- A. The ATC Contractor must also include sufficient man-hours within their bids, for their participation with the Commissioning Agent, SSRC and the rebalancing/readjusting/resetting all device setpoints, as required. For additional work, refer to Division 1, Section 019113 Commissioning.

1.07 THE CONTRACTOR

- A. Each Contractor shall base his bid on site examinations performed by him. This requirement is mandatory. Each Contractor shall visit the proposed site where work is scheduled to be performed and ascertain for himself the amount of work required to fulfill the intent of his Contract and the complexity of the installation. Each Contractor shall not hold the Architect, his Consultants, agents or employees responsible for or bound by, any schedule, estimate or for any plan thereof. Each Contractor shall study all Contract Documents (HVAC, Plumbing, Fire Protection, Electrical, Communications, Architectural, Structural), etc., included under each Contract, to determine exactly the extent of work to be provided under each Section, and in installing new equipment and systems and coordinating the work with the other Trades and existing conditions.
- B. Each Contractor shall faithfully execute his work according to the terms and conditions of the Contract and specifications and shall take all responsibility for and bear all losses resulting to him in the execution of his work.
- C. Each Contractor shall be responsible for the location and performance of work provided under his Contract as indicated on the Contract Documents. All parties employed directly or indirectly by each Contractor shall perform their work according to all the conditions as set forth in these specifications.
- D. Each Contractor shall furnish all materials and perform all work in accordance with the project specifications and any supplementary documents provided by the Architect. The work shall include every item shown on the drawings and/or required by the specifications as interpreted by the Architect. All work and materials furnished and installed shall be new and of the best quality and workmanship. Each Contractor shall cooperate with the Architect so that no error or discrepancy in the Contract Documents shall cause defective materials to be used or poor workmanship to be performed.

1.08 COORDINATION OF WORK

- A. Each Contractor shall compare his drawings and specifications with those of other Trades and report any discrepancies between them to the Architect and obtain from the Architect written instructions for changes necessary in the mechanical or electrical work, to ensure that all work is installed in coordination and cooperation with other Trades installing interrelated work.

Before installation, each Contractor shall make proper provisions to avoid interferences in a manner approved by the Architect. All changes required in the work of each Contractor caused by his negligence, shall be corrected by him at his own expense, to the Architect's satisfaction.

- B. Locations of piping, ductwork, conduits and equipment shall be adjusted to accommodate the new work with interferences anticipated and encountered during installation. Each Contractor shall determine the exact routing and location of his systems prior to fabrication or installation of any system component. Accurate measurements and coordination drawings will have to be completed to verify dimensions and characteristics of the various systems' installations.
- C. Lines which pitch shall have the right-of-way over those which do not pitch. For example, waste piping shall normally have the right-of-way. Lines whose elevations cannot be changed shall have the right-of-way over lines whose elevations can be changed.
- D. Offsets, transitions and changes of direction in all systems shall be made as required to maintain proper headroom and pitch of sloping lines whether or not indicated on the drawings. Each Contractor shall provide manual air vents and drains as required for his work to affect these offsets, transitions and changes in direction, as applicable.
- E. All work shall be installed in a way to permit removal (without damage to other parts) of coils, filters, control appurtenances, fan shafts and wheels, filters, belt guards, sheaves and drives and all other system components provided under this Contract requiring periodic replacement or maintenance. All piping shall be arranged in a manner to clear the openings of swinging overhead access doors, ceiling tiles and cleaning access doors in ductwork.
 - 1. Access to any and all components requiring servicing, adjustment, calibration, maintenance or periodic replacement shall be provided so that the Owner's operations personnel can freely gain access without removal of any materials other than the access panel or ceiling tile. Access shall be understood to mean free, clear and unobstructed from the floor up to the device and/or component being serviced. Access panels for VAV/CV boxes shall be 24" x 24" minimum.
 - 2. Fire rated access doors with closers shall be provided for all rated assemblies.
- F. The Contract Drawings are diagrammatic only intending to show general runs and locations of piping, ductwork, equipment, terminals and specialties and not necessarily showing all required offsets, details and accessories and equipment to be connected. All work shall be accurately laid out with other Trades to avoid conflicts and to obtain a neat and workmanlike installation which will afford maximum accessibility for operation, maintenance and headroom.
- G. Where discrepancies in scope of work as to what Trade provides items, such as starters, disconnects, flow switches, electric control components, etc., exist, such conflicts shall be reported to the Architect prior to signing of the Contract. If such action is not taken, each Contractor, as applicable, shall furnish such items as part of his work, for complete and operable systems and equipment, as determined by the Architect.
- H. Where drawing details, plans and/or specification requirements are in conflict and where pipe or duct sizes of same pipe or duct run are shown to be different between plans and/or between plans and sections or details, the most stringent requirement will be included in the Contract. HVAC systems and equipment called for in the specification and/or shown on the drawings shall be provided under this Contract as if it were required by both the drawings and specifications. However, prior to ordering or installation of any portion of work which appears to be in conflict, such work shall be brought to Architect's attention for direction as to what is to be provided.

- I. Final location of all air distribution devices, thermostats, heaters, control devices, sprinkler heads, etc., shall be coordinated with the Architectural reflected ceiling plans and/or other Architectural details, as applicable. (**Note:** Sprinkler head locations shall provide the specified coverage rating and water flow density, and shall be in accordance with all applicable Codes and in full compliance with the requirements of the Owner's insurance carrier.) Offsets of ductwork, added sheet metal, fittings, elbows, flexible connections, etc., shall be provided as required to comply with the Architectural reflected ceiling plans and/or installation details. Obtain approval of locations of all devices from Architect in the field, prior to installation.
- J. Medical equipment and/or hoods, dishwashers, etc., or other type of equipment shown on the Plumbing, Fire Protection, HVAC and/or Architectural drawings to be provided with services, such as exhaust ductwork, piping, traps, drains, valves, etc., shall be included under this Contract as applicable, including all piping or ductwork connections to systems, to make equipment completely operable. Additional sheet metal, flexible fittings, etc., shall be provided to accomplish the above requirement, as required, all as part of this Contract, at no additional cost to the Owner.

1.09 COORDINATION DRAWINGS

- A. Before materials are purchased, fabricated or work is begun, each Contractor shall prepare coordination drawings for all floors/areas, including buried systems/services (all-Trade-composite at ¼" scale), showing the size and location of his equipment and lines, in the manner described herein under General Requirements.
 - 1. Refer to Section 230510 for 3D Building Information Scope.
- B. Coordination drawings are for the CM and Architect's use during construction and shall not be construed as shop drawings or as replacing any shop drawings. The coordination drawings, when corrected for actual "as-built" conditions, will be reviewed by the Architect, corrected and become the Record Drawings to be submitted to the Owner for his use.
- C. The cost of producing and reproducing the drawings will be included under the Contract of each Trade, including the cost or preparation of the Architectural building outlines. This process may include multiple revisions to these drawings which will be included in the cost. The intent is to provide a fully coordinated set of documents between trades no matter how many times they may have to be redone. The HVAC Contractor shall take the lead to produce the Architectural backgrounds, show all ductwork, piping, etc., and circulate the drawings to any of his Subcontractors and the other Trades (Plumbing, Fire Protection, Electrical), so that they can indicate all their work as directed by the CM and Architect as required, to result in a fully coordinated installation.
- D. In addition to the regular coordination drawing review, the mechanical work will also be reviewed by the Architect/Engineer to ensure that the system and equipment arrangements are suitable to provide maintenance access and service as follows:
 - 1. Valves and instrumentation should be grouped where possible and positioned in accessible locations.
 - 2. Valves on pipes of 6" and larger, positioned above 7'-0" in height from the operating level, will be provided with chain operated valve wheels and be located where chains will not interfere with primary access through the mechanical room.
 - 3. Location of control/diagnostic panels shall be shown and identified on the mechanical room coordination drawings.

- E. Prepare a complete set of computer based drawings:
1. Format shall be:
 - a. REVIT (Latest Version)
 2. Scale not less than ¼" scale equals 1'-0", showing basic layout for the structure and other information as needed for preparation of Coordination Drawings.
 3. The drawings shall indicate the layout of all specialty tradework as indicated herein and shall be designated as Coordination Drawings.
 4. Any drawing provide to assist the contractor will require:
 - a. A signed liability release form will be required from the Contractor prior to the release of the disk from the Engineer.
 5. For 3-D projects see Section 230510 "3D Building information" for additional information
- F. Highlight all smoke and fire rated partitions on the Coordination Drawings for appropriate coordination.
- G. The main paths for the installation or removal of equipment from mechanical and electrical rooms shall be clearly indicated on the Coordination Drawings.
- H. Each of the specialty trades shall add its work to the base drawings with appropriate elevations and grid dimensions. Specialty trade information shall be required for fan rooms and mechanical rooms, horizontal exits from duct shafts, crossovers and for spaces it the above ceilings where congestion of work may occur such as corridors and, where required, entire floors. Drawings shall indicate horizontal and vertical dimensions to avoid interference with structural framing, ceilings, partitions and other services. Indicate elevations relative to finish floor for bottom of ductwork and piping and conduit 6" greater in diameter.
1. Specialty Trade shall include:
 - a. Plumbing system.
 - b. HVAC piping and associated control systems.
 - c. Electrical.
 - d. Sheet Metal Work.
 - e. Fire Protection system.
 - f. Automatic Temperature Control
 - g. Fire Alarm
 - h. Security
 - i. Telecommunications
 - j. Pneumatic Tube
 - k. Commissioning
- I. Upon completing their portion of the Coordination Drawings, each specialty trade shall sign, date and return Coordination Drawings to the Contractor.
- J. Where conflicts occur with placement of materials of various trades, the CM shall be responsible to coordinate the available space to accommodate all trades. Any resulting adjustments shall be initialed and dated by the affected specialty trade Subcontractor. The CM shall then final date and sign each drawing.

- K. Fabrication shall not start until Coordinate Drawings have been distributed to all parties as indicated herein.
- L. Distribution of Coordination Drawings:
1. The CM shall provide one print of each Coordination Drawing to:
 - a. Each specialty trade Subcontractor.
 - b. Owner.
 - c. Engineer
 - d. Architect (for record purposes).
- M. After distribution:
1. Resolve all interference's not previously identified.
- N. Coordination Drawings include but are not necessarily limited to:
1. Structure.
 2. Partition/room layout, including indication of smoke and fire resistance rated partitions.
 3. Ceiling layout and heights.
 4. Light fixtures.
 5. Access panels.
 6. Sheet metal, heating coils, heat pumps, grilles, diffusers, etc.
 7. All heating piping and valves.
 8. Smoke and fire dampers.
 9. Soil, waste and vent piping.
 10. Major water and gases.
 11. Major electrical conduit runs, panelboards, feeder conduit and racks of branch conduit. Motor control centers, starters and disconnects.
 12. Sprinkler piping and heads.
 13. All equipment, including items in the Contract as well as O.F.C.I. and O.F.I. items.
 14. Equipment located above finished ceiling requiring access for maintenance and service. In locations where acoustical lay-in ceilings occur indicate areas in which the required access area may be greater than the suspected grid systems.
 15. Rainwater Piping.
 16. Existing conditions, including, but not limited to, Mechanical, Plumbing, Fire Protection and Electrical items.
 17. ATC panels.
 18. Pneumatic tube system.
- O. The Architect's response to all requests for information (RFI's) generated by the trade contractors shall be distributed to all other affected trades as if this information was contained in the original contract documents. In other words, the party that issues an RFI is responsible for distributing the information to all affected parties.

1.10 RECORD DRAWINGS

- A. Each Contractor shall maintain, current at the site, a set of Contract Drawings for his portion of the work on which he shall accurately show the actual installation of all work provided under his Contract indicating any variation from the Contract Drawings, in accordance with the General Conditions and Supplementary General Conditions.

Changes whether resulting from formal change orders, requests for information, or other instructions issued by the Architect shall be recorded. Include changes in sizes, location and dimensions of piping, ducts, equipment, etc.

- B. Each Contractor shall indicate progress by coloring-in various pipes, ducts and associated appurtenances exactly as they are erected. This process shall incorporate both the changes noted above and all other deviations from the original drawings whether resulting from job conditions encountered or from any other causes.
- C. The marked-up and colored-up prints will be used as a guide for determining the progress of the work installed. They shall be inspected periodically by the Architect and Owner's representatives and they shall be corrected if found either inaccurate or incomplete. This procedure is mandatory. Marked up drawings shall include all flow diagrams, schedules, details and control diagrams.
- D. Each Contractor shall meet at a minimum on a monthly basis, with the Owner's representative to transfer the information from his HVAC, Plumbing, Fire Protection, etc., marked-up and colored-up prints to a set which will become the basis for preparation of as-built drawings.
- E. Upon completion of the project, each Contractor shall submit his marked-up drawings to the Architect for review and comment. After the Architect reviews and comments on this set of documents, each Contractor shall prepare as-built drawings on CAD using AutoCAD (Latest Version). When the work is completed, each Contractor shall provide 2 hard copies to the Architect for submittal to the Owner and disks with all documentation and a set of reproducible drawing plots marked "As-Built" drawings. The Contractor shall bear all costs of producing the CAD "As-Built" drawings, providing all necessary drawing changes and printing the reproducible drawings for the work under his charge.

1.11 GIVING INFORMATION

- A. Each Contractor shall keep himself fully informed as to the shape, size and position of all openings required for his apparatus and shall give information to the Architect and other Contractors [or Subcontractors] sufficiently in advance of the work so that all openings may be built in advance.
- B. The manufacturers listed within this specification have been preselected for use on this project. No submittal will be accepted from a manufacturer other than those specified. Should any Contractor wish to propose a substitution during the bid period, such request shall be made in writing to the Architect, at least (15) working days, prior to bid date. If substitutions are deemed acceptable, such items shall be issued as an Addendum, prior to bid due date. The above requirement is mandatory.

1.12 EQUIPMENT AND MATERIALS

- A. Equipment and materials shall be delivered to the site and stored in original sealed containers, suitably sheltered from the elements, but readily accessible for inspection by the Architect until installed. All items subject to moisture damage such as controls, filters, etc., shall be stored in dry, heated spaces.

- B. Each Contractor shall have his equipment tightly covered and protected against dirt, water and chemical or mechanical injury and theft. At the completion of the work, equipment and materials shall be cleaned, polished thoroughly and turned over the Owner in a condition satisfactory to the Architect. Damage or defects developing before acceptance of the work shall be made good at each Contractor's [or Subcontractor's] expense as applicable.
- C. Each Contractor shall make necessary field measurements to ascertain space requirements, for equipment and connections to be provided under his Trade and shall furnish and install such sizes and shapes of equipment to allow for the final installation to conform to the drawings and specifications.
- D. Manufacturers' directions shall be followed completely in the delivery, storage, protection and installation of any equipment. Promptly notify the Architect in writing of any conflict between any requirements of the Contract Documents and the manufacturer's directions and obtain the Architect's written instructions before proceeding with the work. Should any Contractor perform any work that does not comply with the manufacturer's directions or written instructions from the Architect, he shall bear all costs arising in correcting any deficiencies that should arise.
- E. Each Contractor shall furnish and install all equipment, accessories, connections and incidental items necessary to fully complete the work under his Contract for use, occupancy and operation by the Owner.
- F. Where equipment of the acceptable manufacturers requires different arrangement or connections from those shown, it shall be the responsibility of each Contractor to install the equipment to operate properly and in harmony with the original intent of the drawings and specifications. When directed by the Architect, each Contractor shall submit drawings showing the proposed installation. If the proposed installation is approved, each Contractor shall make all necessary changes in all effected related work provided under other Sections including location of roughing-in connections by other Trades, electrical requirements, piping, supports, insulation, etc. All changes shall be made at no increase in the Contract amount or additional cost to the other Trades and/or Owner.
- G. Testing Agency Labeling Requirements
1. All equipment and materials required for installation under these specifications shall be new and without blemish or defect.
 2. Equipment and materials shall be products which will meet with the acceptance of the Authorities Having Jurisdiction over the work and as specified hereinbefore.
 3. Where such acceptance is contingent upon having the FM Global, it shall be provided with FM Global label. Factory manufactured and assembled packaged equipment, such as the examples of equipment listed below, shall have the entire assembled package inspected and Labeled by Factory Mutual.
 4. All equipment shall meet OSHA standards.
 5. All products shall be listed and labeled by UL or other national testing laboratories such as ETL and the products shall be so labeled.
 - a. Label of Underwriter's Laboratories, ETL or other nationally recognized testing agency acceptable to the Authorities Having Jurisdiction.
 - b. This Labeling shall include not just the control panel and/or motor but all wiring and devices included in the package as a complete package.

Note: Providing a series of individually labeled electrical devices that are then assembled into a package does not meet this requirement, the whole assembly must be labeled as an assembly. The manufacturers have the option of having the equipment inspected and Labeled at the factory or at the site after installation. This requirement shall supersede any other specification language hereinbefore or hereinafter that requires only portions of the equipment to be labeled.

c. Some examples of packaged equipment requiring Labeling:

- 1) Sump pumpsets
- 2) Ejector pumpsets
- 3) Steam condensate pumpsets
- 4) Duplex air compressor system
- 5) Air handling units (packaged and custom built-up)
- 6) Boilers
- 7) Feed water equipment
- 8) pH Neutralization system skids
- 9) High purity water system skids (such as RODI units)
- 10) Laboratory and/or Medical Air compressor skids
- 11) Water pressure booster systems

- H. All equipment of one type (such as valves, fans, air handling units [packaged or custom built], air terminals, heat pumps, plumbing fixtures, etc.), shall be the product of one manufacturer.
- I. Equipment prepurchased on behalf of the Owner or by the Owner himself, if assigned to any of the Contractors, shall be received, inspected, installed, etc., as if it was purchased by the Contractors as applicable. All guarantees, service contracts, etc., shall be the same as for all other equipment provided under this Contract.

1.13 CUTTING AND PATCHING

- A. Each Contractor shall be responsible for all core drilling, as required for work under his Contract, but in no case shall he cut into any structural elements without the written approval of the Architect.
- B. All cutting, rough patching and finish patching, shall be provided under this Contract.
- C. All concrete and masonry equipment bases, housekeeping pads, curbs, chases, pockets and openings required for the proper installation of the work under this section shall be provided by the Contractor, as assigned by the Construction Manager in accordance with Section 03 30 00 – Cast-in-Place Concrete.

1.14 USE OF PREMISES

- A. Each Contractor shall confine all of his apparatus, storage of materials and construction to the limits indicated on the drawings and directed by the Architect and he shall not encumber the premises with his materials.
- B. In storing materials within areas (structure or ground), or when used as a shop, each Contractor shall consult with the Construction Manager and shall restrict his storage to space designated for such purposes. Each Contractor will be held responsible for repairs, patching or cleaning arising from any unauthorized use of premises.

- C. Notwithstanding any approvals or instructions which must be obtained by each Contractor from the Architect in connection with use of premises, the responsibility for the safe working conditions at the site shall remain each Contractor's. The Architect or Owner shall not be deemed to have any responsibility or liability in connection therewith.
- D. Air handling unit or cooling tower sections shall not be used for storage of materials. The HVAC Contractor will be responsible for securing, and maintaining the equipment clean. The above requirement is mandatory.

1.15 PROTECTION/CLEANLINESS

- A. All materials such as valves, fittings, piping, ductwork, plenums, grilles, registers, diffusers, etc., shall be properly protected from the accumulation of dirt, dust, debris or any other contaminants. All ductwork and piping openings shall be temporarily closed by each Contractor [or Subcontractor] installing same, so to prevent obstruction and damage, as a minimum at the end of each working day or more often if required by job conditions. Each Contractor shall take precautions to protect his materials from damage and theft.
- B. Each Contractor shall furnish, place and maintain proper safety guards for the prevention of accidents that might be caused by the workmanship, materials, equipment or electrical systems provided under his Contract.

1.16 DAMAGE CORRECTION AND EXTRA WORK

- A. Each Contractor shall be held responsible and shall pay for all damages caused by his work to the new and existing building structures and new and existing equipment, piping, duct systems, etc., and all work and finishes installed under this Contract in the new or in existing building. Repair of such damage shall be done as herein before specified, at the expense of each Contractor and to the Architect's satisfaction.
- B. Each Contractor shall promptly correct all work provided under his Contract and rejected by the Architect as defective or as failing to conform to the Contract Documents whether observed before or after completion of work and whether or not fabricated, installed or completed. Each Contractor shall bear all costs of correcting such rejected work.
- C. No claim for extra work will be allowed unless it is authorized by the Architect in writing before commencement of the extra said work.
- D. Each Contractor shall be held responsible for protection of existing items, finishes and construction to remain in the completed construction. Where existing items, finishes and construction is required to be removed and reinstalled to complete the scope of work required by the Contract Documents, each Contractor shall include the cost of removal and reinstallation within his scope of work unless otherwise directed by the Construction Manager. The Construction Manager shall designate specific trade responsibility where multiple trades are working in the same area of the project.

1.17 TOUCH-UP PAINTING

- A. Each Contractor shall thoroughly clean all equipment and systems provided under this Contract from rust, splatters and other foreign matter or discoloration, leaving every part of each system in an acceptable prime condition. Each Contractor, for the work under his Contract, shall refinish and restore to the original condition all equipment and piping which has sustained damage to the manufacturer's prime and finish coats of paint and/or enamel.

1.18 HOUSEKEEPING PADS

- A. Coordinate housekeeping pads for:
 - 1. All equipment indoors or outdoors
 - 2. All floor supports or braces
- B. Pads shall be 4" above the finished floor.
- C. Each pad shall be a minimum of 6" larger than the equipment, support or isolation base in all directions.
- D. Pads shall be formed, poured with concrete, and tooled by the General Trades Contractor, as assigned by the Construction Manager.

1.19 SEISMIC

- A. Provide seismic restraints and seismic certified equipment in full compliance with ASCE Standard 7.
 - 1. This shall be in compliance with Division 23 Specifications and provided by the Division 25 Contractor.

1.20 DUCT AND PIPE SLEEVES, PLATES AND ESCUTCHEONS, FIRESTOPPING AND SMOKEPROOFING

- A. Where piping and/or ductwork pass through masonry or concrete walls or drywall partitions or floors, each Contractor shall provide and set individual sleeves for each pipe or duct and all other work under his charge, as necessary for passage of all pipes and/or ducts. Sleeves shall be of sufficient size to provide 1/2" air space around the pipe or duct passing through (including insulation where pipes or ducts are externally insulated). All openings shall be sealed, smokeproofed and made tight. Each Contractor shall be responsible for the exact location of sleeves provided under his Contract and shall coordinate all requirements for piping and ductwork sleeves.
- B. Each Contractor, for work under his charge, shall determine the required inside diameter of each individual wall opening or sleeve before ordering, fabrication or installation.
- C. Sleeves and inserts shall not be used in any portions of the building, where their use would impair the strength or construction features of the building. Elimination of sleeves must be approved by the Architect.
- D. Provide chrome plated brass escutcheons with set screw for exposed piping, in all areas except in mechanical rooms. In this area use plain brass or cast iron escutcheons suitable for painting. All escutcheons shall be sized to fit the bare pipe or insulation in a snug and neat manner. They shall be of sufficient size to cover sleeved openings for the pipes and of sufficient depth to cover sleeves projecting above floors. Escutcheons shall be as manufactured by Beaton & Caldwell, Dearborn Brass, or Grinnell.

- E. Pipe or duct sleeves shall be made of Schedule 40 pipe, 20 gauge galvanized steel or 16 gauge steel as follows:
1. Sleeves on pipes passing through masonry or concrete construction shall be Schedule 40 pipe.
 2. Sleeves on ducts passing through concrete construction shall be 20 gauge steel unless required otherwise by item 4. below.
 3. Sleeves on pipes or ducts passing through fire rated partitions shall be 16 gauge steel.
 4. Sleeves on pipes or ducts passing through non-rated drywall construction shall be 20 gauge galvanized steel.
- F. Pipe or duct sleeves shall be set as follows:
1. Set sleeves 1" above finish floor, (except set sleeves, 6" above finish floor at penthouses or mechanical rooms and 6" above finished roof) and flush on each side of walls. Coordinate roof penetrations with roof Subcontractor.
 2. Sleeves shall be set securely in place before concrete is poured when placed in concrete construction.
 3. Provide sheet metal sleeves for all duct penetrations and cover with sheet metal plates all penetrations after ductwork has been installed through walls/floors.
- G. Each Contractor shall fire stop, smoke stop, and/or acoustically seal the space between the sleeves provided under his Contract and piping or ductwork as applicable, as follows:
1. See Specification Section 078423 Firestopping
- H. Except as otherwise specified, underground piping passing through exterior walls or foundation slabs on grade, shall have penetration closures of the modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and wall opening. Links shall be loosely assembled with bolts to form a continuous belt around the pipe and with a pressure plate under each bolt head and nut. After the seal assembly is positioned in the sleeve, tightening of the bolts shall cause the rubber sealing elements to expand and provide an absolutely watertight seal between the pipe and wall, reducing chances of cathodic reaction between these members. Each Contractor for work under his charge shall determine the required inside diameter of each individual wall opening or sleeve before ordering, fabrication or installation. The inside diameter of the wall opening shall be sized to fit the pipe and ensure a watertight joint. Where applicable, when installing seals, take into account the pipe O.D. if non-standard due to coating or jacketing.
- 1.21 MISCELLANEOUS IRON AND STEEL
- A. Each trade shall provide all primary and secondary steel supports and hangers as shown on the drawings and/or as required to support equipment, ductwork, piping, exhaust fans, or any other materials provided under the work of this Section.
- B. The work of this Section of designing, furnishing and installing all miscellaneous metal work associated with the system, and related items as indicated on the drawings and/or as specified herein, and includes, but is not limited to the items listed herein below.

- C. The scope of work shall include:
1. Control equipment support platforms including ship ladders, steel grating for decking, cross-bracing and floor stands.
 2. Intermediate beams to hang equipment and piping from the roof. All piping and ductwork must be hung from beam or supported from the floor. Provide supplemental steel for support of equipment.
 3. Support of equipment and piping in shafts in addition to support provided by structure.
 4. Support via floor stands as required.
 5. Seismic joint movements.
 6. Piping support in underground concrete trench and manholes.
 7. Seismic restraints.
 8. Pipe anchors in the building.
 9. Hangers, brackets, angel irons or rods required for the support and protection of control equipment.
 10. Field prime painting of galvanized steel and field finish painting.
- D. Shop Drawings for General Miscellaneous Items
1. Submit Shop Drawings of all miscellaneous metal items to Architect for approval, showing sizes and thickness of all members, types of materials, methods of connection and assembly, complete dimensions, clearances, anchorage, relationship to surrounding work by other Trades, shop paint, and other pertinent details of fabrication and installation.
- E. The Subcontractor shall engage the services of a Professional Engineer registered within the state of Connecticut to prepare complete Design Drawings and structural design computations based on, and closely following, the design and details on the Drawings. The Design Drawings and structural design computations, with the Engineer's seal affixed thereto, shall be submitted to the Architect for review. The structural design computations shall provide a complete structural analysis, including anchors and fastening devices, and shall certify as to conformation to governing laws and codes. These submittals, upon review, must be sufficient, when taken in conjunction with this Specification to provide the complete basis of the fabrication and erection.
- F. Samples
1. Submit duplicate samples of all materials to be furnished under this Section if, and in size and form, requested by Architect.
- G. Do not order materials or begin fabrication until Architect's approval of submittals has been obtained.
- H. In addition to the governing laws and codes, the following Specifications and Codes form a part of this Specification:
1. American Iron and Steel Institute applicable standards.
 2. American Institute of Steel Construction "Code of Standard Practice for Steel Buildings and Bridges" and "Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings".
 3. American Welding Society Code: Standard Code for Arc and Gas Welding in Building Construction.

- I. All materials shall be new stock, free from defects impairing strength, durability or appearance and of best commercial quality for each intended purpose.
 - 1. Unless other wise specifically called for, work of this Section shall be fabricated of structural steel conforming to ASTM Specification A36.
 - 2. Steel pipe shall be seamless steel pipe conforming to ASTM Specification A53, Schedule 40.
 - 3. Steel tubing shall be seamless steel tubing conforming to ASTM Specifications A500 to A501.
 - 4. Construction specialties such as slotted inserts, wedge inserts, etc., shall be as manufactured by Hohmann and Barnard, Gateway Erectors, Inc., Richmond Screw Anchor Co.
 - 5. Non-ferrous metals shall be as specified under descriptions of specific items, herein below.

- J. Provide all anchors, bolts, sockets, sleeves, and other parts required for securing each item of work of this Section to the construction, including furnishing to concrete workers all required insets and sleeves for use at concrete.
 - 1. All exposed fastenings shall be of the same material and finish as the metal to which applied, unless otherwise noted.
 - 2. Welding rods shall conform to AWS Standards and the recommendation of the welding rod manufacturer.
 - 3. Shop primer for other ferrous surfaces shall be a high-quality, lead-free, rust-inhibitive primer, Tnemec No. 10-99 Metal Primer or equivalent by Devoe and Reynolds Co., Carboline.

- K. Metal surfaces shall be clean and free from mill scale, flake, rust and rust pitting. metal work shall be well formed and finished to required shape and size, true to details, with straight, sharp lines and angles and smooth surfaces. Curved work shall be true radii. Exposed sheared edges shall be eased.

- L. Weld all permanent connections. Welds shall be continuous on all exposed surfaces and where required for strength on concealed surfaces. Exposed welds shall be ground flush and smooth, with voids filled with metallic filling compound (metallic filling compound not permitted on surfaces to receive hot-dip galvanizing). Tack-welding will not be permitted unless specifically called for. Do not use screws or bolts where they can be avoided. Where used, heads shall be countersunk, screwed up tight, and threads nicked to prevent loosening.

- M. Fastenings shall be concealed where practicable. Thickness of metal and details of assembly and supports shall give ample strength and stiffness. Joints exposed to weather shall be formed to exclude water.

- N. Do all cutting, punching, drilling and tapping required for attachment of anchor bolts and other hardware and for attachment of work by other Trades. All such cutting, punching, drilling, etc., shall be done prior to hot-dip galvanizing of the various components.

- O. Live loads shall be not less than the minimum required by law. Where specific live load are not set forth in the laws and codes applicable to this work, and are not given on the Drawings or in this Specification, designs shall be such as to support the live loads which may normally be imposed without failure, without deflection of more than 1/360 of length of any member, and without permanent deformation, all with a factor of safety of not less than 2 1/2 to 1.

P. Shop Painting

1. All ungalvanized ferrous metals under this Section shall be given a shop coat of rust inhibitive primer of type specified above.
 - a. Immediately before shop painting, remove all rust, loose mill scale, dirt, weld flux, weld spatter, and other foreign material with wire brushes and/or steel scrapers. Power tool clean in accordance with SSPC SP-3 (Power Tool Cleaning).
 - 1) Remove all grease with oil by use of solvent recommended by paint manufacturer. Sandpaper exposed surfaces as required to produce smooth, even finishes.
 - b. Apply paint by spray process in strict accordance with manufacturer's printed instructions to uniform thickness(es) recommended by manufacturer. Apply thoroughly and evenly and work well into corners and joints taking care to avoid sags and runs.
 - c. Do not paint surfaces to be embedded in concrete, or to be welded in the field. After field welds are complete, grind smooth and flush, thoroughly clean and then apply specified primer over all unprimed in the field by brush roller.
 - d. After erection, sand smooth and retouch all portions of the shop coats chipped or damaged during erection, and coat all field welds and connections with primer equivalent to that used for the shop coat.

Q. Installation

1. All materials shall be carefully handled and stored under cover in manner to prevent deformation and damage to the materials and to shop finishes, and to prevent rusting and the accumulation of foreign matter on the metal work. All such work shall be repaired and cleaned prior to erection.
2. Work shall be erected square, plumb and true, accurately fitted, and with the tight joints and intersections. All anchors, inserts and other members to be set in concrete or masonry shall be furnished loose by this Trade to be built-into concrete and masonry and by those Trades as the work progresses. Later cutting or drilling shall be avoided wherever possible.
3. All metal work shall be rigidly braced and secured to surrounding construction, and shall be tight and free of rattle, vibration, or noticeable deflection after installed.
4. Where members, other than expansion bolts or inserts, are fastened into concrete, set such members in holes formed as specified below, and secure permanently in place by installation of proprietary-type expanding grout manufactured specifically for such purpose, used strictly in accordance with manufacturer's directions. Holes to receive members shall be formed with galvanized sheetmetal sleeves, expanded polystyrene foam, or other approved method to provide at least 1/2 inch clearance around entire perimeter. At exposed applications, hold expanding grout back 1/2 inch from finish surface and fill voids with Portland cement grout to match color and texture of surrounding concrete surface.
5. Electrolytic Isolation
 - a. Where dissimilar metals are to come into contact with one another, isolate by application of a heavy coating of bituminous paint on contact surfaces in addition to shop coat specified above. Do not permit the bituminous paint in any way to remain on surfaces to be exposed or to receive sealant.

R. Description of Major Items

1. The items described below constitute the major part of the work of this Section, but are not intended or implied to cover each and every item that may be required to properly complete the work. Carefully review the Drawings to determine the full extent of the miscellaneous metal work required.

S. Steel Ladders/Platforms

1. Fabricate and install interior steel ladder at fans, air handling units, filter racks and all equipment requiring service. Ladders shall have a safety cage as required by OSHA regulations.
2. Except as may be otherwise indicated on the Drawings, ladder shall be minimum 16 inches wide, fabricated of minimum 3/8 inch by 2 1/2 inches hot rolled steel rails and minimum 3/4 inches outside diameter steel pipe rungs. Rungs shall be spaced 12 inches on center and shall be continuously welded to the rails. Provide a pair of steel clip angles or wall brackets at bottom and steel anchor plates or wall brackets at top, welded to the rails, as indicated.
3. Exterior steel ladders shall be hot dip galvanized after fabrication as specified hereinbefore. Rungs are to have non-slip surfaces.
4. All shall be OSHA and ANSI compliant.

T. Gratings and Frames

1. Fabricated and install steel gratings and frames at fan platforms.
2. Steel grating frames shall consist of a steel angle perimeter frame constructed of steel angles, at least 4 inches by 4 inches by 3/8 inches carried around perimeter with coped or mitered, full-welded corners. Perimeter frames shall be anchored with 7/16 inch minimum diameter expansion bolts or other suitable devices of adequate capacity, at corners, two (2) per beam end, and spaced not more than 2 feet on center around full perimeter.
3. Steel Gratings shall be pressure-locked type, with bearing bars spaced 1 3/16 inch on center and cross-bars spaced 4 inches on center. Sizes of bars shall be as required by manufacturer's loading tables to limit deflection of any member across any span to 1/240th of the span at live load of 100 pounds per square foot. Gratings shall be as manufactured by Borden Metal Products, Co., Irving Subway Grating Co., Reliance Steel Products Co., approved by Architect.
4. All (gratings and) frames shall be hot-dip galvanized after fabrication as specified in Section 05 0513 Hot Dip Galvanizing or Aluminum.

U. Miscellaneous Items

1. Carefully review all Drawings for miscellaneous metal items required but not specifically listed above, such as miscellaneous steel clip angles, miscellaneous steel bracketing, and other miscellaneous metal items as indicated on the Drawings, reasonably implied therefrom, or reasonably necessary for the thorough completion of the work.
2. Provide rigid and secure anchorage of all components whether or not specifically described in complete detail on the Drawings.

- V. Piping supports shall be coordinated with the building structure and shall span between roof beams as required.

1.22 WATERPROOFING, FLASHING AND COUNTERFLASHING

- A. Unless specifically indicated otherwise on the drawings, each Contractor shall provide all counterflashing and waterproofing of all piping, ductwork and equipment provided by him, which pierce roofs, walls and other weatherbarrier surfaces. All work under this paragraph shall be coordinated with the (CM).
- B. All work shall be performed in a workmanlike manner to ensure weatherproof installation. Any leaks developed due to each Contractor's work shall be repaired at his expense, to the Architect's satisfaction.
- C. Pipes passing through slabs shall have the sleeve extended above floors as hereinbefore specified to retain any water and the space between the pipe and sleeve caulked waterproof fire stopping. The top and the bottom shall be sealed with monolastic caulking compound.
- D. All flashing required for ductwork and piping penetrations shall be provided by the (CM).

1.23 ELECTRICAL WORK, MOTORS, MOTOR CONTROLLERS

- A. See Section 230513.
- B. See Division 22 for Plumbing.
- C. See Divisions 26, 27 and 28 for Electrical.

1.24 IDENTIFICATION OF MATERIALS

- A. See Section 230553.

1.25 VALVE TAGS, NAMEPLATES AND CHARTS

- A. See Section 230553.

1.26 PARTS LIST AND INSTRUCTIONS FOR OPERATION AND MAINTENANCE

- A. Each Contractor shall thoroughly instruct the representative(s) of the Owner, to the complete satisfaction of the Architect, in the proper operation of all systems and equipment provided by him. Each Contractor shall make arrangements, via the (CM) as to whom the instructions are to be given in the operation of the basic and auxiliary systems and the periods of time in which they are to be given. The Architect shall be completely satisfied that the representative of the Owner has been thoroughly and completely instructed in the proper operation of all systems and equipment before final payment is made. If the Architect determines that complete and thorough instructions have not been given by each Contractor to the Owner's representative, then each Contractor shall be directed by the Architect to provide whatever instructions are necessary until the intent of this paragraph of the specification has been complied with. All time required for Owner's instruction to satisfy the above requirements shall be included in this Contract. No extra compensation for such instructions will be allowed.
- B. Each Contractor, including but not limited to, the HVAC Contractor, shall submit to the Architect for approval, a total of (6) typed sets, bound neatly in loose-leaf binders, of all maintenance and operating instructions for the installation, operation, care and maintenance of all equipment and systems. All data and literature furnished shall be specific for the make and model of the equipment furnished. General non-specific catalog data will not be acceptable.

Information shall indicate possible problems with equipment and suggested corrective action. The manuals shall be indexed for each type of equipment. Each section such as fans, valves, plumbing fixtures, hot water heaters, boilers, air handling units, etc., shall be clearly divided from the other sections. A sub-index for each section shall also be provided. The methodology of setting-up the manuals shall be submitted to the Architect and Owner through the General Contractor for approval prior to final submission of manuals.

- C. The instructions shall contain information deemed necessary by the Architect and shall include, but not be limited to, the following:
1. Instructional classes on equipment and systems operation for Owner's representative and maintenance personnel, by engineering staff of each Contractor. Minimum of 48 hours of instruction for minimum of (6) people. Instruction shall include:
 - a. Explanation of manual and its use.
 - b. Summary description of the HVAC systems.
 - c. Purpose of systems.
 2. System
 - a. Detailed description of all systems.
 - b. Illustrations, schematics, block diagrams, catalog cuts and other exhibits.
 3. Operations
 - a. Complete detailed, step-by-step, sequential description of all phases of operation for all portions of the systems, including start-up, shutdown, adjusting and balancing. Include all posted instruction charts.
 4. Maintenance
 - a. Parts list and part numbers.
 - b. Maintenance, lubrication and replacement charts and manufacturer's recommendations for preventive maintenance, as applicable to his work.
 - c. Troubleshooting charts for systems and components.
 - d. Instructions for testing each type of part.
 - e. Recommended list of on-hand spare parts.
 - f. Complete calibration instructions for all parts and entire systems.
 - g. Instruction for charging, filling, draining and purging, as applicable.
 - h. General or miscellaneous maintenance notes.
 5. Manufacturer's Literature
 - a. Furnish complete listing for all parts required for models actually furnished.
 - b. Names, addresses and telephone numbers of manufacturers and suppliers.
 - c. Describe and operation of all models actually furnished.
 - d. Furnish all and only pertinent brochures, illustrations, drawings, cuts, bulletins, technical data, certified performance charts and other literature with the model actually furnished to be clearly and conspicuously identified.
 - e. Internal wiring diagrams and engineering data sheets for all items and/or equipment furnished under each Contract.
 - f. Guarantee and warranty data.

6. Each Contractor shall furnish instructions for lubricating each piece of equipment installed by him. Instructions shall state type of lubricant, where and how frequently lubrication is required. Frame instructions under glass and hang in a location as directed by Architect.

1.27 MANUFACTURER'S REPRESENTATIVE AND STARTUP OF SYSTEMS

- A. Each Contractor shall provide, at appropriate time or as directed by the Architect, the on-site services of a competent factory trained Engineer or authorized representative of particular manufacturer of equipment provided under his Contract, such as for the air handling units, automatic temperature controls, building automation system (BAS), fire pump, domestic hot water heaters, boilers, etc., provided under this Contract, to instruct the Owner, inspect, adjust and place in proper operating condition any item provided by him, as applicable.
- B. The HVAC Contractor, as applicable, shall test and set in operating condition all major equipment and systems, such as the condenser water, hot water and all air handling systems, etc., in the presence of the applicable equipment manufacturer's representatives, and the Owner and Architect's representatives. In no case will major systems and equipment be started by any of the Contractor's forces alone, without the assistance or presence of the equipment manufacturers.
 1. Each Contractor must also include labor to prepare tests; operate components and systems; witness testing; and for demonstrating all components and systems are functional in all modes of operation as required by the Owner's Independent Commissioning Agent. Refer to Paragraph 1.6 – Commissioning hereinbefore and Section 01 91 13.
- C. A written report shall be issued by the particular equipment manufacturer and the Mechanical Contractor summarizing the results of the startup and performance of each system for the Architect's record. No additional compensation will be allowed for any Contractor for such services.
- D. The Contractor shall prepare and submit to the Architect for acceptance, a schedule of anticipated system startups. No system shall be started without prior acceptance of the schedule by the Architect and Owner. No systems shall be started prior to submittal and acceptance of Operation and Maintenance Manuals.

1.28 CONNECTIONS TO EQUIPMENT

- A. Each Contractor shall provide all duct and/or pipe connections, condensate traps, drains, overflows, relief valves and vents, power connections, etc., to make equipment operable, as provided under other Sections of the specifications, as shown on the Architectural and/or each Trade's drawings and herein specified, including final connections to equipment to result in a complete system, fully operational. Coordinate location of all equipment with Architect. Obtain installation diagrams and methods of installation of all equipment from manufacturers. Follow instructions strictly. If additional information is required, obtain same from Architect. If equipment is indicated on the Architectural drawings, it shall also be construed and understood by the Mechanical Contractor to be constructed as shown on the HVAC drawings and shall be fully serviced and connected at no extra cost to the Owner.

1.29 SMOKE DETECTION AND FIRE SAFETY SYSTEMS

- A. All duct or unit mounted smoke detectors shall be furnished and wired to the building fire alarm system by the Electrical Contractor. All smoke detectors required in units and ducts and for smoke barrier dampers shall be installed in the field by the HVAC Contractor. Refer to the Contractor Coordination Matrix contained under item 1.36 of this Section.
- B. All smoke dampers shall be furnished and by the HVAC Contractor with electric actuators and field wired by the ATC Contractor.
- C. The Electrical Contractor, when providing smoke detectors, shall include additional contacts, as required and coordinated with the ATC Contractor, to allow for other control functions, as specified hereinafter. Close coordination must be exercised to allow for the provision of contacts.
- D. All smoke detectors shall be installed as recommended by the smoke detection system manufacturer in sheet metal ducts or plenums to ensure that the sensing elements are effective and shall coordinate installation of smoke detectors with the Electrical Contractor and detector manufacturer.
- E. The HVAC Contractor shall provide access doors to make all such detection heads accessible, and shall provide bracing for smoke detection sampling tubes, as recommended by the detector manufacturer, to properly and securely support such tubes.
- F. If duct smoke detectors are required to be installed in ducts that are exposed to outside ambient conditions, they shall be installed in ventilated accessible weatherproof enclosures. See details on HVAC Drawings.

1.30 ELECTRICAL ROOM REQUIREMENTS

- A. The ATC Contractor [or Subcontractors] shall not install any piping, ductwork or equipment in or through electrical rooms, transformer rooms, electrical closets, telephone rooms or elevator machine rooms, unless piping, ductwork or equipment is intended to serve these rooms. If any Contractor violates this requirement, he shall remove and/or relocate all items as required at his expense and to the satisfaction of the Architect.

1.31 HOISTING EQUIPMENT AND MACHINERY

- A. All hoisting equipment and machinery required for the proper and expeditious prosecution and progress of the work under this Contract shall be furnished, installed, operated and maintained in safe condition by each Contractor for his material and/or equipment delivered to the designated hoisting area. All costs for hoisting operating services shall be borne by the Mechanical Contractor for all equipment and work under his charge.

1.32 STAGING

- A. All staging, exterior and interior, required to be over 8'-0" in height shall be furnished and erected by each Contractor for work under his charge and maintained in safe condition by him for proper execution of his work.

1.33 PHASING DEMOLITION AND MAINTAINING EXISTING SERVICES

- A. During the execution of the work, required relocation of existing equipment and systems in the existing areas where new work and connections are scheduled to be made shall be performed by each Contractor as indicated on the drawings, as required by the job conditions and as determined by the CM in close cooperation with the Architect and Owner's designated representative to facilitate the installation of the new systems and completion of this Contract. The Owner will require the continuous operation of all existing systems while demolition and relocation work of new tie-ins are being performed. Outages required for construction purposes shall be scheduled for the shortest practical periods of time, in coordination with the Owner's designated representative for specific, mutually agreeable periods of time after each of which the interruption shall cease and service shall be restored. This procedure shall be repeated to suit the Owner's working schedule as many times as required until all work is completed.
- B. Prior to any deactivation and relocation, capping, valving, tie-in or demolition work, consult the drawings and arrange a conference with the Architect and the Owner's representative in the field to inspect each of the items to be deactivated, removed or relocated. Care shall be taken to protect all equipment designated to be relocated and reused. Give notice to all parties, with a minimum of (5) working days in advance.
- C. All draining of existing systems, filling and venting required to remove and relocate existing piping systems shall be included and provided under this Contract as required to perform the various equipment or piping relocations or new tie-ins.
- D. Except as otherwise noted, all deactivation, safe capping, valving, etc., of systems designated to be demolished shall be provided by each Trade, as applicable, and all demolition, removal and disposal of demolished materials shall be performed by the CM. All equipment scheduled to be removed shall be inspected by the Owner, and, if he decides that such equipment is to be salvaged, each Contractor shall deliver said equipment to an area within the site boundaries as determined by the Owner and Architect.
- E. The phasing of the work shall be performed in strict accordance with the CM construction schedule. The new systems will be installed and completely commissioned prior to occupancy. Coordinate requirements for temporary heat or rerouting of existing services as required to accomplish the construction schedule.

1.34 CONTROL WIRING

- A. The ATC Contractor shall provide all control and interlock wiring for all systems provided under the HVAC, plumbing and ATC Contracts.
- B. All control wiring shall be installed in conduit and in accordance with the respective equipment manufacturer's requirements, and all connections shall be provided by the ATC Contractor. All conduit and wiring provided by these Contractors shall be installed in accordance with the requirements of Section 26 of the specifications.

1.35 TELECOMMUNICATION ROOM REQUIREMENTS

- A. The Contractor shall not install any mechanical equipment or piping foreign to the telecommunication or data installation within any room in which telecommunications or data equipment or systems are located. These include the main Communications Equipment Room (CER), the Telephone PBX Main Distribution Frame (MDF) Room or any floor

Telecommunications Room (TR) or Floor Data Distribution Center in accordance with NEC, TIA/EIA, and/or BICSI standards.

- B. Specifically, no panels, pipes, valves, ductwork or mechanical equipment shall be installed within the above-stated locations unless they are specifically for the use of these rooms or the telecommunications or data system.
- C. Any mechanical systems being provided for use in the room shall be fully coordinated with the Telecom Engineer, Owner and Construction Manager so as not to interfere with other hardware and equipment to be used for the telecommunications and/or data network. Specifically, pipes, condensers, or other hazards shall not be installed above electronic equipment or in a means that will impede the proper clearances thereof.

1.36 COMPONENT COORDINATION

- A. The HVAC, ATC and Electrical Contractors Scope of Work shall be implements in accordance with the following matrix:

Device	Furnished By	Installed By	Power Wiring	Control Wiring	Fire Alarm Wiring
Smoke Detectors	26	23	26	25	26
Smoke Dampers in or at AHUs	23	23	N/A	N/A	N/A
Smoke Damper Actuators in or at AHUs	Damper Mfr	23	26	25	N/A
Smoke Dampers	23	23	N/A	N/A	N/A
Smoke Dampers Actuators	Damper Mfr	23	26	28	N/A
Fire Dampers	23	23	25	25	N/A
Supply and Exhaust Boxes	23	23	25	25	N/A
Box Flow Pick-Up	Box Mfr	Box Mfr	N/A	Box Mfr	N/A
Box Damper Actuator	25	Box Mfr	25	25	N/A
Box DDC Controller	25	Box Mfr	25	25	N/A
Box Coil Valve	25	23	N/A	25	N/A
Valve Actuator	25	25	N/A	25	N/A
Supply Valve Reheat Coil	23	23	N/A	N/A	N/A
Reheat Coil Valve	25	23	N/A	25	
Sheet Metal Damper	23	23	N/A	N/A	N/A
Sheet Metal Damper Actuators	25	25	25	25	
Energy Meters	25	23	26	25	N/A
Flow Measuring Stations	25	23	N/A	25	N/A
DDC Panels	25	25	26	25	N/A
Air Compressor	25	25	26	25	N/A
Air Dryer	25	25	26	25	N/A
Control Valves	25	23	25	25	N/A
VSDs at Fans	23	23	26	25	N/A

PART 2 PRODUCTS

2.01 NOT USED

PART 3 EXECUTION

3.01 NOT USED

END OF SECTION

SECTION 250630

SCHEDULES

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Section 250500 and other Division 1 Specification Sections, apply to this Section.

1.02 WORK INCLUDED

- A. Furnish and install temperature controls.

1.03 RELATED SECTIONS

- A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 SUBMITTALS

- A. See Section 250500 and General Conditions for additional requirements.
- B. Product Data: Provide data for duct materials.
- C. Prepare and submit scaled coordination drawings.
- D. Manufacturer's Installation Instructions.

1.05 QUALITY ASSURANCE

- A. See Section 250500.

PART 2 – PRODUCTS

2.01 POINT SCHEDULE

- A. Note: For point software association, see sequence of operation. All points shall be able to integrate to all trends, totalizations, etc., as applicable. For additional points, refer to PID drawings and sequences of operations. Additional points not specifically called for herein but required to perform the sequence as herein specified shall be provided at no additional cost to the Owner.
- B. THE ATC CONTRACTOR SHALL PROVIDE AN ALLOWANCE FOR INSTALLING, WIRING AND SOFTWARE PROGRAMMING FOR 20 ADDITIONAL MONITORING AND CONTROL POINTS OF EACH TYPE (AI, AO, DI, DO) FOR OWNER'S USE (I.E. 80 POINTS). These 80 points are over and above points required that are not specifically listed below but will be required to provide the specified sequences. Each point shall include the following:
 - 1. Fifty (50) feet of conduit and wire to connect to a field device.

2. Man hours to provide Engineering, documentation, start-up/checkout and graphic programming.
 3. If an additional field device is required, such as a sensor, damper, valve, etc., the cost of the field device shall not be included in this allowance.
- C. There shall be an additional eight (8) point expansion module provided if it is required for connection to existing controllers that shall be included in the cost of this allowance.

SYSTEM POINT	POINT				ALARMS			COMMENTS
	AI	AO	DI	DO	HI	LOW	OFF NORMAL	
PLUMBING EQUIPMENT								
POTABLE WATER HEATERS	X				X	X		
NON-POTABLE WATER HEATERS	X				X	X		
MEDICAL AIR COMPRESSOR ALARM			X				X	FROM PANEL DRY CONTACTS
MEDICAL EQUIPMENT AIR COMPRESSOR PRESSURE ALARM			X				X	FROM PANEL DRY CONTACTS
MEDICAL VACUUM PUMP SYSTEM COMMON ALARM			X				X	FROM PANEL DRY CONTACTS
DENTAL AIR COMPRESSOR PRESSURE ALARM			X			X		FROM PANEL DRY CONTACTS
DENTAL AIR COMPRESSOR ALARM			X			X		FROM PANEL DRY CONTACTS
DENTAL AMALGAM SYSTEM			X				X	FROM PANEL DRY CONTACTS
EMERGENCY GENERATOR								
EACH EMERGENCY POWER TRANSFER SWITCH UNDERCURRENT RELAY			X					FROM PANEL DRY CONTACTS
EACH EMERGENCY POWER TRANSFER SWITCH LOSS OF NORMAL POWER			X					FROM PANEL DRY CONTACTS
EACH EMERGENCY POWER TRANSFER SWITCH LOSS OF EMERGENCY POWER			X					FROM PANEL DRY CONTACTS
FIRE ALARM SYSTEM SIGNALS TO OCS								
FAS GENERAL ALARM			X				X	
FAS GENERAL TROUBLE ALARM			X				X	
MISCELLANEOUS POINTS								
ATC UPS BATTERY ALARM			X					LOW BATTERY (EACH)
EXTERIOR SITE LIGHTING ON/OFF				X				COORDINATE LOCATION AND SIGNAL TYPE WITH ELECTRICAL CONTRACTOR
COMPUTER ROOM AIR CONDITIONING UNITS (ALARM) (EACH)			X		X			
GAS STORAGE ROOM OXYGEN DEPLETION (ALARM) (GAS) (EACH)			X			X		
CO ₂ SENSORS (EACH)	X		X		X		X	SEE PLANS
OXYGEN SENSORS (EACH)	X		X			X	X	SEE PLANS

SYSTEM POINT	POINT				ALARMS			COMMENTS
	AI	AO	DI	DO	HI	LOW	OFF NORMAL	
CONDENSATE PUMPS (TYPICAL OF EACH DUPLEX SET)								
HIGH WATER ALARM			X		X		X	

PART 3 – EXECUTION

- A. Provide any other points required by the Sequences or other items specified in Divisions 21, 22, 23, 25 and 26.
- B. Provide any additional points required for systems to function correctly.

END OF SECTION

SECTION 251000

DIRECT DIGITAL/AUTOMATIC TEMPERATURE CONTROLS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Section 250500 and other Division 1 Specification Sections, apply to this Section.

1.02 WORK INCLUDED

- A. Furnish and install a complete system of automatic temperature controls to make a fully operational and controllable building HVAC system. All components of the system – workstations, application controllers, unitary controllers, etc. shall communicate using the BACnet protocol, as defined by ASHRAE Standard 135-2008. No gateways shall be used for communication to controllers furnished under this section. It shall include but not be limited to all labor, materials, special tools, equipment, enclosures, power supplies, software, software licenses, Project specific software configurations and database entries, interfaces, wiring, tubing, installation, labeling, engineering, calibration, documentation, submittals, testing, verification, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, Warranty, specified services and items required by the Contract for the complete and fully functional Controls Systems.
- B. Building Automation System (BAS) Contractor shall provide:
 - 1. A fully integrated and fully programmable BACNET building automation system (BAS), UL listed (UL916 and UL864 as applicable), incorporating direct digital control (DDC) for energy management, equipment monitoring and control, as manufactured by Johnson Controls or Automated Logic. A UL864 listing shall be required for all controllers that are utilized in a smoke control sequence and as necessary to meet or exceed all national and local codes. In addition, UL864 devices and non UL864 shall not be permitted on the same network segment unless the devices are separated with a UL864 Ethernet switch. All MS/TP network segments shall be consistent with its UL864 or non UL864 implementation. In other words, there shall not be UL864 product and non UL864 product on the same MS/TP network segment.
 - 2. Necessary conduit, wiring, enclosures, and panels, for all DDC temperature control equipment and devices. Installation shall comply with applicable local and national codes.
 - 3. All components and control devices necessary to provide a complete and operable DDC system.
 - 4. All final electrical connections to each stand-alone DDC Controller. Connect to 120VAC power as provided by the Division 26 contractor.
 - 5. BAS Contractor shall be responsible for all electrical work associated with the BAS control system and as defined In the Contract Documents. This BAS control wiring shall be furnished and installed in accordance with the Electrical requirements as specified in Division 26, the National Electric Code, and all applicable local codes.

6. Surge transient protection shall be incorporated in design of system to protect electrical components in all Building Controllers, Advanced Application Controllers and operator's workstations. Provide an external protection device listed under UL 1449 with minimum clamping voltage of 130 VRMS and surge current capability of 22,500Amps for all custom fabricated control panels (all main system components (i.e., AHUs, etc.).
7. All 120V and low voltage electrical control wiring exposed throughout the building shall be run in conduit in accordance with the Electrical requirements as specified in Division 26, the National Electric Code, and all applicable local codes. All low voltage wiring that is concealed in accessible ceilings may be run in plenum rated cable per the National and Local Electrical codes.
8. All 24VAC power required for operation of the BAS shall be by the BAS Contractor and shall be limited to 100 VA per the aforementioned codes. Any 24VAC power link that exceeds the 100 VA rating must be installed in conduit per Division 26 and all applicable codes, regardless of the nature of the installation.
9. BAS Contractor shall provide programming modifications necessary to fine tune sequences during commissioning and through the warranty period of system and for an additional 12 months, at no extra cost to the Owner.

- C. The system shall be all electric DDC (direct digital control).
- D. All system components shall be installed in accordance with local and State codes.
- E. Secure all permits and local/State approval for all components and installation as specified under this Section.
- F. Provide complete commissioning for all control system components and sequences of operation.
- G. Preparation and submission of shop drawings.

1.03 RELATED SECTIONS

- A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.
- B. Division 21
- C. Division 22
- D. Division 23
- E. Division 25
- F. Division 26

G. Incidental Work By Others

1. The Division 23 Contractor shall coordinate required work with his designated Contractor and, without limiting the generality thereof, the work he is to perform for the Division 25 Contractor shall include the following:
 - a. Installation of automatic dampers in ductwork. (Dampers interior to air handling units shall be furnished and installed by the Division 23 Contractor).
 - b. Assemble multiple section dampers with required interconnecting linkages and extend required number of shafts through duct for external mounting of damper motors.
 - c. Install automatic temperature control valves.
 - d. Install all pressure taps and sensing wells.
 - e. Install duct smoke detectors and dampers.
 - f. Install airflow and monitoring stations.
2. Work by Division 26 Contractor
 - a. Power wiring to a minimum of (8) junction boxes on each occupied floor (refer to electrical drawings for locations). All power wiring from these junction boxes to ATC equipment, panels, boxes, etc., shall be provided by the ATC Contractor.
 - b. All electric wiring and conduit required to energize the junction boxes above.
 - c. It should be noted that a "reasonable" amount of 120 volt junction boxes for power connections to DDC panels have been indicated on the Electrical drawings. Any and all other electrical power connections to ATC/DDC devices shall be furnished and wired by the ATC Contractor, at no additional cost to the project. This requirement includes the furnishing and installing of 120V, 20 amp circuit breakers in electric panelboards, wire, conduit junction boxes, etc.

1.04 REFERENCES

- A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.
- B. Material standards shall be as specified or detailed hereinafter and as follows:
 1. NFPA 70 – National Electric Code.
 2. UL-916 – Energy Management Systems.
 3. UL-873 – Temperature Indication and Regulating Equipment.
 4. FCC; Part 15, Subpart J – Class A computing Equipment.
 5. UL-864 – Fire and Smoke Control.

1.05 SYSTEM DESCRIPTION

- A. Furnish and install, as hereinafter specified, a combination direct digital/ electric/electronic temperature control system and Building Automation System (BAS). The system shall be comprised of a network of various independent Stand-alone Digital Controllers, electric/electronic control equipment, thermostats, sensors, controllers, valves, dampers, actuators, panels and related hardware, software and other accessory equipment, along with a complete system of electrical control wiring, and software generation to fill the intent of the specifications and provide for a complete and operable system.
1. The DDC systems shall provide automatic restart including all required re-initialization of controlled systems (AHU's, fans, terminal boxes, pumps, etc). Upon the transfer of electrical power from normal-to-emergency or emergency-to-normal as sensed at the electrical transfer switches. Restart time delays shall be incorporated as required to prevent cascading failures of systems upon restart (i.e., terminal boxes must be stroked fully open prior to the restart of the AHU fans to prevent over pressurization of duct systems and emergency fan shutdown due to over pressurization).
 - a. The building automation system (BAS) shall integrate multiple building functions including equipment supervision and control, alarm management, energy management and historical data collection utilizing the BACnet protocol.
 - b. The system shall be modular in nature and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, Building Controllers, Application Controllers, expansion modules and operator devices.
 - c. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. Each DDC Controller shall operate independently by performing its own specified control, alarm management, operator I/O and data collection. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices. Alarm management and data collection that requires a single mechanism for user notification or viewing is strictly prohibited.
 - d. All Controllers shall be able to access any data from, or send control commands and alarm reports directly to, any other DDC Controller or combination of controllers on the network without dependence upon a central processing device (peer-to-peer). All Controllers shall also be able to send alarm reports to multiple operator workstations without dependence upon a central processing device.
 2. All new equipment shall be controlled by the DDC system. Equipment that is provided with factory controls shall be provided with monitoring and start/stop status of the packaged controls through the DDC system.
 3. Contractors must demonstrate compliance with the following criteria in order to be considered:
 - a. The Contractor shall be fully licensed at the time of bid to do business in the job site area.
 - b. The Contractor must have a branch office with the technical staff, complete spare parts inventory, test and diagnostic equipment and all other labor and equipment necessary to keep systems in operation 24 hours per day, seven days per week.
 - c. The Contractor shall have emergency service available performing on-call service 24 hours per day, seven days per week.
 - d. The complete installation and proper operation of the Building Automation Controls System shall include debugging and calibration of each component in the entire

system and shall be the single source responsibility of supplier. The BAS must be supplied and installed by the same controls contractor. Only Factory Authorized Distributors will be considered for installation. The letting of separate contracts by the prime HVAC Contractor for the Control System and a separate contract for its installation by a third party installer is strictly prohibited.

- e. Contractor qualifications shall include a minimum of (10) years of demonstrated technical expertise and experience in the research, installation and preventative maintenance of EMS systems.

4. The system components shall be as follows:

System	Logic	Actuation (Dampers/Valves)
Air Handling Units Damper Actuator Valve Actuator Humidifier · Fan Speed Control (VFD)	DDC	Electric Electric Electronic Electronic
Heat Exchangers · Temperature Control Valves	DDC	Electric
Airflow Measuring Stations	DDC	
CUH, UH · Valve	Electric	Electric
In-Duct Humidifiers	DDC	Electronic
Air Terminal Boxes Damper Actuator Reheat Hot Water Valve Radiation Hot Water Valve Thermostat · Air Volume Tracking	DDC	Electronic Electronic Electronic Electronic Electronic
UL Smoke Dampers in AHUs (Provided by Division 23)	Fire Alarm System	Electric
UL Smoke Dampers in Ductwork (Provided by Division 23)	DDC via Fire Alarm System	Electric
Pumps · Pump Speed Control (VFD)	DDC DDC	Electric Electronic
General Exhaust Fan · Dampers	DDC	Electric
Smoke Control Systems (Via Air Terminal Boxes, where required)	DDC via Fire Alarm System	Electronic
Domestic Hot Water Heaters		Electric

- 5. Microprocessor components shall be as manufactured and approved by the Contractor. The Control system shall be installed by competent control mechanical and electrical subcontractors who are routinely familiar with the installation of their product. The technicians shall be regularly employed by the equipment manufacturer or equipment distributor. Close cooperation shall be exercised between equipment manufacturer and the Contractor.
- 6. All piping and/or electric wiring and connections required for the entire system shall be provided by the Contractor, except as noted.
- 7. Contractor shall be responsible for coordination, interface and the controls performance of all equipment.
- 8. Control system commissioning and acceptance per University of Connecticut Dempsey standards, and the requirements of this specification.

9. Equipment labels and graphic designations.
10. Operation and maintenance manuals, Project Record Documents, and Software Documentation.
11. Training classes on equipment and systems operation for University's representatives and maintenance personnel.
12. Testing and Startup of all systems, per the requirements of this specification. Coordination of work with the HVAC Balancing Contractor to operate the ATC systems as required to allow balancing of all systems.

B. Scope

1. In general, the work required of the Contractor under this contract will include the DDC system components, devices, hardware, real time control network devices and wiring, software and software development, installation, testing and commissioning, documentation required to implement the system. Specific work responsibilities required by this section are specified herein.
 - a. Work shall include providing Operator Workstation (OWS) hardware and software, development of software for the OWS, LAN cabling to the point of connection to the control system, as well as all site information, wiring and devices.
2. Except as otherwise noted, the DDC control system provided shall consist of all microprocessors, digital system controllers, and control system I/O devices, controller software, sensors, transducers, relays, thermostats, dampers, damper operators, switches, control panels, and other accessory equipment, along with a complete system of electrical interlocking wiring to fill the intent of the specification and provide for a complete and operable system. All control equipment shall be fully proportioning. Except as otherwise specified, provide damper operators for equipment such as for dampers, where such operators are not provided by the equipment manufacturers. Coordinate requirements with the various Contractors.
3. The Contractor shall review and study all HVAC drawings and the entire specification to familiarize himself with the equipment and system operations and to verify the quantities and types of dampers, operators, alarms, etc., to be provided. Numerous references to the DDC system are made throughout the project specifications identifying work to be performed by the Contractor, in addition, to work specifically indicated under Division 25.
4. All interlocking, wiring and installation of control devices associated with the air handling units, pumps, etc., shall be provided under this Contract. When DDC system is fully installed and operational, the Contractor and representatives of the Owner will review the operation and check out the system. At this time Contractor shall demonstrate to all present the operation of system and prove that it complies with the intent of the drawings and specifications.
5. Provide all controlled equipment with direct reading gauges as required to allow calibration and troubleshooting.
6. All electronic equipment shall conform to the requirements of F.C.C. Regulation Part 15, Section 15 governing radio frequency electromagnetic interference and any other applicable statutes with respect to radiation and conduction of radio frequency interference and be so labeled.
7. DDC portions of the project shall comply with UL 864 and 1076 and shall be so listed.

- C. The Building Automation System (BAS) shall be designed in strict accordance with ASHRAE's BACnet standard, 135-2010, to provide interoperability between different building subsystems. The system shall also provide a graphical, web-based operator interface that allows for instant access to any system through a standard browser.

- D. The system shall use BACnet network types and protocols exclusively. Non-BACnet-based systems are not acceptable. The contractor must provide PC-based programming workstations, operator workstations and microcomputer controllers of modular design providing distributed processing capability, and allowing future expansion of both input/output points and processing/control functions. Contractor must provide manufacturer's Protocol Implementation Conformance Statement (PICS) for workstation software and every controller model that are installed.
- E. The control systems shall be installed by competent control mechanics and electricians regularly employed by the manufacturer of the control equipment. All control equipment shall be the product of one (1) manufacturer and all components shall be capable of interfacing with the HVAC equipment. The factory trained Contractor must maintain adequate staff and offer standard services to fully support the owner in the timely maintenance, repair, and operation of the control system. Contractors who do not maintain such staff and offer services or must develop some for this project are not acceptable.
- F. Bids from franchised dealers or others whose principal business is not the manufacture, installation and service of temperature control systems will not be acceptable.
- G. The Contractor shall submit a copy of the manufacturer's standard software and firmware licensing agreement for the owner's signature. Such license shall grant use of all programs and application software to Owner as defined by the manufacturer's license agreement, but shall protect manufacturer's rights to disclosure of trade secrets constrained within such software.
- H. All products of the Building Automation System shall be provided with the following agency approvals. With the submittal documents, verification that the approvals exist for all submitted products shall be provided. Systems or products not currently offering the following approvals are not acceptable.
1. UL-916; Energy Management Systems
 2. UL-873; Temperature Indication and Regulating Equipment UL-864; Subcategories UUKL, QVAX, UDTZ; Fire and Smoke Control Systems
 3. FCC; Part 15, Subpart J, Class A Computing Devices
- I. All products shall be labeled with the appropriate approval markings. System installation shall comply with NFPA, NEMA, Local and National Codes.
- J. Design and build all system components to be fault-tolerant.
1. Satisfactory operation without damage at 110% and 85% of rated voltage and at plus 3-Hertz variation in line frequency.
 2. Static, transient and short-circuit protection on all inputs and outputs.
 3. Protect communication lines against incorrect wiring, static transients and induced magnetic interference.
 4. Network-connected devices to be AC-coupled or equivalent so that any single device failure will not disrupt or halt network communication.
 5. All Building / System Controllers shall have real time clocks and data file RAM with battery and SRAM backup.
 6. All controllers shall be EEPROM, flash driven.

7. The BAS Installer shall have a competent and factory certified Project Manager who is able to answer field questions, is aware of all schedules and schedule changes, and is responsible for the BAS Installer's work and the coordination of their work with all other trades. This Project Manager shall be available for on site and shall respond to design, programming, and equipment related questions. Failure to provide the above services shall be considered a substantial breach of Contract Documents.

K. HVAC/Smoke Control System Operation:

1. On/Auto/Off switches and status indicators (LEDS) shall be provided by the Fire Alarm Contractor for monitoring and manual control of each fan, damper, HVAC control unit, stairwell pressurization fan, space pressurization and smoke exhaust fan. To ensure compliance, the units supplied shall meet the following **UL categories: UUKL, PAZX, UDTZ, QVAX** as well as the requirements of NFPA 90A, HVAC, and NFPA 92A & 92B, Smoke Control. The control system shall be field programmable for either 90A operation or 92A/B operation to allow for future use and system expansion.
2. All devices shall be UL 864 and UUKL listed.

1.06 SUBMITTALS

- A. See Section 250500 and General Conditions for additional requirements.

- B. Product Data: Provide data for each system component and software module.

- C. Shop Drawings.

1. Control damper and control valve schedules, including the size, pressure drop, actuator type/fail, project specific part numbers, valve close-off pressure and location for intended use.
2. Terminal unit schedules shall be provided on a floor by floor basis and must include at a minimum but shall not be limited to room numbers, sizes, contract drawing tag id's, capacity values of minimum/maximum along with modes of operation (Occ/Unocc/Purge etc.), calibration values, etc.
3. Provide a Control Systems Network Riser diagram. This shall incorporate the following:
 - a. The riser shall show on a floor by floor basis the ATC controllers and the communication Tier that the controllers reside on.
 - b. The communication Tiers should be qualified (Ethernet, RS-485, etc.) along with the cabling type.
 - c. All Tier 1 devices along with 3rd party interfaces and gateways shall be shown including workstations, servers, controllers, printers, etc.
 - d. Tier 2 and 3 devices can be grouped by type provided a total quantity of devices is indicated. An example of grouping for Tier 2 and 3 would be for terminal equipment showing VAV's with the quantity separate from Fan Coils with a quantity, etc.
 - e. If a separate Network is required to achieve any smoke control or life safety functions to comply with UL-864 requirements the riser shall be segregated accordingly.
 - f. Wire sizing shall be provided as part of this layout.

4. Provide Electrical load calculations for the entire ATC system as follows.
 - a. Electrical Load calculation sheets shall be provided as part of this submittal package. Provide on a panel by panel basis grouping the loads by floor providing a total VA load for the floor.
 - b. This shall also apply to VAV box loading when utilizing step down transformers for 24VAC distribution.
 - c. The ATC contractor shall review the Electrical power plans for the dedicated ATC circuits and indicate in the initial submittal the panels/controllers that will be on each circuit with the panel and circuit number depicted.
 - d. The KVA and Electrical Panel/Circuit number will also be shown on the ATC controller Network riser diagrams showing totals for panels and totals for floors.
 - e. If additional circuits are required, the ATC contractor shall indicate this in the submittal and demonstrate by the load calculations the quantity of additional circuits that are required.
 - f. The Electrical Load Calculations shall be updated and submitted with the final as-built documents.
 5. Electrical panel enclosure layouts and wiring diagrams to numbered terminal blocks shall be provided as part of the submittal documentation for all ATC panels. The layouts shall depict all components and the wiring diagrams must be in ladder logic diagram format.
 6. Unique individual control flow diagrams shall be provided for all systems. These shall show all input and output system components in their correct locations and orientations. Typical diagrams are allowed providing the systems are truly identical but the unit numbers for major systems are clearly listed. For terminal units the drawing number for the "typical" must be indicated on the terminal unit schedules. All control diagrams shall be provided with their associated points schedules.
 7. List connected data points, including connected control unit and input device.
 8. Indicate all system graphics for all controlled systems including all air handling systems, hydronic pumping systems, monitored systems, data (connected and calculated) point addresses and operator notations.
 9. Show system configuration with peripheral devices, batteries, power supplies, diagrams, modems and interconnections.
 10. The sequence of operation for each HVAC system and the associated control diagrams shall be provided. The sequence should include normal operation along with failure modes of operation detailing any software lockouts that require user intervention and any time delays or specialty interfaces. All equipment and control labels shall correspond to those shown on the contract documents.
 11. Develop and provide emergency, fire, smoke management control and device response matrices in an MS Excel spreadsheet format.
 12. Show electronic ranges for each valve, damper, inlet vanes actuators etc., (i.e. 4 – 20 ma or 0-10 vdc).
 13. All control logic and controllable components shall be depicted and identified within each matrices developed.
 14. Furnish PICS and BIBBS for each BACNET compliant device.
 15. All UUKL components shall be depicted and identified.
- D. Manufacturer's Installation Instructions: Indicate manufacturer's installation instructions for all manufactured components.
- E. Submit brochures that contain only that information which is relative to the particular equipment or materials to be furnished. Do not submit catalogs that describe several different items other than those items to be used unless irrelevant information is marked out and relevant material is clearly marked.

F. Specifications Compliance Statement

1. The manufacturer shall submit a point by point statement of compliance with the specifications.
2. The statement of compliance shall consist of a list of all paragraphs (line by line).
3. Where the proposed system complies fully, such shall be indicated by placing the word "comply: opposite the paragraph number.
4. Where the proposed system does not comply, or accomplishes the stated function in a manner different from that described, a full description of the deviation shall be provided.
5. Where a full description of a deviation is not provided, it shall be assumed that the proposed system does not comply with the paragraph in question.
6. Submissions which do not include a point by point statement of compliance as specified shall be disqualified.

G. Project Record Documents: Record actual locations of control components, including control units, thermostats and sensors, trunk cable routing, junction boxes, transformers, VAV terminal box power circuiting, box addresses.

1. Revise shop drawings to reflect actual installation and operating sequences.
2. Include submittal data in final "Record Documents" form.
3. All start-up/checkout documentation shall be initialed and signed by the on-site control technician with intimate knowledge of the project.
4. Provide start-up/checkout documentations for all DDC controllers connected to the BAS network. Documentation shall include all controller points used and unused (spare). Furthermore, all final settings, calibration, coefficient values, K factors, spanning, actual spring ranges, etc., shall be indicated for all active points in use.
5. Revise all control sequences of operation. Sequences of operation that restate the Design Engineer's sequences will not be acceptable. Complete details will be given within the sequences of operation provided by the Contractor. Details shall include, but not be limited to, the following items: Control strategy, timers, delays, logic sequencing, start/stop, end devices involved, sensors involved, set points, globally commanded values, shared data between panels and controllers.
6. Provide a separate drawing with detailed operation sequence for each UL category UUKL smoke control system. This means if there are four pressurized stairs each has its own drawing and sequence specific to that system. No system shall be a duplicate.
7. VAV controller startup/commissioning documentation shall include as a minimum but not limited to the following final as-built information:
 - a. Min/max CFM settings.
 - b. Controller volume tracking differential.
 - c. Box size and area multiplier.
 - d. Box K factor as determined by ATC and TAB.
 - e. Controller network master address.
 - f. Controller address on master.
 - g. Auto-zero enabled/disabled.
 - h. Auto-zero scheduled time.
 - i. Communications priority (life safety, critical, normal).
 - j. Tstat set point override range (+/- 5°F).
 - k. Rom set point (base).
 - l. Generic additional points added to controller.
 - m. Controller box identifier shall match mechanical tag as called out on mechanical plans.
 - n. When used for smoke control unit shall be UL category UUKL.

H. Operations and Maintenance Data:

1. Include interconnection wiring diagrams for completed field installed systems with identified and numbered system components and devices.
2. Include keyboard illustrations and step-by-step procedures indexed for each operator function.
3. Include inspection period, cleaning methods, cleaning materials recommended and calibration tolerances.

1.07 QUALITY ASSURANCE

- A. Perform work in accordance with NFPA 70 and Divisions 26, 27 and 28 specifications.
- B. Design system software under direct supervision of a Professional Engineer experienced in design of this Work and licensed within the State in which the project is located.
- C. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum ten (10) years of documented experience.
- D. Installer Qualifications: Company specializing in performing the type of work specified in this section with minimum ten (10) years of documented experience and approved by manufacturer.
- E. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. and testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.08 WARRANTY

- A. See Section 230500 and General Conditions for additional requirements.
- B. The system specified herein and shown on the drawings shall be guaranteed to be free from original defects in both material and workmanship for a period of twelve (12) months of normal use and service, excepting damages from other causes. This guarantee shall become effective starting the date the Contract work is accepted as complete by the Owner and in accordance with the General Provisions/Conditions.
 1. All warranties for all equipment shall begin at the time that the equipment is TURNED OVER TO AND ACCEPTED BY THE OWNER. The use of equipment by the Contractor for the purposes of completion of the building, testing and evaluation of the system prior to turnover to the Owner, or partial completion of systems shall, in no way, be construed as "accepted by the Owner". The Contractor shall include in his cost the value of extending the warranty period to ensure that the warranty period begins when the equipment is Owner accepted and ends according to the Contract.
- C. Provide five (5) year manufacturer's warranty for field programmable micro-processor based units.
- D. Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.09 MAINTENANCE SERVICE

- A. Provide service and maintenance of energy management and control systems for one (1) year from Date of Substantial Completion/Acceptance of System by Owner.
- B. Provide two (2) complete inspections during the first year, one (1) in each season, to inspect, calibrate and adjust controls as required and submit written reports.

1.10 PROTECTION OF SOFTWARE RIGHTS

- A. Prior to delivery of software, the Owner and the party providing the software shall enter into a software license agreement with provisions for the following:
 - 1. Limiting use of software to equipment provided under these specifications.
 - 2. Limiting copying.
 - 3. Preserving confidentiality.
 - 4. Prohibiting transfer to a third party.

1.11 GENERAL

- A. Acceptable manufactures subject to compliance with the specifications
 - 1. Johnson Controls
 - 2. Automated Logic
- B. The entire system and all control components shall be powered with emergency power.
- C. All electrical work shall comply with Divisions 26, 27 and 28 Specifications.

PART 2 PRODUCTS

2.01 ELECTRIC LOW VOLTAGE WIRING

- A. Furnish all labor and material to install the necessary wiring to accomplish the successful and complete operation of the new automatic system (DDC).
- B. All electric wiring, wiring connections and all interlocking required for the installation of the temperature control system, as herein specified, shall be provided by the Contractor, unless specifically shown on the Electrical drawings or called for in the Electrical specifications.
- C. Furnish all labor and material to install necessary relays, general purpose enclosures and appurtenances to control designated devices relative to the DDC.
- D. All wiring throughout shall be concealed where possible.
- E. All conduit used shall be EMT, 3/4" minimum size or larger. Conduit sizes shall be large enough to permit the individual conductors to be readily installed or withdrawn without damage to the conductors or their insulation. Splicing of wires will be permitted only in junction boxes or pull boxes. Conduit shall be rigid up to 8'-0" AFF in mechanical rooms.
- F. Conduit shall never to be relied upon for a fault current and safety ground return conductor.

- G. All UL category UUKL portions of the system shall be in conduit.
- H. All UL category UUKL portions of the system shall be powered from emergency power.
- I. The ground system shall not be used as a current carrying conductor except for faults and noise suppression. The grounding system shall be used to control noise and transients which might affect the operation of the automation system. As such, the ground requirements shall be in excess of a grounding system used solely for physical protection minimum (Code requirement).
- J. In all cases, the bond to ground shall be as short as possible. A ground point shall be derated by one (1) point (in order of preference) for each 50'-0" of conductor run between it and the automation equipment to be grounded. Therefore, a water pipe bond located 10'-0" away will be preferable to a structural steel bond located 150'-0" away.
- K. Set screw connectors shall be galvanized or plated steel. White metal cast type will not be permitted.
- L. Flexible conduit shall be used at field devices, i.e., pressure switches, flow switches, temperature devices, etc. Convolutions shall be steel, interlocked continuously. Aluminum will not be permitted. "Liquidtight" shall be used in wet locations. Flexible connector shall be a minimum of 18" long.
- M. Only core drilling is permitted to pierce the floors in the electrical closets and elsewhere. The use of water for drilling shall be controlled by a suitable vacuum system, using proper dams to prevent damage to floors below. The ATC Contractor shall be responsible for providing a suitable sleeve in all core drilled holes as specified herein.
- N. All wiring shall be run in EMT as noted below:
 - 1. Sensor to Panel (Block Wall): In Wall Conduit (EMT)
 - 2. Sensor to Panel (Stud Wall): In New Conduit (EMT)
 - 3. Sensor to Panel (Mechanical Room): In New Conduit (EMT)
 - 4. Panel to Front End Workstation: In New Conduit (EMT)
 - 5. Front End: In New Conduit (EMT)
- O. Wiring
 - 1. Type THHN solid #18 AWG for control wiring in dry location up to 194°F.
 - 2. Type THWN in wet location up to 167°F (solid #18 AWG).
 - 3. Twisted shielded pair (18 gauge), with PVC cover, Belden #8760 or approved equal.
 - 4. Conduit is not considered as a shield.
 - 5. All wiring associated with the control signals to the smoke damper control/sequence must be in approved conduit.
 - 6. All signal wiring to all field devices shall be run with no splices, separately from any wiring having voltage greater than 30 volts.
- P. The Contractor shall install all shielded cable and ground systems in accordance with Division 23. The installation of ground loops shall not affect any sensing or control circuits.
- Q. All devices and equipment shall be mounted in minimum NEMA 1 enclosures.

R. Low Voltage Control Wiring (30 VAC or Less)

1. Low voltage control wiring shall be minimum 16 gauge, or heavier if required, twisted pair, 100% shielded with PVC cover Belden #9316 or approved equivalent product of other manufacturers run in conduit with no splices, separate from any wiring above 30 volts.

S. Coordination of Interfacing/Interlocking

1. The Contractor shall be responsible for coordinating all required interface/interlocking software, software logic, sequencing and wiring necessary to provide a fully automated and fully functional operable system to meet or exceed the intent of the Design Engineer's Sequence of Operation. Coordination may include but not limited to the following at no additional cost to the Owner. Variable frequency drive (VFD) interlocking and wiring logic including software, relays factory/field installed wiring and/or VFD drive modifications. This would include coordination of miscellaneous points as specified under the point list in this specification. Systems to include all points, analog, digital, pneumatic sensors wiring, software, wiring, communications gateways, etc., to connect and communicate to any Fire, Plumbing, HVAC, Lighting, ATC, Security, World Wide Web (Internet) systems installed under this project.

2.02 BACNET CONFORMANCE

- A. The Building Automation System (BAS) Contractor shall supply a BACNET (ANSI/ASHRAE 135-2010) Compliant System. Each device category and its required compliance are listed below under sections F-H. BACNET compatible systems that employ the use of proprietary 'gateways' will not be accepted unless otherwise noted.
- B. The BACNET system shall be capable of Internet Protocol (IP) communications. BACNET /IP or Annex J will be considered the basis of design. All other configurations must be submitted prior to bid, in writing, for final approval. These configurations shall include but not limited to, Annex H or third party BACNET tunneling routers.
- C. The secondary or sub-network shall utilize the Master-Slave/Token-Passing protocol, as acknowledged by the ANSI/ASHRAE 135 standard. Proprietary RS-485 or equivalent links will not be considered unless otherwise noted. The MS/TP link shall operate at a 76.8 Kbps minimum, and utilize no more than 2 repeaters in any instance. Multi channel repeaters will not be permitted.
- D. The use of proprietary gateways to transmit input/output data, and/or related information, must reside on the Ethernet LAN and be approved, in writing, prior to the bid.
- E. Building Controller Conformance (BC): The building controller must be certified and listed by BTL (BACNET Testing Laboratory) under Device Profile B-BC (Annex L of the BACNET standard) with support of the following BIBBs:
 1. Alarm and Event Management BIBBs
 - a. AE-ACK-B, AE-ASUM-B, AE-ESUM-B, AE-INFO-B, AE-N-A, AE-N-E-B, AE-N-I-B

2. Device Management BIBBs
 - a. DM-BR-B, DM-DCC-B, DM-DDB-A, DM-DDB-B, DM-DOB-A, DM-DOB-B, DM-OCD-B, DM-RD-B, DM-TM-A, DM-TS-A, DM-TS-B, DM-UTC-A, DM-UTC-B
 3. Data Sharing BIBBS
 - a. DS-COV-A, DS-COV-B, DS-COVU-A, DS-COVU-B, DS-RP-A, DS-RP-B, DS-RPM-A, DS-RPM-B, DS-WP-A, DS-WP-B, DS-WPM-B
 4. Network Management BIBBS
 - a. NM-CE-A, NM-CE-B
 5. Scheduling BIBBs
 - a. SCHED-A, SCHED-E-B, SCHED-I-B
 6. Trending
 - a. T-ATR-B, T-VMT-E-B, T-VMT-I-B
- F. Advanced Application Controller Conformance (AAC): The AAC must be certified and listed by BTL (BACNET Testing Laboratory) under Device Profile B-AAC (Annex L of the BACNET standard) with support of the following BIBBs:
1. Alarm and Event Management BIBBs
 - a. AE-ACK-B, AE-ASUM-B, AE-ESUM-B, AE-INFO-B, AE-N-E-B, AE-N-I-B
 2. Device Management BIBBs
 - a. DM-BR-B, DM-DCC-B, DM-DDB-A, DM-DDB-B, DM-DOB-A, DM-DOB-B, DM-LM-B, DM-OCD-B, DM-RD-B, DM-TM-A, DM-TS-B, DM-UTC-B
 3. Data Sharing BIBBS
 - a. DS-COV-A, DS-COV-B, DS-COVU-A, DS-RP-A, DS-RP-B, DS-RPM-A, DS-RPM-B, DS-WP-A, DS-WP-B, DS-WPM-B
 4. Network Management BIBBS
 - a. NM-CE-A
 5. Scheduling BIBBs
 - a. SCHED-E-B, SCHED-I-B
 6. Trending
 - a. T-ATR-B, T-VMT-E-B, T-VMT-I-B

- G. Application Controller Conformance (ASC): The ASC must be certified and listed by BTL (BACNET Testing Laboratory) under Device Profile B-ASC (Annex L of the BACNET standard) with support of the following BIBBs:
1. Data Sharing BIBBs
 - a. DS-RP-B, DS-WP-B, DS-RP-A, DS-RPM-B, DS-WP-A, DS-WPM-B, DS-COV-B, DS-COVP-B
 2. Device Management BIBBs
 - a. DM-DDB-B, DM-DOB-B, DM-DCC-B, DM-DDB-A, DM-RD-B, DM-TS-B, DM-UTC-B
- H. Read / Write Properties: The entire BACNET BAS system (all BC, AAC and ASC devices) shall support the following Read/Write properties within the given BACnet objects and shall permit dynamic creation and deletion thereof.
1. Analog Input Object
 - a. Read and Write Properties: Description, Name, Value, COV Increment, Out of Service, Reliability
 - b. Read Only Properties: Type, Units, Status Flags, Event State
 2. Analog Output Object
 - a. Read and Write Properties: Description, Name, Value, Out of Service, Reliability
 - b. Read Only Properties: Type, Units, COV Increment, Status Flags, Event State, Priority Array
 3. Analog Variable Object
 - a. Read and Write Properties: Description, Name, Value, Units, COV Increment, Out of Service, Reliability
 - b. Read Only Properties: Type, Status Flags, Event State
 4. Binary Input Object
 - a. Read and Write Properties: Description, Name, Value, Out of Service, Reliability
 - b. Read Only Properties: Type, Status Flags, Event State
 5. Binary Output Object
 - a. Read and Write Properties: Description, Name, Value, Out of Service, Reliability, Minimum On/Off time
 - b. Read Only Properties: Type, Status Flags, Event State, Priority Array
 6. Binary Variable Object
 - a. Read and Write Properties: Description, Name, Value, Out of Service, Reliability
 - b. Read Only Properties: Type, Status Flags, Event State

7. Event Enrollment Object
 - a. Read and Write Properties: Description, Name, Notification Class, Event Enable, Event Parameter, Event Type, Object Reference
 - b. Read Only Properties: Type, Event State, Event Time Stamps, Notification Type, Acknowledged Transactions
8. Notification Class Object
 - a. Read and Write Properties: Description, Name, Priority, Recipient List
 - b. Read Only Properties: Type, Notification Class
9. Calendar Object
 - a. Read and Write Properties: Description, Name
 - b. Read Only Properties: Type, Value
10. Schedule Object
 - a. Read and Write Properties: Description, Name, Object Reference, Weekly Schedule, Effective Period, Schedule Exceptions
 - b. Read Only Properties: Type, Value
11. Trendlog Object
 - a. Read and Write Properties: None
 - b. Read Only Properties: Description, Name, Type, Notification Class, Event Enable, Event State, Event Time Stamps, Notification Type, Acknowledge Transactions, Log Enabled, Start/Stop Time, Log Interval
12. Program Object
 - a. Read and Write Properties: Description, Name, Out of Service, Reliability, Program Change
 - b. Read Only Properties: Type, Status Flags
13. Loop Object
 - a. Read and Write Properties: Description, Name, Value, COV Increment, Out of Service, Reliability, Tuning Parameters, Action, Controlled Variable
 - b. Read Only Properties: Event State, Status Flag, Type
14. File Object
 - a. Read and Write Properties: Description, Name
 - b. Read Only Properties: Type

2.03 BUILDING AUTOMATION SYSTEM ARCHITECTURE

A. General

1. The Building Automation System shall consist of a number of Nodes and associated equipment connected by industry standard network practices. All communication between Nodes shall be by digital means only. The BAS shall provide control, alarm detection, scheduling, reporting and information management for the entire facility, and Wide Area Network (WAN) if applicable, from a single ODBC-compliant database.
2. The system shall be designed with a top-level 10/100bT Ethernet network, using the BACnet/IP protocol. A sub-network using the BACnet MS/TP protocol, with a minimum of 76.8kb speed, shall connect the local, stand-alone controllers with Ethernet-level controller/routers. The use of ARCNET, LONworks, RS-232 serial communications, or BACnet Ethernet for these controllers is prohibited.
3. The Building Automation System network shall at minimum comprise of the following:
 - a. Operator Workstations – fixed and portable.
 - b. Network processing, data storage and communication equipment including file servers.
 - c. Active processing Nodes including field panels.
 - d. Intelligent and addressable elements and end devices.
 - e. Third-party equipment interfaces.
 - f. Other components required for a complete and working Building Automation System.
4. The Building Automation System shall be accessible via Enterprise Intranet and Internet browser with security protection for user access.
5. The PC Workstations, File servers and principal network equipment shall be standard products of recognized major manufacturers available through normal PC vendor channels. "Clones" are not acceptable.
6. Provide licenses for all software residing in the Building Automation System and transfer these licenses to the Owner prior to completion.

B. Network

1. The Building Automation System shall incorporate a primary Tier 1 and Tier 2 networks. At the Contractor's option, the Building Automation System may also incorporate integrated tertiary Tier 3 networks.
 - a. The Tier 1 portion of the Network shall comprise the Operator Workstations, Network File Servers, Network Application Nodes (NAN), Network Application Controllers (NAC), Web Servers and IP based Integration Controllers. This shall be the main backbone of the system which shall be an Ethernet 10/100bT LAN/WAN, using BACnet/IP as the communications protocol. "The BAS shall be on the Owners IT backbone with data drops provided at the BAS panels for all Tier 1 controllers."
 - b. The Tier 2 portion of the Network shall comprise the various Unitary Application Controllers (UAC). These shall communicate via BACnet MS/TP field buses managed by the NAN/NAC's. Minimum speed shall be 76.8kbps. The Level 2 field bus consists of an RS485, token passing bus.

2. The Building Automation System Network shall utilize an open architecture capable of:
 - a. Utilizing standard Ethernet communications of 10/100 Mb/sec with a minimum speed of 100 Mb/sec. This shall be the Tier 1 level of the Network.
 - b. Connecting via BACnet.
3. The BAS Contractor shall furnish and install a temporary Ethernet network for the construction phase of the project as the Owners IT network will be complete until the end of the project. The temporary network shall be maintained by the BAS contractor. This shall include all network devices and cabling as required.

C. Third-Party Interfaces

1. Building Automation System Contractor shall integrate real-time data from systems supplied by other trades as required.
2. The Building Automation System shall include necessary Building Automation System hardware equipment and software to allow data communications between the Building Automation System and systems supplied by other trades.
3. The trade contractor supplying other systems will provide their necessary hardware and software and will cooperate fully with the Building Automation System Contractor in a timely manner at their cost to ensure the complete data integration.
4. The Building Automation System Contractor shall provide all necessary coordination with vendors, contractors, owners, engineers, and other representatives at no additional cost to the Owner. Provide a completed fully functional, operational, integrated and seamless communicating infrastructure system.

D. Power Fail / Auto Restart

1. Provide for the automatic, orderly and predefined shutdown of parts or all of the Building Automation System following total loss of power to parts or all of the Building Automation System.
2. Provide for the automatic, orderly and predefined startup of parts or all of the Building Automation System following total loss of power to those parts or all of the Building Automation System. Archive and annunciate time and details of restoration.
3. Provide for the orderly and predefined scheduling of controlled return to normal, automatically time scheduled, operation of controlled equipment as a result of the auto restart processes.
4. Maintain the Building Automation System real-time clock operation during periods of power outage for a minimum of 72 hours.

E. Downloading and Uploading

1. Provide the capability to generate Building Automation System software-based sequences, database items and associated operational definition information and user-required revisions to same on designated Operator Workstations and the means to download same to the associated Application Nodes.
2. Provide the capability to upload Building Automation System operating software information, database items, sequences and alarms to the designated Operator Workstations with automatic archiving of same on the Operator Workstations. The functions of this Part shall be governed by the codes, approvals and regulations applying to each individual Building Automation System application.
3. The entire control system shall be approved and listed by UL 916 - Energy Management.

4. All DDC panels shall be powered through uninterruptible power sources (UPS) with sufficient capacity to ride through a (2) minute power interruption between transfers from normal to emergency power. UPS's and wiring shall be provided by the ATC Contractor.
5. Uploading or downloading functions performed at any location shall not affect controllers, communications, inputs, outputs at any location or address within the Building Automation Control Architecture nor shall any controller level functions be disrupted in any manner.

F. Network Automation Nodes (NAN)

1. (NAN) Network Automation Nodes shall be stand-alone, multi-tasking, multi-user, real-time digital processor complete with all hardware, software, and communications interfaces, power supplies. The Controls System shall be designed and implemented entirely for use and operation on the Internet. NANs shall have access to data within the industry standard IT network to the Data Server and other NANs as needed to accomplish required global control strategies. The Network Automation Nodes shall be designed, packaged, installed, programmed and commissioned in consideration of their specific service and prevailing operating conditions. They shall be proven standard product of their original manufacturer and not a custom product for this Project.
2. A failure at a Network Automation Node shall not cause failures or non-normal operation at any other system Network Automation Node other than the possible loss of active real-time information from the failed Network Automation Node.
3. Ancillary Network Automation Node equipment, including interfaces and power supplies, shall not be operated at more than 80% of their rated service capacity.
4. NANs shall provide both standalone and networked direct digital control of mechanical and electrical building system controllers as required by the Specifications. The primary NAN shall support a minimum of [5,000] field points together with all associated features, sequences, schedules, applications required for a fully functional distributed processing operation.
5. NANs shall monitor and report communication status to the Controls Systems Application. The Controls Systems shall provide a system advisory upon communication failure and restoration.
6. All NANs on the network shall be equipped with all software functionality necessary to operate the complete user interface, including graphics, via a Browser connected to the Node on the network or directly via a local port on the NAN.
7. All NAN shall be provided with face mounted LED type annunciation to continually display its operational mode, power and communications.
8. The controllers shall reside on the BACnet Ethernet (ISO 8802-3) local area network and provide Read (Initiate) and Write (Execute) services as defined in Clauses 15.5 and 15.8, respectively of ASHRAE Standard 135, to communicate BACnet objects. Objects supported shall include: Analog input, analog output, analog value, binary input, binary output, binary value, and device. The NAN's shall be tested and certified by the BACnet Testing Laboratory (BTL) as Building Controllers (B-BC).
9. Each NAN shall be provided with the necessary un-interruptible power facilities to ensure its continued normal operation during periods of line power outages of, at minimum, 1-minute duration. Normal functionality shall include all normal software processing, communication with powered field devices and network communications with other powered Controls Systems NAN, Data Servers and OWS. Each NAN shall report its communication status to the Application. The Application shall provide a system advisory upon communication failure and restoration. Each NAN shall retain program, control algorithms, and setpoint information in non-volatile memory in the event of a power failure, and shall return to normal operation upon restoration of power.

10. Each NAN shall have sufficient memory to support its operating system, database, and program requirements, including the following:
 - a. Data sharing.
 - b. Device and network management.
 - c. Alarm and event management.
 - d. Scheduling.
 - e. Energy Management.
11. Each NAN shall support firmware upgrades without the need to replace hardware and shall have a minimum of 15 percent spare capacity of secondary system controllers, point capacity and programming functions.
12. Each NAN shall continuously perform self-diagnostics, communication diagnosis, and provide both local and remote annunciation of any detected component failures, low battery condition; and upon failure shall assume the predetermined failure mode.
13. Each NAN shall monitor the status of all overrides and inform the operator that automatic control has inhibited, and allow the operator to manually override automatic or centrally executed command.
14. Provide the capability to generate and modify the Controls Systems Application software-based sequences, database elements, associated operational definition information and user-required revisions to same at any designated Workstation together with the means to download same to the associated System Controllers.
15. In the event of loss of normal power, there shall be orderly shutdown of the controllers to prevent the loss of database or software programming. When power is restored flash memory, battery backup or super capacitor will be automatically loaded into non-volatile flash memory and shall be incorporated for all programming data.

G. Network Application Controller (NAC)

1. The Network Application Controller (NAC) shall provide the same abilities of the NAN to reside on the Ethernet along with Web based interface. The main differences will be in a lower controller count for the Tier 2 network but this controller shall have direct hardwired input/output capabilities. The NAC's shall be tested and certified by the BACnet Testing Laboratory (BTL) as Building Controllers (B-BC).
 - a. Each NAC shall have a minimum of 24 hardwired input/output points.
 - b. Each NAC shall have an integral Input/Output communication bus for point expansion. The input/output expansion modules shall be for point IO only and all control processing algorithms shall reside in the NAC.
 - c. The NAC's shall be utilized for large systems control and the contractor shall provide an NAC for each of the following systems:
 - 1) Air Handling Unit
 - 2) Chiller Plant (based on the size of the plant, more than a single controller may be required for redundant operation).
 - 3) Boiler plant (based on the size of the plant, more than a single controller may be required for redundant operation).
 - 4) Heat Exchanger Systems for Processed Chilled Water, Reheat/Radiation/Radiant Hot Water, etc.

H. Unitary Application Controller (UAC)

1. Unitary Application Controller (UAC) shall provide both standalone and networked direct digital control of HVAC systems. The UAC's shall be tested and certified by the BACnet Testing Laboratory (BTL) as Advanced Application Controllers (B-AAC) or Application Specific Controller (B-ASC).
2. A dedicated UAC shall be configured and provided for each terminal HVAC system (VAV Box, Unit Heater, Fan Coil Unit, CV Box)
3. Each UAC shall be able to retain program, control algorithms, setpoints, logic and command information through the use of non-volatile memory (flash, EEPROM). Other information such as trend data, historical data schedules will be maintained for at least 72 hours in the failure and shall return to normal operation upon restoration of power.
4. Each UAC shall report its communication status to the Building Automation System. The Building Automation System shall provide a system advisory upon communication failure and restoration.
5. Each UAC shall support firmware upgrades without the need to replace hardware and shall have a minimum of 15 percent spare capacity of I/O functions. The type of spares shall be in the same proportion as the implemented functions on the controller, but in no case there shall be less than one point of each implemented I/O type.
6. Provide a means to prevent unauthorized personnel from accessing setpoint adjustments and equipment control functions.
7. The UAC shall provide the ability to download and upload configuration data, both locally at the Node and via the FMS communications network.
8. Each UAC shall be a dedicated controller without the need to use expansion modules to accomplish the entire primary control sequences. Sharing controller, sensor, input/output data over any high level or low level network to accomplish the specified control sequences is unacceptable. Global sharing of general data such as OA-T, OA-RH OA-CO² levels between controllers over the BMS network is acceptable as long as speed of transmitting the data does not impact the UAC controller ability to perform in any mode of operation.
9. If it is determined that the UAC controller cannot perform specified sequence of operation because of dependency for shared information that Contractor shall provide a higher level controller at no additional cost. This change shall be identified by separate submittal to Design Engineers.

2.04 PORTABLE OPERATOR'S TERMINAL

A. Acceptable Manufacturers subject to compliance with the specification:

1. Dell
2. Compaq
3. Toshiba
4. IBM

B. Provide one (1) portable operator terminal with a minimum LCD display of 80 characters by 25 lines and a full featured keyboard. The portable operator's terminal shall be hand-held and plug directly into individual distribution control panels as described below. Provide a user friendly, English language prompted interface for quick access to system information, not codes requiring look-up charts.

C. General

1. Furnish portable operator's terminal for system. Portable operator's terminal shall allow for local accessing of program information.
2. Laptop terminal portable operator's terminal shall have the following features:
 - a. Intel Pentium Core 2 Duo 2.53 GHz w/3 MB cache
 - b. Full active matrix color display with minimum 1024 x 680 resolution, 15".
 - c. AC adapter
 - d. Battery pack / battery charger
 - e. 250 GB fixed disk drive
 - f. 3.0 GB of RAM
 - g. 8X DVD +/- RW drive
 - h. Internal modem
 - i. Audio built in
 - j. Latest version of Microsoft Windows
 - k. Internal Ethernet Adapter Card with UTP/BNC connector
 - l. Equipped with both 1 Type III or 2 Type II PCMCIA Slots
 - 1) Type III 4
 - 2) Type II PCMC1A Slots
 - m. Integrated pointing device

D. Functionality of the portable operator's terminal connected at any high or lower level controller:

1. Access all controllers on the network.
2. Backup and/or restore controller data bases for all system panels, not just the DDC controller.
3. Display all point, selected point and alarm point summaries.
4. Display trending, historical and totalization information.
5. Add, modify, and/or delete any existing or new system point.
6. Command, change setpoint, enable/disable any system point vertical or physical.
7. Program and load custom control sequences as well as standard energy management programs.

E. Connection of a POT on controller to a distributed control processor shall not interrupt nor interfere with normal network operation in any way, prevent alarms from being transmitted or preclude centrally-initiated commands and system modification.

F. Portable operator terminal access to controller shall be password-controlled and menu-driven.

2.05 OPERATOR INTERFACE WORKSTATION (TYPICAL FOR [1])

A. The Contractor shall provide all the necessary hardware and software to interface with the existing Central Facility Management System. A gateway between each system provided under this section and the CFMS system shall be provided by the ATC Contractor. The gateway shall allow the following:

1. Monitoring and commanding of all points of each system. Limited point sharing between the OCC and native systems is not acceptable except when using bundled point technology to control terminal equipment (e.g. VAV box, RHC).

The bundle point information may be passed to the CFMS via a virtual terminal direct connection. This connection shall be over the Ethernet data highway and shown on the CFMS PC as an inset window on the screen. Each bundled point shall be unbundled to continuously pass the actual value of the controlled variable (e.g. room temperature, face velocity) and the controlled variable setpoint. If a virtual terminal connection is not possible, the ATC Contractor shall pass the bundled point through the gateway and Comdale shall unbundle the information for display. Bundled points shall not be allowed for primary HVAC equipment (e.g. AHUs, heat exchangers).

2. Trend reports shall be compiled by the CFMS; however, point information and format shall be provided to the CFMS from the native system as directed.
 3. The CAD drawings for the native system shall be capable of being located into the CFMS for the purpose of making dynamic graphics.
- B. Transmission of the native system to the CFMS shall be via Ethernet. All necessary labor and material to tie into the existing campus Ethernet data highway shall be provided under this section.
- C. Each native system shall have a CFMS gateway unless otherwise provided for in the specification.
- D. The cost to develop the gateway shall be provided under this section. The labor to check out and verify each developed gateway shall be included under this section. The gateway operation must be verified in the presence of and signed-off by the Owner's CFMS representative.
- E. The cost to create graphics, check out, program and any other work necessary to provide a fully functioning CFMS interface with the new Building Automation System control systems shall be included under this section.
- F. The ATC Contractor shall develop all software interfaces for the Vivarium/Animal Facility Monitoring and Control system, to provide a simple computer interface and operating systems for use by the Animal Research Staff in monitoring and resetting temperature, humidity, lighting control, etc. within the animal research spaces.
- G. Provided with a UPS system with one hour backup.

2.06 OPERATOR WORKSTATION

- A. Basic Interface Description
1. Command Entry/Menu Selection Process: Operator Workstation interface software shall minimize operator training through the use of English language prompting, English language point identification, and industry standard PC application software. The operator interface shall minimize the use of a typewriter style keyboard through the use of a mouse or similar pointing device, and "point and click" approach to menu selection. Users shall be able to start and stop equipment or change setpoints from graphical displays through the use of a mouse or similar pointing device.
 2. Graphical and Text-Based Displays: At the option of the user, Operator Workstations shall provide consistent graphical or text-based displays of all system point and application data described in this specification. Point identification, engineering units, status indication, and application naming conventions shall be the same at all workstations.

- B. Computer System Access Operation Control Stations (OCS) Description: This system access workstation is also referred to as the Building Automation System "Front end".
- C. Provide Workstation with:
1. Workstation shall be general purpose, commercially available, personal computer with sufficient memory and processor capacity to perform all functions described in this specification.
 2. Sufficient hard drive memory storage shall be provided to accommodate all fully configured point data bases, all application databases, all graphics data bases, all user-defined reports, and all historical data archival as described in this specification.
 3. Each shall include the following:
 - a. Intel Core 2 Duo 3.0 GHz, 6 MB cache with 4 GB DDR2 SDRAM memory.
 - b. 19" color LCD monitor 1280x1024.
 - c. SVGA video output (256 MB RAM).
 - d. 750 GB fixed disk.
 - e. HI-RES bus mouse.
 - f. (1) Printer for alarms, minimum 240 characters/seconds.
 - g. (1) Printer for reports, minimum Laser printer similar to HP 4000.
 - h. 16X DVD +/- RW drive
 - i. Ethernet network interface card
 - j. Server type platform shall have at a minimum a RAID level 1 array with multiple fixed hot swappable disks for redundancy. Provide minimum two fixed disks.
 4. The operator functions provided by the system access Operator Terminal shall include, but not be limited to, the following:
 - a. Start and Stop Points
 - b. Modify Setpoints
 - c. Modify PID Loop Setpoints
 - d. Override PID Control
 - e. Change Time/Date
 - f. Add/Modify Start/Stop Weekly Scheduling
 - g. Add/Modify Setpoint Weekly Scheduling
 - h. Enter Temporary Override Schedules
 - i. Define Holiday Schedules
 - j. View Analog Limits
 - k. Enter/Modify Analog Warning Limits
 - l. Enter/Modify Analog Alarm Limits
 - m. Enter/Modify Analog Differentials
 - n. View Point History Files
 5. UPS system with one hour backup.
 6. The workstation shall provide access to all real or calculated points in the controller to which it is connected, or any other controller in the network. This capability shall not be restricted to a subset of predefined "global points", but shall provide totally open exchange of data between the operator terminal and any DDC panel in the network.
 7. Provide English language prompting to eliminate the need for the user to remember command formats or point names. Prompting shall be provided consistent with a user's password clearance and the types of points being displayed, to eliminate the possibility of operator error. Operator shall not require the use of special templates for navigation.

8. On-line, interactive user's "Help" manuals and tutorials shall be provided. Based upon operator request, the "help" function shall provide general system operating instructions, and specific descriptions of commands available in the currently displayed menus.
 9. Identification for all real or calculated points shall be consistent for all network devices.
 10. In addition to instantaneous summaries, the Operator's Terminal shall allow a user to view a Point History file for system points. Point History files shall provide a record of value of analog points over the last 24 hours, at 30 minute intervals, or a record of the last (10) status changes for binary type points.
- D. Provide Server with:
1. PC Hardware – The Workstation/Server computer shall be configured as follows:
 - a. Memory – 4 GB
 - b. CPU– Intel® Xeon®, 2.8 GHz, 8M Cache,
 - c. Hard Drive – 500 GB each for RAID level 1 array
 - d. Hard drive backup system –DVD +/- RW
 - e. Ports – (1) Serial, (2) USB ports
 - f. Keyboard – 101 Keyboard and 2 Button Mouse
 - g. CRT configuration
 - 1) 17" LCD Flat Panel Monitor 1280 x 1024 resolution minimum
 - 2) 16 bit or higher color resolution
 - h. LAN communications – Ethernet communications board; 100Mbps Min
 2. Operating System Software
 - a. Windows XP Professional, IIS Version 5.1, .Net Version 2.0, SQL server 2005 Express software with SP2 or <Alternately> Microsoft Windows Server 2003 OS with SP2, IIS Version 6.0, .Net version 2.0 and SQL Server 2005 with SP@
 - b. Provide required software and hardware required for for integration of computing hardware on enterprise IT network.
- E. Dynamic Color Graphic Displays: Color graphics shall be provided as specified in the Execution portion of this specification to optimize system performance analysis and speed alarm recognition.
1. System Selection/Penetration: The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration drill down scheme, menu selection, and text-based commands.
 2. Dynamic Data Displays: Dynamic temperature values, humidity values, flow values, and status indication shall be shown in their actual respective locations, and shall automatically update to represent current conditions without operator intervention.
 3. Windowing: The windowing environment of the workstation shall allow the user to simultaneously view several graphics at the same time to analyze total building operation, or to allow the display of a graphic associated with an alarm to be viewed without interrupting work in progress.

4. Graphics Definition Package: Graphic generation software shall be provided to allow the user to add, modify, or delete system graphic displays.
 - a. The Contractor shall provide libraries of pre-engineered screens and symbols depicting standard air handling unit components (e.g. fans, cooling coils, filters, dampers, etc.), complete mechanical systems (e.g. constant volume-terminal reheat, VAV, etc.) and electrical symbols.
 - b. The graphic development package shall use a mouse or similar pointing device in conjunction with a drawing program to allow the user to perform the following:
 - 1) Define symbols
 - 2) Position and size symbols
 - 3) Define background screens
 - 4) Define connecting lines and curves
 - 5) Locate, orient and size descriptive text
 - 6) Define and display colors for all elements
 - 7) Establish correlation between symbols or text and associated system points or other displays.
 - 8) Ability to input scanned images and CAD drawings in Autodesk, Drawing Format.
 - c. Graphical displays can be created to represent any logical grouping of system points or calculated data based upon building function, mechanical system, building layout, or any other logical grouping of points which aids the operator in the analysis of the facility. To accomplish this, the user shall be able to build graphic displays that include point data from multiple DDC panels, including application specific controllers used for DDC unitary or VAV terminal unit control.
5. Graphic
 - a. Provide graphic screens each system for this project.
 - b. Provide the following as a minimum:
 - 1) Each air handling unit.
 - 2) Chilled water system.
 - 3) Steam system.
 - 4) Hot water systems.
 - 5) Each heat exchanger.
 - 6) Each exhaust fan.
 - 7) Each supply fan.
 - 8) Each energy meter location with summary.
 - 9) Differential control valves.
 - 10) Each piece of equipment.
 - 11) Each controlled system.
 - 12) Each typical type of VAV or constant volume box, including occupied/unoccupied control for each box/terminal and Laboratory pressurization control system.
 - 13) Each floor plan indicating location of central panels and equipment including smoke control damper/zone pressurization.

- c. Provide graphic representation of building's form and site plans locating all equipment and panels.
 - 1) Dynamic system status graphic of the site-specific architecture showing status of system hardware, including quantity and address of networks, field panels, terminal equipment controllers, and printers.
 - 2) The BAS Contractor shall employ the use of accurate floor plans as part of the overall graphics package. The floor plans shall illustrate the location of room sensors and equipment. In addition, the floor plans shall utilize a thermographic scheme to instantly alert the end user of hot and cold areas. The thermograph shall illustrate and automatically intensify the red and blue gradient fills for each area, as to indicate the severity of the overheating or overcooling problem.
- d. Each hardware point shall be represented on graphic screen.
- e. Selected software points shall be represented on respective process system graph as determined by the Owner. Examples of these software points are:
 - 1) Control loop setpoint value.
 - 2) Control loop auto/manual selection.
 - 3) Lead/lag selection for pumps and other motors.
 - 4) Campus chilled water global points.
 - 5) Calculated points such as run time.
 - 6) Other vertical software points as required.
- f. The Contractor shall coordinate all required graphical modes, features, binding, logic, etc., for a complete fully functional graphical operating system. All graphical schemes shall be submitted and approved by Architect/Engineer and Owner prior to programming.

F. Database Configuration

- 1. Provide database configuration for each hardware and software point.
- 2. Specific point parameters, such as alarm limits, alarm message, point name and point description shall be as approved by the Owner.

G. Trends

- 1. Provide real time and historical trends for hardware and software points as directed by the Owner.
- 2. Archiving or transfer of trend and historical data information shall not interfere, reduce communication throughout stow network speed or reduce local controller operation by any measure, due to trend or historical data capture rates and storage routines.

H. Internet / Intranet Browser

- 1. A multi-user color graphics and textual interface shall be provided that allows customers to access their Building Automation System data via the Internet or Intranet. This interface shall use HTML-based pages to send and receive data from a Building Automation System to a web browser.

2. Browser shall:
 - a. Automatically reflect any changes made to the Building Automation System without additional programming.
 - b. When installed behind a corporate firewall, shall work in conjunction with other security measures that have been implemented.
 - c. Allow the user to navigate and command the Building Automation System using the same format as the Operator Workstation.
 - d. Be an industry-standard browser
 - e. Provide user password access control.
 - f. Provide the means by which the user can create, edit and view groups of FMS data points.
 - g. Provide navigation tools for moving between the views. In addition, it shall provide tools for gaining access to help and for logging out of the system.

I. Remote Notification

1. Provide as part of the project automatic remote notification for personnel of user defined Building Automation System events in the form of alphanumeric paging, email and text messaging. Communication protocols for support of this shall include but not be limited to the following:
 - a. TAP-Compliant (Telelocator Alphanumeric Protocol)
 - b. SMTP (Simple Mail Transfer Protocol)
 - c. SMS (Short Message Services)

J. Reports

1. Provide real time reports for hardware and software points as directed by the Owner.
2. The ATC Contractor shall program and test all alarming and alarm report routing to final devices such as printer, computers, pagers, monitors, cell phones, www, etc. Alarming requirements and routing shall be coordinated with the Owner by first compiling and all points listing for Owner's review prior to any programming.

K. Network Speed and Transmission

1. Network speed (communication rate) 100 megabits per second (MBPS) minimum for all level one controllers.
2. Network configurations shall be Star, Bus or mixed (Star and Bus).

2.07 UNINTERRUPTIBLE POWER SUPPLY (UPS)

A. Provide UPS backup for the following components of the BAS system:

1. All field controllers as follows:
 - a. NAN
 - b. NAC
 - c. UAC types if part of a smoke control application
2. All components of the BAS communication infrastructure.
3. Workstations and Servers

- B. The BAS contractor shall be responsible for sizing the UPS system/system's that will be required. All additional cabinets required for protection, cooling fans and filters shall be part of this projects scope. Load calculations shall be submitted for review.
- C. The UPS shall provide the following:
1. Sized for 125% of the connected load for the following durations:
 - a. Workstations and Servers: 1 hour.
 - b. Field Controllers and all network infrastructure components: 2 minutes.
 2. Designed to operate on Emergency Generator power.
 3. Utilizes double conversion online topology designed to protect equipment by supplying reliable, network-grade power providing extremely tight voltage and frequency regulation.
 4. Internal bypass and input power factor correction.
 5. The primary sections of the UPS are: input disconnect and filter stage, input PFC power stage, energy storage stage (DC bus capacitor bank), output power stage (inverter), bypass and a battery charger. The control of power module and fault detection logic is microcontroller-based providing the following:
 - a. Input filter stages.
 - b. Provide seamless transitions from battery to line and vice versa, as well as the low and high frequency power stages ripple.
 - c. The output power (inverter) stage operates directly from the DC bus and produces a 120VAC output.
 6. Field-replaceable hot swappable battery modules allowing for replacement without the need to interrupt the connected load
 7. Either an optional dry contact to provide a battery low alarm or an integrated network card. If a network card is required, the BAS contractor shall own as part of this project the scope required to install and monitor the UPS network and report the UPS alarms on the BAS network.
- D. The BAS contractor shall include the UPS infrastructure on their Network Riser Diagram and submit for review. The UPS/UPS's shall be shown on the project coordination drawings.
- E. Acceptable Manufacturer:
1. APC
 2. Sola
 3. Eaton

PART 3 EXECUTION

3.01 PROJECT MANAGEMENT

- A. The ATC Contractor shall designate a project manager who will be responsible for the following:
1. Construct and maintain project schedule.
 2. On-site coordination with all applicable trades and subcontractors.
 3. Authorized to accept and execute orders or instructions from Owner/Architect.
 4. Attend project meetings as necessary to avoid conflicts and delays.

5. Make necessary field decisions relating to this scope of work.
6. Coordination/Single point of contact.

3.02 NUMBERING/NAMING CONVENTIONS

- A. The Contractor shall collaborate with the Owner directly to determine the Owner's preference for naming conventions, etc. before entering the data in the system.
- B. As a minimum the ATC Contractor shall submit to the Architect/Engineer and Owner the layout of the network, identifying all DDC controllers. Each controller will be identified by address and system being served. All physical and software generated objects, points and attributes shall be listed along with a description.

3.03 START-UP AND COMMISSIONING

- A. When installation of the system is complete, calibrate equipment and verify transmission media operation before the system is placed on-line. All testing, calibrating, adjusting and final field tests shall be completed by the installer. Verify that all systems are operable from local controls in the specified failure mode upon panel failure or loss of power.
- B. Provide any recommendation for system modification in writing to Owner. Do not make any system modification, including operating parameters and control settings, without prior approval of Owner.
- C. The ATC Contractor will provide industry standard checkout and startup checklists for each DDC controller installed for the project. If not standard is available, the ATC Contractor shall develop a spreadsheet in MS Excel format and submit to the Engineer for approval prior to system checkout.

3.04 INSTRUCTION AND ADJUSTMENT

- A. The Contractor shall provide factory-trained instructor to give full instructions to the owner designated personnel in the operation of the system installed. Instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach. The Contractor shall provide all students with a student binder containing product specific training modules for the system installed. All training shall be held during normal working hours of 8:00 AM to 5:00 PM weekdays.
- B. Upon completion of the project, the Contractor shall:
 1. Fine-tune and "de-bug" all software control loops, routines, programs and sequences of control associated with the control system supplied.
 2. Completely adjust and make ready for use, all transmitters, relays, damper operators, valves, etc., provided under this Section. This Contractor shall furnish copies of complete, detailed, calibrating checkout and commissionary documentation for each controller. Documentation shall list each procedure and shall be signed by the control specialist performing the service.
 3. Furnish a complete set of system operation manual, including standard manufacturers' operating manuals, complete as-built installation diagrams, and complete software hardcopy documentation, as well as a magnetic media back-up.

4. Provide an on-site training program for the Owner's staff in the operation and use of the control system. Training shall include two (2) segments, as follows:
 - a. Segment 1 shall include 24 hours of classroom and hands-on training. This segment shall instruct personnel in the system configuration, component characteristics, control strategy on each controlled system and all requirements for daily operation and use of the system. This segment shall give the Owner's representative a working proficiency in the day-to-day operational requirements (i.e., system monitoring, alarm acknowledgment, HVAC system troubleshooting techniques, setpoint and time schedule adjustments, manual override, etc.).
 - b. Segment 2 shall include 12 hours of on-site training. This segment will be geared for the Owner's designated prime operator. An emphasis on overall software management and manipulation shall be made, to allow the prime operator(s) to make control strategy and overall facility and system management changes as required. Attendees shall have attended Segment 1.
 - c. All training shall take place at the site and at times mutually agreed to between that ATC Contractor and the Owner. The ATC Contractor shall provide to the Owner's designated representative, at least three (3) weeks before each segment, a course syllabus outline and schedule. The ATC Contractor shall provide all training material, reference material and training aids, as required, all as part of his Contract cost.

END OF SECTION

SECTION 253523

DDC CFM TRACKING TERMINAL BOXES (VAV, VCV, CV, VVE, CVE Designations)

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Section 250500 and other Division 1 Specification Sections, apply to this Section.

1.02 WORK INCLUDED

- A. Furnish and install temperature controls.

1.03 RELATED SECTIONS

- A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 SUBMITTALS

- A. See Section 250500 and General Conditions for additional requirements.
- B. Product Data: Provide data for duct materials.
- C. Prepare and submit scaled coordination drawings.
- D. Manufacturer's Installation Instructions.

PART 2 – PRODUCTS

2.01 DDC CFM TRACKING TERMINAL BOXES (VAV, VCV, CV, VVE, CVE Designations)

A. General

- 1. For this project, all air terminal boxes shall be purchased/furnished/installed by the HVAC Contractor. Successful terminal box manufacturer shall receive the terminal box controller and actuator from the Automatic Temperature Control Contractor and mount them onto the boxes at the box factory. The HVAC Contractor shall pay for installation of the controllers, actuators, etc. onto the boxes.
 - a. The HVAC Contractor shall coordinate the shipment of the components, and the Automatic Temperature Control Contractor shall pay for shipment of controllers to the air terminal box manufacturer and provide the controls to the box manufacturer in a coordinated sequence to enhance the construction phase.

- b. All terminal box actuators shall be provided with the following agency approvals. With the submittal documents, verification that the approvals exist for all submitted products shall be provided. Systems or products not currently offering the following approvals are not acceptable.
 - 1) UL-864; Subcategories UUKL, QVAX, UDTZ; Fire and Smoke Control Systems.
2. The following control manufacturers shall be acceptable for CFM tracking air terminal box controls contingent on compliance with the specifications:
 - a. Johnson Controls
 - b. Automated Logic
3. The DDC CFM tracking air terminals shall be totally integrated with the central automation system.
4. The DDC CFM tracking air terminal control manufacturers must certify their company's/product capability and reliability to furnish, install, start-up and maintain their proposed system configuration.
5. The following type of control strategies shall be required for this project. The controller provided shall be a Variable Volume controller in all application to allow for flexibility.
 - a. Variable Air Volume Supply
 - b. Constant Volume (with heat coil) Supply
 - c. Combination Variable/Constant Volume (with heat coil) Supply
 - d. Variable Volume Exhaust
 - e. Constant Volume Exhaust
 - f. Variable Volume Exhaust
6. The Automatic Temperature Control Contractor shall submit to the Architect and Owner for approval, within 60 days of receipt of his Contract, a complete submittal on the proposed airflow control systems, to include, but not be limited to, system flow schematic wiring and tubing diagram, identifying control, instruments listing the manufacturer, model number, and their performance capabilities.
7. The direct digital controller shall communicate to the DDC terminal front end automation system through a BACnet MSTP interface. This 2-way interface shall allow commands to be sent to the controller, which shall in turn send status information back to the system.
8. The Automatic Temperature Control Contractor shall provide all necessary factory and/or field labor for complete calibration and adjustment of the airflow control components and shall be responsible for setting all control setpoints, operating sequences and alarming systems contained within the airflow control centers to produce the following overall system performance.
9. In conjunction with the system start-up, the Automatic Temperature Control Contractor shall instruct the Owner's personnel in the proper operation of the airflow control system.
10. The Automatic Temperature Control Contractor shall guarantee the proper operation of the airflow control system and shall calibrate the initial system installation.
11. The Automatic Temperature Control Contractor shall guarantee the proper operation of the system and furnish all required service for one (1) full year from the date of system acceptance.
12. Reheat valves are installed by HVAC, actuators installed by ATC, actuators shall be fully modulating electronic, furnished by the Automatic Temperature Control Contractor.

13. The Automatic Temperature Control Contractor shall provide auto-zeroing function with all required software, programming, timers, scheduling and controller hardware to prevent terminal boxes and their controllers from disrupting the integrity of the environment being served. Disruption of airflow, room pressure relationship, temperature and/or humidity levels will be unacceptable.

B. Air Terminal Box Controller

1. The Controller shall be as specified above.

C. Room Temperature Sensor (with Setpoint Control)

1. Room sensors with integral setpoint adjustment shall be provided where shown on the drawings. Controller shall be capable of receiving both adjustments from the sensor and separate EEPROM communications interface. The sensors shall be supplied by the Controller manufacturer. The room temperature sensors shall be an RTD type room temperature sensor and shall have an RS-232C communication port. A single cable interface from RS232 to a RJ48 jack on the space sensor is acceptable. Room sensors shall have an accuracy of $\pm 2\%$ at 70°F with a tolerance of 0.4°F. The unit shall provide room temperature data to the controller. The communication port shall allow for direct communication to both of the pair of air terminals directly associated with the sensor, via a hand-held laptop computer.
2. Control of each pair of terminal boxes shall be stand-alone (one [1] controller) and shall not depend on control information from any other Air Terminal Box Controller for primary control. Failure of any component, including the individual microprocessor controlling the unit, shall not cause interruption of control on any other VAV box controller. The DDC controller shall have programmable parameters stored in a non-volatile EEPROM. Each controller shall be capable of addressing read only memory for a specific integrated circuit containing all logic analog amplifiers with programmable gain and offset, analog to digital converter for RS-485 communication. No battery backup shall be necessary. Controller shall also have capabilities of random access memory operating at a communication rate of 4800 baud as standard. Software capabilities shall have multiple stand-alone control strategies which shall be programmed at the factory through service tool or lap-top computer, or BAS active strategy initiated through BAS communications or physical device such as pressure switches, duct sensors, etc., as indicated. The control system shall be capable of tracking one exhaust box based upon the combined supply airflows of multiple supply boxes.
3. The following information (minimum) shall be communicated into the front end and the local room sensors:

Room Without Fume Hood		
Item	Readout (Units)	Adjustment
Room CFM Differential (Actual)	Yes (Volume)	Yes
Room Temperature (Actual)	Yes (°F)	Yes
Supply Volume	Yes (CFM)	Yes
Exhaust Volume	Yes (CFM)	Yes
Temperature Setpoint	Yes (°F)	Yes
Differential Volume Setpoint	Yes (CFM)	Yes

PART 3 – EXECUTION

3.01 INSTALLATION

- A. All work shall be installed per manufacturer's instruction and recommendations.

END OF SECTION

SECTION 255000

INSTRUMENTATION TERMINAL DEVICES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Section 250500 and other Division 1 Specification Sections, apply to this Section.

1.02 WORK INCLUDED

- A. Furnish and install temperature controls.

1.03 RELATED SECTIONS

- A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 SUBMITTALS

- A. See Section 250500 and General Conditions for additional requirements.
- B. Product Data: Provide data for duct materials.
- C. Prepare and submit scaled coordination drawings.
- D. Manufacturer's Installation Instructions.

1.05 QUALITY ASSURANCE

- A. See Section 250500.

PART 2 PRODUCTS

2.01 INSTRUMENTATION TERMINAL DEVICES

- A. Local Control Panels
 - 1. All controls, relays and switches for equipment located within the mechanical equipment rooms shall be mounted on enclosed control panels with hinge type door and latching mechanism, mounted adjacent to the system controlled. All panels shall include labeling identifying equipment served and electric power source serving panel. Control panels shall include a disconnect switch inside the panel for servicing.
 - 2. Details of each panel shall be submitted for review prior to fabrication. Locations of each panel shall be convenient for adjustment and service. All manual switches shall be flush mounted on the hinged door.

3. All electrical devices within the panels shall be factory prewired to a numbered terminal strip. All wiring within the panel shall be in accordance with NEMA and UL Standards and shall meet all Local Codes.
4. All panels shall include UL listing label.

B. Sensors, Transducers, and I/O Devices

1. Linear precision resistance elements or thermistors and resistance averaging elements shall be provided for temperature sensing. Their range and type shall be applicable to their installation.
2. All temperature sensors in air handling units and in ductwork shall be averaging type, long enough to completely cover the airflow area.
3. Binary Temperature Devices
 - a. Low-voltage space thermostat shall be 24 V, bimetal-operated, snap action type, with either adjustable or fixed anticipation heater, concealed setpoint adjustment, 13°C to 30°C [55°F to 85°F] setpoint range, 1°C [2°F] maximum differential, and vented ABS plastic cover.
 - b. Line-voltage space thermostat shall be bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch type, or equivalent solid-state type, with heat anticipator, UL listed for electrical rating, concealed setpoint.
4. Temperature sensors
 - a. Temperature sensors shall be Resistance Temperature Device (RTD) or thermistor.
 - b. Duct sensors shall be rigid or averaging as shown. Averaging sensors shall be a minimum of 1.5 m [5 feet] in length.
 - c. Immersion sensors shall be provided with a separable stainless steel, or copper well. Pressure rating of well is to be consistent with the system pressure in which it is to be installed.
 - d. Space sensors shall be equipped with set point adjustment, override switch, display, and/or communication port as shown.
 - e. Provide matched temperature sensors for differential temperature measurement.
5. Humidity sensor/transmitters
 - a. Duct and room sensors shall have a sensing range of 5% to 95%.
 - b. Duct sensors shall be provided with a sampling chamber.
 - c. Outdoor air humidity sensors shall have a sensing range of 20% to 95% RH. They shall be suitable for ambient conditions of -40°C to 75°C [-40° F to 170° F].
 - d. Humidity sensor's drift shall not exceed 3% of full scale per year.
 - e. Sensor accuracy shall be $\pm 2\%$ of full scale.
6. Flow switches
 - a. Flow-proving switches shall be either paddle or differential pressure type, as shown.
 - b. Paddle type switches (water service only) shall be UL Listed, SPDT snap-acting with pilot duty rating (125 VA minimum). Adjustable sensitivity with NEMA 1 enclosure unless otherwise specified.

- c. Differential pressure type switches (air or water service) shall be UL Listed, SPDT snap-acting, pilot duty rated (125 VA minimum), NEMA 1 enclosure, with scale range and differential suitable for intended application, or as specified. Dirty filter shall be sensed by an electric differential pressure relay with adjustable setpoint. Range shall be as required to meet project requirements. Every filter bank shall be provided with a filter pressure relay switch.
7. Relays
 - a. Control relays shall be UL Listed plug-in type. Contact rating, configuration, and coil voltage suitable for application.
 - b. Time delay relays shall be UL Listed solid-state plug-in type with adjustable time delay. Delay shall be adjustable $\pm 200\%$ (minimum) from set point shown on plans. Contact rating, configuration, and coil voltage suitable for application. Provide NEMA 1 enclosure when not installed in local control panel.
 8. Override timers
 - a. Override timers shall be spring-wound line voltage UL Listed, contact rating and configuration as required by application. Provide 0-to-6 hour calibrated dial unless otherwise specified; suitable for flush mounting on control panel face, located on local control panels or where shown.
 9. Current transmitters
 - a. AC current transmitters shall be self-powered combination split-core current transformer type with built-in rectifier and high-gain servo amplifier with 4 to 20 mA two-wire output. Unit range shall be scaled to the requirements of the expected load. A full scale, internal zero and span adjustment, and $\pm 2\%$ full-scale accuracy at 500 ohm maximum burden.
 - b. Transmitter shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA Recognized.
 - c. Unit shall be split-core type for clamp-on installation on existing wiring.
 - d. Acceptable manufacturers: Veris Industries 700 and 900 Series, Greystone 300 Series, Flexcore PCM Series or Functional Devices R1BX Series.
 10. Current transformers
 - a. AC current transformers shall be UL/CSA Recognized and completely encased (except for terminals) in approved plastic material.
 - b. Transformers shall be available in various current ratios and shall be selected for $\pm .5\%$ accuracy from 1% to 100% of rating, and 5 A full scale output.
 - c. Transformers shall be fixed-core or split-core type for installation on new or existing wiring, respectively.
 - d. Acceptable manufacturers: Flexcore Series 600, Veris H681 or approved equal.
 11. Voltage transmitters
 - a. AC voltage transmitters shall be self-powered single loop (two-wire) type, 4 to 20 mA output with zero and span adjustment.
 - b. Ranges shall be 0 to 150, 0 to 300, 0 to 600 VAC, with $\pm .5\%$ full-scale accuracy with 500 ohm maximum burden.

- c. Transmitters shall be UL/CSA Recognized at 600 VAC rating and meet or exceed ANSI/ISA S50.1 requirements.
 - d. Acceptable manufacturers: Flexcore VTR Series or approved equal.
12. Potential transformers
- a. AC voltage transformers shall be UL/CSA Recognized, 600 VAC rated.
 - b. Transformers shall be suitable for ambient temperatures of 4 to 55°C [40 to 130°F] and shall provide $\pm 0.5\%$ accuracy at 120 VAC and a 5 VA load.
 - c. Windings (except for terminals) shall be completely enclosed with metal or plastic material.
 - d. Acceptable manufacturers: Flexcore Model 460 or 467, Square D Power Logic or approved equal.
13. Power meters (Sub-metering Applications)
- a. Power monitors shall be three-phase type furnished with three-phase disconnect/shorting switch assembly, UL Listed voltage transformers and UL Listed split-core current transformers.
 - b. Shall provide a selectable rate pulse output for kWh reading and a 4 to 20 mA output for kW reading. Shall operate with 5 A current inputs with a maximum error of $\pm 2\%$ at 1.0 power factor or $\pm 2.5\%$ at 0.5 power factor.
 - c. Acceptable manufacturers: Flexcore Model PC5 Series, Square D Power Logic or approved equal.
14. Energy Meters (Electrical – Sub-metering Applications)
- a. Provide meters with multi-variable outputs: Voltage, Current, Active Power, Active Energy, Frequency, Demand Limit Alarms, and Tamper Detect. Provide where shown on drawings.
 - b. Meters shall be Enfo Solutions Three-Phase Energy Meters or approved equal.
15. Energy Meters (Steam and Chilled Water)
- a. Refer to Section 230519.10 for chilled water and steam energy meters.
16. Energy Meters (Condensate): (210F; flow based on the condensate receiver pump being selected.)
- a. Installation and selection requirements
 - 1) Locate flow meter downstream of all building condensate pumps where condensate from building heat exchangers, coils, hot water heaters, etc. are collected.
 - 2) Provide 10 straight pipe diameters upstream and 5 straight pipe diameters downstream with no valves or fitting changing flow direction in between.
 - 3) Provide isolation valves upstream and downstream of meter.
 - 4) Output signal to Building Automation System
 - b. Manufacturer & model number: Niagara Liquid Meters Series WPX model 210 with Model 840 Reed switch with pulse output.
 - c. Contractor via the Construction Manager shall submit meter shop drawing, piping size and layout at the meter for approval.

17. Energy Meter (Domestic Water)
 - a. Monitor and record pulsed output signals from plumbing cold water supply and "deduct" meters ([2] meters). Meters shall be furnished and installed by the Division 22 Contractor.
18. Current switches:
 - a. Current-operated switches shall be self-powered, solid-state with adjustable trip current. The switches shall be selected to match the current of the application and output requirements of the DDC system.
 - b. Acceptable manufacturers: Greystone 300 Series, Veris H-708, 908 or approved equal.
19. Pressure and differential Pressure transmitters (Hot water and Chilled Water):
 - a. Transducer shall have linear output signal. Zero and span shall be field-adjustable. Accuracy shall be +/- .07% span.
 - b. Transducer sensing elements shall withstand continuous operating conditions of positive or negative pressure 50% greater than calibrated span without damage.
 - c. Water pressure transducer shall have 316 stainless steel diaphragm construction, proof pressure of 150 psi minimum. Transducer shall be complete with 4 to 20 mA output, required mounting brackets, and block and bleed valves. Provide local LCD indicator.
 - d. Water differential pressure transducer shall have stainless steel diaphragm construction, proof pressure of 150 psi minimum. Over-range limit (differential pressure) and maximum static pressure shall be 300 psi. Transducer shall be complete with 4 to 20 mA output, required mounting brackets, and five-valve manifold.
 - e. Transmitters shall be calibrated and spanned for full expected range plus 10%.
 - f. Acceptable manufacturers: Foxboro IGP10 – Gauge Pressure Transmitter, Foxboro IDP10 – Differential Pressure Transmitter, Mamac 264-Gauge Pressure Transmitter, Mamac 282-Differential Pressure Transmitter or Rosemont.
20. Pressure and differential pressure type switches – Water and Air Service
 - a. Water Service
 - 1) Differential pressure switches shall be UL listed, SPST mercury –wetted, 5 amp rated at 120VAC, metal enclosure, with scale range and differential suitable for intended application, or as shown. Range 0-5.5 PSID to 0-5000 PSID.
 - a) Acceptable manufacturers: Mercoid PG and BB Series.
 - 2) Pressure switches shall be UL listed, SPDT snap-acting switch, rated at 15 amps at 120 VAC. Adjustable setpoint and deadband. Range 0-30"HG to 10-300PSIG.
 - a) Acceptable manufacturers: Mercoid DA Series, Penn P74 (pump status only).

b. Air Service

- 1) Differential Pressure switches shall be diaphragm operated, actuating a single pole, double throw snap acting switch rated at 15 amps, at 120 VAC. Max surge pressure 25 PSIG, Rated Pressure 10 PSIG. Ranges .05-.25 "wc to 9-85 "wc.
- 2) Acceptable manufacturers: Dwyer Series 1620, 1630 or 1800; Penn P32 (fan status only).

C. Fan and Pump Status (Under 3 HP)

1. Water flow for each pump shall be indicated by means of a differential pressure switch which opens an electrical contact as the differential pressure falls below a preadjusted pressure range setting. Water differential pressure switch shall be the Penn Model P-74 or similar. High pressure differential switch shall be suitable for the flow and pressure of each system.
2. Differential pressure sensing devices shall be provided for each fan specified as requiring such application in the point list. Differential pressure switch shall be the Penn Model P-32, Dwyer 1910 or similar. This point shall be used as start/stop feedback for points specified as feedback on the point list. Auxiliary contact shall be provided for each fan as specified as requiring such application in the point list.

D. Fan and Pump Status (3 HP and Larger)

1. Verification of all air and water for all fans and pumps shall be by an analog current transformer device, which shall be furnished under the Electrical Section of these specifications. The current transformer output shall be a true analog value. Digital output devices will not be considered acceptable.
2. If the fan or pump is controlled via a VFD, the ATC contractor shall furnish the analog current transformer which shall be located within the VFD. The ATC contractor shall calibrate the current transformer status for belt drive motors by removal of the belt to set the on/off status point.

E. Motor Start/Stop

1. Start/stop relay module shall provide either momentary or maintained switching action as appropriate for the motor being started.
2. All relays shall be plugged in, interchangeable, mounted on a circuit board and wired to numbered terminal strips.

F. Low Limit Alarms

1. Electric low temperature warning sensors shall be provided and shall have 20'-0" low point sensitive elements installed to cover the entire coil area. Provide a minimum of one freeze-stat per 30 sq.ft. of coil area. Where there are multiple coils, provide one (1) freeze-stat per coil. Sensors shall be wired to their respective monitoring panel (for freeze alarm) and, separately, to shut down the fan motor. Assure that the bottom 6" of each coil is protected by a freeze-stat. Capillary shall be serpentine such that the distance between capillary runs shall not exceed 24".

G. Pressure Transmitters

1. Pressure sensors and transmitters shall be selected to operate within pressure ranges of the systems as specified. Sensors and transmitters shall be mounted at the pipe tap as specified and wired to the digital system controller. Sensor shall be accurate to 0.5% across full pressure span. Sensor shall maintain integrity between 20°F and 75°F.
2. Dirty filter shall be sensed by an electric differential pressure relay with adjustable setpoint for each filter bank. Range shall be as required to meet project requirements. These points shall be mapped back to the network manager for alarm annunciation.
3. Air flow switch shall be sensed by an electric differential pressure relay with adjustable setpoint. Range shall be as required to meet project requirements. Provide dual contact device to allow for status and safety circuit wiring (ex. Humidifier airflow switch) without need for additional relay device.

H. Actuators

1. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action under all environmental conditions (temperature, low power voltage fluctuations, tight seal damper design, maximum air and water flow forces). Refer to tables 1 & 2 for failure mode requirements.
 - a. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
 - b. Non spring-Return Motors for Valves Larger Than NPS 2-1/2": Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
 - c. Spring-Return Motors for Valves Larger Than NPS 2-1/2": Size for running and breakaway torque of 150 in. x lbf.
 - d. Non spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
 - e. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.
2. Electronic Damper and Valve Actuators: Direct-coupled type non-hydraulic designed for minimum 100,000 full-stroke cycles at rated torque. The actuator shall have rating of not less than twice the thrust needed for actual operation of the damper or valve
 - a. Coupling: V-bolt and V-shaped, toothed cradle.
 - b. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
 - c. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on non-spring-return actuators.
 - d. Actuators shall have the ability to be tandem mounted.
 - e. All spring-return actuators shall have a manual override. Complete manual override shall take no more than 10 turns.
 - f. Power Requirements (Two-Position Spring Return): 24V ac or dc, Maximum 10VA.
 - g. Power Requirements (Modulating): Maximum 15 VA at 24V ac.
 - h. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
 - i. Temperature Rating: -22°F to 140°F.
 - j. Run Time: 200 seconds open, 40 seconds closed.

- k. All actuators shall have a 5 year warranty
- l. Valve Actuators:
 - 1) Size for torque required for valve close-off at maximum pump differential pressure (regardless of water loop system pressures).
 - 2) Valve and Actuators shall come from the factory fully assembled and tested for functionality, close off, and leakage.
 - 3) Spring Return Manual Override shall come with a 10 Degree Valve Preload to assure tight close off.
 - 4) All valve actuators shall have manual override
- m. Damper Actuators:
 - 1) Size for running torque calculated as follows:
 - a) Parallel-Blade Damper with Edge Seals: 7 inch-pounds/sq. ft. of damper.
 - b) Opposed-Blade Damper with Edge Seals: 5 inch-pounds/sq. ft. of damper.
 - c) Parallel-Blade Damper without Edge Seals: 4 inch-pounds/sq. ft. damper.
 - d) Opposed-Blade Damper without Edge Seals: 3 inch-pounds/sq. ft. of damper.
 - e) Dampers with 2 to 3 Inches wg. of Pressure Drop or Face Velocities of 1000 to 2500 FPM Multiply the minimum full-stroke cycles above by 1.5.
 - f) Dampers with 3 to 4 Inches wg. of Pressure Drop or Face Velocities of 2500 to 3000 FPM Multiply the minimum full-stroke cycles above by 2.0.
 - 2) Spring Return Manual Override actuators shall a factory set 5 Degree Damper Preload.
- 3. Tracking conventional VAV box damper actuators shall be electronic and shall mount on the damper shaft and shall provide complete modulating control of the damper.
 - a. The actuator motor shall de-energize when the damper has reached the operator or system determined position.
 - b. Damper actuator position status shall be monitored from the central or remote operator's terminal and shall be displayed in percent open notation. Systems which provide only end switch feedback are not acceptable.
 - c. The actuator shall be a removable and separate device from the Terminal Equipment Control Unit. If integral to the Terminal Equipment Control Unit, the actuator shall be removable for servicing without removing the Terminal Equipment Control Unit.
- I. Control Valves
 - 1. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated. REFER to specification section 230523 for valve construction requirements and system service class.

2. Globe Valves NPS 2" and Smaller: Bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure. Valves shall have allowable media temperature of 20°F to 281°F to assure that the valve packing will have a long life (valves with narrower allowable media temperatures have no reserve packing capability for long term watertight seal).
3. Globe Valves NPS 2-1/2" and Larger: Iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc. 2-way valves shall have a rangeability of at least 100:1 and minimum ANSI Class IV leakage.
4. Hydronic system globe valves shall have the following characteristics:
 - a. Rating: Class 125 for service at 125 psig. and 250°F operating conditions.
 - b. Internal Construction: Replaceable plugs and seats of stainless steel or brass.
 - c. Sizing: 3 psig. maximum pressure drop at design flow rate.
 - d. Temperature Requirements: Valve and actuator assembly shall be able to operate in ambient temperatures of -22°F to 140°F
 - e. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics. Operators shall close valves against pump shutoff head.
 - f. Product Life: Valve and actuator assembly shall be rated for a minimum of 200,000 cycles and tested for close off and leakage prior to delivery.
5. Steam system globe valves shall have the following characteristics:
 - a. Rating: Class 125 for service at 125 psig. and 250°F operating conditions.
 - b. Temperature Requirements: Valve and actuator assembly shall be able to operate in ambient temperatures of -22°F to 140°F.
 - c. Product Life: Valve and actuator assembly shall be rated for a minimum of 200,000 cycles and tested for close off prior to delivery.
 - d. Internal Construction: Replaceable plugs and seats of stainless steel.
 - e. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom of guided plugs.
 - f. Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom of guided plugs.
 - g. Sizing:
 - 1) 10 psig. inlet pressure and 5 psig. pressure drop.
 - 2) Pressure drop across steam valve at a maximum flow of 80 percent of inlet pressure for low-pressure systems and 42 percent for high-pressure systems.
 - 3) 15 psig steam maximum inlet pressure for bronze body globe valves ½" to 2".
 - 4) 35 psig steam maximum inlet pressure for cast iron globe valves 2 ½" to 6".
6. Control Ball Valves NPS 3" and smaller (2" for 3-way valves): Forged brass body, chrome plated brass ball, blowout proof stem and EPDM o-rings with minimum 600 psi body rating. Valve shall contain glass filled ball insert capable of providing equal percentage flow. Valves shall have allowable media temperature of -20°F to 250°F. Flow Characteristics: 2 way valves shall have equal percentage characteristics. 3 way valves shall have an equal percentage characteristic through the control port and a linear characteristic through the bypass port. Coordinate 3-way portions with piping contractor.
 - a. Rating: No less than 360 psi at 250°F operating conditions.

- b. Rangeability: 2-way valves shall have a rangeability of at least 100 to 1.
 - c. Medium: Valves shall be used with hot water or cold water with up to 50% glycol.
 - d. Temperature Requirements: Valve and actuator assembly shall be able to operate in ambient temperatures of -22°F to 140°F.
 - e. Sizing:
 - 1) Minimum 100 psi close off on 2 way valves and 70 psi on 3 way valves.
 - 2) Maximum differential pressure shall be 35 psi or less to ensure quiet operation.
7. Ball valves over 3": Characterized, v-ported, carbon steel, minimum class 150 flanged body similar to FlowTek. Carbon or Stainless Steel body, stainless steel ball, leak proof stem and RPTFE seats. Valves shall have allowable media temperature of -20°F to 250°F. Flow Characteristics: 2 way valves shall have equal percentage characteristics.
- a. Rangeability: 2-way valves shall have a rangeability of at least 200 to 1.
 - b. Medium: Valves shall be used with hot water or cold water with up to 50% glycol.
 - c. Temperature Requirements: Valve and actuator assembly shall be able to operate in ambient temperatures of -22°F to 140°F.
8. Product Life: Valve and actuator assembly shall be rated for a minimum of 200,000 cycles and tested for close off and leakage prior to delivery.
9. Butterfly Valves: 200 psig. maximum pressure differential, ASTM A 126 cast-iron or ASTM A 536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals. NOTE: **Butterfly valves are not acceptable for modulating applications. Ball valves must be used for this application. All 3-way applications must be coordinated with the piping contractor.**
- a. Body Style: Wafer, Lug, or Groove
 - b. Disc Type: Nylon coated ductile iron.
 - c. Disc Attachment: Disc shall be permanently mounted to shaft. External pins are not acceptable.
 - d. Sizing: 1 psig. maximum pressure drop at design flow rate.
10. Terminal Unit Control Valves: 360 psi forged yellow brass body, nickel plated brass ball, with optimizer insert for modulating applications, blow-out resistant stem, two or three-port as indicated, and threaded ends for chilled or hot water, up to 50% glycol solutions. Actuators shall be as noted above with 5 year warranty. Spring return is required for all Unit Ventilator heating valves and other terminal equipment that has an outside air source. All non-spring return valves must have manual override ability built in to the actuator.
- a. Rating: ANSI class IV, maximum static pressure of 250 psig., minimum fluid temperature of 20°F and maximum of 250°F operating conditions.
 - b. Sizing: 4 psig. maximum pressure drop at design flow rate, to close against pump shutoff head.
 - c. Flow Characteristics: Two-way and three-valves shall have equal percentage characteristics.

J. Dampers

1. All automatic dampers shall be furnished by the Division 23 Contractor. Dampers shall be single or multiple blades as required. Dampers shall be installed by the Sheet Metal Subcontractor, under the supervision of the Temperature Control Subcontractor. All blank-off plates and conversions necessary to install smaller or larger than duct size dampers shall be the responsibility of the Sheet Metal Subcontractor. All dampers shall be equal to Ruskin Models CD-50 (rectangular) or CDR-25 (round).
 - a. Each damper operator shall control a maximum of 20 sq. ft. of damper and a maximum 5 ft. of damper width per operator. All damper operators shall be furnished and installed by the Temperature Controls Contractor.
2. All damper frames shall be constructed of extruded aluminum with 5"x1"x1.25" extruded aluminum and shall have flanges for duct mounting. All multiple damper sections must have jackshafts.
3. Damper blades shall not exceed 6" in width. All blades shall be of extruded aluminum airfoil type construction, fabricated from 6063-T5 aluminum. Blades shall be suitable for high velocity performance, ultra-low leakage type, with leakage not greater than 6.2 cfm/sq.ft. at 4" w.g. pressure differential for 48"x48" damper size, as published and certified under AMCA Certified Ratings Program. Damper leakage shall be less than 0.1% of total CFM at maximum damper system velocity.
4. All damper bearings shall be made of nylon or molded synthetic, bushings that turn in the bearings are to be oil impregnated sintered metal.
5. Replaceable butyl rubber seals shall be provided with the damper. Seals shall be installed along the top, bottom and sides of the frame and along each blade edge. Seals shall provide a tight closing, low leakage damper. Leakage and flow characteristic charts must be submitted to the Engineer prior to approval of dampers.
6. The Division 23 Contractor shall provide an access door upstream and downstream of each automatic damper location.
7. Dampers: AMCA-rated, parallel, opposed blade designs; 0.1084 inch minimum, galvanized-steel frames with holes for duct mounting; damper blades shall not be less than 0.0635 inch galvanized steel with maximum blade width of .8 inches.
 - a. Blades shall be secured to 1/2-inch diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
 - b. Operating Temperature Range: -40°F to 200°F
 - c. For standard applications, include optional closed-cell neoprene edging.
 - d. For low-leakage applications, use parallel- or opposed-blade design with inflatable seal blade edging, or replaceable rubber seals, rated for leakage at less than 10 cfm per sq. ft. of damper area, at differential pressure of 4 inches wg. when the damper is being held by torque of 50 in. x lbf; when tested according to AMCA 500D.

K. Electrical Power Consumption and Demand Meters

1. The building shall have two electric power services. The Division 26 shall furnish and install new consumption and demand initiation devices on each of the two (2) new building electric consumption and demand check meters.

The Automatic Temperature Control Contractor shall wire and program the above devices such that electricity consumption (FWH) and demand (kW) are read and recorded by the Building Automation System (BAS) and the Central Facilities Management System.

2. There shall be a Modbus communication interface to the electrical metering system.

L. Room Type Instruments

1. DDC room thermostats, humidistats and transmitters shall be linear precision resistance elements with accuracies as specified elsewhere. Local setpoint adjustment shall be available to change setpoint $\pm 4^{\circ}\text{F}$. DDC thermostats and humidistats shall be furnished with high impact plastic cover with tamperproof screws with concealed adjustment without thermometer in all public areas. Thermostats and humidistats for patient rooms, private offices, conference rooms, laboratories, and single-occupancy areas shall be provided with local adjustment, and digital display.
2. DDC room sensors shall be linear precision resistance elements with an accuracy of $\pm 0.5\%$. Local setpoint adjustment shall be available to change setpoint $\pm 4^{\circ}\text{F}$. This setpoint shall be capable of being overridden by the Building Automation System.
3. Mechanical and electric room thermostats shall be of the heavy duty, all-metal type.
4. Provide electric/electronic thermostats as required to suit the control application as outlined herein.
5. DDC sensors and humidistats serving prisoner holding rooms and psychiatric rooms shall be duct-mounted in each room's return/exhaust duct. All humidistats shall have replaceable sensor tips.
6. All room sensors shall have a communication port which will allow for access to the associated controller for that room along with all other controllers on that communication bus at a minimum.

M. Smoke Detection System

1. The HVAC Contractor shall install smoke detectors furnished by the Electrical Subcontractor in all ductwork and/or equipment, as applicable. The Automatic Temperature Control Contractor shall provide all interlocking of air handling units to shut down upon activation (units and fans with capacity of 2000 cfm and larger). Alarm connection of the smoke detectors to building fire alarm system shall be by the Electrical Contractor.
2. All supply and return ventilation systems 2000 cfm and larger shall automatically stop when the in-duct smoke detectors are activated, except where return systems are utilized for smoke exhaust.
3. For supply systems 15,000 cfm and larger, the HVAC Contractor shall provide normally open smoke dampers. Automatic Temperature Control Contractor shall provide all interlocking required controlled in a way that upon fan shutdown, due to fire and/or smoke detection, the smoke dampers will automatically close. The reverse sequence shall occur where dampers are called for to be normally closed.
4. Smoke dampers (at air handling units) shall be properly controlled in a way that the system fans shall not start until dampers are open, except where coordination for fan start-up is required in the Sequences of Operation and system fans shall be shut off before smoke dampers are fully closed. All end switches, damper switches, etc., required shall be provided by the Automatic Temperature Control Contractor.

5. All smoke dampers associated with the floor smoke zones and actuators shall be furnished and installed by the Division 23 Contractor.
 - a. Power wiring shall be by the Fire Alarm Contractor unless specified or indicated to be by the Division 26 Contractor.
 - b. Interlock wiring shall be by the Fire Alarm Contractor.
 - c. Interlock wiring from the fire alarm system to the HVAC equipment (for smoke control) shall be by the Temperature Control Contractor.
6. The Division 26 Contractor, when providing smoke detectors, shall include additional contacts, as required, to allow for other control functions, as specified hereinafter. Close coordination shall be exercised to allow for the provision of contacts.
7. The Division 23 Contractor shall install all smoke dampers and all smoke detectors as recommended by the smoke detection system manufacturer in sheet metal ducts or plenums to ensure that the sensing elements are effective. The Division 23 Contractor shall coordinate installation of smoke detectors with the Division 26 Contractor and detector manufacturer.
 - a. The Division 23 Contractor shall provide access to make all such detection heads accessible and shall provide bracing for smoke detection sampling tubes, as required, to properly and securely support such tubes.

N. High Static Pressure Sensors (Typical All Air Handling)

1. For each fan, provide a pair of analog static pressure sensors located in each of the supply and exhaust fan's suction/discharges, which shall be hardwired to the motor starter to stop the fan(s) upon activation and, in addition, send their signals to the DDC/VFD system. Provide dual contact device to allow for status and safety circuit wiring without need for additional relay device. One side of each switch shall sense the pressure to be measured and the other side shall reference atmospheric pressure. Should a static pressure be sensed greater than a selected high limit or 6" differential pressure (adj.), the unit shall shut down and an alarm condition shall be annunciated.
2. Transducer shall have a minimum accuracy of 0.5% of span. The span shall match the minimum to maximum station design cfm.

O. Air Flow Measuring Station

1. The HVAC Contractor shall provide a Flow Measuring Station at the inlet of each fan in built-up air handling units. The Automatic Temperature Control Contractor shall furnish duct mounted Flow Measuring Stations for supply main and return main ductwork at packaged air handling units (the HVAC Contractor shall install the Flow Measuring Stations).
 - a. Acceptable Manufacturers (Provided they are in compliance with these specifications)
 - 1) Airflow/Temperature Measurement Device
 - a) EBTRON, Inc. (basis of design)
 - b) Air Monitor
 - c) Ruskin

2. Airflow/Temperature Measurement Devices

a. General

- 1) Each element designed and built to comply with, and provide results in accordance with, accepted practice for duct system traversing as defined in the ASHRAE Handbook of Fundamentals, AMCA publication #203, as well as the Industrial Ventilation Handbook.
- 2) The number of sensing element, and the quantity of elements utilized at each installation, shall comply with ASHRAE Standard #111 for equal area duct traversing.
- 3) The airflow traverse elements shall produce steady, non-pulsating signals of true flow, with an accuracy of 2% of actual flow for operating velocities as low as 50 feet per minute.
- 4) The operating temperature range for the measuring probes shall be -20° F to 140° F. The operating humidity range for the measuring probe shall be 0-99% RH (non-condensing).
- 5) The airflow traverse elements shall not induce a pressure drop greater than 0.2 inches of water column at 4000 feet per minute.
- 6) The units shall have a self-generated sound rating of less than NC35 and the sound level within the duct shall not be amplified, nor shall additional sound be generated.

b. Products Included in this Section:

- 1) Duct and plenum mounted airflow measurement devices
- 2) Fan inlet mounted airflow measurement devices

c. Provide airflow/temperature measurement devices where indicated on the plans. Fan inlet sensors shall not be substituted for duct or plenum sensor probes indicated on the plans.

- 1) Duct and plenum mounted sensors shall be fabricated of anodized aluminum alloy tube with 303/304 stainless steel mounting brackets.
- 2) Fan inlet probes shall be field adjustable to fit the fan inlet and have 303/304 stainless steel mounting feet.

d. Each measuring device shall consist of one or more multi-point measuring probes and a single microprocessor-based transmitter. Each transmitter shall have an LCD display capable of displaying airflow and temperature. Airflow shall be field configurable to be displayed as a velocity or volumetric rate. Each transmitter shall operate on 24 VAC.

e. Each sensing point shall independently determine the airflow rate and temperature, which shall be equally weighted and averaged by the transmitter prior to output. Devices, which average multiple non-linear sensing point signals, are not acceptable. Pitot tube arrays are not acceptable.

f. A single manufacturer shall provide both the airflow/temperature measuring probe(s) and transmitter at a given measurement location. Probes and transmitters shall not require field matching for proper operation.

g. The operating airflow range shall be 100-5,000 FPM unless otherwise indicated on the plans.

- h. The operating temperature range for the measuring probes shall be -20° F to 140° F. The operating humidity range for the measuring probe shall be 0-99% RH (non-condensing).
- i. The operating temperature range for the transmitter shall be -20° F to 120° F. The transmitter shall be protected from weather and water.
- j. Each independent airflow sensor shall have a laboratory accuracy of +/-2% of reading over the entire operating airflow range and be wind tunnel calibrated or verified against standards that are traceable to NIST.
 - 1) Devices whose accuracy is the combined accuracy of the transmitter and sensor probes must demonstrate that the total accuracy meets the performance requirements of this specification throughout the measurement range.
- k. Each independent temperature sensor shall have a laboratory accuracy of +/-0.15° F over the entire operating temperature range and be calibrated or verified against standards that are traceable to NIST.
- l. The number of sensors for each location shall be as follows:

1) Ducts and plenums:

<u>Area (sq.ft.)</u>	<u>Sensors</u>
<=1	2
>1 to <4	4
4 to <8	6
8 to <12	8
12 to <16	12
>=16	16

2) Fan inlets: 2 per inlet

- m. The airflow/temperature measuring device shall be capable of displaying the airflow and temperature readings of each sensor on the transmitter's LCD display.
- n. The transmitter shall fully communicate with the host controls and the ATC utilizing one of the following interface options:
 - 1) Linear analog output signals for airflow and temperature: Field selectable, fuse protected and electrically isolated from all other circuitry, 0-5VDC / 0-10VDC / 4-20mA (4-wire)
 - 2) RS-485: Field selectable BACnet-MS/TP.
 - a) BACnet devices shall provide analog variables for airflow and temperature containing individual sensor airflow rate and temperature data.
 - 3) 10 Base-T Ethernet: Field selectable BACnet Ethernet, BACnet-IP, Modbus-TCP and TCP/IP
 - a) Provide dynamic link libraries and VBA functions to interface Ethernet devices to Microsoft Excel for remote monitoring of airflow and temperature using a MS Windows -based PC.

- o. Airflow/Temperature measuring devices shall be UL listed as an entire assembly.
 - p. The manufacturer's and or there authorized representative shall review and approve placement and operating airflow rates for each measurement location indicated on the plans. A written report shall be submitted to the consulting mechanical engineer if any measurement locations do not meet the manufacturer's placement requirements.
3. Remote/Duct Mounted Static Pressure Sensing Stations (SPSS)
- a. The Automatic Temperature Control Contractor shall provide static pressure measuring stations as described herein. Units shall be compatible with the Automatic Temperature Control system provided. Static pressure measuring stations shall be as manufactured by Tek-Air, Air Monitor, or Air Sentinel Corporation.
 - b. The air SPSSs shall be complete with components to provide straightening, multi-sensing, self-equalizing, equal area traverse, stationary velocity pressure signals. Single-point sensing will not be acceptable. They shall be of all metal construction, 16 gauge minimum galvanized steel casings, aluminum sensors and manifolds, aluminum straightening tubes or honeycombs. Units mounted in fume hood/ganged general exhaust ductwork shall be fully Type 316 stainless steel construction.
 - c. Flow Measuring Stations for the remote static pressure sensing in the ductwork and at fans shall be furnished, wired and piped by the Automatic Temperature Control Contractor. Units shall be installed in the ductwork and at fans by the HVAC Contractor. Units shall be Air Monitor or Air Sentinel, with a minimum of three (3) static pressure sensors per square foot. Interconnecting sensor equipment, based on ASHRAE equal area traverse for the averaging of observations, into one (1) metering port of each (total and static) pressure. The manifold mounting hardware shall be so constructed as to eliminate any possible violation of the integrity of the total or static pressure measurements. The tubing for the equalized total and static pressures shall not be exposed to internal pressures. Tubing for units serving fume hood fans shall be acid/chemical/corrosion resistant. Except for meter connecting ends, all tubing shall be internal. The converted airflow measurement signal shall have an accuracy within 2% of the full scale throughout the static pressure range.
 - d. Resistance to airflow shall not exceed 0.15 times velocity head for FMS units. The FMS shall not amplify the sound level within the ducts. The range of the transmitter shall be 0-5" w.g.
 - e. SPSS shall be provided for each variable volume supply, return and exhaust air handling system. SPSSs shall be mounted 2/3 to 3/4 of the way along the longest duct run(s) for each system. SPSS for radioisotope fume hood exhaust system fans shall be mounted in the vertical riser 2/3 to 3/4 of the way along the duct riser, in a fully accessible location, constructed of stainless steel. All Flow Measuring Stations and SPSS's shall be fully accessible.

P. Temperature Sensors (Air Handling Units)

- 1. All air handling unit temperature sensors shall be averaging sensors which cover the entire area of airflow with multiple sensors provided as necessary to assure a maximum distance of 24" between sensor elements. Units shall be RTD type.

Q. Carbon Dioxide (CO₂) Sensors1. Wall Mounted CO₂ Sensors

- a. Shall be similar to Vaisala CARBOCAP® Carbon Dioxide Transmitter Model GMW25.
- b. Wall mounted transmitter shall incorporate a silicon-based sensor.
- c. Accuracy at 25°C (77°F): $\leq \pm$ (40 ppm + 3% of reading). Measurement range of 0 to 2000 PPM for 0 to 100% RH (non-condensing) and -5 to 45°C (23 to 113°F).
- d. Temperature coefficient of no larger than 0.15%FS/°C. Analog outputs must be jumper selectable: 0-20 mA, 4-20 mA, or 0-10V. Power supply shall be 24 VDC/VAC.
- e. Long term stability shall be $\leq +100$ PPM per 5yrs. Must be capable of calibration check in place using certified gases or portable meter. Factory recommended calibration frequency of once per five (5) years.

2. Duct Mounted CO₂ Sensors

- a. Duct mounted CO₂ sensors shall be similar to Vaisala CARBOCAP® Carbon Dioxide Transmitter shall be similar to Model GMD20D (with display and relay).
- b. Duct mounted transmitter shall incorporate a silicon-based sensor shall be similar to CARBOCAP® NDIR.
- c. Transmitter shall not require a separate aspiration assembly. Sensor shall be in duct when installed with transmitter outside of duct.
- d. Accuracy at 25°C (77°F) shall be $\leq \pm$ (30 ppm + 2% of reading).
- e. Measurement range of 0 to 2000 ppm for 0 to 100% RH (non-condensing) and -5 to 45°C (23 to 113°F). Unit shall be capable of being calibrated for other ranges: 0-5000 ppm, 0-10,000 ppm, 0-20,000 ppm. Temperature coefficient no larger than 0.15%FS/°C.
- f. Analog outputs shall be jumper selectable: 0-20 mA, 4-20 mA, or 0-10V.
- g. Power supply must be 24 VDC/VAC.
- h. Long term stability shall be $\leq +100$ ppm per 5yrs. Must be capable of calibration check in place using certified gases or a portable meter. Factory recommended calibration frequency of once per five (5) years.

R. Oxygen (O₂) Sensors1. Wall Mounted O₂ Sensors for MRI spaces

- a. Shall be similar to MSA Toxgard II® Gas Monitor.
- b. Shall use a sample draw pump system that uses no metal components near or inside the MRI room, eliminating RF interference from the MRI system.
- c. Shall provide local audible and visual alarms. Remote monitoring and alarming shall be provided for each sensor MRI space.
- d. Accuracy \pm 2% of full scale. Temperature range of -20 to 50°C (-4 to 122°F) for 0 to 100% RH (non-condensing) and.
- e. Long term stability shall be $\leq \pm$ 3% of full scale per 2yrs. Must be capable of calibration check in place using certified gases or portable meter.
- f. The ATC contractor shall mount panel in MRI Control Room and pipe sample tube to MRI room. The ATC contractor shall coordinate the location of the panel and the sample tube location per the MRI representative and manufacturers recommended installation instructions.

PART 3 EXECUTION

3.01 INSTALLATION

- A. All work shall be installed per manufacturer's instruction and recommendations.
1. Mount sensors rigidly and adequately for the environment within which the sensor operates.
 2. Room temperature sensors shall be installed on concealed junction boxes properly supported. Additionally, the wiring to the sensor shall not be required to be polarity sensitive. The design of the sensor shall be modular that allows for the rough-in of all wiring without the presence of the electronics or esthetic covering.
 3. All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.
 4. Sensors used in mixing plenums, and hot and cold decks shall be of the averaging type. Averaging sensors shall be installed in a serpentine manner vertically across duct. Each bend shall be supported with a capillary clip.
 5. Low limit sensors used in coil discharge shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip. Provide 1ft of sensing element for each square ft of coil area.
 6. All pipe mounted temperature sensors shall be installed in wells. Install all liquid temperature sensors with heat-conducting fluid in thermal wells.
 7. Install outdoor air temperature sensors on north wall, complete with sun shield at designated location.
 8. Differential air static pressure.
 - a. Supply duct static pressure: Pipe the high pressure tap to the duct using a pitot tube. Pipe the low pressure port to a tee in the high pressure tap tubing of the corresponding building static pressure sensor (if applicable) or to the location of the duct high pressure tap and leave open to atmosphere.
 - b. Return duct static pressure: Pipe the high pressure tap to the duct using a pitot tube. Pipe the low pressure port to a tee in the low pressure tap tubing of the corresponding building static pressure sensor.
 - c. Building static pressure: Pipe the low pressure port of the pressure sensor to the static pressure port located on the outside of the building at roof level to serve as a common outdoor reference. Pipe the high pressure port to a location behind a thermostat cover.
 - d. The piping to pressure ports on all pressure transducers shall contain a capped test port located adjacent to the transducer.
 - e. All pressure transducers other than those controlling VAV boxes shall be located in field device panels, not on the equipment monitored or on ductwork. Mount transducers in a location accessible for service without the use of ladders or special equipment.
 - f. All air and water differential pressure sensors shall have gauge tees mounted adjacent to all taps. Water gauges shall also have shutoff valves installed before the tee.

END OF SECTION

DIVISION 26

ELECTRICAL TABLE OF CONTENTS

<u>SECTION</u>	<u>TITLE</u>
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SECTION 260510

ELECTRICAL SPECIAL CONDITIONS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. All of the Contract Documents, as listed on the Table of Contents and including General and Supplementary Conditions and Division 01, General Requirements, shall be included in, and made part of, this Section.

1.02 DESCRIPTION OF WORK

- A. Carefully examine all of the Contract Documents, criteria sheets and all other Sections of the specifications for requirements which affect work under this Section, whether or not such work is specifically mentioned in this Section.
- B. The work under this Contract shall include all labor, materials, tools, equipment, transportation, insurance, temporary protection, supervision and incidental items essential for proper installation and operation, even though not specifically mentioned or indicated on the drawings, but which are usually provided or are essential for proper installation and operation, of all systems as indicated on the drawings and specified herein.
- C. The specifications and drawings describe the minimum requirements that must be met by the Electrical Contractor for the installation of all work as shown on the drawings and as specified hereunder.
- D. Coordinate work with that of all other Trades affecting or affected by the work of this Section. Cooperate with such Trades to assure the steady progress of all work under the Contract.

1.03 RELATED WORK

- A. For work to be included as part of this Section, to be furnished and installed by the Electrical Contractor, refer to the following Sections:
 - 1. Section 26 0520 – Basic Materials and Methods
 - 2. Section 26 0530 – Wiring Methods
 - 3. Section 26 0548 – Vibration and Seismic Controls for Electrical Systems
 - 4. Section 26 0570 – Power System Studies (Extension of Existing)
 - 5. Section 26 0580 – Electrical Acceptance Tests
 - 6. Section 26 2010 – Low Voltage Distribution
 - 7. Section 26 3010 – Emergency Power Distribution
 - 8. Section 26 5010 – Lighting Fixtures
- B. For work to be included as part of other Divisions, to be furnished and installed by the Electrical Contractor, refer to the following Divisions:
 - 1. Division 28 Electronic Safety and Security
 - a. Section 28 3110 – Fire Alarm System - Existing System Extension

- C. For work related to, and to be coordinated with the electrical work, but not included in this Section and required to be performed under other designated Divisions, see the following:
1. Division 01 - General Requirements
 - a. Section 01 5100 - Temporary electricity
 - b. Section 01 9100 - Commissioning
 2. Division 02 – Existing Conditions
 3. Division 03 Concrete
 - a. Section 03 3000 – Cast-in-Place Concrete
 4. Division 04 – Masonry
 5. Division 05 – Metals
 - a. Section 05 4516 – Electrical Metal Supports
 6. Division 06 – Wood Plastics and Composites
 7. Division 07 - Thermal and Moisture Protection
 - a. Section 07 6200 – Sheet Metal Flashing and Trim
 - b. Section 07 8000 – Fire and Smoke Protection
 8. Division 08 – Openings
 - a. Section 08 3100 – Access Doors and Panels
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 - a. Section 09 9100 – Painting
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 20. Division 28 - Electronic Safety and Security
 21. Division 31 - Earthwork
 22. Division 32 – Exterior Improvements
 23. Division 33 – Utilities
 24. Division 34 – Transportation

1.04 REFERENCES

- A. All materials and workmanship shall comply with all applicable Codes, Specifications, Local and State Ordinances and Industry Standards, latest editions.

- B. In case of difference between Building Codes, State Laws, Local Ordinances, Industry Standards and the Contract Documents, the Electrical Contractor shall promptly notify the Architect in writing of any such difference.
- C. In case of conflict between the Contract Documents and the requirements of any Code or Authorities having jurisdiction, the most stringent requirements of the aforementioned shall govern.
- D. Should the Electrical Contractor perform any work that does not comply with the requirements of the applicable Building Codes, State Laws, Local Ordinances, Industry Standards and Utility Company Regulations, he shall bear all costs arising in correcting the deficiencies, as approved by the Architect/Owner.
- E. Applicable Codes and Standards shall include all State Laws, Local Ordinances, Utility Company Regulations, and the applicable requirements of the latest adopted edition of the following Codes and Standards, without limiting the number, as follows:
1. NFPA 13: Sprinkler Systems
 2. NFPA 70: National Electrical Code
 3. NFPA 72: National Fire Alarm Code
 4. NFPA 99: Health Care Facilities
 5. NFPA 101: Life Safety Code
 6. Occupational Safety and Health Standards
 7. Environmental Protection Agency
 8. National Fire Protection Association
 9. Department of Environmental Protection
 10. Building Officials Code Association (BOCA)
 11. Uniform Building Code (UBC)
 12. International Building Code (IBC)
 13. Connecticut Building Code
 14. National Electrical Code
 15. Connecticut State Inspection Department
 16. IES – Illuminating Engineering Society Lighting Handbook
- F. In these specifications, references made to the following Industry Standards and Code Bodies are intended to indicate the latest volume or publication of the Standard. All equipment, materials and details of installation shall comply with the requirements and latest revisions of the following Bodies, as applicable:
1. ANSI: American National Standards Institute
 2. ASTM: American Society of Testing Materials
 3. AWG: American Wire Gauge
 4. FM: Factory Mutual
 5. IEEE: Institute of Electrical and Electronics Engineers
 6. NEMA: National Electrical Manufacturers Association
 7. UL: Underwriters' Laboratories
- G. Electrical Contractor for the work in his scope of work shall give all necessary notices, obtain all permits, pay all governmental taxes, fees and other costs in connection with his work; file for necessary approvals with the jurisdiction under which the work is to be performed. Electrical Contractor shall obtain all required Certificates of Inspection for his respective work and deliver same to the Architect before request for acceptance of his portion of work is made and before final payment.

1.05 QUALITY ASSURANCE

- A. Attention is directed to the provisions of Section 01 4000 regarding quality requirements for the work under this Contract. The Electrical Contractor shall review the requirements and assure all components are in compliance.
- B. The manufacturers listed within these specifications have been preselected for use on this project. No submittal will be accepted from a manufacturer other than specified.
- C. Electrical Contractor shall furnish and install all equipment, accessories, connections and incidental items necessary to fully complete the work under his Contract for use, occupancy and operation by the Owner.
- D. Where equipment of a substitute manufacturer differ from that specified and require different arrangement or connections from those shown, it shall be the responsibility of the Subcontractor responsible for the substitution to modify the installation of the equipment/system to operate properly and in harmony with the original intent of the drawings and specifications. When directed by the Architect, the Electrical Contractor shall submit drawings showing the proposed, substitute installation. If the proposed installation is accepted, the Electrical Contractor shall make all necessary changes in all affected related work provided under his and other Sections including location of roughing-in connections by other Trades, conduit, supports, etc. All changes shall be made at no increase in the Contract amount or additional cost to the Owner. The Construction Manager shall be responsible to assure that the Subcontractor responsible for the substitution bears the cost arising to all other Trades as a result of the substitution.
- E. Unless specifically indicated otherwise, all equipment and materials required for installation under these specifications shall be new, unused and without blemish or defect. Equipment and materials shall be products which will meet with the acceptance of the Authorities having jurisdiction over the work and as specified hereinbefore. Where such acceptance is contingent upon having the products listed and/or labeled by FM or UL or another testing laboratory, the products shall be so listed and/or labeled. Where no specific indication as to the type or quality of material or equipment is indicated, a first class standard article shall be provided.

1.06 WARRANTY

- A. Attention is directed to the provisions of the General Requirements and Supplementary General Requirements regarding guarantees and warranties for work under this Contract.
- B. All warranties shall begin on the Date of Substantial Completion of the entire project or the Owner's acceptance of the workmanship and/or material covered by the warranty, whichever is later. The warranty coverage shall continue for the specified period. Refer to individual specification sections for warranty period. If no specific warranty period is specified, the warranty shall extend for a minimum of 365 days.
- C. Manufacturers shall provide their standard warranties for work under the Electrical Trades. However, such warranties shall be in addition to, and not in lieu of, all other liabilities which the manufacturer and Electrical Contractor may have by law or by other provisions of the Contract Documents.

- D. All materials, items of equipment and workmanship furnished under the Electrical Section shall carry the standard warranty against all defects in material and workmanship. Any fault due to defective or improper material, equipment, workmanship or design which may develop shall be made good, forthwith, by and at the expense of the Electrical Contractor for the work under his Contract, including all other damage done to areas, materials and other systems resulting from this failure.
- E. The Electrical Contractor shall warranty that all elements of the systems which are to be provided under his Contract, are of sufficient capacity to meet the specified performance requirements as set forth herein or as indicated.
- F. Upon receipt of notice from the Owner or Architect of failure of any part of the systems or equipment during the warranty period, the affected part or parts shall be replaced by the Electrical Contractor for his work or any other work affected by the failure(s).
- G. Electrical Contractor shall furnish, before the final payment is made, a written warranty covering the above requirements in accordance with the General Requirements.

1.07 DEFINITIONS

- A. Words in the singular shall also mean and include the plural, wherever the context so indicates, and words in the plural shall mean the singular, wherever the context so indicates.
- B. Wherever the terms "shown on drawings" are used in the specifications, they shall mean "noted", "indicated", "scheduled", "detailed", or any other diagrammatic or written reference made on the drawings.
- C. Wherever the term "provide" is used in the specifications it will mean "furnish" and "install", "connect", "apply", "erect", "construct", or similar terms, unless otherwise indicated in the specifications.
- D. Wherever the term "material" is used in the specifications it will mean any "product", "equipment", "device", "assembly", or "item" required under the Contract, as indicated by trade or brand name, manufacturer's name, standard specification reference or other description.
- E. The terms "approved", or "approval" shall mean the written approval of the Architect.
- F. The term "Contract Documents" shall mean the entire set of Drawings and Specifications as listed in the Table of Contents of the General Conditions including all bound and unbound material and all items officially issued to date such as addenda, bulletins, job modifications, etc.
- G. The term "specification" shall mean all information contained in the bound or unbound volume, including all "Contract Documents" defined therein, except for the drawings.
- H. The terms "directed", "required", "permitted", "ordered", "designated", "prescribed", and similar words shall mean the direction, requirement, permission, order, designation or prescription of the Architect; the terms "approved", "acceptable", "satisfactory", and similar words shall mean approved by, acceptable or satisfactory to the Architect; and, the terms "necessary", "reasonable", "proper", "correct", and similar words shall mean necessary, reasonable, proper or correct in the judgment of the Architect.

- I. "Accessible" indicates ease of access with or without the use of ladders and without requiring extensive removal of other equipment, such as ductwork, piping, etc. to gain access. "Accessible ceiling" indicates acoustic tile type hung ceilings. Concealed spline or sheetrock ceilings with access panels shall not be considered accessible ceilings.
- J. "Concealed" means hidden from sight in chases, furred spaces, shafts, hung ceilings, embedded in construction or in crawl spaces.
- K. "Exposed" means not installed underground or "concealed" as defined above.
- L. "Medium voltage" refers to all equipment operating above 600 volts AC.
- M. "Electrical Contractor" refers to the Subcontractor responsible for furnishing and installation of all work indicated on the Electrical drawings and in the Electrical specifications.
- N. "Architect" shall refer to the Architect "ARC and Svigals + Partners" and/or the Engineer "Bard, Rao + Athanas Consulting Engineers, LLC (BR+A)".
- O. "Owner" shall refer to the Owner "University of Connecticut Health Center (UCHC)" or his designated representative.
- P. "Construction Manager" shall refer to the Construction Manager "Fusco" (CM) for this project.
- Q. "Other Work Contractor" (O.W.C.) refers to the Contractor(s), or Subcontractor(s) performing work under other Sections of the Contract Documents.

1.08 THE SUBCONTRACTOR

- A. The Electrical Contractor shall visit the site of the proposed new facility and base his bids from his own site examinations and estimates. The Electrical Contractor shall not hold the Architect, Engineer, Owner or their agents or employees responsible for, or bound by, any schedule, estimate or of any plan thereof. The Electrical Contractor shall study the Contract Documents included under this Contract to determine exactly the extent of work provided under this Contract, as well as to ascertain the difficulty to be encountered in performing the work, in installing new equipment and systems and coordinating the work with the other Trades and existing building conditions.
- B. The Electrical Contractor shall faithfully execute his work according to the terms and conditions of the Contract and specifications, and shall take all responsibility for and bear all losses resulting to him in the execution of his work.
- C. The Electrical Contractor shall be responsible for the location and performance of work provided under his Contract as indicated on the Contract Documents. All parties employed directly or indirectly by the Electrical Contractor shall perform their work according to all the conditions as set forth in these specifications.
- D. The Electrical Contractor shall furnish all materials and do all work in accordance with these specifications, and any supplementary documents provided by the Architect. The work shall include everything shown on the drawings and/or required by the specifications as interpreted by the Architect, regardless of where such information is indicated in the Contract Documents (Architectural, HVAC, Plumbing, Fire Protection, etc.). Unless specifically indicated otherwise, all work and materials furnished and installed shall be new, unused and of the best quality and workmanship.

The Electrical Contractor shall cooperate with the Architect so that no error or discrepancy in the Contract Documents shall cause defective materials to be used or poor workmanship to be performed.

1.09 COORDINATION OF WORK

- A. The Electrical Contractor shall compare his drawings and specifications with those of other Trades as well as the Architectural drawings and specifications, and report any discrepancies between them to the Architect and obtain from the Architect written instructions for changes necessary in the electrical work.
- B. Coordinate work with that of all other Trades affecting or affected by the work of this Section. Cooperate with such Trades to assure the steady progress of all work under the Contract.
- C. All work shall be installed in cooperation with other Trades installing interrelated work. Before installation, Electrical Contractor shall make proper provisions to avoid interferences in a manner approved by the Architect. All changes required in the work of the Electrical Contractor or that of any other trade caused by the Electrical Contractor's neglect, shall be made by him at his own expense, to the Architect's satisfaction.
- D. **The Electrical Contractor must include in his bid sufficient dollar amounts to coordinate the work of this Contract. This project is complex and will require additional time to coordinate all Trades and allow implementation of the Owners Standards and maintenance serviceability requirements. This requirement shall include, but not be limited to, producing the coordination drawings, as many times and as many drawings as required, to ensure serviceability of equipment, as approved by the Architect.**
- E. Locations of conduits, boxes distribution equipment, systems, etc. shall be adjusted to accommodate the work with interferences anticipated and encountered. The Electrical Contractor shall determine the exact routing and location of his systems prior to fabrication or installation of any system component. Accurate measurements and coordination drawings shall be completed to verify dimensions and characteristics of the various systems installations.
- F. Lines which pitch shall have the right-of-way over those which do not pitch. For example, steam piping shall normally have the right-of-way. Lines whose elevations cannot be changed shall have the right-of-way over lines whose elevations can be changed.
- G. Offsets, transitions and changes of direction in all systems shall be made as required to maintain proper headroom and pitch of sloping lines whether or not indicated on the drawings. The Electrical Contractor shall provide elbows, conduit bends, "LB" fittings, offsets in busway, etc. as required for his work to effect these offsets, transitions and changes in direction.
- H. All work shall be installed in a way to permit removal (without damage to other parts) of pull and junction box covers, wiring, lighting fixtures, and all other system components provided under this Contract requiring periodic replacement or maintenance. All pull and junction boxes shall be arranged in a manner to clear the openings of swinging overhead access doors as well as ceiling tiles. All work shall be done to allow easy access for maintaining equipment. The Owner and Engineer will require proof via the preparation of large scale sections and part plans that pull and junction boxes, etc. are accessible after the work is completed. Any items in the field discovered to be in non-compliance shall be removed and relocated, as required, and as directed by the Architect.

- I. The Contract Drawings are diagrammatic only intending to show general runs and locations of conduits, distribution equipment, lighting fixtures, systems equipment, etc. and not necessarily showing all required offsets, details and accessories and equipment to be connected. All work shall be accurately laid out with other Trades to avoid conflicts and to obtain a neat and workmanlike installation which will afford maximum accessibility for operation, maintenance and headroom.
- J. Where discrepancies in scope of work as to what Trade provides items, such as starters, disconnects, flow switches, etc., exist, such conflicts shall be reported to the Architect during bidding and prior to signing of the Contract. If such action is not taken, the Electrical Contractor shall furnish such items as part of his work as necessary, for complete and operable systems and equipment, as determined by the Architect.
- K. The Electrical Contractor shall coordinate the installation of all equipment and any catwalks or service platforms provided.
- L. Where drawing details, plans, specification requirements and/or scheduled equipment capacities are in conflict and where feeders, branch circuits or equipment are shown to be different between plans and/or between plans and riser diagrams, details or specifications, the most stringent requirement will be included in the Contract. Electrical systems and equipment called for in the specification and/or shown on the drawings shall be provided under this Contract as if it were required by both the drawings and specifications. However, prior to ordering or installation of any portion of work which appears to be in conflict, such work shall be brought to Architect's attention for direction as to what is to be provided.
- M. Final location of all lighting fixtures, smoke detectors, exit signs, switches, receptacles, fire alarm devices, etc., shall be coordinated with the Architectural reflected ceiling plans, architectural elevations, and/or other Architectural details, as applicable and shall not be scaled from locations indicated on the electrical drawings. Obtain approval of locations of all devices from Architect in the field. The Owner/Architect reserves the right to relocate any receptacle, device, lighting fixture, etc. 10'-0" in any direction prior to installation at no additional cost to the Project.
- N. Autoclaves, fume hoods or other type equipment shown on the Electrical and/or Architectural drawings to be provided with services, shall be included under this Contract as applicable, including all conduit and wiring connections to systems, to make equipment complete and operable. Additional wiring, equipment, etc., shall be provided to accomplish the above requirement, as required, all as part of this Contract, at no extra cost to the Owner. This requirement necessitates that the Electrical Contractor review the Architectural drawings and the drawings of other Trades during bidding to ascertain the extent of all requirements, and interface between the Trades and scope of work.
- O. **The Electrical Contractor shall coordinate his work with other Trades' work so that all equipment and systems can be easily, safely and properly serviced and maintained. It is imperative that service personnel can safely access all equipment. Provide safety rails, steps, ladders, valve chains, handle extensions, etc. as required, in addition to the ones shown on the drawings, to ensure safe and easy access to all equipment is provided in a manner approved by the Architect.**

- P. The HVAC, ATC and Electrical Contractors Scope of Work shall be implemented in accordance with the following matrix:

Device	Furnished By	Installed By	Power Wiring	Control Wiring	Fire Alarm Wiring
Smoke Detectors	26	23	26	25	26
Smoke Dampers in or at AHUs	23	23	N/A	N/A	N/A
Smoke Damper Actuators in or at AHUs	Damper Mfr	23	26	25	N/A
Smoke Dampers	23	23	N/A	N/A	N/A
Smoke Dampers Actuators	Damper Mfr	23	26	28	N/A
Fire Dampers	23	23	25	25	N/A
Supply and Exhaust Boxes	23	23	25	25	N/A
Box Flow Pick-Up	Box Mfr	Box Mfr	N/A	Box Mfr	N/A
Box Damper Actuator	25	Box Mfr	25	25	N/A
Box DDC Controller	25	Box Mfr	25	25	N/A
Box Coil Valve	25	23	N/A	25	N/A
Valve Actuator	25	25	N/A	25	N/A
Supply Valve Reheat Coil	23	23	N/A	N/A	N/A
Reheat Coil Valve	25	23	N/A	25	
Sheet Metal Damper	23	23	N/A	N/A	N/A
Sheet Metal Damper Actuators	25	25	25	25	
Energy Meters	25	23	26	25	N/A
Flow Measuring Stations	25	23	N/A	25	N/A
DDC Panels	25	25	26	25	N/A
Air Compressor	25	25	26	25	N/A
Air Dryer	25	25	26	25	N/A
Control Valves	25	23	25	25	N/A
VSDs at Fans	23	23	26	25	N/A

Notes:

- "Electric" refers to the Electrical Contractor/Division 26/Division 28; "HVAC" refers to the HVAC Contractor/Division 23; "ATC" refers to the ATC Subcontractor - Division 25.
- The Electrical Contractor shall provide 120 volt power to junction boxes per floor. All 120 volt power and all low voltage wiring from the junction boxes to control panels and devices shall be provided by the ATC Subcontractor.

1.10 GIVING INFORMATION

- A. Electrical Contractor shall keep himself fully informed as to the shape, size and position of all openings required for his apparatus and shall give information to the Construction Manager and other Subcontractors sufficiently in advance of the work so that all openings may be built in advance.

1.11 EQUIPMENT AND MATERIALS

- A. Equipment and materials shall be delivered to the site and stored in original sealed containers, suitably sheltered from the elements, but readily accessible for inspection by the Architect until installed. All items subject to moisture damage such as controls shall be stored in dry, heated spaces. Equipment such as switchgear with heater elements installed shall have the heater elements energized after the equipment is received by the Electrical Contractor.
- B. Equipment shall be tightly covered and protected against dirt, water, and chemical or mechanical injury and theft. At the completion of the work, equipment and materials shall be cleaned and polished thoroughly and turned over to the Owner in a condition satisfactory to the Architect. Damage or defects that develop before acceptance of the work shall be made good at the Electrical Contractor's expense.
- C. The Electrical Contractor shall make necessary field measurements to ascertain space requirements, for equipment and connections to be provided under his respective Trade and shall furnish and install such sizes and shapes of equipment to allow for the final installation to conform to the drawings and specifications.
- D. Manufacturer's directions shall be followed completely in the delivery, storage, protection and installation. Promptly notify the Architect in writing of any conflict between any requirements of the Contract Documents and the manufacturer's directions. Obtain the Architect's written instructions before proceeding with the work. Should Electrical Contractor perform any work that does not comply with the manufacturer's directions or written instructions from the Architect, he shall bear all costs arising in correcting any deficiencies that should arise.
- E. All equipment of one type (such as distribution equipment, cable, wiring devices, fire alarm system, etc.) shall be the products of one manufacturer.
- F. Equipment prepurchased by the Construction Manager on behalf of the Owner or by the Owner himself, if assigned to the Electrical Contractor, shall be received, installed, tested, etc., as if the equipment was purchased by the Electrical Contractor. All guarantees, service contracts, etc., shall be the same as for all other equipment provided under this Contract.

1.12 USE OF PREMISES

- A. The Electrical Contractor shall confine all apparatus, storage of materials and construction to the limits as directed by the Architect and he shall not encumber the premises with his materials. The Electrical Contractor shall be held responsible for repairs, patching, or cleaning arising from any unauthorized use of premises.
- B. Notwithstanding any approvals or instructions which must be obtained by the Electrical Contractor from the Architect in connection with the use of the premises, the responsibility for the safe working conditions at the site shall remain that of the Electrical Contractor. The Architect, Engineer or Owner shall not be deemed to have any responsibility or liability in connection with safe working conditions at the site.

1.13 PROTECTION

- A. Materials, conduit, lighting fixtures, switchgear, etc., shall be properly protected during construction and all conduit openings shall be temporarily closed so as to prevent obstruction and damage. Post notice prohibiting the use of all systems provided under the Electrical Contract, prior to completion of work and acceptance of all systems by the Owner except as otherwise, instructed by Architect. Take precautions to protect all materials furnished from damage and theft.
- B. The Electrical Contractor shall furnish, place and maintain proper safety guards for the prevention of accidents that might be caused by the workmanship, materials, equipment or electrical systems provided under his Contract.

1.14 DAMAGE TO OTHER WORK

- A. The Electrical Contractor shall be held responsible and shall pay for all damages caused by his work to the building structures, equipment, conduits, systems, etc., and all work and finishes installed under this Contract. Repair of such damage shall be done by the Construction Manager at the expense of the Electrical Contractor, to the Architect's satisfaction.

1.15 CORRECTION OF WORK

- A. The Electrical Contractor shall promptly correct all work provided under his Contract and rejected by the Architect as defective or as failing to conform to the Contract Documents, whether observed before or after completion of work, and whether or not fabricated, installed or completed.

1.16 EXTRA WORK

- A. No claim for extra work will be allowed unless it is authorized by the Architect before commencement of the extra said work.

1.17 TOUCH-UP PAINTING

- A. All equipment and systems shall be thoroughly cleaned of rust, splatters and other foreign matter of discoloration leaving every part of all systems in an acceptable prime condition. The Electrical Contractor for the work under his Contract shall refinish and restore to the original condition all equipment which have sustained damage to the manufacturer's prime and finish coats of paint and/or enamel during the course of construction, regardless of the source of damage.

1.18 PARTS LIST AND INSTRUCTIONS FOR OPERATION AND MAINTENANCE

- A. The Electrical Contractor shall thoroughly instruct the Owner, to the complete satisfaction of the Architect, in the proper operation of all systems and equipment provided by him. The Electrical Contractor shall make arrangements, via the Architect, as to whom the instructions are to be given in the operation of the basic and auxiliary systems and the period of time in which they are to be given. The Architect shall be completely satisfied that the Owner has been thoroughly and completely instructed in the proper operation of all systems and equipment before final payment is made.

If the Architect determines that complete and thorough instructions have not been given by the Electrical Contractor to the Owner's representative, then the Electrical Contractor shall be directed by the Architect to provide whatever instructions are necessary until the intent of this specification has been complied with.

- B. Electrical Contractor shall submit to the Architect for approval, the required typed sets (see General Conditions and Division 01) bound neatly in loose-leaf binders, of all instructions for the installation, operation, emergency operation, start-up, care and maintenance of all equipment and systems (including instructions for the ordering and stocking of spare parts for all equipment installed under this Contract). The lists shall include part numbers and suggested supplier. Each set shall also include an itemized list of component parts that should be kept on hand and where such parts can be purchased.
- C. Information shall indicate possible problems with equipment and suggested corrective action. The manuals shall be indexed for each type of equipment. Each section shall be clearly divided from the other sections. A sub-index for each section shall also be provided. The methodology of setting-up the manuals shall be submitted to the Architect and Owner for review prior to final submission of manuals.
- D. The instructions shall contain information deemed necessary by the Architect and include but not limited to the following:
 - 1. Introduction
 - a. Explanation of Manual and its use.
 - b. Summary description of each Electrical system.
 - c. Purpose of each system.
 - 2. System
 - a. Detailed description of each system.
 - b. Illustrations, schematics, block diagrams, catalog cuts, and other exhibits.
 - 3. Operations
 - a. Complete detailed, walk-through, with step-by-step, sequential description of all phases of operation for all portions of the systems, including start-up, shutdown, testing and adjusting. Include all posted instruction charts.
 - 4. Maintenance
 - a. Parts list and part numbers.
 - b. Maintenance, and replacement charts and Electrical Contractor's recommendations for preventive maintenance.
 - c. Troubleshooting charts for systems and components.
 - d. Instructions for testing each type of part.
 - e. Recommended list of on-hand spare parts.
 - f. General or miscellaneous maintenance notes.
 - g. Provide an estimate of manhours and material costs to perform scheduled preventative maintenance.

5. Manufacturer's Literature

- a. Complete listing for all parts with names, addresses and telephone numbers.
- b. Care and operation.
- c. All and only pertinent brochures, illustrations, drawings, cuts, bulletins, technical data, certified performance charts and other literature with the model actually furnished to be clearly and conspicuously identified.
- d. Internal wiring diagrams and engineering data sheets for all items and/or equipment to be furnished.
- e. Guarantee and warranty data.

1.19 MANUFACTURER'S REPRESENTATIVE

- A. The Electrical Contractor shall provide, at the appropriate time or as directed by Architect, the on-site services of a competent factory trained Engineer of the manufacturer of specific equipment, such as the distribution equipment, fire alarm system, etc., to inspect, test, adjust and place in proper operating condition any and all items of the same manufacturer. No additional compensation will be allowed for such services. A written report shall be issued by the particular manufacturer with his findings for the Architect's record.

1.20 COORDINATION DRAWINGS

- A. Before materials are purchased, fabricated or work is begun, each Subcontractor shall prepare and obtain approval of coordination drawings, and sections for all floors/areas, including buried system/services, resulting in one (1) set of all-Trade-composite at 3/8" scale drawings, showing the size and location of all equipment, in the manner described hereinunder General Requirements. **Architects review and approval of coordination drawings must be obtained prior to any fabrication or installation of any equipment or systems.**
- B. The coordination drawings shall be generated from a computer CAD program compatible with AutoCAD Release 2007, in DWG or DXF format. The HVAC Subcontractor shall take the lead, supervise, and coordinate production of coordinated layout drawings, to show and coordinate all equipment. These drawings shall then be circulated to the Electrical Contractor so that he can indicate all his work as directed by the Construction Manager and Architect and as required, to result in a fully coordinated installation.
- C. The Electrical Contractor shall indicate all electrical equipment and conduit provided by him or his Sub-subcontractors on the coordination drawings. This equipment and conduit shall include, but not be limited to, the following:
 1. All electrical distribution equipment, drawn to scale with clearance requirements. (Transformers, panelboards, distribution switchboards, automatic transfer switches, busways, etc.)
 2. All motor control centers, drawn to scale with clearance requirements.
 3. All switchboards and panelboard feeder conduits.
 4. All conduits for all systems over 2-1/2" in diameter.
 5. Conduit routing and rack locations for all conduits regardless of conduit size when more than 4 conduits are grouped in a rack.
 6. All pull and splice boxes over 8" in any direction.
 7. MC cable routing and rack locations for all MC cable when more than 4 runs are grouped in a rack.
 8. Lighting fixture housings and supports that interfere with other system and furnishings.

- D. All costs associated with all aspects of coordination drawings, regardless as to how long they take to produce and how many times they have to be redrawn, shall be borne by the Electrical Contractor.
- E. The Electrical Contractor may request the electrical AutoCAD computer drawing files from the Electrical Contract set from the Engineer. The Electrical Contractor will be required to sign a release form and upon receipt of the form, the Engineer will provide files on electronic media within 3-5 business days. The Electrical Contractor will be responsible for verification of dimensions and installation of equipment.
- F. The Engineer may provide these files as a courtesy for the Electrical Contractors use. The use of these files will be at the Electrical Contractors risk. The Engineer makes no guarantee as to the completeness or accuracy of the files.
- G. The Electrical Contractor shall issue to the HVAC Subcontractor, via diskette, a complete set of equipment installation layout documents in AutoCAD Release 2007 (DWG or DXF) format, for use in developing the required coordination drawings.
- H. The Electrical Contractor shall be responsible for coordinating the Electrical AutoCAD coordination drawings, including, but not limited to, the drawing lists, layering system, producing copies of the drawings for the Architect as directed, etc.

1.21 RECORD DRAWINGS/AS-BUILT DRAWINGS

- A. The Electrical Contractor shall maintain current at the site a set of his drawings on which he shall accurately show the actual installation of all work provided under his Contract indicating hereon any variation from the Contract Drawings, in accordance with the General Conditions and Division 01. Changes, whether resulting from formal change orders or other instructions issued by the Architect, shall be recorded. Include changes in sizes, location, and dimensions of conduit, switchgear, lighting fixtures, fire alarm equipment, wiring devices, etc.
- B. The Electrical Contractor shall indicate progress by coloring-in various conduits, equipment and associated appurtenances exactly as they are erected. This process shall incorporate both the changes noted above and all other deviations from the original drawings whether resulting from job conditions encountered or from any other causes.
- C. The marked-up and colored-up prints will be used as a guide for determining the progress of the work installed. They shall be inspected periodically by the Architect and Owner and they shall be corrected immediately if found either inaccurate or incomplete. This procedure is mandatory.
- D. At the completion of the job, these prints shall be submitted to the Construction Manager and then to the Architect for final review and comment. The prints will be returned with appropriate comments and recommendations. These corrected prints, together with corrected prints indicating all the revisions, additions and deletions of work, shall form the basis for preparing a set of As-built Record Drawings.
- E. The Subcontractor shall be responsible for generating as-built Record Drawings utilizing CAD based documents in AutoCAD Release 2007 DWG or DXF format. A bound set of plans, as well as the computer files, on disk, shall be turned over to the Architect for review. After acceptance of the as-built documents by the Architect, the Electrical Contractor shall make any corrections necessary to the as-built documents and prepare one reproducible set of drawings as well as bound blueprint set(s) (quantity as determined by the Architect) for distribution to the Owner via the Architect.

- F. The Electrical Contractor may use the computer drawing files used for coordination drawings or may request the Engineers most recently updated computer drawing files. The Engineer may provide these files as a courtesy for the Electrical Contractors use, however the updated drawings may not include all changes made during the course of construction. It shall be the Electrical Contractors responsibility to update the as-built documents to include all changes brought forth to the project resulting from bulletins, request for information (RFI's), change orders, etc. The Electrical Contractor may review the Engineers latest computer files for completeness prior to use, however the Engineer will not be responsible for updating the computer files. The use of these files will be at the Electrical Contractors risk.
- G. Included with the above shall be a complete drawing list and a standard layering system, which shall be required to be maintained within the as-built Record CAD documents.
- H. The Subcontractor shall be issued bulletins in the same manner as the original Design Documents described above.
- I. The as-built CAD documents required shall be in addition to other requirements stated elsewhere.

1.22 SUBMITTALS

- A. Prepare and submit shop drawings in accordance with the requirements hereinbefore specified, and with Section 01 3300 – Submittal Procedures in the manner described therein, modified as noted hereinafter.
- B. Electronic Submittals
 - 1. If the Electrical Contractor chooses to provide electronic submittals, in addition to the requirements in Section 01 3300 for electronic submittals, for each submittal and resubmittal, the Electrical Contractor shall deliver to the Architect a minimum of two (2) complete hard copy (paper) submittals and resubmittals for use by the Engineer. These hardcopies shall remain the property of the Architect and Engineer and submittal review comments shall be returned in electronic format.
- C. All shop drawings shall have clearly marked the appropriate specification number of drawing designation, for identification of the submittal.
- D. Disposition of shop drawings shall not relieve the Electrical Contractor from the responsibility for deviations from drawing or specifications, unless he has submitted in writing a letter itemizing or calling attention to such deviations at time of submission and secured written approval from the Engineer, nor shall such disposition of shop drawings relieve the Electrical Contractor from responsibility for errors in shop drawings or schedules.
- E. Specifications Compliance Statement
 - 1. The manufacturer shall submit a point by point statement of compliance with the specifications.
 - 2. The statement of compliance shall consist of a list of all paragraphs (line by line).
 - 3. Where the proposed system complies fully, such shall be indicated by placing the word "comply" opposite the paragraph number.
 - 4. Where the proposed system does not comply, or accomplishes the stated function in a manner different from that described, a full description of the deviation shall be provided.

5. Where a full description of a deviation is not provided, it shall be assumed that the proposed system does not comply with the paragraph in question.
6. Submissions which do not include a point by point statement of compliance as specified shall be disqualified.

1.23 UNIT PRICES

- A. Should certain additional work be required above that on which the Contract Sum is based, by Change Order or Construction Change Directive, the Electrical Contractor agrees that the following unit prices may be used as the basis of payment to him for such additional work, if the Architect so directs, in accordance with the requirements of Article 7 of the General Conditions and Supplementary General Conditions.
- B. The unit prices given shall include cost of material, installation, labor, rigging, etc., and shall represent the exact amount, per unit, to be paid the Electrical Contractor. It is understood that no additional adjustment will be made for overhead, profit, insurance, or other direct or indirect expense of Electrical Contractor or Subcontractors.
- C. The difference in cost between adds and deducts for the same unit of cost shall not be more than 20%.
- D. All such changes shall be processed in accordance with Article 7 of the General Conditions.

1.24 EQUIPMENT AND BRANCH CIRCUITING DESIGN CRITERIA

- A. Panelboards
 1. Provide in each panel 10% spare breakers and 10% spaces for future breakers in addition to the active breakers.
- B. Receptacle Branch Circuit Criteria
 1. Convenience receptacles for general use, such as Office Areas, Lounges, Lobbies, etc., will have a maximum of six (6) duplex receptacles per 20 ampere, single-pole circuit.
 2. All duplex and special purpose receptacles indicated for specific equipment will be on a dedicated circuit.
 3. All poke-thrus and A/V equipment shall have a dedicated 20 amp, 1 pole circuit.
 4. Each dental chair shall be wired back to a dedicated 20 amp, 1 pole circuit.
- C. Motors
 1. All motors above 1/8 HP shall be served from an individual branch circuit, refer to floor plans.
 2. Refer to HVAC and Plumbing drawings for location and ratings of motors.
 3. Selected motors shall have variable frequency drive (VFD) units furnished by the HVAC Contractor. The Electrical Contractor shall coordinate with the HVAC Contractor and provide a disconnecting means and overcurrent device sized to serve each VFD unit.

PART 2 PRODUCTS

2.01 NOT USED

PART 3 EXECUTION

3.01 COOPERATION AND WORK PROGRESS

- A. The Electrical work shall be carried on under the usual construction conditions, in conjunction with all other work at the site. The Electrical Contractor shall cooperate with the Architect, Construction Manager, all other Subcontractors and equipment suppliers working at the site. The Electrical Contractor shall coordinate the work and proceed in a manner so as not to delay the progress of the project.
- B. The Electrical Contractor shall coordinate his work with the progress of the building and other Trades so that he will complete his work as soon as conditions permit and such that interruptions of the building functions will be at a minimum. Any overtime hours worked or additional costs incurred due to lack of or improper coordination with other Trades or the Owner by the Electrical Contractor, shall be assumed by him without any additional cost to the Owner.
- C. The Electrical Contractor shall furnish information on all equipment that is furnished under this Section but installed under another Section to the installing Subcontractor as specified herein.
- D. The Electrical Contractor shall provide all materials, equipment and workmanship to provide for adequate protection of all electrical equipment during the course of construction of the project. This shall also include protection from moisture and all foreign matter. The Electrical Contractor shall also be responsible for damage which he causes to the work of other Trades, and he shall remedy such injury at his own expense.
- E. Waste materials shall be removed promptly from the premises. All material and equipment stored on the premises shall be kept in a neat and orderly fashion. Material or equipment shall not be stored where exposed to the weather. The Electrical Contractor shall be responsible for the security, safekeeping and damages, including acts of vandalism, of all material and equipment stored at the job site.
- F. The Electrical Contractor shall be responsible for unloading all electrical equipment and materials delivered to the site. This shall also include all large and heavy items or equipment which require hoisting. Consult with the Construction Manager for hoisting/crane requirements. During construction of the building, the Electrical Contractor shall provide additional protection against moisture, dust accumulation and physical damage of the main service and distribution equipment. This shall include furnishing and installing temporary heaters within these units, as approved, to evaporate excessive moisture and ventilate it from the room, as may be required.
- G. It shall be the responsibility of the Electrical Contractor to coordinate the delivery of the electrical equipment to the project prior to the time installation of equipment will be required; but he shall also make sure such equipment is not delivered too far in advance of such required installation, to ensure that possible damage and deterioration of such equipment will not occur. Such equipment stored for an excessively long period of time (as determined in the opinion of the Architect) on the project site prior to installation may be subject to rejection by the Architect.
- H. The Electrical Contractor shall erect and maintain, at all times, necessary safeguards for the protection of life and property of the Owner, Workmen, Staff and the Public.
- I. Prior to installation, the Electrical Contractor has the responsibility to coordinate the exact mounting arrangement and location of electrical equipment to allow proper space requirements as indicated in the NEC. Particular attention shall be given in the field to group installations.

If it is questionable that sufficient space, conflict with the work of other Subcontractors, architectural or structural obstructions will result in an arrangement which will prevent proper access, operation or maintenance of the indicated equipment, the Electrical Contractor shall immediately notify the Contractor and not proceed with this part of the Contract work until definite instructions have been given to him by the Architect.

- J. The Electrical Contractor shall not allow any equipment or piping foreign to the electrical installation to be installed or pass through any room in which electrical systems or equipment are located, such as electric rooms, electric closets, telephone or data closets. The Electrical Contractor shall notify the Contractor of such violations and request immediate removal.
- K. The Electrical Contractor shall obtain from the Plumbing and HVAC Subcontractors copies of all shop drawing prints showing the ductwork and piping installation as they will be put in place on the project. These drawings shall be thoroughly checked by the Electrical Contractor and the routing of all conduits and installation of all outlets and electrical equipment shall be coordinated with the ductwork and piping so as to prevent any installation conflict. Such coordination shall be done prior to roughing in conduits, outlets and electrical equipment.
- L. Location of all wall outlets shall be verified with the Architect prior to roughing in conduits. Refer to details and wall elevations on the Architectural drawings. Mounting heights indicated on these drawings and/or specific dimensional information given to the Electrical Contractor by the Architect shall take precedence over such information indicated on the Electrical drawings.
- M. Refer to all other drawings associated with this project. Any and all equipment which require an electrical supply circuit, switch, controls or connections, whether indicated on the Electrical drawings or not, shall be furnished and installed as directed by the Architect. Locations of lighting fixtures shall conform to the Architectural reflected ceiling plans.
- N. Refer to the Architectural drawings for areas in which the concrete slab is poured on grade. In these areas a waterproofing membrane will be installed on the grade fill or earth prior to pouring of slab. Electrical conduits shall be installed to avoid the necessity of penetrating this waterproofing membrane. Penetration of the membrane, if required, shall only be made when specifically allowed by the Architect, and shall be made only at locations directed by the Architect.

3.02 INSTALLATION

A. General

1. Unless specifically noted or indicated otherwise, all equipment and material specified in Division 26 of this specification or indicated on the drawings shall be installed under this Contract whether or not specifically itemized herein. This Section covers particular installation methods and requirements peculiar to certain items and classes or material and equipment.
2. The Electrical Contractor shall obtain detailed information from manufacturers of equipment as to proper methods of installation.
3. The Electrical Contractor shall obtain final roughing dimensions and other information as needed for complete installation of items furnished under other Sections or furnished by the Owner.
4. The Electrical Contractor shall keep fully informed of size, shape and position of openings required for material and equipment provided under this and other Sections. Ensure that openings required for work of this Section are coordinated with work of other Sections. Provide cutting and patching as necessary.

5. The Electrical Contractor shall coordinate the electric service installation with the Owner, Telephone Company, the City Building Department and the City Fire Department.
6. All miscellaneous hardware and support accessories, including support rods, nuts, bolts, screws and other such items, shall be of a galvanized or cadmium plated finish or of another approved rust-inhibiting coating.
7. Throughout this Section where reference is made to steel channel supports, it shall be understood to mean that the minimum size shall be 1 5/8" mild strip steel with minimum wall thickness of 0.105", similar to Unistrut P1000 or equal products manufactured by Kindorf or Husky Products Co.

3.03 MATERIALS AND WORKMANSHIP

- A. All materials and equipment shall be new and unused and shall meet requirements of the latest Standards of NEMA, UL, IPCEA, ANSI and IEEE. Equipment shall have components required or recommended by OSHA, applicable NFPA documents and shall be UL listed and labeled.
- B. Despite references in the specifications or on the drawings to materials or pieces of equipment by name, make or catalog number, such references shall be interpreted as establishing standards of quality for materials and performance.
- C. Finish of materials, components and equipment shall not be less than Industry good practice. When material or equipment is visible or subject to corrosive or atmospheric conditions, the finish shall be as approved by the Architect.
- D. Provide proper access to material or equipment that requires inspection, replacement, repair or service. If proper access cannot be provided, confer with the Architect as to the best method of approach to minimize effects of reduced access.
- E. All work shall be installed in a neat and workmanlike manner and shall be done in accordance with all Local and State Codes.
- F. The Owner will not be responsible for material, equipment or the installation of same before testing and acceptance.

3.04 CLEANING

- A. This Section of the specifications shall include the cleaning of all equipment on a day-to-day basis and final cleaning of all electrical equipment prior to turning building over to the Owner. All necessary cleaning referred to herein shall be cleaned to the satisfaction of the Owner.
- B. Electrical Distribution Equipment
 1. All electrical distribution equipment shall be completely cleaned and dried inside and out prior to initial energizing and turned over to UCHC.
 2. Cleaning shall consist of vacuuming all busses, windings, enclosures (inside and out), etc. After vacuuming is complete, all equipment shall be wiped down. If equipment is wet or contains moisture, it shall be thoroughly dried and inspected by the manufacturer's representative before energizing.
- C. Raceways and Junction Boxes
 1. All raceways and junction boxes shall be blown out and dried prior to installation of feeder conductors and branch circuit conductors.

D. Low Tension Systems

1. All cabinets and panels for low tension systems shall be thoroughly cleaned and dried prior to system start-up.

E. Electric and Telephone Rooms

1. Upon completion of cleaning electrical equipment as described in Paragraph B. above, but before energizing equipment, the entire room shall be swept clean and material storage and garbage shall be removed from the room. At this time, equipment may be energized.
2. Once equipment and room are cleaned and energized, the area shall remain clean and doors shall remain closed and locked until completion of job. Electric rooms shall not be used to store material after equipment is energized. If rooms and equipment are subject to dust and moisture after energizing equipment, the equipment shall be de-energized and re-cleaned to the same specifications.

F. Final Cleaning

1. All lighting fixtures, devices, device plates, etc., shall be cleaned and left in "like new" condition to the satisfaction of the Architect, prior to occupancy.
2. All rubbish and discarded materials shall be disposed of and removed from the site on a day-to-day basis.
3. All equipment, whether part of the Electrical Contractor's Contract or not, which must be cleaned due to the Electrical Contractor's work, shall be cleaned by the Electrical Contractor to the satisfaction of the Architect.

3.05 FINAL INSPECTION

- A. When all Electrical work on the project has been completed and is ready for final inspection, such an inspection shall be made. At this time, and in addition to all other requirements in the Contract Documents, the Electrical Contractor, for the work under this Contract, shall demonstrate that the requirements of these specifications have been met to the Architect's satisfaction.

END OF SECTION

SECTION 260520

BASIC MATERIALS AND METHODS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. All of the Contract Documents, as listed on the Table of Contents and including General and Supplementary Conditions and Division 01, General Requirements, shall be included in, and made part of, this Section.

1.02 DESCRIPTION OF WORK

- A. The following general systems and equipment shall be provided for the renovated areas of the existing building, as a minimum, but not necessarily limited to the following:
 1. Grounding.
 2. Connections to HVAC, Plumbing, Fire Protection, Automatic Temperature Control, Construction Manager and Owner furnished equipment.
 3. 120 volt power for remote alarms and connections to oil tank alarms, etc.
 4. Testing, cleaning and adjusting.
 5. Fees, permits, royalties, guarantees.
 6. Firestopping, smokeproofing, waterproofing.
 7. Shop drawings.
 8. Phasing of construction and power interruptions.
 9. Access doors.
 10. Electrical Identification
 11. Hangers and supports.
 12. Mechanical suspension channel.
 13. Wireways.

1.03 RELATED WORK

- A. For work to be included as part of this Section, to be furnished and installed by the Electrical Contractor, refer to the Related Work section of Specification Section 26 0510.
- B. Carefully examine all of the Contract Documents, criteria sheets and all other Sections of the specifications for requirements which affect work under this Section, whether or not such work is specifically mentioned in this Section.

1.04 WARRANTY

- A. Attention is directed to provisions of the General Requirements, Supplementary General Requirements and Section 26 0510 regarding guarantees and warranties for work under this Contract.

1.05 FIRESTOPPING AND SMOKESTOPPING

- A. Attention is directed to the provisions of Section 07 8000 regarding firestopping and smokeproofing for work under this Contract. The Electrical Contractor shall review the requirements and coordinate the system installation.

- B. Where conduits pass through masonry or concrete walls or floors, the Electrical Contractor shall provide and set individual sleeves for each conduit and all other work under his charge, as necessary for passage of all raceways. Sleeves shall be of sufficient size to provide 1/2" air space around the conduit passing through the floor or walls. All openings shall be sealed, smokestopped and made tight. The Electrical Contractor shall be responsible for the exact location of sleeves provided under this Contract and shall coordinate all requirements for conduit sleeves.
- C. Except as otherwise specified, underground piping passing through exterior walls, foundation slabs on grade, or manhole walls, shall have penetration closures of the modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the conduit and wall opening. Links shall be loosely assembled with bolts to form a continuous belt around the conduit and with a pressure plate under each bolt head and nut. After the seal assembly is positioned in the sleeve, tightening of the bolts shall cause the rubber sealing elements to expand and provide an absolutely watertight seal between the conduit and wall, reducing chances of cathodic reaction between these members.
- D. The Electrical Contractor for work under his charge shall determine the required inside diameter of each individual wall opening or sleeve before ordering, fabrication or installation. The inside diameter of the wall opening shall be sized to fit the conduit and ensure a watertight joint. Where applicable, when installing seals, take into account the conduit O.D. if non-standard due to coating or jacketing.

1.06 WATERPROOFING AND COUNTERFLASHING

- A. Attention is directed to the provisions of Section 07 6000 regarding flashing and counterflashing for work under this Contract. The Electrical Contractor shall review the requirements and coordinate the system installation.
- B. Electrical Contractor shall provide all counterflashing of all conduit and equipment provided by him, which pierce roofs, walls and other weatherbarrier surfaces.
- C. All work shall be performed in a workmanlike manner to assure weatherproof installation. Any leaks developed due to Electrical Contractor's work shall be repaired at his expense, to Architect's satisfaction.
- D. Conduit passing through slabs shall have the sleeve extended above floors as hereinafter specified to retain any water and the space between the conduit and sleeve caulked with lead wool.

1.07 MISCELLANEOUS IRON AND STEEL

- A. Attention is directed to the provisions of Section 05 4500 regarding miscellaneous iron and steel supports for work under this Contract. The Electrical Contractor shall review the requirements and coordinate the system installation.
- B. Except where specifically indicated for the Construction Manager to provide supports, Electrical Contractor shall provide all steel supports and hangers required to support all equipment or materials provided under this Contract.
- C. All supports shall be cut, assembled, welded and finished by skilled mechanics. Welds shall be ground smooth. Stands, brackets and framework shall be properly sized and strongly constructed.

- D. Measurements shall be taken on the job and worked out to suit adjoining and connecting work. All work shall be performed by experienced metal-working mechanics. Members shall be straight and true and accurately fitted.

1.08 PHASING, DEMOLITION AND MAINTAINING EXISTING SERVICES

- A. Attention is directed to the provisions of Division 02 regarding existing conditions for work under this Contract. The Electrical Contractor shall review the requirements and coordinate the system installation.
- B. During the execution of the work, required relocation, rerouting, etc., of existing equipment and systems on the site or where new work is to be installed or new connections are scheduled to be made, shall be performed by the Electrical Contractor, as indicated on the drawings, and/or as required by job conditions and as determined by the Architect in the field, to facilitate the installation of the new systems.
- C. The Owner will require continuous operation of the existing systems, while demolition, relocation work or new tie-ins will be performed. Outages required for construction purposes shall be scheduled for the shortest practical periods of time, in coordination with the Owner's designated representative, for specified, mutually agreeable periods of time, after each of which the interruption shall cease and the service shall be restored. This procedure shall be repeated to suit the Owner's working schedule, as many times as required until all work is completed. Any outages of service shall be approved by the Owner, prior to commencing the work. No outages or shutdowns of service shall occur without the written authorization of the Owner, prior to commencing the work. Give notice of any scheduled shutdowns, a minimum of two (2) weeks in advance. The Owner shall make their best efforts to meet this request without adversely affecting the electric service to the site. Shutdowns shall not be scheduled during normal business hours (i.e., shutdowns shall be from 6:00 PM to 6:00 AM). Maximum duration of each shutdown shall be eight (8) hours. Not more than one shutdown per twenty-four 24 hour period.
- D. The Electrical Contractor shall submit with his bid, a preliminary shutdown schedule for review by the Owner, Architect and Construction Manager. Shutdown schedule shall be finalized with the successful Electrical Contractor.
- E. Prior to any deactivation and relocation or demolition work, consult the drawings and arrange a conference with the Architect and the Owner's representative in the field to inspect each of the items to be deactivated, removed or relocated. Care shall be taken to protect all equipment designated to be relocated and reused or to remain in operation and be integrated with the new systems.
- F. All deactivation, relocation and temporary tie-ins shall be provided by the Electrical Contractor. All demolition, removal and the legal disposal of demolished materials of system designated to be demolished shall be provided by the Construction Manager.
- G. The Owner reserves the right to inspect the material scheduled for removal, and salvage any items he deems usable as spare parts.
- H. Phasing
 - 1. The Electrical Contractor shall construct the subject project in phases as directed by the Architect and Construction Manager to suit the project progress schedule, as well as the completion date of the project.

2. For additional information related to phasing, review the General Conditions and Supplementary Conditions and the Architectural drawings.

- I. Electrical devices, safety switches, junction boxes, outlet boxes, conduits, branch circuit wiring, etc. located on walls to be demolished shall be completely disconnected and removed.
- J. Where existing conduits and equipment are embedded in concrete walls, ceilings or floors, the conduit shall be cut back flush to the surface, all wiring shall be disconnected and removed and equipment shall be removed for the Construction Manager to patch the existing opening.

1.09 SUBMITTALS

- A. Prepare and submit shop drawings in accordance with the requirements hereinbefore specified, and with Section 01 3300 – Submittal Procedures in the manner described therein, modified as noted hereinafter.
- B. All shop drawings shall have clearly marked the appropriate specification number of drawing designation, for identification of the submittal.
- C. Disposition of shop drawings shall not relieve the Electrical Contractor from the responsibility for deviations from drawing or specifications, unless he has submitted in writing a letter itemizing or calling attention to such deviations at time of submission and secured written approval from the Engineer, nor shall such disposition of shop drawings relieve the Electrical Contractor from responsibility for errors in shop drawings or schedules.
- D. Shop drawings shall include, but shall not be limited to, the following:
 - 1. Access doors.
 - 2. Electrical Identification
 - 3. Hangers and supports.
 - 4. Mechanical suspension channel.
 - 5. Wireways.

PART 2 PRODUCTS

2.01 ACCESS DOORS

- A. Attention is directed to the provisions of Section 08 3100 regarding access doors required for work under this Contract. The Electrical Contractor shall review the requirements and coordinate the system installation.
- B. Furnish, for installation by the designated Trade as determined by the Construction Manager, all access doors in locations wherever pull or junction boxes, "LB" fittings, equipment, etc., are installed behind gypsum wallboard or masonry walls or ceilings and where such devices would be inaccessible for inspection, maintenance or servicing. Access doors shall be a minimum of 12" by 12" and shall be sized to suit the access requirement to service the equipment and located in a manner approved by the Architect and to meet requirements specified here and elsewhere, for specific applications.
- C. Doors shall be set square and flush in cooperation with the designated Subcontractors performing the work. Particular attention shall be exercised in the selection of doors for masonry walls in order that frame sizes used will match the courses of brick or block.

All access panels shall be located in closets, storage rooms and/or other non-public areas where possible, positioned so that the junction can be easily reached and shall be constructed in a workmanlike manner. When access panels are required in corridors, lobbies or other habitable areas, they shall be located as directed by Architect.

- D. Access panels shall be flush type with 14 gauge panels and 16 gauge frames, minimum, unless otherwise noted. Each access panel shall be furnished complete with continuous piano hinge and flush screwdriver operated cam latch, with factory applied prime finish. Access panels shall be as manufactured by Inryco/Milcor, Karp Associates Inc., Birmingham Ornamental Iron Co., Miami-Carey, Babcock-Davis or equal approved by the Architect.
- E. Access panels shall be installed in gypsum wallboard ceilings only where specifically approved by the Architect. Where possible, all access requirements for raceways and equipment shall be beyond the gypsum wallboard ceilings.
- F. Access panels shall be specifically designed for each type of wall, ceiling finish and construction with which they are used, as follows:
 - 1. Suspended latch and gypsum wallboard ceilings: Style K with 16 gauge frame, 14 gauge panel and flush screwdriver operated camlocks.
 - 2. Masonry rated walls: Style M with 16 gauge frame, 14 gauge panel and flush screwdriver operated camlocks.
 - 3. Masonry fire rated walls and at shafts: Fire rated with UL, 1.5-hour "B" rating, 16 gauge frame, 20 gauge sandwich type insulated panel, self-latching lock having interior release mechanism, and flush screwdriver operated camlocks.
 - 4. Where installed at fire rated walls or ceilings, access panels shall be of fire-resistive construction with mineral core panel faced both sides and edges with 20 gauge sheet steel, and shall bear the UL label required to meet the fire rating of the wall.
 - 5. Where installed in surfaces finished with ceramic tile or glazed coatings, access panels shall be of stainless steel with No. 4 finish.
 - 6. Where installed in acoustical ceilings, access panels shall be of type which will accept adhesive mounted acoustical panels flush with surrounding surfaces (acoustical panels to be provided by Acoustical Ceiling Trade).
 - 7. Where installed in gypsum wallboard walls or ceilings, access panels shall be of type with 14 gauge face panels and 16 gauge frames equipped with integral perforated, textured metal casing bead edge which will receive drywall compound for flush finishing. (Compound finishing shall be provided by Gypsum Drywall Trade.)

2.02 ELECTRICAL IDENTIFICATION

A. Nameplates

- 1. Provide nameplates on all equipment furnished under this contract including switchgear, automatic transfer switches, transformers, busway, remote mounted enclosed circuit breakers, receptacles (see Wiring Device Section), panelboards, motor disconnect switches, remote control stations, starters, etc.
- 2. The following information shall be provided on custom engraved nameplates unless clearly identified on the nameplates provided by the factory:
 - a. Switchgear and service entrance equipment:
 - 1) Equipment designation
 - 2) Voltage

- 3) Phase
- 4) Phase bus amperage
- 5) Neutral bus amperage (if provided)
- 6) Ground bus amperage
- 7) Maximum available fault current as determined by the final approved power system study, including date fault current calculation was performed.
- 8) Source of power

b. Switchboards and distribution panels:

- 1) Equipment designation
- 2) Voltage
- 3) Phase
- 4) Phase bus amperage
- 5) Neutral bus amperage (if provided)
- 6) Ground bus amperage
- 7) Source of power

c. Busway (on each floor):

- 1) Equipment designation
- 2) Voltage
- 3) Phase
- 4) Amperage
- 5) Source of power

d. Panelboards:

- 1) Equipment designation
- 2) Voltage
- 3) Phase
- 4) Amperage
- 5) Source of power

e. Transformers:

- 1) Equipment designation
- 2) Primary voltage
- 3) Secondary voltage
- 4) Phase
- 5) Impedance
- 6) Source of primary power
- 7) Source fed by secondary

f. Enclosed circuit breakers, disconnect switches, motor starters, controllers, etc.:

- 1) Equipment designation
- 2) Voltage
- 3) Phase
- 4) Amperage
- 5) Source of power
- 6) System or equipment served

3. Nameplates for equipment shall be laminated, bakelite nameplates with engraved letters. Designation shall be a minimum of ½" letters (all capitals). The remainder shall be a minimum of ¼". Nameplates shall be securely attached to the equipment with galvanized screws. Adhesives or cements shall not be used.
 4. Nameplate colors shall be as follows:
 - a. Normal Power System: Black background, white letters
 - b. Emergency Power System: Red background, white letters
 5. A list of nameplates shall be submitted to the Architect for approval prior to fabrication.
- B. Directories
1. Equipment that serves multiple panels and/or loads, such as panelboards shall have type written directories listing all circuit loads, breaker sizes and phases.
 2. Each branch circuit shall be identified on the index with the room number and usage.
- C. Flash Protection Boundaries and Incident Energy Exposures Labeling
1. Provide field labeling of electrical equipment that is likely to require examination, adjustment, servicing or maintenance while energized. Labeling shall be provided in accordance with the following codes and standards:
 - a. National Fire Protection Association
 - 1) NFPA 70 – National Electrical Code
 - 2) NFPA 70E - Standard for Electrical Safety Requirements for Employee Workplaces
 - b. IEEE Std 1584-2002 & IEEE Std 1584a-2004 - Guide for Performing Arc-Flash Hazard Calculations
 - c. Underwriters Laboratories (UL) Factory Mutual (FM)
 - d. Occupational Safety and Health Administration (OSHA) – 1910.333
 - e. American National Standards Institute (ANSI)
 - f. American Society of Testing Materials (ASTM)
 - g. National Electrical Manufacturers Association (NEMA)
 2. Flash protection boundaries and incident energy exposures field labeling shall warn persons of potential electric arc flash hazards and include as a minimum, specific to the equipment, the following information:
 - a. Warning of arc flash hazard
 - b. Requirement that only qualified personnel access equipment
 - c. Flash protection boundary limit
 - d. Incident energy exposure available
 - e. Date of installation
 - f. Statement that system changes occurring subsequent to the installation may affect the level of hazard involved and that additional electrical system review may be required to confirm level of hazard has not changed

3. Field labeling shall be applied to all electrical equipment, indicated in the Power System Study, including but not necessarily limited to:
 - a. Motor starters
 - b. Panelboards
 - c. Disconnect switches
 - d. Controller equipment such as variable frequency/adjustable speed drives
 - e. Fuses and circuit breakers
 - f. Rotating equipment
 - g. Premises wiring
 - h. Switchboards
 - i. Automatic transfer switches
4. Field labeling shall be clearly visible to qualified persons before examination, adjustment, servicing, or maintenance of the equipment is performed. Field labeling shall conform to the requirements of ANSI Z535.4-2007, *American National Standard for Product Safety Signs and Labels*, provides guidelines for the design of safety signs

D. Wire Markers

1. Markers for wire and cable circuits shall, be as manufactured by, Brady self-laminating vinyl Datab labels.

E. Cable Tags

1. Cable tags shall be brass identification tags with plastic tie wrap.

F. Low Voltage Raceway Identification

1. Provide manufacturer's standard pre-printed, flexible or semi-rigid, permanent, plastic-sheet conduit markers, extending 360° around conduits; designed for attachment to conduit by adhesive, adhesive lap joint of marker, matching adhesive plastic tape at each end of marker, or pre-tensioned snap-on. Except as otherwise indicated, provide lettering which indicates voltage of conductor(s) in conduit. Provide minimum 8" length for 2" and smaller conduit, 12" length for larger conduit.
2. Color coding for all raceways shall match the Owners color coding. If no color coding exists, paint raceways as indicated below. Spacing of paint markings shall be a maximum of 10'-0" on centers for entire length of conduit. Painted conduit connectors and junction boxes will be an acceptable means of conduit identification, provided there is a painted connector/box a maximum of 10'-0" on center.

a.	Life safety/Emergency system	Orange
b.	Critical system/Optional-standby	Yellow
c.	Fire alarm system	Red
d.	Telecommunication System	Blue
e.	Other low voltage systems	Brown

G. Color-Code Tape

1. Colored tape shall be polyvinyl chloride, self-adhesive not less than 3 mils thick and 1 1/2" wide, suitable for use on 90°C conductors, UL listed and shall be furnished in colors as specified herein.

2.03 HANGERS AND SUPPORTS

A. General

1. Hangers, supports, clamps, etc., shall be provided as required for all electrical equipment, including but not limited to, lighting fixtures, junction boxes, pull boxes, conduit, cable tray, busway, trapeze mounted transformers, open plenum type cabling, etc.
2. The Electrical Contractor shall provide all labor, materials, equipment and incidentals required for hangers and supports for all electrical equipment including concrete inserts, anchor bolts, metallic hanging and supporting devices, etc. for supporting electrical equipment.
3. Hangers and supports shall be approved standard design, 1-5/8" and shall be adequate to maintain the supported load in proper position and alignment under all operating conditions. All supports shall be designed to adequately secure the equipment against excessive dislocation due to thermal expansion and contraction and all probable external forces such as equipment, conduit and personnel contact.
4. All electrical equipment shall be supported in such a manner as to prevent any strain being imposed on the equipment supported.
5. All material used in manufacturing hangers and supports shall be capable of meeting the respective ASTM Standard Specifications with regards to tests and physical and chemical properties, and be in accordance with MSS SP-58.
6. Hangers and supports shall be spaced in accordance with MSS SP-69 Table 3.
7. Hangers and supports shall be as manufactured the following manufactures. Product numbers used herein are based on B-Line Systems , Inc.
 - a. B-Line Systems, Inc.
 - b. Caddy/Eritrust
 - c. Unistrut
 - d. Power-Strut
 - e. Cope
 - f. Thomas and Betts – Super Strut

B. Hangers

1. All hangers and supports shall have some form of adjustment available after installation. Hanger material shall be compatible with the conduit material.
2. Hangers for conduit 4" and smaller shall be B-Line series BL1400.

C. Hanger Rods

1. Hanger rods shall be B-Line series ATR (All Threaded Rod) or series B3205 with threaded at ends with allowance for adjustments. Wire and strap hangers will not be permitted. All electrical equipment shall be supported by rods, hangers, etc., using bolts.
2. Hanger rods shall be subjected to tension only. Lateral and axial movements shall be accommodated by proper linkage in the rod assembly.
3. Hanger rod diameters shall be based on MSS SP-69 Table 4.

D. Beam Clamps

1. All beam clamps shall be concentric loaded type clamps which engage both edges of the beam flange. The hanger shall be located directly below the web of the beam. Consult with Structural Engineer to ascertain maximum loading on hanger in each area.

2. Beam clamps shall be B-Line series B3054, B3055 or B3291 through B3297.

E. Concrete Inserts

1. Concrete inserts for hangers shall be continuous metal or spot inserts designed to be used in ceilings, walls or floors and shall be as follows:
 - a. Continuous concrete inserts shall be used where applicable for hanger rod sizes up to 3/4" diameter. Inserts may be used where supports are parallel to the main slab reinforcement and shall be B-Line series B22I, B32I or B52I.
 - b. Spot concrete inserts shall be used where applicable for hanger rod sizes up to and including 7/8" diameter. Inserts shall be B-Line series B2505 through B2508, B2500, B2501 or B3014.

F. Welded Steel Brackets

1. Wall or column supported conduits shall be supported by welded steel brackets B-Line series B3064 or B3066.

G. Stanchions

1. For floor supported equipment, such as safety switches in mechanical areas, provide either cast-in-place concrete supports or field installed supports. Each support shall be screwed or welded to the corresponding size base stand. Supporting pipe shall be of schedule 40 steel pipe construction. Each base stand shall be secured to the concrete floor by expansion bolts. Base stands shall be B-Line series B3088 or B3088T.

H. Riser Conduits

1. Riser conduits shall be supported independently from of any horizontal conduits.
2. Support all vertical runs of conduits at each floor with B-Line series B3373 or B3373CT as required.

I. Strut Channel

1. Strut channel trapeze hangers shall be used to support parallel conduit runs. Conduit racks or stanchions fabricated with strut channel shall be used in areas with multiple conduit runs. Strut clamps and straps shall be used to maintain proper alignment. Strut shall be a minimum of 1 5/8" wide x 1 5/8" deep, B-Line series B22 or heavier as required. Clamps and straps shall be B-Line series B2000 suitable for the conduit material (EMT, IMC or RGS).
2. Provide strut channel above ceilings for support of electrical equipment such as lighting fixtures where mechanical equipment and ductwork interfere with direct mounting methods. Strut shall be used to span the width of the interference and supported by rods on each end.
3. Provide all required appurtenances required to properly hang and assemble strut supports.

2.04 MECHANICAL SUSPENSION CHANNEL

- A. Mechanical suspension channel shall be furnished and installed to support electrical equipment, (panelboards, disconnect switches, starters, transfer switches, transformers, etc.) independent of walls. Where walls back up to occupied spaces, the suspension channels shall be at least 1/2" clear of the wall and shall not be connected or braced to the wall.
- B. Channel shall be Unistrut, Type P3000 or approved equal. All fasteners and fittings shall be supplied to provide a complete installation as required. Channel shall be sized and mounted to allow for future conduits.
- C. All channel and fittings shall be furnished with the manufacturer's standard rustproofed finish.
- D. Channel shall be manufactured by one of the following:
 - 1. B-Line Systems, Inc.
 - 2. Caddy/Eritrust
 - 3. Unistrut
 - 4. Power-Strut
 - 5. Cope
 - 6. Thomas & Betts – Kindorf

2.05 WIREWAYS

- A. Furnish and install wireways as required and/or as indicated on the drawings. Wireways in electric rooms shall be minimum 6" x 6", mounted a minimum of 6'-6" above finished floor. Wireway covers shall be completely removable.
- B. Wireways shall be as manufactured by Cutler Hammer, General Electric Square D or Siemens.

PART 3 EXECUTION

3.01 COOPERATION AND WORK PROGRESS

- A. The Electrical work shall be carried on under the usual construction conditions, in conjunction with all other work at the site. The Electrical Contractor shall cooperate with the Architect, Construction Manager, all other Subcontractors and equipment suppliers working at the site. The Electrical Contractor shall coordinate the work and proceed in a manner so as not to delay the progress of the project.
- B. The Electrical Contractor shall furnish information on all equipment that is furnished under this Section but installed under another Section to the installing Subcontractor as specified herein.
- C. The Electrical Contractor shall provide all materials, equipment and workmanship to provide for adequate protection of all electrical equipment during the course of construction of the project. This shall also include protection from moisture and all foreign matter. The Electrical Contractor shall also be responsible for damage which he causes to the work of other Trades, and he shall remedy such injury at his own expense.

- D. Waste materials shall be removed promptly from the premises. All material and equipment stored on the premises shall be kept in a neat and orderly fashion. Material or equipment shall not be stored where exposed to the weather. The Electrical Contractor shall be responsible for the security, safekeeping and damages, including acts of vandalism, of all material and equipment stored at the job site.
- E. The Electrical Contractor shall be responsible for unloading all electrical equipment and materials delivered to the site. This shall also include all large and heavy items or equipment which require hoisting. Consult with the Construction Manager for hoisting/crane requirements. During construction of the building, the Electrical Contractor shall provide additional protection against moisture, dust accumulation and physical damage of the main service and distribution equipment. This shall include furnishing and installing temporary heaters within these units, as approved, to evaporate excessive moisture and ventilate it from the room, as may be required.
- F. It shall be the responsibility of the Electrical Contractor to coordinate the delivery of the electrical equipment to the project prior to the time installation of equipment will be required; but he shall also make sure such equipment is not delivered too far in advance of such required installation, to ensure that possible damage and deterioration of such equipment will not occur. Such equipment stored for an excessively long period of time (as determined in the opinion of the Architect) on the project site prior to installation may be subject to rejection by the Architect.
- G. Prior to installation, the Electrical Contractor has the responsibility to coordinate the exact mounting arrangement and location of electrical equipment to allow proper space requirements as indicated in the NEC. Particular attention shall be given in the field to group installations. If it is questionable that sufficient space, conflict with the work of other Subcontractors, architectural or structural obstructions will result in an arrangement which will prevent proper access, operation or maintenance of the indicated equipment, the Electrical Contractor shall immediately notify the Contractor and not proceed with this part of the Contract work until definite instructions have been given to him by the Architect.
- H. Refer to the Architectural drawings for areas in which the concrete slab is poured on grade. In these areas a waterproofing membrane will be installed on the grade fill or earth prior to pouring of slab. Electrical conduits shall be installed to avoid the necessity of penetrating this waterproofing membrane. Penetration of the membrane, if required, shall only be made when specifically allowed by the Architect, and shall be made only at locations directed by the Architect.
- I. Junction / pullboxes shall not be installed 10'-0" above finished floor.

3.02 INSTALLATION

A. General

1. Unless specifically noted or indicated otherwise, all equipment and material specified in Part 2 of this specification or indicated on the drawings shall be installed under this Contract whether or not specifically itemized herein. This Section covers particular installation methods and requirements peculiar to certain items and classes or material and equipment.
2. The Electrical Contractor shall obtain detailed information from manufacturers of equipment provided under Part 2 of this specification as to proper methods of installation.

3. The Electrical Contractor shall obtain final roughing dimensions and other information as needed for complete installation of items furnished under other Sections or furnished by the Owner.
4. The Electrical Contractor shall keep fully informed of size, shape and position of openings required for material and equipment provided under this and other Sections. Ensure that openings required for work of this Section are coordinated with work of other Sections. Provide cutting and patching as necessary.
5. All miscellaneous hardware and support accessories, including support rods, nuts, bolts, screws and other such items, shall be of a galvanized or cadmium plated finish or of another approved rust-inhibiting coating.
6. Throughout this Section where reference is made to steel channel supports, it shall be understood to mean that the minimum size shall be 1 5/8" mild strip steel with minimum wall thickness of 0.105", similar to Unistrut P1000 or equal products manufactured by Kindorf or Husky Products Co.

B. Access Panels

1. Access panels shall be furnished to the Construction Manager for installation by his designated Contractor.

C. Hangers and Supports

1. All horizontal runs of conduits shall be properly grouped, aligned, using substantial hangers, straps, etc. Hangers and supports shall be installed at intervals not exceeding NEC requirements.
2. Structural Support Interface
 - a. All conduit, raceways, electrical equipment and other similar system components which are supported by roof or floor joists shall be hung from the top chord or bottom chord panel point or a panel point shall be provided by applying a vertical web member. The maximum load shall not exceed 250 pounds.
 - b. All conduit, raceways, electrical equipment, etc., which are supported by roof/floor beams shall be hung from the beams with clamp attachments which engage both edges of the beam flange.
The hanger shall be located directly below the web of the beam and the hanger load shall be limited to 1000 pounds in area above mechanical room and 250 pounds in remaining areas, unless otherwise approved by the Architect.
 - c. All additional supports, clamps, web members, etc., required to comply with the above requirements shall be provided by the Electrical Contractor, as applicable, for the work furnished and installed under this Contract.

3.03 MATERIALS AND WORKMANSHIP

- A. All materials and equipment shall be new and unused and shall meet requirements of the latest Standards of NEMA, UL, IPCEA, ANSI and IEEE. Equipment shall have components required or recommended by OSHA, applicable NFPA documents and shall be UL listed and labeled.
- B. Despite references in the specifications or on the drawings to materials or pieces of equipment by name, make or catalog number, such references shall be interpreted as establishing standards of quality for materials and performance.

- C. Finish of materials, components and equipment shall not be less than Industry good practice. When material or equipment is visible or subject to corrosive or atmospheric conditions, the finish shall be as approved by the Architect.
- D. Provide proper access to material or equipment that requires inspection, replacement, repair or service. If proper access cannot be provided, confer with the Architect as to the best method of approach to minimize effects of reduced access.
- E. All work shall be installed in a neat and workmanlike manner and shall be done in accordance with all Local and State Codes.
- F. The Owner will not be responsible for material, equipment or the installation of same before testing and acceptance.

3.04 GROUNDING

- A. Install a complete equipment grounding system. Equipment grounding system shall be designed so metallic structures, enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, metal fences, portable equipment and other conductive items in proximity to electrical circuits operate continuously at ground potential and provide low impedance path for possible ground fault currents.
- B. System shall meet NEC requirements, and as shown on the drawings and as specified. Bonding jumpers shall be installed at all locations required by NEC.
- C. Provide separate green insulated equipment grounding conductor for each single- or 3-phase feeder. Install grounding conductor in common conduit with related phase and neutral conductors. Where parallel feeders are installed in more than (1) raceway, an individual, full size green insulated equipment ground conductor shall be provided in each.
- D. Provide separate green insulated equipment grounding conductor for each branch circuit. Where multiple branch circuits (3 maximum) are installed in a common raceway or prefabricated conductor assembly (i.e. MC or AC cable), a minimum of one ground conductor shall be included, provided that each of the branch circuits originate from a different phase. Install grounding conductor in common conduit or prefabricated conductor assembly with related phase and neutral conductors.
- E. Determine numbers and sizes of screw terminals for equipment grounding bars in panelboards and other electrical equipment. Provide screw terminals for active circuits, spares and spaces.
- F. Provide green, insulated equipment ground conductor in same raceway with associated phase conductors, as follows:
 - 1. From main service ground to ground bus in service entrance equipment to ground bus in all distribution panels, remote panels, motor control centers, etc., size as shown on the drawings.
 - 2. From green ground terminals of receptacles to green 10-32 washer-in-head outlet box machine screw and to panelboard grounding bus. (Receptacles with special cast boxes and factory designed and approved ground path do not require separate ground jumper.)

3. From panelboard ground bus to green 10-32 washer-in-head machine screw in ceiling outlet box or junction box, through flexible metallic conduit to ground terminal on lighting fixture and from green 10-32 washer-in-head machine screw in ceiling outlet box or junction box through flexible metallic conduit to green 10-32 washer-in-head machine screw in switch outlet box.
 4. From panelboard ground bus to green 10-32 washer-in-head machine screw in junction box or disconnect switch through flexible metallic conduit to ground terminal in connection box mounted on single-phase fractional horsepower motor.
 5. From equipment ground bus in motor control center through conduit and flexible metallic conduit to ground terminal in connection box mounted on 3-phase motors. Ground conductors for motors with separate starters and disconnect devices shall originate at ground bar in panelboard and shall be bonded to each starter and disconnect device enclosure.
 6. From dry type transformer neutrals to the building steel (or the ground grid system) by means of copper wire, as scheduled on the drawings.
- G. Provide green insulated grounding conductor in all non-metallic conduits.
- H. All empty conduit runs shall be provided with insulated and grounding bushing and grounded by a #12 AWG green ground conductor to the nearest panel ground bus.

END OF SECTION

SECTION 260530

WIRING METHODS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. All of the Contract Documents, as listed on the Table of Contents and including General and Supplementary Conditions and Division 01, General Requirements, shall be included in, and made part of, this Section.

1.02 DESCRIPTION OF WORK

- A. The following general systems and equipment shall be provided for the renovated areas of the existing building, as a minimum, but not necessarily limited to the following:
 - 1. Connections to HVAC, Plumbing, Fire Protection, Automatic Temperature Control, Construction Manager and Owner furnished equipment.
 - 2. 120 volt power for remote alarms and connections to oil tank alarms, etc.
 - 3. Hoisting, rigging, setting of all conduit, cable and equipment.
 - 4. Testing, cleaning and adjusting.
 - 5. Alarm panels.
 - 6. Boxes.
 - 7. Cable assemblies (prefabricated).
 - 8. Conductors – 600 volts.
 - 9. Conduit.
 - 10. Gas alarms, oil tank alarms, wiring and connection.
 - 11. Solderless lugs and connectors.
 - 12. Surface mounted raceway system.
 - 13. Wiring devices and device plates.
 - 14. Mineral Insulated (MI) metal sheathed cable.

1.03 RELATED WORK

- A. For work to be included as part of this Section, to be furnished and installed by the Electrical Contractor, refer to the Related Work section of Specification Section 26 0510.
- B. Carefully examine all of the Contract Documents, criteria sheets and all other Sections of the specifications for requirements which affect work under this Section, whether or not such work is specifically mentioned in this Section.

1.04 WARRANTY

- A. Attention is directed to provisions of the General Requirements, Supplementary General Requirements and Section 26 0510 regarding guarantees and warranties for the work under this Contract.

1.05 CONNECTIONS TO ARCHITECTURAL, HVAC, PLUMBING AND OWNER FURNISHED EQUIPMENT

- A. The Electrical Contractor shall provide all conduit connections to equipment provided under other Sections of the specifications, including final connections to equipment to result in a complete system, fully operational.
 - 1. Coordinate location of all equipment with the Construction Manager. Obtain installation diagrams and methods of installation of all equipment, from manufacturers. Follow instructions strictly. If additional information is required, obtain same from Architect.
- B. All electrical connections to vibration isolated equipment shall be by flexible conduit of length at least 15 diameters, installed with visible slack, or in a loop configuration, to allow free movement of the equipment and prevent transmission of noise and vibration.

1.06 SUBMITTALS

- A. Prepare and submit shop drawings in accordance with the requirements hereinbefore specified, and with Section 01 3300 – Submittal Procedures in the manner described therein, modified as noted hereinafter.
- B. All shop drawings shall have clearly marked the appropriate specification number of drawing designation, for identification of the submittal.
- C. Disposition of shop drawings shall not relieve the Electrical Contractor from the responsibility for deviations from drawing or specifications, unless he has submitted in writing a letter itemizing or calling attention to such deviations at time of submission and secured written approval from the Engineer, nor shall such disposition of shop drawings relieve the Electrical Contractor from responsibility for errors in shop drawings or schedules.
- D. Shop drawings shall include, but shall not be limited to, the following:
 - 1. Alarm panels.
 - 2. Boxes.
 - 3. Cable assemblies (prefabricated).
 - 4. Conductors – 600 volts.
 - 5. Conduit.
 - 6. Gas alarms, oil tank alarms, wiring and connection.
 - 7. Solderless lugs and connectors.
 - 8. Surface mounted raceway system.
 - 9. Wiring devices and device plates.
 - 10. Routing of all conduits 2½ inches in diameter and larger.
 - 11. Mineral Insulated (MI) metal sheathed cable.

PART 2 PRODUCTS

2.01 ALARM PANELS AND SYSTEMS FURNISHED BY OTHER TRADES

- A. Furnish and install all power wiring connections and conduit (120 volt) as required for alarm panels and metering devices supplied by Plumbing, Fire Protection, HVAC and Automatic Temperature Control Trades. All alarm system panels, components, interface wiring and conduit shall be provided by the respective Trade.

2.02 BOXES

A. Junction Boxes

1. Junction boxes shall be constructed of code gauge galvanized steel and shall be installed at points as required whether indicated on the drawings or not. Minimum dimension shall not be less than NEC requirements.
2. Provide flat plain covers with suitable flat head machine screws or slotted truss head bolts.
3. Boxes exceeding 4'-0" in any direction shall be reinforced with angle iron stiffeners.
4. PVC Schedule 40 junction boxes shall be provided in areas with corrosive atmosphere.
5. Boxes shall be manufactured by one of the following: Wiegmann, Lee Products Co., Harry Richmond Co., Commercial Sheet Metal Co., Hoffman, B-Line or McKinstry.

B. Wiring Device Boxes

1. Wiring device boxes shall be one-piece galvanized steel construction meeting NEC requirements, of proper size and suitable for location indicated on the drawings.
2. Wiring device boxes in wall partitions shall not be installed back-to-back.
3. For wiring devices mounted in metal stud partitions, boxes shall be mounted on "stud-to-stud" type mounting brackets. Bracket shall be secured using self-threading metal screws and shall engage more than one stud for support, similar to Erico/Caddy Series SGB.
4. Wiring device boxes for surface mounted devices shall be a finished type (surface box). Boxes shall be stainless steel.
5. Wiring device boxes for exterior work shall be FS or FD Series, with cadmium plated covers. Steel boxes will not be permitted.
6. PVC Schedule 40 wiring device boxes shall be provided in areas with corrosive atmosphere.
7. Wiring device boxes used as junction boxes shall not be less than 4 11/16" square and 2" deep.
8. Wiring device boxes shall be manufactured by one of the following: Crouse-Hinds Co., Appleton Electric Co., Steel City Electric Co., T&B, RACO or Erico.

C. Pull Boxes

1. Pull boxes shall be constructed of code gauge galvanized steel and shall be installed at points as required whether indicated on the drawings or not. Minimum dimension shall not be less than NEC requirements.
2. Provide flat plain covers with suitable flat head machine screws or slotted truss head bolts.
3. Boxes exceeding 4'-0" in any direction shall be reinforced with angle iron stiffeners and contain two (2) section covers and cable supports.
4. PVC Schedule 40 pull boxes shall be provided in areas with corrosive atmospheres.
5. Pull boxes for medium voltage feeders shall have barriers to separate each medium voltage circuit.
6. Boxes shall be manufactured by one of the following: Wiegmann, Lee Products Co., Harry Richmond Co., Commercial Sheet Metal Co., Hoffman, B-Line or McKinstry.

2.03 METAL CLAD (MC) CABLE

A. General

1. Furnish and install multi-conductor, factory assembled Hospital Grade MC cable as shown on the drawings and specified herein, including all necessary fittings, hangers, accessories, etc. Multi-conductor cable assemblies shall be prefabricated at the factory and shipped to the site on cable reels.

B. Reference Standards

1. MC cable shall be in compliance with the latest applicable edition of the following industry standards:
 - a. National Electrical Code (NEC)
 - 1) NEC 230
 - 2) NEC 250
 - 3) NEC 300
 - 4) NEC 330
 - 5) NEC 517
 - b. Federal Specification A-A59544
 - c. Underwriters Laboratory (UL)
 - 1) UL 1569
 - 2) UL 1479
 - 3) UL 83 or UL 44

C. Construction

1. Conductors

- a. Phase, neutral and insulated ground conductors shall be Class B stranded, soft-drawn solid copper conductors. Insulation shall be constructed with THHN insulation rated for 90°C dry and rated for 600 volts.
- b. Grounding/bonding conductor shall be a galvanized-alloy conductor material, and shall be sized based on NEC table 250.122 and Table 6.1 in UL 1569.
- c. Included with each length of MC cable shall be the required number of phase conductors (maximum 3), one insulated neutral conductor per phase conductor, one full size insulated grounding conductor and an uninsulated aluminum grounding/bonding conductor.
- d. All insulated circuit conductors and insulated grounding conductors shall be cabled together and contained under an overall nonmetallic tape covering. The single bare galvanized grounding/bonding conductor shall be placed outside of the nonmetallic tape covering and have the same lay (twist) as the insulated conductor assembly.

- e. Unless indicated otherwise on the drawings, minimum size conductors for 20 ampere branch circuits shall be as follows:

Minimum Conductor Size	Distance to First Device			
	120 Volt	208 Volt	277 Volt	480 Volt
#12 AWG	<60'	<110'	<140'	<250'
#10 AWG	60' – 100'	110' – 170'	140' – 230'	250' – 400'
#8 AWG	>100'	>170'	>230'	>400'

NOTE:

For branch circuits utilizing #8 AWG conductors, the branch circuit conductors from the panel shall terminate in a network junction box within 30' of the device(s). Branch conductors from this junction box to the device(s) on the circuit shall be #10 AWG conductors.

- f. Unless indicated otherwise on the drawings, minimum size wire for remote control signal circuit and interlock wiring shall be #14 AWG. Fire alarm wiring shall be per the Fire Alarm System Section of these specifications.
- g. Each conductor, including the insulated ground conductor, shall be wrapped with nylon covering.
- h. Color Coding
 - 1) Color coding of conductors shall match the Owners color coding standard. If no standard color coding system exists, use the following:

208/120 Volts		480/277 Volts	
A Phase	- Black	A Phase	- Brown
B Phase	- Red	B Phase	- Orange
C Phase	- Blue	C Phase	- Yellow
Neutral	- White	Neutral	- Grey
Ground	- Green	Ground	- Green with Yellow Stripe
Isolated Ground	- Green with Orange Stripe		

- 2) Color coding shall be continuous on insulation for all conductors.
- 3) Electrical Contractor shall provide additional identification to identify each neutral conductor with its associated phase conductor.

2. Exterior armor

- a. Interlocked armor shall be listed and identified as being suitable for grounding. Armor ground path performance shall be equivalent in performance to an NEC 250.122 sized equipment grounding conductor.
- b. Aluminum interlocking armor shall be formed and helically wrapped around the cable assembly such that the interlocked armor and galvanized grounding/bonding conductor are in intimate contact throughout the entire cable.
- c. The interlocking metal tape armor shall be aluminum and shall be green.

3. Each components of the cable assembly shall contain less than 300 ppm of lead, and shall meet the requirements of LEED for Healthcare MR Credit 4.2.

D. Manufacturer

1. Hospital grade MC cable shall be as manufactured by Southwire Series HCF MCAP, or equivalent product as manufactured by AFC or Encore.

E. Fittings

1. Fittings for MC cable shall be screw-type, not clip, suitable for use with the appropriate cable assembly.
2. Fitting shall be as manufactured by Neer, Bridgeport, Arlington, Electroline, OZ Gedney, Thomas and Betts, ETP or Regal.
3. Include manufacturers literature with shop drawings stating application compatibility with each cable type.

2.04 CONDUCTORS, COPPER – 600 VOLTS

A. General

1. Wire and cable for feeders, lighting, power, branch circuits and control circuits for systems operating between 50 and 600 volts shall be soft drawn, 98% conductive copper with 600 volt rated insulation.
2. All wiring shall be installed in conduit (power, low voltage and control wiring), unless specifically indicated otherwise.
3. All feeder, branch circuit, remote control, signal circuit and interlock wiring shall be single conductor. Conductors #8 AWG and larger shall be stranded. All wiring #10 AWG and smaller shall be solid.
4. Unless indicated otherwise on the drawings, minimum size conductors for 20 ampere branch circuits shall be as follows:

Minimum Conductor Size	Distance to First Device			
	120 Volt	208 Volt	277 Volt	480 Volt
#12 AWG	<60'	<110'	<140'	<250'
#10 AWG	60' – 100'	110' – 170'	140' – 230'	250' – 400'
#8 AWG	>100'	>170'	>230'	>400'

NOTE:

- 1) For branch circuits utilizing #8 AWG conductors, the branch circuit conductors from the panel shall terminate in a network junction box in the area of the circuit(s) served. Branch conductors from this junction box to the device(s) on the circuit shall be #10 AWG conductors.
5. Unless indicated otherwise on the drawings, minimum size wire for remote control signal circuit and interlock wiring shall be #14 AWG. Fire alarm wiring shall be per the Fire Alarm System Section of these specifications.
6. Conductors #10 and #12 AWG shall be connected with pre-insulated spring connectors encased in a steel shell and rated at not less than 105°C. A minimum of 3/8" skirt shall cover the bare wires. The connector shall meet with UL approval for fixture and pressure work and shall be "B-Cap" Type B1, B2 and B4 electrical spring connectors as manufactured by the Buchanan Co., or approved equal.

7. Each components of the cable assembly shall contain less than 300 ppm of lead, and shall meet the requirements of LEED for Healthcare MR Credit 4.2.

B. Manufacturers

1. Southwire
2. Cerro
3. Encore
4. Service Wire

C. References

1. All wiring shall conform to the National Electrical Code for construction and use.
2. Wiring in hot locations and for recessed fixtures shall have heat-resistant insulations recognized by NEC such as RHH, etc.
3. Conductor type THHW shall meet or exceed the following:
 - a. ASTM B-3 or B-8
 - b. UL
 - c. UL listed as type THHW
4. Conductor types THWN shall meet or exceed the following:
 - a. ASTM B-3 or B-8
 - b. UL Standard 83
 - c. UL listed as type THWN
5. Conductor type XHHW shall meet or exceed the following:
 - a. ASTM B-3 or B-8
 - b. UL 44
 - c. UL listed as type XHHW
6. Conductor type XHHW-2 shall meet or exceed the following:
 - a. ASTM B-3 or B-8
 - b. UL 44
 - c. UL listed as type XHHW-2

D. Insulation types for all conductors shall be as follows:

Description	Location		
	Dry	Damp	Wet
Interior branch circuits #6 AWG and smaller	THHW	THWN	THWN
Interior branch circuits larger than #6 AWG	XHHW	XHHW	XHHW-2
Interior feeders	XHHW	XHHW	XHHW-2
Exterior feeder and exterior branch circuit wiring	XHHW-2	XHHW-2	XHHW-2
Feeders connected to 100% rated circuit breakers	XHHW-2	XHHW-2	XHHW-2

E. Color Coding

1. Color coding of conductors shall match the Owners color coding standard. If no standard color coding system exists, use the following:

208/120 Volts			480/277 Volts		
A Phase	-	Black	A Phase	-	Brown
B Phase	-	Red	B Phase	-	Orange
C Phase	-	Blue	C Phase	-	Yellow
Neutral	-	White	Neutral	-	Grey
Ground	-	Green	Ground	-	Green with Yellow Stripe
Isolated Ground	-	Green with Orange Stripe			

2. Color coding shall be continuous on insulation for all conductors. For conductors larger than #6 where continuous color coding is not available, each conductor shall be marked with color tape at all connections and in all pull, junction and outlet boxes.
3. For 120 volt and 277 volt single phase circuits, Electrical Contractor shall provide additional identification to identify each neutral conductor with its associated phase conductor in all pull, junction and outlet boxes.

2.05 CONDUCTORS, ALUMINUM – 600 VOLTS

- A. All feeder wiring 125 amps and larger shall be manufactured of aluminum, rated at 600 volts, single conductor.
- B. Minimum size shall be 2/0kcMIL.
- C. Wire and cable feeders operating between 50 and 600 volts shall be compact stranded of an 8000 Series aluminum alloy with 600 volt rated insulation.
- D. All wiring shall be installed in conduit.
- E. References
 1. All wiring shall conform to the National Electrical Code for construction and use.
 2. Conductors shall be Type XHHW-2 and shall meet or exceed the following:
 - a. ICEA S-95-658
 - b. NEMA WC-70
 - c. UL 44
 - d. UL listed as type XHHW-2
 - e. Federal Specification A-A-59544

F. Insulation

1. Insulation types for all conductors shall be XHHW-2.

G. Color Coding

1. Color coding of conductors shall match the Owners color coding standard. If no standard color coding system exists, use the following:

208/120 Volts			480/277 Volts		
A Phase	-	Black	A Phase	-	Brown
B Phase	-	Red	B Phase	-	Orange
C Phase	-	Blue	C Phase	-	Yellow
Neutral	-	White	Neutral	-	Grey
Ground	-	Green	Ground	-	Green with Yellow Stripe
Isolated Ground	-	Green with Orange Stripe			

2. Color coding shall be continuous on insulation for all conductors. For conductors larger than #6 where continuous color coding is not available, each conductor shall be marked with color tape at all connections and in all pull, junction and outlet boxes.

H. Manufacturers

1. Branch circuit and feeder conductors shall be manufactured by one of the following: Southwire or Alcan.

2.06 CONDUIT PENETRATION SEALS

- A. Conduit penetration seals shall be Link-Seal by PSI-Thunderline. Seals shall be modular, mechanical type, consisting of inter-locking synthetic rubber links shaped to continuously fill the annular space between the pipe and the wall opening.
- B. Elastomeric elements shall be sized and selected per manufacturer's recommendations and have the following properties as designated by ASTM. Coloration shall be throughout elastomer for positive field inspection. Each link shall have a permanent identification of the size and manufacturer's name molded into it.
 1. -40 to +250°F (-40 to +121°C)
 2. EPDM = ATSM D2000 M3 BA510
 3. Color = Black
- C. Modular seal pressure plates shall be molded of glass reinforced nylon polymer with the following properties:
 1. Izod Impact - Notched = 2.05ft-lb/in. per ASTM D-256
 2. Flexural Strength @ Yield = 30,750 psi per ASTM D-790
 3. Flexural Modulus = 1,124,000 psi per ASTM D-790
 4. Elongation Break = 11.07% per ASTM D-638
 5. Specific Gravity = 1.38 per ASTM D-792
- D. Models LS200-275-300-315 shall incorporate the most current Link-Seal® Modular Seal design modifications and shall include an integrally molded compression assist boss on the top (bolt entry side) of the pressure plate, which permits increased compressive loading of the rubber sealing element.

- E. Models 315-325-340-360-400-410-425-475-500-525-575-600 shall incorporate an integral recess known as a "Hex Nut Interlock" designed to accommodate commercially available fasteners to insure proper thread engagement for the class and service of metal hardware. All pressure plates shall have a permanent identification of the manufacturer's name molded into it.
- F. All fasteners shall be sized according to latest Link-Seal® modular seal technical data. Bolts, flange hex nuts shall be:
 - 1. Mild Steel with a 60,000 psi minimum tensile strength and 2-part Zinc Dichromate coating per ASTM B-633 and Organic Coating, tested in accordance with ASTM B-117 to pass a 1,470 hour salt spray test.
- G. Provide Model WS steel sleeves at all wall and floor penetrations. Sleeves shall be Schedule 40 and have integrally water stop sized having a minimum of two inches larger than the outside diameter of the sleeve itself and allowing 1/2" movement between wall forms to resist pour forces.
 - 1. Each sleeve assembly shall have end caps installed at each end of the sleeve so as to prevent deformation during the initial concrete pour, and to facilitate attaching the sleeve to the wall forms. End caps shall remain in place to protect the opening from residual debris and rodent entry prior to pipe insertion.
- H. Conduit penetration seal components and systems shall be domestically manufactured at a plant with a current ISO-9001:2000 registration. Copy of ISO-9001:2000 registrations shall be a submittal item.

2.07 METALLIC CONDUIT

A. General

- 1. Raceways for feeders and branch circuits shall be metallic, rigid metal conduit, intermediate metal conduit (IMC) or electrical metallic tubing (EMT) subject to the restrictions of the National Electrical Code, minimum of 3/4".

B. Electrical Metallic Tubing (EMT)

- 1. EMT shall be permitted for both exposed and concealed work.
- 2. EMT shall not be permitted:
 - a. Where subject to physical damage, including mechanical equipment rooms below 10'-0" AFF.
 - b. In corrosive areas.
 - c. In cinder block construction.
 - d. In hazardous (classified) locations.
 - e. For 480 volt and 208 volt feeders.
- 3. Fittings shall be steel compression type.

C. Intermediate Metal Conduit (IMC)

- 1. IMC shall be permitted under all conditions subject to the restrictions of the National Electrical Code.
- 2. IMC shall not be permitted for non-concrete encased medium voltage feeders.

3. Fittings shall be steel threaded.
- D. Rigid Metal Conduit (RMC)
1. RMC shall be permitted under all conditions subject to the restrictions of the National Electrical Code.
 2. All fittings shall be threaded.
- E. PVC Coated Rigid Metal Conduit (PVC-RMC)
1. PVC-RMC shall be permitted under all conditions subject to the restrictions of the National Electrical Code.
 2. All fittings shall be threaded.
 3. PVC-RMC and threads shall be hot-dipped galvanized inside per UL-6 as primary corrosion protection. PVC-RMC conduits shall comply with all sections of UL-6, ANSI C80.1 and NEMA RN-1 2005 standard.
 4. Full lengths of pipe shall have hot-dipped galvanization on both ends and threads.
 5. PVC-RMC shall be Thomas & Betts – OCAL or approved equal that provides hot-dipped galvanization as primary protection and PVC coating as primary protection in accordance with UL, NEMA and ANSI Standards.
- F. Flexible liquid-tight metal conduit shall be used only for connection to motors, pumps, air handling units, transformers, modular office furniture, and final connections to all other vibrating equipment and shall be waterproof type, with an interwoven ground conductor. Separate ground conductor shall be installed for all flexible conduit sizes. Flexible conduit may also be used for connecting to lighting fixtures. Maximum length of flexible conduit allowed shall be 5'-0" from the junction box to the fixture. All lighting branch circuit home runs to panelboard shall be in conduit. Flexible liquid-tight metal conduit shall be manufactured by Electri-Flex, AFC, Anamet, or equal.
- G. All empty conduit runs shall have nylon pull cords installed. Tie a washer larger than the conduit on each end of nylon pull cord to avoid losing pull cord in conduits.
- H. Conduit fittings shall be cast ferrous alloy complete with gaskets and covers where required. Expansion fittings shall be used where conduit passes through building expansion joints, weatherproof telescopic type. The expansion fitting shall permit a minimum movement of 4".
- I. Conduit and tubing shall be manufactured by one of the following:
1. Allied Tube & Conduit Co.
 2. Wheatland
 3. Republic
- J. Flexible conduit shall be manufactured by one of the following:
1. AFC
 2. Electri-Flex
 3. Anaconda
- 2.08 PLASTIC CONDUIT
- A. Direct buried plastic conduit shall be Schedule 40 and concrete encased in duct banks. Conduit shall be composed of PVC, UL listed and shall conform to NEMA Standards.

- B. PVC Schedule 40 conduit shall be furnished in corrosive atmosphere areas.
- C. All penetrations through floor slabs, foundation walls or manhole walls shall be rigid steel conduits.
- D. Plastic conduit and fittings shall be manufactured by one of the following:
 - 1. JM/Eagle
 - 2. Cantex
 - 3. National

2.09 SOLDERLESS LUGS AND CONNECTORS

- A. All lugs for 600 volt feeder conductors and connectors for branch circuit joints shall be UL Listed for copper and aluminum conductors and of the solderless type.
- B. Compression Lugs
 - 1. Compression terminals shall be UL Listed for copper and aluminum conductors and shall be electro tin plated with internally beveled barrel and shall be clearly marked with wire size, die index, color code and the proper number and location of crimps. Connectors shall be prefilled from manufacturer with oxide inhibiting compound. (Burndy YA – A series connectors or equal)
 - 2. Compression connectors shall be properly crimped to the recommended torque value. Identification of proper torque value and/or use of proper size die shall be visible on all compression terminals. (Burndy Hypress Tools and lugs or equal.) All compression connections shall be made with connectors and tools which can be verified to be UL listed to be used together. (Burndy Hypress tools and lugs or equal)
- C. Lugs and wire connectors shall be one of the following: IlSCO, Anderson, Burndy Corp. or Thomas & Betts Co.

2.10 SURFACE-MOUNTED RACEWAY SYSTEM

- A. General
 - 1. This specification covers a power wiring system with a multi-outlet raceway used for branch circuit wiring and/or voice, data, video and other low-voltage wiring. Multiple outlet raceway system shall consist of raceway, appropriate fittings, receptacle harness and receptacle identification to complete the installation as shown on the building plans.
 - 2. The assembly is to be utilized in dry interior locations, and UL Listed as a Multi-outlet Assembly and Surface Metal Raceway as covered in Articles 380 and 386 of the National Electrical Code, as adopted by the National Fire Protection Association and as approved by the American National Standards Institute.
 - a. The prewired raceway systems shall be listed by Underwriters' Laboratories under File Nos. E68073 Guide PVGT and E77734 Guide RJBT.
 - 3. Submit drawings for approval, show the complete layout of all products that make up the complete system for each floor prior to installation with raceway lengths, device type (power and communications), locations and circuit identification.
 - 4. Three (3) copies of record drawings, showing each raceway section, shall be provided upon delivery of the system.

B. Manufacturer

1. Manufacturer for the assembly specified herein shall be as follows:
 - a. Wiremold - Series 3000
 - b. PG LifeLink - Versaduct - Series
 - c. Hubbell Inc. – Series
2. Manufacturers requesting consideration as an alternative to the specified prewired systems shall submit documentation establishing their product equality at least 10 days prior to bid date. Request shall include documentation of UL listings as both a Multi-outlet Assembly and a Surface Raceway and include a sample of the prewired components. A list of similar installations in service for two (2) years or longer must be provided. Systems of other manufacturers may be considered equal, if in the opinion, and the written approval of the Engineer, they meet all the performance standards specified herein.

C. Raceway

1. Raceway shall have 1 wiring compartments with field removable cover(s). Raceway shall have a nominal wall thickness of 0.078". Multiple compartment raceway shall have an integral dividing barrier isolating wiring compartments and provided with fittings that maintain the separation of compartments.
2. Raceway covers shall be a minimum of 18" in length to facilitate future modification. Covers must be removable with a standard straight blade screwdriver without marring. Raceways having two covers must allow each cover to be removed separately without allowing access into the compartment(s) enclosed by the other cover.
3. Raceway shall be manufactured of extruded #6063-T5 aluminum with a heavy etched Architectural Class II clear anodized finish (AA-C22A31) with a minimum thickness of 0.004". Each length of raceway shall be cut to specified job requirements. Field cutting of raceway will not be permitted.
4. Ground continuity shall be maintained throughout the entire raceway length by means of a factory installed grounding conductor. The grounding conductor(s) shall be the same size(s) of the branch circuit(s) serving the raceway.

D. Wiring Devices

1. Wiring devices and other connectors shall be factory installed on 18" centers, electrically wired, and covers labeled with silver, self-adhesive polyester label with black letters as identified in the building plans.
2. Each receptacle shall be identified noting the panel number and circuit number from which it is fed. Receptacles rated higher than a NEMA 50-20R configuration shall also be provided with voltage, phase and amperage identified in the same manner.
3. Receptacles in raceway connected to the optional-standby branch of the emergency power system shall be red.
4. Receptacles mounted within 6'-0" of a sink shall be GFI type.
5. Raceway sections shall be provided with 12" pigtails at feed locations for ease of installation. Grounding shall be maintained by means of factory installed NEC sized grounding conductor(s) and utilize insulation displacement connectors as required.

E. Communication Outlets

1. Raceway covers shall have holecut provision for tele-communications outlets, voice and data/LAN outlets.

F. Fittings

1. The multi-outlet system is to consist of factory assembled product with a full complement of fittings including, but not limited to, elbows (90°, internal and external), slide couplings for joining raceway sections, blank and caps for closing open ends of the raceway, and flat tees.

G. Installation

1. Raceway shall be installed with all appropriate fittings in accordance with the manufacturers installation instructions and in compliance with all appropriate codes. Raceway is to be plumb, square, level and in alignment with casework or furniture as required.

2.11 WIRING DEVICES

- A. Furnish and install Federal Specification grade and Hospital grade wiring devices, complete with all accessories as indicated on the drawings and as specified hereunder. All wiring devices shall be the product of a single manufacturer except where specifically stated otherwise.

B. Receptacles

1. Federal Specification (WC596) grade duplex receptacles shall be U-ground, rated for 125 volts, 20 amperes. Catalog numbers shall be as follows:

- a. Pass & Seymour: #PT5362A-I

2. Duplex receptacles with ground fault interrupter characteristics shall be U-ground, rated for 125 volts, 20 amperes, Federal Specification grade, feed-through type. Ground fault receptacles shall meet the requirements of UL 943, 2006. All receptacles in bathrooms/toilets, within 6'-0" of sink locations, exterior outlets, utility vault, in wet areas, etc. shall be ground fault type whether indicated on the drawings or not. Provide weatherproof covers for exterior outlets. Catalog numbers shall be as follows:

- a. Pass & Seymour: #PT2095-I

3. Special purpose receptacles shall be specification grade, back and side wired, U-ground. Catalog numbers shall be as shown on special purpose receptacle schedule on drawings.

C. Hospital Grade Devices

1. Hospital grade receptacles shall be provided in all patient care rooms/areas, whether or not indicated on the drawings:
2. Tamper resistant receptacles shall be hospital grade and provided in the rooms, playrooms, activity rooms and patient care areas of pediatric wards whether indicated on the drawings or not. Tamper resistant receptacles shall be U-Ground, rated for 125 volts, 20 amperes. Catalog numbers shall be as follows:

- a. Pass & Seymour: #PT2095HGTR-I

3. Hospital grade duplex receptacles connected to normal power circuits shall be U-ground, rated for 125 volts, 20 amperes. Catalog numbers shall be as follows:
 - a. Pass & Seymour: #PT8300IL-I
4. All duplex receptacles connected to the life safety, critical or equipment branch of the essential electrical system shall be red, Hospital grade, U-ground, rated for 125 volts, 20 amperes with illuminated face. Catalog numbers shall be as follows:
 - a. Pass & Seymour: #PT8300IL-RED
5. Duplex receptacles with ground fault interrupter characteristics shall be U-ground, rated for 125 volts, 20 amperes, Hospital grade, feed-through type. Ground fault receptacles shall meet the requirements of UL 943, 2006. All receptacles in bathrooms/toilets, within 6'-0" of sink locations, exterior outlets, utility vault, in wet areas, etc. shall be ground fault type whether indicated on the drawings or not. Provide weatherproof covers for exterior outlets. Catalog numbers shall be as follows:
 - a. Pass & Seymour: 2.12 #PT2095HGTR-I
6. Tamper resistant receptacles with integral or external ground fault mechanism shall be hospital grade and provided within 6'-0" of sink locations in the rooms, playrooms, activity rooms and patient care areas of pediatric wards whether indicated on the drawings or not. Tamper resistant receptacles shall be U-Ground, rated for 125 volts, 20 amperes. External ground fault mechanism shall be a ground fault circuit breaker located within the panelboard serving the receptacle. Catalog numbers shall be as follows:
 - a. Pass & Seymour: #PT2095HGTR-I

B. Switches

1. Toggle switches shall be full size, heavy duty, AC type, rated for 120/277 volts, 20 amperes. Catalog numbers shall be as follows:

<u>Manufacturer</u>	<u>Single Pole</u>	<u>3-Way</u>	<u>4-Way</u>	<u>Key Switches</u>
Pass & Seymour:	#PS20AC1	#PS20AC3	#PS20AC4	#PS20AC-L

2. Occupancy sensors
 - a. Single zone and two zone wall mounted occupancy sensors shall be dual technology type rated 1,200 watts at 277 volts or 800 watts at 120 volts and require no minimum load. Sensors shall be compatible with all load types, including electronic, LED and compact fluorescent ballasts. Sensor shall have 180° field of view and shall cover up to 900 sq. ft. Sensor shall have an adjustable time delay from 30 seconds to 30 minutes and a manual "off" override. Manufacturer shall be as follows:
 - 1) Sensor Switch #WSD Series
 - b. Wall sensors for loads in excess of 1,200 watts at 277 volts or 800 watts at 120 volts shall utilize relay control of the branch circuit.

- c. Ceiling mounted occupancy sensors shall be dual technology type rated 4,800 watts at 277 volts or 2,400 watts at 120 volts and require no minimum load. Sensors shall be compatible with all load types, including electronic, LED and compact fluorescent ballasts. Sensor shall have 360° field of view and shall cover up to 1,000 sq.ft. Sensor shall have an adjustable time delay from 30 seconds to 30 minutes. Provide power packs and relay modules as required. Manufacturer shall be as follows:
 - 1) Sensor Switch #CM10 Series
 - d. All occupancy sensors shall include auxiliary contacts for use by ATC system.
 - e. All occupancy sensors in offices and similar spaces, where a controlled receptacle is specified for the purpose of energy management, shall include an additional auxiliary contact to control the receptacle.
3. Dimmers shall be 120 volt, 1,000 and 277 volts, 2,000 watts with slider control, color selected by Architect, manufactured by Lutron N2000 Series or approved equal. Wattage rating of light fixtures connected to the dimmer shall not exceed 80% of dimmer rating. Provide additional dimmer as required whether shown on drawings or not.
- C. Color of all wiring devices shall be per the Architect and conform to the Owners Standards. Receptacles on emergency system shall be red.
- D. Device plate shall be as follows:
- 1. All normal power wiring device plates shall be high impact nylon/thermoplastic:
 - a. Pass & Seymour
 - 2. All Life Safety, Critical and Equipment branch power wiring device plates shall be red high impact nylon/thermoplastic labels indicating "LIFE SAFETY, CRITICAL, EQUIPMENT", respectively coordinate requirements with Owner:
 - a. Pass & Seymour: #TP Series
 - 3. Heads of device plate screws shall be of the same material/color as the device plate.
 - 4. The wiring device, or device plate of receptacles that are controlled via motion sensors, for the purpose of energy management, shall include the following symbol:



2.12 2 HOUR FIRE RATED MINERAL INSULATED (MI) CONDUCTORS

- A. General
 - 1. This section includes 2 hour fire rated type MI mineral-insulated metal-sheathed cable having a single copper conductor, a seamless copper sheath, cable connectors and connections.

2. The following life safety branch, critical branch and equipment branch feeders, branch circuits and control circuits shall be 2 hour fire rated type MI mineral-insulated metal-sheathed cable where not installed in spaces fully protected by an approved, automatic fire suppression system, including a wet sprinkler system or within 2 hour fire rated rooms, closets and/or shafts:
 - a. Feeders from the generator(s) to main emergency distribution equipment.
 - b. Feeders from main emergency distribution equipment to each life safety branch, critical branch and equipment branch automatic transfer switch.
 - c. Feeders from each life safety branch, critical branch and equipment branch automatic transfer switch to associated distribution equipment.
 - d. Feeders from life safety branch, critical branch and equipment branch distribution equipment to all downstream switchboards panelboards, transformers, enclosed circuit breakers, etc.
 - e. Feeder from the main normal distribution system to the fire pump controller.
 - f. Branch circuit wiring to all smoke evacuation, stairwell pressurization, elevator pressurization fans, and associated equipment.
 - g. Branch circuit to elevator motor(s), controller(s) and cab lighting.
 - h. Engine start circuit from each automatic transfer switch to the generator.
 - i. Control wiring between each automatic transfer switch and the generator control switchgear.

B. References

1. ANSI/NFPA 70 - National Electrical Code
2. UL Category FHIT – Classified Electrical Circuit Integrity System with a 2 hour fire rating, 12/2012.
3. FM 3D0Q9.AM 8/1997

C. Qualifications

1. Manufacturer shall be a company specializing in manufacturing products specified in this Section with minimum ten years documented experience.
2. Cable shall not off gas or propagate smoke.

D. Regulatory Requirements

1. Cable shall conform to requirements of ANSI/NFPA 70.
2. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

E. Project Conditions

1. Verify that field measurements and conditions are as shown on Drawings.
2. Cable routing shown on Drawings is approximate. Route cable as required to meet project conditions.
3. Where cable routing is not shown, and destination only is indicated, determine exact routing and lengths required.

F. Coordination

1. Coordinate work specified in this section with work provided under other electrical work and the work of other trades.
2. Determine required separation between cable and other work.
3. Determine cable routing to avoid interference with other work.

G. Manufacturer

1. Pentair Thermal Management/Pyrotenax System 1850 2-hour fire rated.

H. Mineral-Insulated Metal-Sheathed Cable

1. Description: ANSI/NFPA 70, Type MI
2. Conductor: Copper
3. Insulation Voltage Rating: 600 volts.
4. Cable Temperature Rating:
 - a. 60 degrees C. for conductors rated 125 amperes and below.
 - b. 75 degrees C. for conductors rated 126 amperes and above.
5. Termination Temp. Rating:
 - a. 60 degrees C. for conductors rated 125 amperes and below.
 - b. 75 degrees C. for conductors rated 126 amperes and above.
6. Insulation Material: Magnesium oxide refractory mineral.
7. Metal-sheath Material: Seamless soft-drawn copper.
8. Fire Rating: Cable assembly, including factory splices and supports shall have a 2 hour fire rating as listed and classified by Underwriters Laboratories, Inc.
9. Overjacket: None required; or PVC if cable is directly buried.
10. Cable sheath shall be marked with conductor size, voltage and UL fire resistant classification number.
11. Each components of the cable assembly shall contain less than 300 ppm of lead, and shall meet the requirements of LEED for Healthcare MR Credit 4.2.

I. Wiring Connectors And Terminations

1. Cable Termination:
 - a. Pentair Thermal Management/Pyrotenax Model Quick-Term, Installation Sheet 638. Where solid rated lugs are used, approved terminations for this termination shall be provided.
2. Lug Connection for solid copper conductor:
 - a. ILSCO Model Lo-250: #1 AWG through 250 kcMIL
 - b. ILSCO Model CRA-300: 350 kcMIL
 - c. ILSCO Model CRA-400: 500 kcMIL

3. Cable Splice:

- a. All cable splices of MI cable required due to length of conductor shall be factory installed and have 2 hour fire rating equivalent to the conductor itself. Field splices shall not be allowed unless installed within 2 hour fire rated rooms. Field splices within 2 hour fire rated rooms shall be Pentair Thermal Management/Pyrotenax Model Installation Sheet 550.

J. Examination

1. Verify that cable end factory temporary seals have remained intact, that the insulation has not been exposed to air, and that no moisture has entered cable insulation.
2. Verify that work of other trades likely to damage cable has been completed.

K. Storage

1. Cables shall be shipped from the manufacturer with ends temporarily sealed against moisture ingress.
2. When cables are cut in the field, the end shall be sealed using standard sealing compound and PVC tape.
3. Cable shall be stored in a clean dry location.

L. Handling

1. Cable shall be uncoiled by rolling or rotating supply reel. Do not pull from coil periphery or center.
2. Take precautions necessary to prevent damage to cable from contact with sharp objects, including pulling over foreign material or sheaves.

M. Wiring Methods

1. Fire Rated Locations: Use only fire rated cable.
2. Use wiring methods indicated on Drawings and as specified herein.

2.13 UNDERGROUND DUCT SYSTEM

- A. Electrical Subcontractor shall furnish and install raceways and fittings for an underground duct system, as indicated on the drawings and specified herein.
- B. Trade size of raceways shall be as per drawings for various systems.
- C. All ductbanks shall utilize grade forms.
- D. Concrete, reinforcing rods, etc., shall be furnished and installed under this Section. The Electrical Subcontractor shall consult a structural engineer for proper placement and quantities of reinforcing rods.
- E. Raceways shall transform from PVC to rigid steel conduit within 5'-0" of a manhole. Galvanized steel conduit shall be required within 10'-0" of either side of foundation wall. Electrical Subcontractor shall furnish and install proper coupling(s) to accommodate aforementioned transition.

- F. Where offsets are required to clear obstructions and other underground services, a maximum of a 5° angle will be allowed at duct joints with prior approval of the Engineer.
- G. Ducts shall be installed so as to drain to manholes.
- H. All raceways as previously described shall utilize a mandrel of sufficient size to thoroughly clear raceways of all obstructions prior to installation of any wiring.
- I. All concrete construction, excavation and backfill for the underground ductbank system shall be by the General Contractor.
- J. Warning tape shall be provided on all duct systems to indicate route during installation.
- K. All conduits penetrating into the buildings shall be totally sealed, and waterproofing shall be applied on the conduit from face of the building to 5'-0" beyond in order to prevent any migration of water through the ductbank into the building.
- L. Prior to backfilling of underground duct system, the Electrical Subcontractor shall provide a yellow (with black lettering) marking tape, 1'-0" from finished grade, stating, "Caution, Electric Line (Telephone, etc.) Buried Below". Tape shall be manufactured by Panduit or equal.

PART 3 EXECUTION

3.01 COOPERATION AND WORK PROGRESS

- A. The Electrical work shall be carried on under the usual construction conditions, in conjunction with all other work at the site. The Electrical Contractor shall cooperate with the Architect, Construction Manager, all other Subcontractors and equipment suppliers working at the site. The Electrical Contractor shall coordinate the work and proceed in a manner so as not to delay the progress of the project.
- B. The Electrical Contractor shall coordinate his work with the progress of the building and other Trades so that he will complete his work as soon as conditions permit and such that interruptions of the building functions will be at a minimum. Any overtime hours worked or additional costs incurred due to lack of or improper coordination with other Trades or the Owner by the Electrical Contractor, shall be assumed by him without any additional cost to the Owner.
- C. The Electrical Contractor shall furnish information on all equipment that is furnished under this Section but installed under another Section to the installing Subcontractor as specified herein.
- D. The Electrical Contractor shall provide all materials, equipment and workmanship to provide for adequate protection of all electrical equipment during the course of construction of the project. This shall also include protection from moisture and all foreign matter. The Electrical Contractor shall also be responsible for damage which he causes to the work of other Trades, and he shall remedy such injury at his own expense.
- E. Waste materials shall be removed promptly from the premises. All material and equipment stored on the premises shall be kept in a neat and orderly fashion. Material or equipment shall not be stored where exposed to the weather. The Electrical Contractor shall be responsible for the security, safekeeping and damages, including acts of vandalism, of all material and equipment stored at the job site.

- F. The Electrical Contractor shall be responsible for unloading all electrical equipment and materials delivered to the site. This shall also include all large and heavy items or equipment which require hoisting. Consult with the Construction Manager for hoisting/crane requirements. During construction of the building, the Electrical Contractor shall provide additional protection against moisture, dust accumulation and physical damage of the main service and distribution equipment. This shall include furnishing and installing temporary heaters within these units, as approved, to evaporate excessive moisture and ventilate it from the room, as may be required.
- G. It shall be the responsibility of the Electrical Contractor to coordinate the delivery of the electrical equipment to the project prior to the time installation of equipment will be required; but he shall also make sure such equipment is not delivered too far in advance of such required installation, to ensure that possible damage and deterioration of such equipment will not occur. Such equipment stored for an excessively long period of time (as determined in the opinion of the Architect) on the project site prior to installation may be subject to rejection by the Architect.
- H. Prior to installation, the Electrical Contractor has the responsibility to coordinate the exact mounting arrangement and location of electrical equipment to allow proper space requirements as indicated in the NEC. Particular attention shall be given in the field to group installations. If it is questionable that sufficient space, conflict with the work of other Subcontractors, architectural or structural obstructions will result in an arrangement which will prevent proper access, operation or maintenance of the indicated equipment, the Electrical Contractor shall immediately notify the Contractor and not proceed with this part of the Contract work until definite instructions have been given to him by the Architect.
- I. The Electrical Contractor shall obtain from the Plumbing and HVAC Subcontractors copies of all shop drawing prints showing the ductwork and piping installation as they will be put in place on the project. These drawings shall be thoroughly checked by the Electrical Contractor and the routing of all conduits and installation of all outlets and electrical equipment shall be coordinated with the ductwork and piping so as to prevent any installation conflict. Such coordination shall be done prior to roughing in conduits, outlets and electrical equipment.
- J. Location of all wall outlets shall be verified with the Architect prior to roughing in conduits. Refer to details and wall elevations on the Architectural drawings. Mounting heights indicated on these drawings and/or specific dimensional information given to the Electrical Contractor by the Architect shall take precedence over such information indicated on the Electrical drawings.
- K. Refer to all other drawings associated with this project. Any and all equipment which require an electrical supply circuit, switch, controls or connections, whether indicated on the Electrical drawings or not, shall be furnished and installed as directed by the Architect.
- L. Refer to the Architectural drawings for areas in which the concrete slab is poured on grade. In these areas a waterproofing membrane will be installed on the grade fill or earth prior to pouring of slab. Electrical conduits shall be installed to avoid the necessity of penetrating this waterproofing membrane. Penetration of the membrane, if required, shall only be made when specifically allowed by the Architect, and shall be made only at locations directed by the Architect.

3.02 INSTALLATION

A. General

1. Unless specifically noted or indicated otherwise, all equipment and material specified in Part 2 of this specification or indicated on the drawings shall be installed under this Contract whether or not specifically itemized herein. This Section covers particular installation methods and requirements peculiar to certain items and classes or material and equipment.
2. The Electrical Contractor shall obtain detailed information from manufacturers of equipment provided under Part 2 of this specification as to proper methods of installation.
3. The Electrical Contractor shall obtain final roughing dimensions and other information as needed for complete installation of items furnished under other Sections or furnished by the Owner.
4. The Electrical Contractor shall keep fully informed of size, shape and position of openings required for material and equipment provided under this and other Sections. Ensure that openings required for work of this Section are coordinated with work of other Sections. Provide cutting and patching as necessary.
5. All miscellaneous hardware and support accessories, including support rods, nuts, bolts, screws and other such items, shall be of a galvanized or cadmium plated finish or of another approved rust-inhibiting coating.
6. Throughout this Section where reference is made to steel channel supports, it shall be understood to mean that the minimum size shall be 1 5/8" mild strip steel with minimum wall thickness of 0.105", similar to Unistrut P1000 or equal products manufactured by Kindorf or Husky Products Co.

B. Metal Clad (MC) Cable

1. Uses Permitted
 - a. MC cable may be utilized in lieu of conduit and cable in dry, hollow partitions and ceiling cavities for general purpose, 20 ampere, single phase, 120 or 277 volt, branch circuits for receptacles and lighting fixtures only.
 - 1) For lighting fixture whips; maximum length 6', maximum 4 fixtures connected to a common junction box.
 - 2) For 20 ampere, single phase, 120 volt receptacle circuits; maximum length from junction box to first receptacle 30'. Maximum length between receptacles 15'. Maximum 4 receptacles connected together.
 - b. For branch circuit homeruns to surface mounted panels, MC cable shall terminate in a junction box 5'-0" (minimum) horizontally away from the panel. If panelboards are located in rooms designated as electric rooms or closets, MC cable shall terminate in a junction box outside of the electric room and conduit shall be run to the panel.
2. Uses Not Permitted
 - a. MC cable shall not be allowed in electric rooms or closets.
 - b. MC cable shall not be used in mechanical or plumbing rooms, closets or shafts, including mechanical penthouse.
 - c. Branch circuits larger than 20 ampere.

- d. MC cable shall not be used for emergency wiring systems.
3. Multiconductor cable assemblies shall be installed concealed only in areas as permitted in these specifications.
4. Multiconductor cable assemblies shall be run through openings in metal studs. The cable assembly shall be attached with approved clips to metal studs as follows:
 - a. 4'-0" on center for vertical runs
 - b. Within 12" of each outlet box
 - c. 6'-0" on center for horizontal runs
5. Where multiple runs of multiconductor cable assemblies are run together, all cables shall be bundled and secured together in a neat and workmanlike manner utilizing tie wraps, etc.

C. Conduits

1. Conduit shall be run concealed in finished areas above suspended ceilings, in wall spaces, etc. Exposed conduit runs in finished areas require Architect's approval. All conduit runs shall be properly grouped and installed parallel to walls, ceilings, etc., and supported with proper hangers, clamps, etc. Door swings shall be checked before installing back boxes for switches and receptacles.
2. Conduit bends shall be made with conduit bending machines or by an approved hickey. Lock nuts and insulated throat bushings of the compatible material shall be used to fasten conduit to outlet boxes, cabinets, etc.
3. Feeder and branch circuit conduit runs are not allowed in any floor slabs. Feeder and branch circuit conduit may run below the basement floor slab provided it is supported from the basement floor slab 5'-0" on center.
4. Separation of Wiring:
 - a. Raceways for the emergency branch of the emergency electrical system shall be kept entirely independent of all other raceways and shall not enter the same raceways, boxes or cabinets with each other or other wiring, except in transfer switches.
 - b. Where a branch of the emergency system contains multiple transfer switches, raceways downstream from the two (or more) transfer switches shall be kept independent of each other.
5. No plastic conduit runs are allowed in any floor slabs. PVC Schedule 40 may be run below the lowest floor slab, provided it is encased in concrete and is supported from the lowest floor slab 5'-0" on center.
6. Conduit ends shall be cut square, threaded and reamed to remove burrs and sharp edges. Field threads shall be of the same type and have the same effective length as factory cut threads. Excessive exposed threads will not be allowed. Turns, wherever required in exposed conduit runs, shall be made by the use of factory-made bends, or field-made bends as approved. In condulets, or in the event of a multiplicity of conduits making the same turn, a steel junction box with a removable steel cover may be used. Offsets and bends for changes in elevation of exposed conduit runs shall be made at walls or beams and not in open spaces between walls or beams. Conduits shall be routed so as not to interfere with the operation or maintenance of any equipment. The entire job shall be done in a neat and workmanlike manner, as approved by the Architect. Steel supports or racks shall be galvanized steel channel and fittings.

7. All conduit work shall be carefully cleaned and dried inside before the installation of conductors. Wire shall not be pulled into conduit system until building roof and walls are weathertight and all rough spackling is completed. Plug conduit ends to exclude dust, moisture, plaster or mortar while building is under construction. No lubricants or cleaning agents which might have a deleterious effect on conductor coverings shall be used for drawing conductors into raceways.
8. Drawings, in relation to routing of conduits, are diagrammatic. Except where additional conduits may be required to avoid derating of branch circuits, as required elsewhere within this Section, the number and size of conduits and wire shall be furnished and installed as indicated by the drawings. Conduits shall be routed in the field so as to be coordinated with the building structure. Permanently concealed conduit shall be as short and direct as possible. Exposed conduit and conduit concealed by removable finishes such as accessible ceiling tile shall be run in straight lines parallel and perpendicular to walls, beams and columns and with right angle bends.
9. Conduits passing through floors, walls and beams shall be of such size, number and in such locations so as not to impair the strength of the construction.
10. Raceways in ceiling spaces shall be routed in such an approved manner as to eliminate or minimize the number of junction boxes required, but also shall be routed in an orderly and organized manner. Support rods and clamps shall be furnished and installed as directed by the Architect. Support of conduits by use of wire is strictly prohibited. Conduits shall be supported and secured by conduit support devices as approved by the Architect.
11. Electrical raceways that are part of the emergency distribution system shall be located in spaces fully protected by an approved automatic fire suppression system or in spaces with a two (2) hour fire resistance rating.
12. Where rigid metal conduit is threaded in the field, a standard conduit cutting die providing 3/4" taper per foot shall be employed. Threadless coupling shall not be used on rigid metal conduit except where specifically allowed by the Architect. Running threads shall not be used on rigid metal conduit. Compression fittings shall not be used with rigid steel, intermediate metallic or aluminum conduit.
13. Conduit work shall be installed in such a manner to keep exposed threads to an absolute minimum, and in no case shall more than (3) threads be left exposed after the conduit work is made up tight.
14. Where conduits are exposed to the weather, PVC-RMC shall be provided. PVC – RMC shall be installed by a factory trained Certified installer. PVC-RMC fittings, exposed threads and damaged coatings shall be field coated with Thomas & Betts – OCAL "Heat Cure Patch"
15. Provide flexible conduits for connections to equipment furnished under HVAC, Plumbing Sections and other equipment as specified under Part 2 of this specification and where available space dictates; and where noise transmission must be eliminated or reduced. Flexible conduit shall be liquid-tight except for connections to recessed lighting fixtures.
16. Conduit and EMT runs shall be mechanically and electrically continuous from service entrance equipment to distributing equipment. Conduit shall enter and be secured to cabinet, junction box, pull box or outlet box with locknut outside and bushing inside, or with liquid-tight, threaded, self-locking, cold-weld wedge adapter. Locknuts and bushings or self-locking adapters will not be required where conduits are screwed into tapped connections. Vertical conduit runs that terminate in bottoms of wall boxes or cabinets shall be protected from entrance of foreign material before installation of conductors.
17. Size of rigid steel conduit, intermediate metal conduit, electrical metallic tubing and flexible metallic conduit shall be as shown on the drawings.
18. For recessed mounted panels furnish and install five (5) 3/4" EMT conduits from each recessed panel and stub out 6" above nearest accessible ceiling.

19. Check raceway sizes to determine that green equipment ground conductor fits in same raceway with phase and neutral conductors to meet NEC percentage of fill requirements. Increase duct, conduit, tubing and raceway sizes shown or specified as required to accommodate conductors.
20. Conduit secured rigidly on opposite sides of building expansion joints and long runs of exposed conduit subject to stress shall have expansion fittings. Fittings shall safely deflect and expand to twice distance of structural movement. Provide separate external copper bonding jumper secured with grounding straps on each end of fitting.
21. Threaded sealing fittings for rigid steel conduits shall be zinc or cadmium-coated, cast or malleable iron. Sealing fittings for aluminum conduit shall be threaded cast aluminum. Fittings that prevent passage of water vapor shall be continuous drain. Install and seal fittings as required by manufacturer's recommendations. In concealed work, install fittings in flush steel box with blank cover plate.
 - a. Install sealing fittings at following points, and elsewhere as shown:
 - 1) Where conduits enter or leave hazardous areas equipped with explosion-proof lighting fixtures, switches, receptacles and other electrical devices.
 - 2) Where conduits pass from warm to cold locations.
 - 3) Where required by NEC.
 - b. Secure conduit system as required by NEC.
22. Provide space on conduit racks or struts for 25 percent additional conduits.
23. A minimum 3/16" diameter, twisted nylon plastic type fish cord shall be furnished and installed in all empty raceways. Provide a tag and washer sized larger than the conduit on each end of fish cord indicating the location of the other end.

D. Pull, Junction and Outlet Boxes

1. The Electrical Contractor shall furnish and install junction boxes for feeders and branch circuits as required. Boxes shall be sized in accordance with NEC. Junction boxes shall be code gauge steel with removable covers. Covers shall be secured with brass machine screws. Splicing of feeders will not be allowed.
2. The Electrical Contractor shall furnish and install outlet boxes for all wiring devices. Outlet boxes for wiring devices in hollow frame partitions shall be mounted on "stud-to-stud" type mounting brackets. Brackets shall be secured using self-threading metal screws, and shall engage more than one stud for support.
3. Pull, junction or outlet boxes for the emergency branch of the emergency electrical system shall be kept entirely independent of all other pull, junction or outlet boxes. Wiring, devices and equipment shall not enter the same raceways, boxes or cabinets with each other or other wiring, except in transfer switches. Barriers installed in pull, junction or outlet boxes shall not be acceptable.
4. Through-the-wall outlet boxes shall not be permitted. Outlet boxes shall not be installed back-to-back but shall be staggered on opposite sides of partitions a minimum of 12" on center.
5. If any discrepancies regarding the locations of outlet boxes are found to exist between the Electrical drawings and any other drawings associated with the project, notify the Architect at once and have location verified before outlets are installed. Any reasonable change in location of outlets prior to roughing shall not involve additional expense to the Owner. The term "reasonable" shall be interpreted as moving outlet locations a maximum of 10'-0" in any direction from the location indicated on the drawings.

6. Whenever outlet boxes of any system are installed in brick, masonry or concrete construction, furnish and install the necessary boxes and conduit in connection therewith so that the Contractor may build them in as the work progresses. Box offsets shall be made at all outlets to provide for proper adjustment to finished surfaces.
7. The Electrical Contractor is responsible for cutting openings in brick, tile and all types of construction blocks at outlets. Exposed mortar shall not be permitted around device plates.
8. All boxes shall be rigidly mounted to construction and shall be equipped with suitable screw fastened covers. Unused open knockouts in all boxes shall be plugged with suitable blanking devices. All boxes installed that do not have equipment mounted on them shall be provided with blank covers.

E. Cutting, Patching and Conduit Sleeves

1. The Electrical Contractor shall be responsible for all core drilling required for his work, but in no case shall he cut into any structural elements without the written approval of the Architect. No cutting to be performed within existing switchgear room unless approved by the Owner.
2. All cutting, rough patching and finish patching required for electrical work shall be provided by the Electrical Contractor.
3. All concrete and masonry equipment bases and pads, concrete duct banks, curbs, chases, pockets and openings required for the proper installation of the work under this Contract will be provided by the Construction Manager, using dimensions, templates, bolts, anchors, as required by the manufacturer's installation details of the various equipment.
4. Where conduits pass through masonry or concrete walls, foundations or floors, the Electrical Contractor shall set such sleeves as are necessary for passage of the conduits. Sleeves shall be of sufficient size to provide air space around the conduit passing through for fireproofing. The Electrical Contractor shall be responsible for the exact location of sleeves provided under his Contract.
5. Conduit passing through exterior walls and floors below grade shall be made watertight with caulking compound and pipe sleeves with wall collar located at the center of the wall extending 8" all around the conduit. Collar shall be 1/8" thick steel welded to sleeve. Coordinate material requirements with the Contractor.
6. Sleeves and inserts shall not be used in any portions of the building where their use would impair strength or construction features of the building. Elimination of sleeves must be approved by Architect.
7. Pipe sleeves shall be Schedule 40 galvanized steel and shall be set, as follows:
 - a. Set sleeves 6" above finish floor and flush on each side of walls.
 - b. Set sleeves 6" above finished floor and flush on each side of walls and electric room floors.
 - c. Sleeves in walls and partitions shall terminate flush with finished floor.
 - d. Sleeves shall be set securely in place before concrete is poured.
 - e. Sleeves shall be minimum 2" larger in diameter than the pipe passing through it.
8. Conduits passing through fire partitions shall be provided with 10 gauge steel pipe sleeves and firestopped.
9. All cutting and patching required by the Electrical Contractor in finished areas which require access shall have access panels as specified elsewhere in this specification.

10. Fill for floor penetrations shall be fire-resistant, compatible with floor material and finished to prevent passage of water, smoke and fumes. Fill in walls shall be similar to wall material, shall be fire-resistant in fire walls, and shall prevent passage of air, smoke and fumes. Fill spaces in openings after installation of conduit or cable. All fireproofing inside sleeves shall be by the Electrical Contractor. Fireproofing required outside of sleeves shall be by the Construction Manager.
11. Where conduits passing through openings are exposed in finished rooms, finishes of filling materials shall match and be flush with adjoining floor, ceiling and wall finishes.
12. Fill slots, sleeves and other openings in floors and walls if opening is not used. Identify unused sleeves and slots for future installation.
13. Lay out conduit and openings in advance, to permit provision in work. Set sleeves and conduit in forms before concrete is poured. Provide remedial work where sleeves and conduits are omitted or improperly placed.
14. Bus duct penetrations through floors shall have concrete curbs built around the floor openings, 3" minimum height.

F. Feeder and Branch Circuit Conductors (600 Volts)

1. Install wire and cable in approved raceways as specified and as approved by Authorities that have jurisdiction. Surface metal raceways shall not be used unless explicitly specified and shown on the drawings. Do not use surface raceways on floor.
2. The phase, neutral and ground conductors for all feeder, branch circuit and auxiliary system wiring passing through pull boxes and/or being made up in panelboards shall be properly grouped, bound and tied together in a neat and orderly manner in keeping with the highest standards of the Trade, with plastic cable ties in at least one location within the enclosure. Loose ends of the cable ties shall be properly trimmed after making up same. Cable ties shall be Ty-Raps, as manufactured by Thomas & Betts, Holub Industries, Inc., Quick-Wrap, Burndy Unirap or equal.
3. For large size conductors available only in black, use colored plastic tape at all ends, where connections and splices are made and in all pull boxes for the specified color code identification. Tape shall be wrapped around the conductor (3) complete turns.
4. Tags or labels shall be stamped or printed to correspond with markings on the drawings or marked so that feeder or cable may be identified readily. If suspended tags are provided, attach with 1/32" diameter, nylon, 55 pound test monofilament line or slip-free plastic cable lacing unit.
5. The number and size of conductors in each run of conduit is indicated on the drawings. Where there is a conflict between the number of wires indicated and the actual number required, the actual number and size shall be installed.
6. Provide 1/4" polyethylene ropes for pulling wire. Provide wire pulling lubricants that meet applicable UL requirements as necessary.
7. Cable supports shall be provided for vertical feeders every other floor or every 40'-0" whichever is less and as required by NEC 300.19. Vertical support boxes shall be located as high above finished floor as possible, while still maintaining proper access.
8. Provide split wedge cable supports with clamps for cable without metallic sheath in pull boxes. Supports shall be as manufactured by O.Z./Gedney or approved equal.
9. Wire from point of service connection to receptacles, lighting fixtures, devices, equipment, outlets for future extension, and other electrical apparatus as shown on the drawings. Provide slack wire for connections where required. Tape ends of wires and provide blank covers for outlet boxes designed for future use.
10. Conductors #10 and smaller in branch circuit panelboards, signal cabinets, signal control boards in switchboards and motor control centers shall be bundled.

11. The branch circuit wiring shall include a separate neutral conductor for each 120 volt and 277 volt circuit. Home runs may be combined in a common raceway provided that no more than three phase conductors (each of a different phase leg), three neutral conductors and one ground conductor are installed in the same conduit. Each neutral shall be identified/labeled with its respective phase branch circuit.
12. The neutral conductor for each lighting branch circuit shall run with its associated phase conductor to each fixture and each fixture control point.
13. Follow homerun circuit numbers shown on the drawings to connect circuits to panelboards. Where homerun circuit numbers are not shown on the drawings, divide similar types of connected loads among phase busses so that currents in each phase are within 10% of each other during normal usage.
14. Branch circuits and auxiliary system wiring shall be peeled out of the wiring gutters at the terminal cabinet and panels at 90° to circuit breakers and terminal lugs for connecting to same.
15. Joints and splices shall be made in an approved manner and shall be equivalent, electrically and mechanically, to the conductor insulation. All conductors shall be connected by use of solderless crimp (compression) type connectors; these joints and splices shall be taped with (1) wrap of varnish cambric tape and then a minimum of (3) wraps of No. 88 Scotchbrand (3M Company) all-weather vinyl plastic electrical tape, or equal Permacel or Plymouth Co. Each wrap of tape shall be half-lapped. Conductors of size #4 AWG or larger shall have (2) coats of insulating varnish applied over the tape for joints in manholes, handholes or exposed-to-weather conditions.
16. Provide nonferrous identifying tags or pressure-sensitive labels for cables, feeders, and power circuits in pull boxes, manholes and switchboard rooms, at cable termination and in other locations.
17. All branch circuits shall be connected to breakers at Electrical Contractor's discretion. The balancing of all loads between phases shall be the Electrical Contractor's responsibility.
18. Splices, taps and lugs shall be electrically and mechanically secure and solderless lugs, and crimp connectors shall be used. Lugs shall be used for conductor sizes #8 AWG and larger. All lugs shall be of the proper size, and in no case shall strands be cut from a conductor in order to fit the conductor into a lug. Provide lug/cable adapters for breakers where oversized cables are indicated. All lug connections to buses in switchboards, unit substations, motor control centers, etc., shall be 2-bolt/nut connections.
19. All wiring shall be installed and supported in accordance with the requirements of the NEC.
20. Phase Arrangement
 - a. The Electrical Contractor shall ensure that phase arrangement of bus bars in all distribution equipment remain consistent throughout the project from the service entrance equipment and stand-by generator(s) to all switchgear, distribution panels, automatic transfer switches, transformers, motor control centers, lighting and receptacle branch circuit panels, enclosed circuit breakers, disconnect switches, etc.
 - b. For all three phase equipment, the bus bars shall be arranged "A", "B", "C", from front-to-back and/or top-to-bottom and/or left-to-right as viewed from the front of the equipment. Proper color coding shall be consistent throughout.
 - c. For 480 volt and 208 volt single phase equipment, the bus bars shall be arranged "A", "B", "A", "C"; or "B", "C", as appropriate, from front-to-back and/or top-to-bottom and/or left-to-right as viewed from the front of the equipment. Proper color coding shall be consistent throughout.

G. Mineral Insulated (MI) Metal-Sheathed Cable

1. Install products in accordance with manufacturer's instructions.
2. Bending:
 - a. Not less than five (5) times the cable diameter for cable not more than $\frac{3}{4}$ inch (250 kcMIL).
 - b. Not less than ten (10) times the cable diameter for cable more than $\frac{3}{4}$ inch (350 and 500 kcMIL).
3. Pulling:
 - a. For all cables up to and including #1 AWG use ten inch (250mm) or larger sheaves.
 - b. For #1/0 through 250 kcMIL inclusive, use 18 inch (460mm) or larger sheaves.
 - c. For 350 kcMIL and larger cables, use 24 inch (590mm) or larger sheaves.
 - d. On pulls of over 360 degrees, contact manufacturer for assistance.
 - e. 350 and 500 kcMIL cables shall not be pulled more than 360 degrees in total.
4. Splicing:
 - a. All fire rated splices shall be made in the factory.
 - b. In the event a field splice is necessary, it must be made within a 2 hour fire rated room, approved by the engineer and:
 - 1) Made in the field by manufacturer's field technician, or
 - 2) Made in the field by personnel trained by the cable manufacturer using manufacturer's components.
5. Terminations:
 - a. Field made terminations shall be made with cable manufacturer's termination kits only. Stripping tools, crimping and compression tools available from the manufacturer shall be used for proper cable termination.
 - b. Terminations must be completed immediately once started to avoid moisture ingress from surrounding air. Prior to completing each termination, test insulation resistance and follow manufacturer's drying procedures until insulation resistance reaches an acceptable level.
 - c. Connections to ferrous cabinets for single conductor cables shall incorporate brass plates $\frac{1}{4}$ inch (6mm) thick by 4 inch (100mm) wide by length as required with $\frac{1}{2}$ inch (12mm), $\frac{3}{4}$ inch (19mm), 1 inch (25mm) or 1 $\frac{1}{4}$ inch (32mm) drilled and tapped holes. Install per manufacturers' drawing.
6. Sheath induction reduction:
 - a. When multi-phase circuits have paralleled single conductors, cables shall be run in groups having one of each phase in each group.
 - b. Each set of paralleled conductors shall be separated by at least two single cable diameters.
 - c. On balanced three-phase wye circuits neutral conductors may be located within the two cable diameter space between groups of phase conductors.

- d. Each group of cables shall be fastened tightly together, at least once between each cable support on horizontal runs and twice on vertical runs, using ½ inch (13mm) wide by 0.030 inch (0.75mm) thick stainless steel straps.
7. Exposed or Surface installations:
 - a. Cable may be secured directly to fire rated building structure using an approved method such as one, or any combination, of the following:
 - 1) Straps: ½ inch (13mm) wide x 3 1/2 inch (38mm) long by 0.030 (0.75mm) thick stainless steel or copper straps. Each strap shall contain two ¼ inch (6mm) holes for securing with 3/16 inch (5mm) by minimum 1 3/4 inch (44mm) long steel anchors.
 - 2) Steel struts and cable tray: Use only the steel strut framing system and support recommended by Pyrotenax. Aluminum or other materials are not acceptable.
 - b. Supports shall not exceed three (3) feet on center horizontally, or six (6) feet vertically.
 - c. Cables shall be installed parallel to building lines.
 8. Embedded Installations:
 - a. Cables will be run in the same trifoil configuration as exposed installations.
 - b. Protect against damage during pulling, and during concrete pouring or backfill and tamping.
 - c. Where cables emerge from grade, provide PVC conduit, metal plate or angle iron. This protection shall minimally extend from 18 inches (460mm) below grade to 8 ft. (2.5m) above grade.
 9. Wall or floor penetrations:
 - a. Provide sleeve to protect cable and penetration opening during pulling.
 - b. Provide approved fire stopping of all penetrations.
 10. Neatly train and lace cable inside boxes, equipment, and panelboards.
 11. Field Quality Control
 - a. Inspect cable for physical damage and proper connection.
 - b. Measure tightness of bolted connections and compare torque measurements with manufacturer's recommended values.
 - c. Verify continuity of each conductor.
 - d. Prior to energizing cables, measure insulation resistance of each cable. Tabulate and submit for approval.
 - e. Provide certification from cable manufacturer that installation is in accordance with their requirements.

H. Wiring Devices

1. All wiring devices shall be installed in appropriately sized outlet boxes. Where more than (1) switch or a double duplex receptacle is indicated on the drawings multiple gang outlet boxes shall be provided to accept all devices in the area.

Separate boxes are required for wiring devices on emergency circuit, ganging of boxes, using barriers, are not acceptable.

2. All duplex receptacles shall be mounted vertically with the grounding post on the top side of the outlet as viewed from the front.
3. Each and every receptacle either wall or raceway mounted, shall have panel and circuit identification labeled on their faceplates. Labels shall be (high impact thermoplastic, red plate with white letters for emergency receptacles, black plate with white letters for normal receptacles.)
4. All device plate screws shall be colored alike to the device plates. All screws shall be installed "finger-tight" to avoid damage to device plate.

I. Underground Conduits

1. Steel conduits in ground or on vapor barriers shall be field coated with asphaltum or shall have additional outside factory coating of polyvinyl chloride or phenolic-resin-epoxy material or other equally flexible and chemical resistant material. Couplings and damaged areas of coated conduits shall be field-coated with same compound as conduits. Joints shall be threaded.
2. Joints in conduits and fittings shall be watertight and shall meet the requirements of manufacturer's installation recommendations. Threaded portions of steel conduits not encased in concrete, and adjoining ends of conduits, couplings and fittings shall be coated with asphaltum after installation. Connections between conduits of different types shall be made in an approved manner, using adapters and other materials and methods recommended by conduit manufacturers.
3. Where nonmetallic underground conduit enters the building and continues inside to the main electric service, pull box, cabinet or other electrical apparatus, the portion of the conduit that passes through the floor or wall and the remainder of the raceway inside the building shall be steel. Provide an adapter outside the building (5'-0" beyond building wall minimum) wall to connect plastic and metal conduit.
4. All metal conduit buried in the earth or fill shall be PVC coated galvanized steel , including couplings.
5. Where underground conduit enters the building through membrane-waterproofed wall or floor, provide a malleable iron seal with gland assembly and adjustable pressure bushings secured to masonry construction with (1) or more integral flanges. Membrane waterproofing shall be secured to device in a watertight manner.
6. Mechanical conduit penetration seals shall be provided where underground conduit, without concrete envelope, enters the building through non-waterproofed wall or floor.
7. Excavation, shoring, bracing, backfilling and grading will be provided by the General Contractor. Trenches shall be evenly graded so that conduits slope uniformly a minimum 3" per 100'-0", without horizontal or vertical waves. Unless specified otherwise, conduit shall slope uniformly from (1) manhole to the next or from a high point between manholes to prevent pooling of water. Conduits run from building to manhole shall slope toward manhole to avoid water draining into the building. Avoid low points between manholes or upturned elbows.
8. Run conduits straight between manholes and upturned elbows. Unavoidable bends in nonmetallic conduits shall be made by assembling couplings at a slight angle if resulting radius is at least 100'-0". For radii less than 100'-0", use 5° angle couplings or 5° factory-made bend sections. Conduit shall terminate in end bells where raceway enters manholes. All conduit bends for telecommunication ductbanks shall be 12'-6" radius sweeps. Conduit bends for power cable conduits shall be minimum 36" radius.

9. Support multiple conduit runs and banks on preformed nonmetallic spacing block separators on 4'-0" centers. Separator containing metal shall have metal non-continuous and shall not form a magnetic loop. Unless otherwise shown on the drawings, spacing between exterior surfaces of conduits shall be as follows:
 - a. 2" between telephone conduits
 - b. 2" between conduits containing cables operating at 600 volts or less
 - c. 12" between telephone conduit and power conduit in the same concrete envelope
 - d. 2 1/2" between conduits containing cables operating at more than 600 volts
 - e. Space conduit separators to prevent sagging of raceway and breaking of couplings and watertight seals, to maintain deformation of conduit at separators to 0.10" or less. Secure with cords where necessary. Do not use tie wires, reinforcing rods or other metallic materials.
10. Stagger conduit couplings so that couplings on adjacent conduits do not lie on the same transverse plane. Space end bells 9" center-to-center at manhole wall face for 4" conduits and space proportionately for other sizes. Transition to end bell spacing shall start 10'-0" from face of manhole wall. Conduit slope shall equal that of main bank. Make new conduit entrances into manholes and building walls consistent with grading requirements and entrances. Waterproof all conduit entrances into manholes and buildings as required by the Architect.
11. Where underground metallic conduits pass below the grade level floor, they shall be supported every 5'-0" from the concrete floor. Plastic conduits run below the grade level floor shall be encased in concrete and shall be supported every 5'-0" from the concrete floor.
12. Concrete for conduit envelopes shall be as required or as specified under Division 03. Concrete shall extend a minimum 3" beyond exterior surface of each conduit in bank. Coordinate work of this Section with that of Division 03.
13. Concrete envelopes between manholes, or between manhole and building, shall be poured in a single operation. Where more than (1) pour is necessary, provide 3/4" reinforcing rod dowels extending 18" into concrete on each side of joint. Dowels shall be coated with bonded adhesive prior to the second pour. Concrete envelopes installed over extensive area of disturbed earth shall have a separate concrete base.
14. Concrete envelopes that cross other conduits or pipelines or are run under roads and driveways shall be reinforced. Provide reinforcement where envelopes connect to manhole and building walls. Concrete envelopes that terminate for future extension shall have dowels as specified for joints between pours. Reinforcement shall be as required; consult with Structural Engineer.
15. Trenches shall not be backfilled until concrete envelopes have had sufficient time to set. After concrete envelopes have set, nonmetallic conduits shall be cleared with mandrel of the same size as the conduit.
16. Where conduits cross under existing roadways, walks or other paved areas, steel conduits may be driven instead of conduits in trenches. After installation, paved grass areas and other areas disturbed shall be restored to original condition.
17. Cap ends of spare conduits 5'-0" beyond pavement and protect them from mechanical damage. Mark the location of conduit ends with concrete monuments, 6" in diameter by 18" long, set flush in the ground with "S/C" indented in the top.
18. Arrange multiple conduits as shown on the drawings. Make minor changes in location, or cross-sectional arrangement as necessary. Where conduit runs cannot be installed as shown because of conditions not discoverable prior to digging of trenches, request the Architect's instructions before further work is done. Coordinate this work with other outside service work.
19. Seal active and spare conduits that enter the building with oakum or other plastic expandable compound until conductors are ready for installation.

3.03 GAS ALARMS, OIL TANK ALARMS, WIRING AND CONNECTION

- A. The Electrical Contractor shall furnish and install conduit and power wiring, etc. indicated on the drawings and as required by the Plumbing and HVAC Trades, connections to alarm panels, remote alarms, etc. Also, refer to HVAC and Plumbing drawings for location and numbers of panels/alarms to be connected. All wiring shall be per the manufacturer's recommendations.

3.04 MATERIALS AND WORKMANSHIP

- A. All materials and equipment shall be new and unused and shall meet requirements of the latest Standards of NEMA, UL, IPCEA, ANSI and IEEE. Equipment shall have components required or recommended by OSHA, applicable NFPA documents and shall be UL listed and labeled.
- B. Despite references in the specifications or on the drawings to materials or pieces of equipment by name, make or catalog number, such references shall be interpreted as establishing standards of quality for materials and performance.
- C. Finish of materials, components and equipment shall not be less than Industry good practice. When material or equipment is visible or subject to corrosive or atmospheric conditions, the finish shall be as approved by the Architect.
- D. Provide proper access to material or equipment that requires inspection, replacement, repair or service. If proper access cannot be provided, confer with the Architect as to the best method of approach to minimize effects of reduced access.
- E. All work shall be installed in a neat and workmanlike manner and shall be done in accordance with all Local and State Codes.
- F. The Owner will not be responsible for material, equipment or the installation of same before testing and acceptance.

3.05 REQUIREMENTS FOR EMERGENCY SYSTEMS WIRING

- A. All feeder wiring for the life safety/emergency and critical/legally required systems shall be installed in spaces or areas that are fully protected by an automatic fire suppression system. Where feeders run above ceilings, fire suppression system shall be also be installed to protect the area above the ceiling. Feeders that are not protected by an automatic fire suppression system shall be installed within dedicated 2-hour fire rated rooms, closets or shafts or shall be a listed 2 hour fire rated assembly, such as MI cable.
- B. All feeder and branch circuit wiring for each system of the emergency and legally required systems shall be kept entirely independent of all other wiring, devices and equipment, and shall not enter the same raceways, boxes or cabinets with each other or other wiring, except as specifically allowed by the Code.
- C. Where multiple transfer switches are provided for the same branch of emergency power, all wiring between the multiple systems shall be kept entirely independent of each other and all other branches of emergency power.

3.06 EQUIPMENT CONNECTIONS

- A. Motors furnished under Heating, Ventilating and Air Conditioning Section and the Plumbing Section shall be 460 volts, 3 phase, 60 Hz for motors 1/2 HP and above, except as indicated otherwise on the drawings.
- B. Kitchen equipment motors, heating elements, shop equipment and miscellaneous items will be of a voltage and phase as indicated on the drawings.
- C. Make all final connections to equipment. Special plugs for receptacles indicated on the special purpose receptacle schedule shall be connected to the cord of the equipment, where this equipment is available to the Electrical Contractor prior to the completion of the work; otherwise the plug shall be delivered to the Owner.
- D. Equipment grounding integrity of all equipment and non-current-carrying metal parts must be ensured.
- E. All equipment requiring electrical connections which is furnished under other Sections and by others shall be connected under this Section.
- F. Before connecting any piece of equipment, check the nameplate rating against the information shown on the drawings and call to the attention of the Architect any discrepancies.
- G. The Electrical Contractor shall carefully study all equipment manufacturer's wiring diagrams and make corrections accordingly.
- H. The Electrical Contractor shall be held responsible for any damage done to motors or equipment driven by motors, due to incorrect direction of rotation, caused by faulty electrical connections, and incorrectly sized motor circuit protection, furnished under this Contract.
- I. Drawings and specifications of other Subcontractors and equipment suppliers furnishing motors shall be consulted for verification of size, speed and operation.
- J. Motor and equipment disconnect switches indicated on the drawings are attached to the motor symbol and are indicated this way for drafting convenience only. All such switches shall not be attached to the motor itself, but shall be mounted adjacent to the motor and supported independent of the motor.
- K. Motor starters furnished by other Subcontractors shall be furnished complete with individual running overcurrent protection in each phase and shall be installed and wired by the Electrical Contractor. Sizing of motor running overcurrent protection for starters furnished by others shall be the responsibility of the Subcontractor who furnishes the motor starter. Motor starters for motor control centers shall be furnished complete under this Section. Refer to schedules on the drawings.
- L. Furnish, install, wire and connect all motor disconnect switches, motor starters and remote control stations, except as otherwise indicated on the drawings. All automatic temperature control wiring for equipment furnished by the HVAC Subcontractor will be furnished and installed under Heating, Ventilating and Air Conditioning Section, except as otherwise indicated on the Electrical drawings.

- M. Motor starters, where grouped, shall be mounted on 3/4" thick, exterior grade plywood mounting board painted with fire-resistant paint of a color to match starter enclosures. Coordinate backboards with Division 06, Wood, Plastics and Composites.
- N. On multi-speed motors, the isolating switches at the motor location shall be so interlocked or shall be of such a type that operation of (1) switch shall simultaneously open all conductors to the motor.
- O. All electrical connections to vibration isolated equipment shall be by flexible conduit of length at least 15 diameters, installed with visible slack, or in a loop configuration, to allow free movement of the equipment and prevent transmission of noise and vibration.

END OF SECTION

SECTION 260548

VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. All of the Contract documents, as listed on the Table of Contents and including General and Supplementary Conditions and Division 01, General Requirements, shall be included in, and made part of, this Section.

1.02 DESCRIPTION OF WORK

A. Seismic restraints

- 1. Furnish and install necessary seismic restraints for electrical equipment in accordance with the Connecticut State Building Code and the requirements of this specification.
- 2. Seismic restraints shall be provided for both vibration isolated equipment and conduit as well as non-isolated equipment and conduit.

B. Vibration Isolation

- 1. Furnish and install vibration isolation materials and equipment to eliminate excessive noise and vibration from building electrical systems. Include adjustment of each isolation system and the measurement of system performance.

C. The work in this Section shall include seismic restraints and vibration isolation controls for the following:

- 1. Conduits and raceways, including hangers and supports.
- 2. Emergency distribution and automatic transfer switches
- 3. Busducts
- 4. Switchboards
- 5. Low voltage distribution equipment
- 6. Lighting fixtures
- 7. Fire alarm system

1.03 RELATED WORK

- A. For work to be included as part of this section, to be furnished and installed by the Electrical Contractor, refer to the Related Work section of Specification Section 26 0510.
- B. Attention is directed to the provisions of Section 13 4800 regarding seismic restraints and vibration control required for the work under this Contract. The Electrical Contractor shall review the requirements and coordinate the system installation.
- C. Carefully examine all of the Contract Documents, criteria sheets and all other Sections of the specifications for requirements which affect work under this Section, whether or not such work is specifically mentioned in this Section.
- D. Coordinate work with that of all other Trades affecting or affected by the work of this Section. Cooperate with such Trades to assure the steady progress of all work under the Contract.

1.04 REFERENCES

- A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents:
1. NFPA 70: National Electrical Code
 2. NFPA 72: National Fire Alarm Code
 3. NFPA 99: Health Care Facilities
 4. NFPA 101: Life Safety Code
 5. Occupational Safety and Health Standards
 6. National Fire Protection Association
 7. Building Officials Code Association (BOCA)
 8. Uniform Building Code (UBC)
 9. International Building Code (IBC)
 10. Connecticut Building Code
 11. National Electrical Code
 12. Connecticut Inspectional Department
- B. Material standards shall be as specified or detailed hereinafter and as follows:
1. NEBB-1977 – Procedural Standards for Measuring Sound and Vibration; National Environmental Balancing Bureau; 1977.
 2. NEBB-1977 – Sound and Vibration in Environmental Systems; National Environmental Balancing Bureau – 1977.

1.05 ACCEPTABLE MANUFACTURERS

- A. Products numbers listed in these specifications are those of Mason Industries, and are used to establish minimum standard. Other acceptable manufacturers shall be:
1. Mason Industries (MI)
 2. Amber/Booth (AB)
 3. Kinetics Noise Control (KNC)
 4. Vibration Eliminator Co. (VEC)
 5. Vibration Mountings & Controls (VMC)
 6. Novia Associates, Inc.

1.06 SUBMITTALS

- A. Prepare and submit shop drawings in accordance with the requirements hereinbefore specified, and with Section 01 3300 – Submittal Procedures in the manner described therein, modified as noted hereinafter.
- B. The submittal shall be prepared and stamped by a Structural Engineer registered in the State of Connecticut.

C. Seismic Restraints

1. A seismic restraint Action Submittal shall be prepared for all systems and equipment covered by this section.
2. The following information shall be included for each piece of equipment or system:
 - a. Dimensions, weight and center of gravity.
 - b. The seismic restraint detail, including anchoring methods appropriate for the supporting structure.
 - c. The seismic restraint detail shall be derived from one of the following:
 - 1) Calculations showing demand lateral loading, restraint loading, and design of restraint and connections.
 - 2) Application of a pre-calculated seismic restraint system applicable for the required loads and carrying the approval of ICBO.
 - 3) Application of a pre-calculated seismic restraint detail for the applicable loads provided by the equipment manufacturer and carrying the approval of ICBO.
 - d. Documentation of approval for applications.
 - e. Anchors to concrete shall be specified in detail, including any testing requirements, and shall have ICBO Approval for the specific application.
 - f. Reaction loads to structure.
 - g. Layouts of seismic restraints for conduit, busways, etc. or specific instructions for determination of layout and appropriate bracing detail in the field.

D. Vibration Isolation

1. The Vibration Isolation Submittal shall include descriptive data for all products and materials including the following:
 - a. Product Descriptions
 - 1) A complete description of products to be supplied, including product data, model number, dimensions, specifications and installation instructions.
 - b. An itemized list of isolated and non-isolated equipment. Detailed schedule and selection data for each vibration isolator and seismic restraint supporting equipment, including:
 - 1) Equipment identification mark
 - 2) Isolator type
 - 3) Actual load
 - 4) Static deflection expected under actual load
 - 5) Specified minimum static deflection
 - 6) Additional deflection-to-solid under load
 - 7) Ratio of spring height under load to spring diameter
 - 8) Base type
 - 9) Seismic restraint type

- c. Steel rails, steel base frames, and concrete inertia bases showing steel work, reinforcing, vibration isolator mounting attachment method, and location of equipment attachment bolts.
 - d. Show equipment base construction for equipment, including dimensions, structural member sizes and support point locations.
 - e. Indicate isolation devices selected with complete dimensional and deflection data.
 - f. Show methods of suspension and support for ceiling hung equipment.
 - g. Detail methods of isolation for conduits, busways, etc. piercing walls and slabs.
 - h. Provide special details necessary to convey complete understanding of the work to be performed.
- E. The submittal shall be reviewed for completeness and use of applicable criteria by the Design Professional in charge of this section. The reaction loads to structure shall be approved by the project Structural Engineer.
- F. Submission of samples may be requested for each type of seismic restraint. Samples will be returned for use at the job site if requested. Costs associated with submission of samples shall be borne by the Contractor.

1.07 QUALITY ASSURANCE

- A. Attention is directed to the provisions of Section 01 4000 regarding quality requirements for the work under this Contract. The Electrical Contractor shall review the requirements and assure all components are in compliance.
- B. Qualifications
1. Manufacturer: Company specializing in the design and manufacturing of seismic restraints specified in this section, with documented experience of more than five (5) years.
 2. Installer: Company specializing in executing the scope of work specified in this section with documented experience of more than five (5) years.
- C. Quality Standards – Seismic Restraints
1. Quality assurance testing required as a condition of product approvals such as concrete anchors shall be carried out and paid for by the contractor.
 2. Upon completion of seismic restraint installation, the Contractor and the anchorage engineer shall indicate that, to the best of their knowledge, the seismic anchorage was installed according to the approved submittal and/or any approved revisions thereto. This report shall also identify changes made from the approved submittal. Reports may be submitted by system, or by like groups of components, or for the entire installation covered by this specification section.
- D. Quality Standards – Vibration Isolation
1. Vibration isolators shall have calibration markings or some method to determine the actual deflection under the imposed load after installation and adjustment.
 2. Isolators shall operate within the linear portion of their load versus deflection curves. Load versus deflection curves shall be furnished by the manufacturer and must be linear over a deflection range of at least 50% above the design deflection.

3. The theoretical vertical natural frequency for each support point, based upon load per isolator and isolator stiffness, shall not differ from the design objectives for the equipment as a whole by more than $\pm 10\%$, and shall be non-resonant with equipment forcing frequencies or support structure natural frequencies.
4. Neoprene components shall have a shore hardness of 30 to 50 $\pm 5\%$, after minimum aging of (20) days or equal oven aging.
5. Substitution of internally isolated and restrained equipment in lieu of the isolation and restraints specified in this Section is acceptable provided conditions of this Section are met. Provide a letter, from the equipment manufacturer, stating that the specified noise and vibration levels will be obtained and that the seismic restraints shall be in compliance with these specifications. Pay costs for converting to the specified external vibration isolation and restraints should submissions or installations be found unacceptable pursuant to the intent of this specification.
6. Should any rotating equipment cause excessive noise or vibration, the Electrical Contractor shall be responsible for rebalancing, realignment, or other remedial work required to reduce noise and vibration levels. Excessive is defined as exceeding the manufacturer's specifications for the unit in question.
7. Upon completion of the work, the Architect shall inspect the installation and shall inform the Contractor of any further work that must be completed. Make adjustments as approved by the Architect that result from the final inspection. This work shall be done before vibration isolation systems are accepted.
8. Manufacturer Responsibility
 - a. Manufacturer of vibration isolation equipment shall have the following responsibilities:
 - 1) Determine vibration isolation sizes and locations.
 - 2) Provide equipment vibration isolation as scheduled or specified.
 - 3) Guarantee specified isolation system deflections.
 - 4) Provide installation instructions, drawings and field supervision to ensure proper installation and performance of systems.

1.08 SEISMIC RESTRAINT REQUIREMENTS

A. General

1. Equipment and systems shall be restrained for seismic requirements by Restraint Types as described in PART 2—PRODUCTS.
2. Floor or roof mounted equipment, regardless of weight or vibration isolation requirements shall be restrained to the structure to allow for required acceleration.
3. Suspended equipment shall be 2-point or 4-point independently braced with Type III restraints, installed taut for non-isolated equipment, and slack (with 1/2" cable deflection) for isolated equipment. Stiffeners for support rods may be required, certifications shall clearly delineate when such stiffening is required or not. Equipment supports and the required seismic bracing shall be anchored to the structure.
4. Where base anchoring of equipment is insufficient to resist seismic forces, restraints such as Type III shall be located above the unit's center of gravity to resist "G" forces. Vertically mounted tanks and upblast tubular centrifugal fans may require this additional restraint.
5. Design of restraints must consider capacity of structural elements. Project Structural Engineer shall be consulted prior to design of restraints for large or unusual loads.

B. Restraint Requirements

1. Conduit, busway and cable tray bracing shall be: 20'-0" maximum transversely; 40'-0" maximum longitudinally; and within 4'-0" each change of direction.
2. Seismic restraints are not required on the following:
 - a. Individually supported electrical conduit less than 2" nominal diameter.
 - b. The exclusion for bracing can only be used for conduits with hangers less than 12" in length.
3. Suspended conduit, not excluded by diameter or distance from structure allowances, shall have Seismic Restraint Type III or V.
4. Trapeze hangers supporting conduit alone or in combination with piping, where each individual element does not require bracing, will require seismic restraint when the aggregate weight of all elements supported on the trapeze assembly exceeds 10 pounds per foot. Weight shall be determined assuming all pipes are filled with water and conduits are filled with conductors as scheduled.
5. Conduit and busway risers through cored shafts require no additional seismic bracing. (Core diameters to be a maximum of 2" larger than conduit O.D.)

C. Non-Isolated Equipment Restraint Requirements

1. Ceiling suspended equipment.
 - a. Restraint Type III or V.
2. Suspended ceilings containing light fixtures may be considered as meeting seismic zone requirements. In which case, earthquake clips or other approved means of positive attachment shall secure fixture to T-bar structure.
3. Floor or wall mounted equipment.
 - a. Restraint Type III or V.

D. Provide restraints for suspended transformers and other suspended electrical equipment.

E. Install equipment on isolators and after the isolators have been adjusted for required deflection.

PART 2 PRODUCTS**2.01 SEISMIC RESTRAINT – GENERAL**

- A. Seismic restraints shall be capable of accepting, without failure, seismic forces determined in accordance with the Connecticut State Building Code. They shall maintain the equipment in a captive position and not short circuit isolation during normal operating conditions. Isolators shall have provisions for bolting and/or welding to the structure.
- B. Metal parts of seismic restraint equipment installed out-of-doors shall be cold dip galvanized, cadmium plated, or neoprene or PVC coated after fabrication. Galvanizing shall meet ASTM alt Spray Test Standards and Federal Test Standard #14.
- C. Attachment plates to be cast into housekeeping pads, concrete inserts and beam clamps that may be required for seismic compliance shall be provided by this Section.

2.02 SEISMIC RESTRAINT TYPES

A. Type I

1. Type I shall comply with general characteristics of spring isolator Type A with snubbing restraint in all directions capable of supporting equipment at fixed elevations during installation. Cast or aluminum housings, except ductile iron are not acceptable.
 - a. Type I seismic restraint shall be Mason Industries Type SSLFH.

B. Type II

1. Each corner or side of equipment base shall incorporate a seismic restraint snubber having a minimum of 5/8" thick resilient pad limit stop. Seismic snubbers shall be in accordance with manufacturer's recommendations.
2. Type II seismic restraints shall be Mason Industries Type Z-1011 or Z-1225.

C. Type III

1. Type III shall be multiple metal cable or strut type with approved fastening devices to equipment and structure. System to be field bolted to deck or to overhead structural members using 2-sided beam clamps or appropriately designed inserts for concrete. All parts of the system including cables, excluding fasteners, are to be of a single supplier to ensure seismic compliance.

D. Type IV

1. Type IV shall have double deflection neoprene isolator (minimum 0.3") encased in ductile iron or steel casing.
2. Type IV seismic restraints shall be Mason Industries Type BR, RBA or RCA.

E. Type V

1. Non-isolated equipment shall be field bolted or welded (powder shots not acceptable) to the structure as required to meet seismic forces. Bolt diameter, embedment data and/or weld length must be shown in certified calculations.

2.03 VIBRATION ISOLATION – GENERAL

- A. Vibration isolation equipment shall be capable of accepting, without failure, seismic forces determined in accordance with the Connecticut State Building Code and the Contract Documents. They shall maintain the equipment in a captive position and not short circuit isolation during normal operating conditions. Isolators shall have provisions for bolting and/or welding to the structure.
- B. Metal parts of vibration isolation units installed out-of-doors shall be cold dip galvanized, cadmium plated, or neoprene or PVC coated after fabrication. Galvanizing shall meet ASTM alt Spray Test Standards and Federal Test Standard #14.
- C. Base supported isolators shall have baseplates with bolt holes for fastening the isolators to the support members.

- D. Isolator types are specified to establish minimum standards. At the Contractor's option, laborsaving accessories can be an integral part of isolators supplied to provide initial lift of equipment to operating height, hold piping at fixed elevations during installation and initial system filling operations, and similar installation advantages. Accessories must not degrade the vibration isolation system.
- E. Static deflections stated are the minimum acceptable deflection under actual load. Isolators shall be selected for no less than 50% reserve deflection beyond actual operating conditions.
- F. Attachment plates to be cast into housekeeping pads, concrete inserts and beam clamps that may be required for seismic compliance shall be provided.
- G. Coordinate the size, location and special requirements of vibration isolation equipment and systems with other Sections. Coordinate plan dimensions with size of housekeeping pads.

2.04 VIBRATION ISOLATORS

A. Type A (Floor Spring and Neoprene)

- 1. The Type A spring isolator shall:
 - a. Have a minimum outside diameter to overall height of 0.8:1.
 - b. Have corrosion resistance where exposed to corrosive environment with:
 - 1) Springs cadmium plated or electro-galvanized.
 - 2) Hardware cadmium plated.
 - 3) Other metal parts hot dip galvanized.
 - c. Have reserve deflection (from loaded to solid height) of 50% of rated deflection.
 - d. Have minimum 1/4" thick neoprene acoustical base pad on underside, unless designed otherwise.
 - e. Be designed and installed so that ends of springs remain parallel.
- 2. Type A isolator shall be Mason Industries Type SLF.
- 3. Type A isolator must be used with Seismic Restraint II.

B. Type B (Floor Spring and Neoprene Travel Limited)

- 1. The Type B spring isolator shall be the same as Type A with the following additional features.
 - a. Built-in vertical limit stops with minimum 1/4" clearance under normal operation.
 - b. Tapped holes in top plate for bolting to equipment.
 - c. Capable of supporting equipment at fixed elevation during equipment installation. Installed and operating heights shall be identical.
 - d. Adjustable and removable spring pack with separate neoprene isolation pad.
- 2. Type B isolator shall be Mason Industries Type SLR.
- 3. Type B isolator must be bolted or welded to the structure.

- C. Type C (Spring Hanger Rod Isolator)
1. Spring isolator (Type A) seated on a steel washer within a neoprene cup incorporating a rod isolation bushing.
 2. Spring diameters and hanger box shall allow 30° of hanger rod movement.
 3. Type C isolator shall be Mason Industries Type 30 or W30.
 4. Type C isolator must be used with Seismic Restraint III.
- D. Type D
1. Type D isolator is the same as Seismic Restraint IV.
- E. Type E (Elastomer Hanger Rod Isolator)
1. Molded (minimum 1 3/4" thick) neoprene element with projecting bushing lining the rod clearance hole. Static deflection at rated load shall be minimum 0.35".
 2. Steel retainer box encasing neoprene mounting capable of supporting equipment up to (4) times the rated capacity of the element.
 3. Type E isolator shall be Mason Industries Type HD.
 4. Type E isolator must be used with Seismic Restraint III.
- F. Type F (Combination Spring/Elastomer Hanger Rod Isolator)
1. Spring and neoprene elements in a steel retainer box with the features as described for Type C and Type E isolators.
 2. Type F isolator shall be Mason Industries Type 30N.
 3. Type F isolator must be used with Seismic Restraint III.
- G. Type G (Pad Type Elastomer Isolator)
1. 0.75" minimum thickness, 50psi maximum loading, ribbed or waffled design.
 2. Minimum 0.1" deflection.
 3. 1/16" galvanized steel plate between multiple pad layers.
 4. Provide load distribution plate where attachment to equipment bearing surface is less than 75% of the pad area.
 5. Type G isolators shall be Mason Industries Type Super W.
 6. Bolting of Type G isolator required for seismic compliance. Neoprene and duck washers and bushings shall be provided to prevent short circuiting.
- H. Type H (Pad Type Elastomer Isolator)
1. Laminated canvas duck and neoprene, maximum loading 1000 psi, minimum 1/2" thick.
 2. Provide load distribution plate where attachment to equipment bearing surface is less than 75% of the pad area.
 3. Type H isolator shall be Mason Industries Type HL.
 4. Bolting of Type H isolator required for seismic compliance. Neoprene and duck washers and bushings shall be provided to prevent short circuiting.
- I. Type J (Steel Rails)
1. Steel members of sufficient strength to prevent equipment flexure during operation.
 2. Height saving brackets as required to reduce operating height.
 3. Type J isolator shall be Mason Industries Type ICS.

J. Type K (Anchors and Guides)

1. Acoustical pipe anchor or guide, consisting of a telescopic arrangement of (2) sizes of steel tubing separated by a minimum 1/2" thickness of Type H pad.
2. Vertical restraints shall be provided by a similar material arranged to prevent vertical travel in either direction (anchors only).
3. Allowable loads on isolation materials shall not exceed 500 psi, and the design shall be balanced for equal resistance in any direction.
4. Anchors and guides must be bolted or welded to meet seismic criteria.
5. Type K anchor shall be Mason Industries Type ADA or VDA.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Seismic restraint systems must be installed in strict accordance with approved submittals, the manufacturer's details, and Connecticut State Building Code requirements.
- B. Electrical equipment shall be mounted on vibration isolation steel rails using Type G or H isolators.
- C. The floor supported distribution transformers located within the building shall be mounted on isolation units utilizing type B springs, appropriately secured to the housing. Spring units shall be selected for a minimum static deflection of 1.5".
- D. Suspended electrical equipment shall be supported on an appropriate steel frame from Type F hangers, selected for a minimum static deflection of 0.75".
- E. Vibration isolation systems must be installed in strict accordance with the manufacturer's installation guidelines, Connecticut State Building Code requirements, and approved submittals.
- F. Vibration isolators shall not cause any change of position of equipment resulting in stress on equipment connections.
- G. Conduit and busway penetrations through floors and walls shall not be rigidly connected to the building structure. Provide sleeves with clearances around the outside, as recommended by the vibration materials manufacturer. Penetrations shall be smokeproofed and firestopped in an approved manner as specified.
- H. Generally, isolation shall be designed to limit equipment room floor or roof loading to a maximum of 50 lbs./sq.ft. and vibration isolators shall be carefully and specifically selected for each piece of equipment.
- I. Motor driven equipment which is to be isolated shall have motor mounted on the isolated equipment or shall have motor, equipment and drive mounted on a common base.
- J. Hanger isolators shall be installed with the hanger box hung as closely as possible (without direct contact) to the structure.
- K. Hanger isolators shall be suspended from substantial structural members sized for a maximum deflection of L/360 at mid span, not from slab diaphragm, unless specifically permitted by the Architect.
- L. Hanger rods shall not short circuit the hanger box.

- M. Floor mounted transformers shall be installed on non-metallic, vibration isolating pads meeting seismic requirements and selected for at least 0.2" deflection.
- N. Set steel bases for 1" clearance between housekeeping pad and base. Set concrete inertia bases for 2" clearance. Adjust equipment level.
- O. Position equipment, structural base and concrete base on blocks or wedges at proper operating height.
- P. Check equipment and verify operating load conditions before transferring base isolation loads to springs and removing wedges.
- Q. Electrical corrections to vibration isolated mechanical and electrical equipment shall be made with liquid tight flexible conduit. The conduit shall be installed in a slack condition.
- R. Verify installed isolators and mounting system permit equipment motion in all directions.
- S. Adjust or provide additional resilient restraints to flexibly limit lateral motion to 1/4" during start-up of equipment.
- T. Before start-up, clean out all foreign matter from between bases and equipment to prevent short circuit.
- U. Install flexible connectors on conduit connected to equipment supported by vibration isolation. Flexible conduit length shall be at least 15 times the diameter of the conduit.
- V. Upon completion of installation of vibration isolation devices, the manufacturer's local representative shall inspect the completed project and certify in writing to the Electrical Contractor that all systems are either installed properly, or require correction. The Electrical Contractor shall submit a report to the Architect, including the manufacturer's report, certifying correctness of the installation or detailing corrective work to be done.

3.02 CONDUIT ISOLATION REQUIREMENTS

- A. Isolate conduit connected to rotating or reciprocating equipment.
- B. Vertical riser conduit supports, where required, under 2" diameter shall utilize Type H isolation.
- C. Conduit anchors or guides, where required, shall utilize Type K isolators.
- D. Riser sway supports, where required, shall utilize (2) neoprene elements (Type G or H) to accommodate tension and compression forces.

END OF SECTION

SECTION 260570

POWER SYSTEM STUDIES (EXTENSION OF EXISTING)

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. All of the Contract Documents, as listed on the Table of Contents and including General and Supplementary Conditions and Division 01, General Requirements, shall be included in, and made part of, this Section.

1.02 DESCRIPTION OF WORK

- A. The following Electrical Engineering Studies shall be performed by the distribution equipment manufacturer or a firm engaged by the distribution equipment manufacturer:
 - 1. Short Circuit Studies
 - 2. Protective Device Evaluation Studies
 - 3. Protective Device Coordination Studies
 - 4. Arc Flash Hazard Analysis
- B. The studies shall include all portions of the electrical distribution system from the normal power incoming secondary source or sources, down to and including all panels and distribution equipment in the distribution system. Normal system connections and those which result in maximum fault conditions shall be adequately covered in the study.
- C. In addition, the study shall include all existing distribution equipment directly affected by the new work at the building, as shown on the drawings. Electrical Contractor shall obtain/verify existing characteristics, feeder sizes, nameplate data, etc. as may be required to complete the studies.
- D. The power system studies shall include all new and existing electrical system components to confirm the adequacy of the interrupting ratings, proper coordination settings of all overcurrent protection devices and to determine the requirements for arc flash protection boundary and incident energy exposure labeling to the satisfaction of the Electrical Engineer. Refer to Specification Section 26 0520 for requirements for field labeling based on the results of the arc flash study.
- E. The switchgear equipment manufacturer shall carry in his bid to the Electrical Contractor, a sufficient allowance to provide modifications to the equipment, if necessary, based on the results of the studies identified herein.

1.03 REFERENCES

- A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - 1. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems
 - 2. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
 - 3. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis

4. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings
5. IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems.
6. IEEE 1584 - Guide for Performing Arc-Flash Hazard Calculations

B. American National Standards Institute (ANSI):

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

C. The National Fire Protection Association (NFPA)

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

1.04 RELATED WORK

- A. For work to be included as part of this Section, to be furnished and installed by the Electrical Contractor, refer to the Related Work section of Specification Section 26 0510.
- B. Carefully examine all of the Contract Documents, criteria sheets and all other Sections of the specifications for requirements which affect work under this Section, whether or not such work is specifically mentioned in this Section.

1.05 SUBMITTALS

- A. Prepare and submit shop drawings in accordance with the requirements hereinbefore specified, and with Section 01 3300 – Submittal Procedures in the manner described therein, modified as noted hereinafter.
- B. All shop drawings shall have clearly marked the appropriate specification number of drawing designation, for identification of the submittal.
- C. Disposition of shop drawings shall not relieve the Electrical Contractor from the responsibility for deviations from drawing or specifications, unless he has submitted in writing a letter itemizing or calling attention to such deviations at time of submission and secured written approval from the Engineer, nor shall such disposition of shop drawings relieve the Electrical Contractor from responsibility for errors in shop drawings or schedules.
- D. The studies shall be submitted to the Architect prior to receiving final approval of the distribution equipment shop drawings and prior to release of equipment for manufacture. If formal completion of the studies may cause delay in equipment manufacture, approval from the Architect may be obtained for a preliminary submittal of sufficient study data to ensure that the selection of device ratings and characteristics will be satisfactory.

1.06 QUALITY ASSURANCE

- A. Attention is directed to the provisions of Section 01 4000 regarding quality requirements for the work under this Contract. The Electrical Contractor shall review the requirements and assure all components are in compliance.
- B. The firm performing the studies shall be currently involved in high and low voltage power system evaluation. The study shall be performed, stamped and signed by a registered professional engineer in the State of Connecticut. Credentials of the individual(s) performing the study and background of the firm shall be submitted to the Engineer for approval prior to start of the work. A minimum of five (5) years experience in power system analysis is required for the individual in charge of the project.
- C. The firm performing the study shall demonstrate capability and experience to provide assistance during start up as required.
- D. Submit qualifications of individual(s) who will perform the work for approval prior to commencement of the studies. Provide studies in conjunction with equipment submittals to verify equipment ratings required. Submit a draft of the study to the Architect for review prior to delivery of the study to the Owner. Make all additions or changes as required by the reviewer.

PART 2 PRODUCTS

2.01 NOT USED

PART 3 EXECUTION

3.01 DATA COLLECTION FOR THE STUDY

- A. The Electrical Contractor shall provide the required data for preparation of the studies. The Engineer performing the system studies shall furnish the Electrical Contractor with a listing of the required data immediately after award of the contract.
- B. The Electrical Contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and prior to release of the equipment for manufacture.
 - 1. Source combination may include present and future motors and generators.
 - 2. Load data utilized may include existing and proposed loads obtained from Contract Documents provided by Owner, or Contractor.
 - 3. If applicable, include fault contribution of existing motors in the study. The Contractor shall obtain required existing equipment data, if necessary, to satisfy the study requirements.

3.02 SHORT CIRCUIT STUDY

- A. The short circuit study shall be performed with the aid of a digital computer program and shall be in accordance with the latest applicable IEEE and ANSI standards.
- B. In the short circuit study, provide calculation methods and assumptions, the base per unit quantities selected, one-line diagrams, source impedance data including power company system characteristics, typical calculations, tabulations of calculation quantities and results, conclusions, and recommendations.

Calculate short circuit interrupting and momentary (when applicable) duties for an assumed 3-phase bolted fault at each supply switchgear lineup, unit substation primary and secondary terminals, low-voltage switchgear lineup, switchboard, motor control center, distribution panelboard, branch circuit panelboards, and all other distribution equipment throughout the system. Provide a ground fault current study for the same system areas, including the associated zero sequence impedance data. Include in tabulations fault impedance, X to R ratios, asymmetry factors, motor contribution, short circuit kVA, and symmetrical and asymmetrical fault currents.

- C. Include complete fault calculations as specified herein for each proposed and ultimate source combination. Note that source combinations may include present and future supply circuits, large motors or generators as noted on Drawing one-lines.
- D. Study shall include the results for each mode of operation, as follows:
 - 1. Normal power available and all transfer switches in the normal position.
 - 2. Emergency generator(s) or emergency source(s) running and all transfer switches in the emergency position
- E. Motor Contribution
 - 1. Include fault contribution of all motors in the study as follows:
 - a. 100% of all motors with standard starters (no VFD's)
 - b. 25% of all motors provided with VFD's and bypass starters
 - c. 0% of motors provided with VFD's without bypass starters
 - 2. Motor short circuit contribution shall be included at the appropriate locations in the system as indicated on the drawings, so that the computer calculated values represent the theoretical short circuit current available.
- F. Notify the Architect, in writing, of circuit protective devices not properly rated for fault conditions.

3.03 PROTECTIVE DEVICE EVALUATION AND COORDINATION STUDY

- A. In the protective device coordination study, provide time-current plots graphically indicating the coordination proposed for the system, centered on conventional, full-size, log-log forms.
- B. Include a complete one-line diagram of the entire system with legend. Text on the one line shall be legible and a minimum of 3/32" tall. Include a detailed description of each protective device identifying its type, function, manufacturer, and time-current characteristics. Tabulate recommended device tap, time dial, pickup, instantaneous, and time delay settings. For each device, provide a reference indicating the plot sheet(s) where the curves are indicated.
- C. Also include on each plot sheet the following:
 - 1. A complete title block with project name, date plot name and scale
 - 2. Time current curve for each devices represented
 - 3. A function block for each curve identifying what the curve represents (device or damage curve). Include a detailed description of each protective device identifying its type, function, manufacturer, and time-current characteristics and recommended device tap, time dial, pickup, instantaneous, and time delay settings.
 - 4. A one line representation of the devices represented on the plot.

- D. Include on the plot sheets power company relay and fuse characteristics, system medium-voltage equipment relay and fuse characteristics, low-voltage equipment circuit breaker trip device characteristics, transformer characteristics, motor and generator characteristics, and characteristics of other system load protective devices. Include all devices down to largest branch circuit and largest feeder circuit breaker in each motor control center, and main breaker in branch panelboards.
- E. Include all adjustable settings for ground fault protective devices. Include manufacturing tolerance and damage bands in plotted fuse characteristics. Show transformer full load and 150, 400, or 600 percent currents, transformer magnetizing inrush, ANSI transformer withstand parameters, and significant symmetrical and asymmetrical fault currents. Terminate device characteristic curves at a point reflecting the maximum symmetrical or asymmetrical fault current to which the device is exposed.
- F. Provide settings for the chiller motor starters or obtain from the Mechanical Subcontractor, include in the study package, and comment.
- G. Select each primary protective device required for a delta-wye connected transformer so that its characteristic or operating band is within the transformer characteristics, including a point equal to 58 percent of the ANSI withstand point to provide secondary line-to-ground fault protection. Where the primary device characteristic is not within the transformer characteristics, show a transformer damage curve. Separate transformer primary protective device characteristic curves from associated secondary device characteristics by a 16 percent current margin to provide proper coordination and protection in the event of secondary line-to-line faults. Separate medium-voltage relay characteristic curves from curves for other devices by at least a 0.4-second time margin.
- H. When an emergency generator is provided, include phase and ground coordination of the generator protective devices. Show the generator decrement curve and damage curve along with the operating characteristic of the protective devices. Obtain the information from the generator manufacturer and include the generator actual impedance value, time constants and current boost data in the study. Do not use typical values for the generator.
- I. Evaluate proper operation of the ground relays in 4-wire distributions with more than one main service circuit breaker, or when generators are provided, and discuss the neutral grounds and ground fault current flows during a neutral to ground fault.
- J. For motor control circuits, show the MCC full-load current plus symmetrical and asymmetrical of the largest motor starting current and time to ensure protective devices will not trip during major or group start operation.
- K. For distribution transformer primary protection, the system study engineer shall obtain transformer in-rush current characteristics from the manufacturer. If a miscoordination occurs on the primary circuit breaker due to transformer in-rush current, the system study engineer shall contact the successful switchgear manufacturer.

The manufacturer shall be responsible to select appropriate circuit breaker frame, sensor and trip sizes to assure each primary breaker coordinates with transformer inrush current. Manufacturer shall alert the Electrical and Engineer to determine if conductor sizes will be required to be increased. If so, the increased conductors shall be provided at no additional cost to the Owner.

L. Selective Coordination

1. All overcurrent protection devices shall be coordinated with all upstream overcurrent protection devices based on the highest calculated value of available short circuit current at the overcurrent protection device terminals as follows:

Distribution System:	Coordination Time, in Seconds	NEC Code Article
a. Emergency Distribution System	0.01	700.28
b. Life Safety Branch Distribution System	0.01	700.28
c. Critical Branch Distribution System	0.01	700.28
d. Information Technology Equipment	0.01	645.27
e. All Other Power Distribution Systems	0.10	240.12

2. If a miscoordination occurs between upstream and downstream overcurrent protection devices, the system study Engineer shall contact the successful switchgear manufacturer to obtain results of factory laboratory testing for the selected overcurrent protection devices. If a miscoordination still exists, the system study Engineer shall advise the manufacturer. The manufacturer shall be responsible to select appropriate circuit breaker frame, sensor and trip sizes to assure each upstream overcurrent protection device will coordinate with all breakers downstream as indicated in 1., 2., 3. and 4. above.

3.04 FLASH PROTECTION STUDY

A. Flash Protection Boundaries

1. Calculation of flash protection boundaries shall be performed on all parts of the electrical system, for the Owner's documentation and implementation of details of limits of approach boundaries as required by NFPA 70E Standard for Electrical Safety Requirements for Employee Workplaces.
2. Flash protection boundaries shall be calculated for equipment where work could be performed on energized and exposed equipment and/or conductors. Calculations shall be provided for the following equipment including but not limited to:
 - a. Substation and switchboard assemblies
 - b. Motor control centers
 - c. Panelboards
 - d. Disconnect switches
 - e. Controller equipment such as variable frequency/adjustable speed drives
 - f. Fuses and circuit breakers
 - g. Rotating equipment
 - h. Batteries
 - i. Generators
 - j. Automatic transfer switches
 - k. Premises wiring

3. Flash protection boundaries for circuits rated 600V and less shall be calculated utilizing one of the following formulae:

$$D_c = [2.65 \times MVA_{bf} \times t]^{1/2}$$

or,

$$D_c = [53 \times MVA \times t]^{1/2}$$

where:

D_c = distance of person from an arc source for a just curable burn in feet

MVA_{bf} = bolted fault MVA at point involved

MVA = MVA rating of transformer. For transformers with MVA ratings below 0.75 MVA, multiply the transformer MVA rating by 1.25

t = time of arc exposure in seconds

B. Incident Energy Exposures

- Calculation of incident energy exposures shall be performed on all parts of the electrical system, for the Owner's determination and implementation of details of personal protective equipment as required by NFPA 70E Standard for Electrical Safety Requirements for Employee Workplaces.
- Incident energy exposures shall be calculated for equipment where work could be performed on energized and exposed equipment and/or conductors. Incident energy exposures for circuits rated 600V and less and emanating from any of the equipment listed in Paragraph titled Flash Protection Boundaries shall be calculated utilizing the 'Arc in a Cubic Box' formula listed as follows with results expressed in calories/square centimeter (cal/cm^2):

$$E_{MB} = 1038.7 \times D_B^{-1.4738} \times t_A \times [(0.0093 \times F^2) - (0.3453 \times F) + 5.9675]$$

where:

E_{MB} = maximum 20 in. cubic box incident energy, cal/cm^2

D_B = distance from arc electrodes, inches (for distances 18 in. and greater)^{Note 1}

t_A = arc duration, seconds

F = bolted fault short circuit current, kA (for the range of 16 to 50 kA)

Note 1: Incident energy exposure level shall be based on the working distance of the employee's face and chest areas from a prospective arc source for the specific task to be performed. Utilize 18 inches for all calculations.

- Incident energy exposure calculations for lower level (downstream) components shall be considered the same as for higher level (upstream) components of the same feeder or branch circuit where the same overcurrent protective device serves both higher and lower components and where the available short circuit current is not depreciablely reduced due to increased system impedances such as would be introduced with long conductor lengths.
- Results of the study will be used for the required field labeling of equipment as indicated in Specification Section 260520

3.05 STUDY REPORT

- A. A draft report shall be sent to the equipment manufacturer for review prior to issuance of the final report. The manufacturer shall review system discrepancies and make modifications to equipment as necessary to meet the requirements of the study. The study shall be updated to include changes in devices and reissued as necessary to ensure all devices meet the study requirements.
- B. The final results of the power system study shall be summarized in a report. Multiple bound copies of the final report shall be submitted to the Architect per the requirements indicated in Submittals above.
- C. The final study report shall include the following sections:
 - 1. Executive Summary.
 - 2. Descriptions, purpose, basis and scope of the study.
 - 3. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties, and commentary regarding same.
 - 4. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip settings, fuse selection.
 - 5. Fault current calculations including a definition of terms and guide for interpretation of computer printout.
 - 6. Flash protection incident energy exposures including a definition of terms and guide for interpretation of calculations.
 - 7. Flash protection boundaries indicated on scaled drawings for inclusion in the electric rooms. Refer to Specification Section 26 0520.
 - 8. One line diagram
 - 9. CD or flash drive with the electronic input data files

3.06 ARC FLASH TRAINING

- A. The Electrical Contractor shall provide training to the Owner's qualified electrical personnel of the potential arc flash hazards associated with working on energized equipment (minimum of 4 hours). The training shall be certified for continuing education units (CEUs) by the International Association for Continuing Education Training (IACET) or equivalent.

3.07 POWER COMPANY APPROVAL

- A. Where required, copies of the final report shall be submitted to the power company for their review and approval. Approved copies of the report shall be submitted to the Architect.

END OF SECTION

SECTION 260580

ELECTRICAL ACCEPTANCE TESTS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. All of the Contract Documents, as listed on the Table of Contents and including General and Supplementary Conditions and Division 01, General Requirements, shall be included in, and made part of, this Section.

1.02 DESCRIPTION OF WORK

- A. The Electrical Subcontractor shall engage the services of a recognized independent NETA testing firm for the purpose of performing inspections and tests as herein specified.
- B. The testing firm shall provide all material, equipment, labor, and technical supervision to perform such tests and inspections. It is the purpose of these specifications to assure that all tested electrical equipment, both Electrical Subcontractor and Owner supplied, is operational and within industry and manufacturer's tolerances and is installed in accordance with design specifications.
- C. The tests and inspections shall determine suitability for energization.
- D. An itemized description of equipment to be inspected and tested follows:
 - 1. Grounding system.
 - 2. Ground fault protection systems.
 - 3. Conductors
 - a. 600 volt conductors. (60 amperes and larger)
 - 4. Low voltage distribution equipment
 - a. Busway.
 - b. Metering.
 - c. Panelboards.
 - d. Switchboards.
 - e. Enclosed circuit breakers.
 - 5. Motors.
 - 6. Emergency system equipment
 - a. Automatic transfer switches.
 - 7. Surge arresters.

1.03 RELATED WORK

- A. For work to be included as part of this Section, to be furnished and installed by the Electrical Subcontractor, refer to the Related Work section of Specification Section 26 0510.

- B. Carefully examine all of the Contract Documents, criteria sheets and all other Sections of the specifications for requirements which affect work under this Section, whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

- A. All inspections and field tests shall be in accordance with the latest adopted edition of the following codes, standards, and specifications except as provided otherwise herein.
1. American National Standards Institute - ANSI
 2. American Society for Testing and Materials - ASTM
 3. Association of Edison Illuminating Companies - AEIC
 4. Institute of Electrical and Electronic Engineers - IEEE
 - a. ANSI/IEEE C2, National Electrical Safety Code
 - b. ANSI/IEEE C37, Guides and Standards for Circuit Breakers, Switchgear, Relays, Substations, and Fuses.
 - c. ANSI/IEEE C57, Distribution, Power, and Regulating Transformers.
 - d. ANSI/IEEE C62, Surge Protection.
 - e. ANSI/IEEE Std. 43 (R1992). IEEE Recommended Practice for Testing Insulation Resistance of Rotating Machinery.
 - f. ANSI/IEEE Std. 81. IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.
 - g. ANSI/IEEE Std. 142. IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems (IEEE Green Book.).
 - h. ANSI/IEEE Std. 241. IEEE Recommended Practice for Electric Power Systems in Commercial Buildings (Gray Book).
 - i. ANSI/IEEE Std. 242. IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (Buff Book).
 - j. ANSI/IEEE Std. 399. IEEE Recommended Practice for Power Systems Analysis (Brown Book).
 - k. ANSI/IEEE Std. 446. IEEE Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications (Orange Book).
 - l. ANSI/IEEE Std. 493. IEEE Recommended Practice for the Design of Reliable Industrial and Commercial Power Systems (Gold Book).
 - m. ANSI/IEEE Std. 602. IEEE Recommended Practice for Electric Systems in Health Care Facilities (White Book).
 - n. ANSI/IEEE Std 1100. IEEE Recommended Practice for Powering and Grounding Sensitive Electronic Equipment (Emerald Book).
 5. Insulated Cable Engineers Association - ICEA
 6. InterNational Electrical Testing Association - NETA
 - a. NETA Maintenance Testing Specifications for Electrical Power Distribution Equipment and Systems.
 7. National Electrical Manufacturer's Association - NEMA
 - a. NEMA Standard for Publication No. AB4: Guidelines for Inspection and Preventive Maintenance of Molded-Case Circuit Breakers Used in Commercial and Industrial Applications.

- b. NEMA Publication MG1: Motors and Generators
8. National Fire Protection Association - NFPA
- a. ANSI/NFPA 70: National Electrical Code.
 - b. ANSI/NFPA 70B: Recommended Practice for Electric Equipment Maintenance.
 - c. ANSI/NFPA 70E: Electrical Safety Requirements for Employee Workplaces.
 - d. ANSI/NFPA 99: Standard for Healthcare Facilities.
 - e. ANSI/NFPA 101: Life Safety Code.
 - f. ANSI/NFPA 110: Emergency and Standby Power Systems.
 - g. ANSI/NFPA 780: Lightning Protection Code.
9. Occupational Safety and Health Administration - OSHA
10. State and local codes and ordinances
11. Underwriters Laboratory - UL

1.05 QUALIFICATIONS OF THE TESTING FIRM

- A. The testing firm shall be an independent testing organization which can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems evaluated by the testing firm.
- B. The testing firm shall be regularly engaged in the testing of electrical equipment devices, installations, and systems.
- C. The testing firm shall meet the criteria for Full Membership or be a Full Member company of the InterNational Electrical Testing Association.
- D. The lead, on site, technical person shall be currently certified by the InterNational Electrical Testing Association (NETA) or the National Institute for Certification in Engineering Technologies (NICET) in electrical power distribution system testing.
- E. The testing firm shall utilize technicians who are regularly employed by the firm for testing services.
- F. The testing firm shall submit proof of the above qualifications with bid documents when requested.

1.06 DIVISION OF RESPONSIBILITY

- A. The Electrical Subcontractor shall perform routine insulation-resistance, continuity, and rotation tests for all distribution and utilization equipment prior to, and in addition to, tests performed by the testing firm specified herein.
- B. The Electrical Subcontractor shall supply a suitable and stable source of electrical power to each test site. The testing firm shall specify the specific power requirements.
- C. The Electrical Subcontractor shall notify the testing firm when equipment becomes available for acceptance tests. Work shall be coordinated to expedite project scheduling.
- D. The Electrical Subcontractor shall supply a short-circuit analysis and coordination study, a protective device setting sheet, a complete set of electrical plans, specifications, and any pertinent change orders to the testing firm prior to commencement of testing.

- E. The Architect shall be notified prior to commencement of any testing.
- F. Any system, material, or workmanship which is found defective on the basis of acceptance tests shall be reported.
- G. The testing firm shall maintain a written record of all tests and shall assemble and certify a final test report.
- H. Safety and Precautions
 - 1. Safety practices should include, but are not limited to, the following requirements:
 - a. Occupational Safety and Health Act.
 - b. Accident Prevention Manual for Industrial Operations, National Safety Council.
 - c. Applicable state and local safety operating procedures.
 - d. Owner's safety practices.
 - e. ANSI/NFPA 70E, Electrical Safety Requirements for Employee Workplaces.
 - f. American National Standards for Personnel Protection: Lockout/Tagout.
 - 2. All tests shall be performed with apparatus de-energized except where otherwise specifically required.
 - 3. The testing organization shall have a designated safety representative on the project to supervise operations with respect to safety.

1.07 SUITABILITY OF TEST EQUIPMENT

- A. All test equipment shall be in good mechanical and electrical condition.
- B. Split-core current transformers and clamp-on or tong-type ammeters require careful consideration of the following in regard to accuracy:
 - 1. Position of the conductor within the core.
 - 2. Clean, tight fit of the core pole faces.
 - 3. Presence of external fields.
 - 4. Accuracy of the current transformer ratio in addition to the accuracy of the secondary meter.
- C. Selection of metering equipment should be based on a knowledge of the waveform of the variable being measured. Digital multimeters may be average or RMS sensing and may include or exclude the dc component. When the variable contains harmonics or dc offset and, in general, any deviation from a pure sine wave, average sensing, RMS scaled meters may be misleading.
- D. Field test metering used to check power system meter calibration must have an accuracy higher than that of the instrument being checked.
- E. Accuracy of metering in test equipment shall be appropriate for the test being performed but not in excess of two percent of the scale used.
- F. Waveshape and frequency of test equipment output waveforms shall be appropriate for the test and tested equipment.

1.08 TEST INSTRUMENT CALIBRATION

- A. The testing firm shall have a calibration program which assures that all applicable test instruments are maintained within rated accuracy.
- B. The accuracy shall be directly traceable to the National Institute of Standards and Technology. (NIST).
- C. Instruments shall be calibrated in accordance with the following frequency schedule:
 - 1. Field instruments: Analog, 6 months maximum; Digital, 12 months maximum
 - 2. Laboratory instruments: 12 months
 - 3. Leased specialty equipment: 12 months where accuracy is guaranteed by lessor.
- D. Dated calibration labels shall be visible on all test equipment.
- E. Records, which show date and results of instruments calibrated or tested, must be kept up-to-date.
- F. Up-to-date instrument calibration instructions and procedures shall be maintained for each test instrument.
- G. Calibrating standard shall be of higher accuracy than that of the instrument tested.

1.09 TEST REPORT

- A. The test report shall include the following:
 - 1. Summary of project.
 - 2. Description of equipment tested.
 - 3. Description of test.
 - 4. Test results.
 - 5. Analysis and recommendations.
- B. Furnish a copy or copies of the complete report to the Owner as required in the acceptance Contract.

PART 2 PRODUCTS NOT USED

PART 3 EXECUTION

3.01 SWITCHBOARD ASSEMBLIES

- A. Visual and Mechanical Inspection
 - 1. Compare equipment nameplate data with drawings and specifications.
 - 2. Inspect physical, electrical, and mechanical condition.
 - 3. Confirm correct application of manufacturer's recommended lubricants.
 - 4. Verify appropriate anchorage, required area clearances, physical damage, and correct alignment.

5. Inspect all doors, panels, and sections for paint, dents, scratches, fit, and missing hardware.
6. Verify that fuse and/or circuit breaker sizes and types correspond to drawings and coordination study as well as to the circuit breaker's address for microprocessor-communication packages.
7. Verify that current and potential transformer ratios correspond to drawings.
8. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
9. Confirm correct operation and sequencing of electrical and mechanical interlock systems.
 - a. Attempt closure on locked-open devices. Attempt to open locked-closed devices.
 - b. Make key exchange with devices operated in off-normal positions.
10. Inspect insulators for evidence of physical damage or contaminated surfaces.
11. Verify correct barrier and shutter installation and operation.
12. Exercise all active components.
13. Inspect all mechanical indicating devices for correct operation.
14. Verify that filters are in place and/or vents are clear.
15. Test operation, alignment, and penetration of instrument transformer withdrawal disconnects, current-carrying and grounding, as indicated elsewhere in these specifications.
16. Inspect control power transformers.
 - a. Inspect physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
 - b. Verify that primary and secondary fuse ratings or circuit breakers match drawings.
 - c. Verify correct functioning of drawout disconnecting and grounding contacts and interlocks.

B. Electrical Tests

1. Perform tests on all instrument transformers as indicated elsewhere in these specifications.
2. Perform ground resistance tests as indicated elsewhere in these specifications.
3. Perform resistance tests through all bus joints with a low-resistance ohmmeter. Any joints that cannot be directly measured due to permanently installed insulation wrap shall be indirectly measured from closest accessible connection.
4. Perform insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground.
5. After insulation resistance test levels are above minimum published values, perform an overpotential test on each bus section, each phase to ground with phases not under test grounded, in accordance with manufacturer's published data. The test voltage shall be applied for one minute.
6. Perform insulation-resistance tests at 1000 volts dc on all control wiring. Do not perform this test on wiring connected to solid-state components.
7. Perform control wiring performance test in accordance with System Function Tests indicated elsewhere in these specifications.
8. Perform current injection tests on the entire current circuit in each section of switchgear.
 - a. Perform current tests by primary injection, where possible, with magnitudes such that a minimum of 1.0 ampere flows in the secondary circuit.
 - b. Where primary injection is impractical, utilize secondary injection with a minimum current of 1.0 ampere.

- c. Test current at each device.
9. Determine accuracy of all meters and calibrate watt-hour meters in accordance with the metering section of these specifications. Verify multipliers.
 10. Perform phase arrangement check to ensure the bus bars are arranged "A", "B", "C", from front-to-back and/or top-to-bottom and/or left-to-right as viewed from the front of the equipment. In addition, on double-ended switchgear, ensure correct bus phasing from each source.
 11. Perform the following tests on control power transformers.
 - a. Perform insulation-resistance tests. Perform measurements from winding-to-winding and each winding-to-ground. Test voltages shall be in accordance with manufacturers published data.
 - b. Perform secondary wiring integrity test. Disconnect transformer at secondary terminals and connect secondary wiring to correct secondary voltage. Confirm potential at all devices.
 - c. Verify correct secondary voltage by energizing primary winding with system voltage. Measure secondary voltage with the secondary wiring disconnected.
 - d. Verify correct function of control transfer relays located in switchgear with multiple power sources in following energized source for control power transformers.
 12. Potential Transformer Circuits
 - a. Perform secondary wiring integrity test. Disconnect transformer at secondary terminals and connect secondary wiring to correct secondary voltage. Confirm correct potential at all devices.
 - b. Verify secondary voltage by energizing primary winding with system voltage. Measure secondary voltage with the secondary wiring disconnected.
 13. Verify operation of switchgear/switchboard heaters.

C. Test Values

1. Bolt-torque levels shall be in accordance with manufacturers published data.
2. Compare bus connection resistances to values of similar connections.
3. Insulation-resistance values for bus, control wiring, and control power transformers shall be in accordance with manufacturer's published data. Values of insulation resistance less than manufacturer's minimum should be investigated. Overpotential tests should not proceed until insulation-resistance levels are raised above minimum values.
4. Apply overpotential test voltages in accordance with manufacturer's recommendations. The insulation shall withstand the overpotential test voltage applied.

3.02 DRY TYPE TRANSFORMERS

- A. Air-Cooled, 600 Volt and Below - Small (167 kVA Single-Phase, 500 KVA Three-Phase, and Smaller)
 1. Compare equipment nameplate data with drawings and specifications.
 2. Inspect physical and mechanical condition.
 3. Verify that resilient mounts are free and that any shipping brackets have been removed.
 4. Perform insulation-resistance test. Calculate polarization index. Measurements shall be made from winding-to-winding and each winding-to-ground. Test voltages and minimum

resistance shall be in accordance with manufacturers published data. Results shall be temperature corrected as applicable.

5. Verify secondary voltage and make recommendations for tap setting changes.
- B. Air-Cooled, All Above 600 Volt and 600 Volt and Below - Large (Greater than 167 Single-Phase and 500 kVA Three-Phase)
1. Visual and Mechanical Inspection
 - a. Compare equipment nameplate data with drawings and specifications.
 - b. Inspect physical and mechanical condition.
 - c. Verify that control and alarm settings on temperature indicators are as specified.
 - d. Verify that cooling fans operate correctly and that fan motors have correct overcurrent protection.
 - e. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
 - f. Perform specific inspections and mechanical tests as recommended by manufacturer.
 - g. Make a close examination for shipping brackets or fixtures that may not have been removed during installation. Insure that resilient mounts are free.
 - h. Verify that winding core, frame, and enclosure grounding are correct.
 - i. Verify secondary voltage and make recommendations for tap setting changes.
 2. Electrical Tests
 - a. Perform insulation-resistance tests winding-to-winding and each winding-to-ground, with test voltage in accordance with manufacturers published data. Calculate polarization index.
 - b. Perform power-factor or dissipation-factor tests in accordance with the test equipment manufacturer's instructions.
 - c. Perform a turns-ratio test on all tap connections. Verify that winding polarities are in accordance with nameplate.
 - d. Perform an excitation-current test on each phase.
 - e. Measure the resistance of each winding at each tap connection.
 - f. Verify that core is solidly grounded. If core is insulated and a removable core ground strap is available, perform core insulation-resistance test at 500 volts dc.
 - g. Verify correct secondary voltage phase-to-phase and phase-to-neutral after energization and prior to loading.
 - h. Perform an overpotential test on all high- and low-voltage windings-to-ground.
 - i. Perform phase arrangement check to ensure the bus bars are arranged "A", "B", "C", from front-to-back and/or top-to-bottom and/or left-to-right as viewed from the front of the equipment.
- C. Test Values
1. Bolt-torque levels shall be in accordance with manufacturers published data.
 2. Insulation-resistance test values at one minute should not be less than values recommended by the manufacturer. Results shall be temperature corrected as applicable.
 3. The polarization index should be compared to manufacturer's factory test results. If manufacturer's data is not available, acceptance test results will serve as baseline data.
 4. Turns-ratio test results should not deviate more than one-half percent from either the adjacent coils or the calculated ratio.

5. C_H and C_L dissipation-factor/power-factor values will vary due to support insulators and bus work utilized on dry transformers. The following should be expected on C_{HL} power factors:
 - a. Power Transformers: two percent or less
 - b. Distribution Transformers: five percent or less
6. Consult transformer manufacturer's or test equipment manufacturer's data for additional information.
7. If winding-resistance test results vary more than one percent from adjacent windings, consult manufacturer.
8. Typical excitation current test data pattern for three-legged core transformer is two similar current readings and one lower current reading.
9. If core insulation resistance is less than one megohm at 500 volts dc, consult manufacturer.
10. AC overpotential test shall not exceed 75 percent of factory test voltage for one minute duration. DC overpotential test shall not exceed 100 percent of the factory RMS test voltage for one minute duration. The insulation shall withstand the overpotential test voltage applied.

3.03 CABLES - 600 VOLT, 60 AMPERES AND ABOVE

A. Visual and Mechanical Inspection

1. Compare cable data with drawings and specifications.
2. Inspect exposed sections of cables for physical damage and correct connection in accordance with single-line diagram.
3. Verify tightness of accessible bolted connections by calibrated torque wrench in accordance with manufacturer's published data.
4. Inspect compression-applied connectors for correct cable match and indentation.
5. Verify cable color coding with applicable engineer's specifications and National Electrical Code standards.

B. Electrical Tests

1. Perform insulation-resistance test on each conductor with respect to ground and adjacent conductors. Applied potential to be 1000 volts dc for one minute.
2. Perform continuity test to insure correct cable connection.

C. Test Values

1. Bolt-torque levels shall be in accordance with manufacturers published data.
2. Minimum insulation-resistance values shall be not less than 50 megohms.
3. Investigate deviations between adjacent phases.

3.04 METAL-ENCLOSED BUSWAYS

A. Visual and Mechanical Inspection

1. Compare equipment nameplate data with drawings and specifications.
2. Inspect busway for physical damage and correct connection in accordance with single-line diagram.
3. Inspect for appropriate bracing, suspension, alignment, and enclosure ground.

4. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
5. Confirm physical orientation in accordance with manufacturer's labels to insure adequate cooling.
6. Examine outdoor busway for removal of "weep-hole" plugs, if applicable, and the correct installation of joint shield.

B. Electrical Tests

1. Measure insulation resistance of each busway, phase-to-phase and phase-to-ground for one minute, in accordance with manufacturers published data.
2. Perform an overpotential test on each busway, phase-to-ground with phases not under test grounded, in accordance with manufacturer's published data. The test voltage shall be applied for one minute.
3. Perform contact-resistance test on each connection point of non-insulated busway. On insulated busway, measure resistance of assembled busway sections and compare values with adjacent phases.
4. Perform phasing test on each busway tie section energized by separate sources. Tests must be performed from their permanent sources.
5. Perform phase arrangement check to ensure the bus bars are arranged "A", "B", "C", from front-to-back and/or top-to-bottom and/or left-to-right as viewed from the front of the equipment.

C. Test Values

1. Bus bolt-torque levels shall be in accordance with manufacturers published data.
2. Insulation-resistance test voltages and resistance values shall be in accordance with manufacturer's specifications. Minimum resistance values are for a nominal 1000-foot busway run or megohms for 1000 feet. For busway runs over 1000 feet, derate accordingly by the formula:

$$R_{1000ft} = \text{Measured Resistance} \times \text{Length of Run}/1000$$

Values of insulation resistance less than manufacturer's minimum should be investigated. Overpotential tests should not proceed until insulation-resistance levels are raised above minimum values.

3. Overpotential test voltages shall be applied in accordance with manufacturer's recommendations. The insulation shall withstand the overpotential test voltage applied.

3.05 INSULATED CASE/MOLDED CASE CIRCUIT BREAKERS (400 AMPERES AND ABOVE)

A. Visual and Mechanical Inspection

1. Compare nameplate data with drawings and specifications.
2. Inspect circuit breaker for correct mounting.
3. Operate circuit breaker to insure smooth operation.
4. Inspect case for cracks or other defects.
5. Verify tightness of accessible bolted connections and/or cable connections by calibrated torque-wrench method in accordance with manufacturer's published data.
6. Inspect mechanism contacts and arc chutes in unsealed units.

B. Electrical Tests

1. Perform a contact-resistance test.
2. Perform an insulation-resistance test at 1000 volts dc from pole-to-pole and from each pole-to-ground with breaker closed and across open contacts of each phase.
3. Perform adjustments for final settings in accordance with coordination study supplied by Electrical Subcontractor.
4. Perform long-time delay time-current characteristic tests by passing 300 percent rated current through each pole separately unless series testing is required to defeat ground fault functions.
5. Determine short-time pickup and delay by primary current injection.
6. Determine ground-fault pickup and time delay by primary current injection.
7. Determine instantaneous pickup current by primary injection using run-up or pulse method.
8. Verify correct operation of any auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, and anti-pump function.
9. For all circuit breakers with solid state trip units, verify the calibration of all functions of the trip unit by means of secondary injection.

C. Test Values

1. Bolt-torque levels shall be in accordance with manufacturers published data.
2. Compare microhm or millivolt drop values to adjacent poles and similar breakers. Investigate deviations of more than 25 percent. Investigate any value exceeding manufacturer's recommendations.
3. Insulation resistance shall not be less than 100 megohms.
4. Trip characteristic of breakers shall fall within manufacturer's published time-current characteristic tolerance band, including adjustment factors.
5. For molded-case circuit breakers all trip times shall fall within times indicated in Table 5-3 of NEMA Standard AB4-1991. Circuit breakers exceeding specified trip time at 300 percent of pickup shall be tagged defective.
6. For molded-case circuit breakers instantaneous pickup values shall be within values shown on Table 5-4 of NEMA Standard AB4-latest adopted edition.

3.06 INSTRUMENT TRANSFORMERS**A. Visual and Mechanical Inspection**

1. Compare equipment nameplate data with drawings and specifications.
2. Inspect physical and mechanical condition.
3. Verify correct connection of transformers with system requirements.
4. Verify that adequate clearances exist between primary and secondary circuit wiring.
5. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
6. Verify that all required grounding and shorting connections provide contact.
7. Verify correct operation of transformer withdrawal mechanism and grounding operation.
8. Verify correct primary and secondary fuse sizes for potential transformers.

B. Electrical Tests - Current Transformers

1. Perform insulation-resistance test of the current transformer and wiring-to-ground at 1000 volts dc. Do not perform this test on solid-state devices.
2. Perform a polarity test of each current transformer.

3. Perform a ratio-verification test using the voltage or current method in accordance with ANSI C57.13.1 (IEEE Guide for Field Testing of Relaying Current Transformers).
4. Perform an excitation test on transformers used for relaying applications in accordance with ANSI C57.13.1. (IEEE Guide for Field Testing of Relaying Current Transformers).
5. Measure current circuit burdens at transformer terminals and determine the total burden.
6. When applicable, perform insulation-resistance and dielectric withstand tests on the primary winding with secondary grounded. Test voltages shall be in accordance with NETA standards and ANSI C57.13-1993 respectively.

C. Electrical Tests - Voltage Transformers

1. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Test voltages shall be applied for one minute in accordance with NETA standards. Do not perform this test with solid-state devices connected.
2. Perform a polarity test on each transformer to verify the polarity marks or H1-X1 relationship as applicable.
3. Perform a turns ratio test on all tap positions, if applicable.
4. Measure potential circuit burdens at transformer terminals and determine the total burden.

D. Test Values

1. Insulation-resistance measurement on any instrument transformer shall be not less than NETA standards.
2. Polarity results shall agree with system drawings.
3. Compare measured burdens to calculated burdens supplied by owner.
4. Ratio accuracy shall be within 0.5 percent of nameplate or manufacturer's published data.
5. The insulation shall withstand the overpotential test voltage applied.

3.07 METERING

A. Visual and Mechanical Inspection

1. Compare equipment nameplate data with drawings and specifications.
2. Inspect physical and mechanical condition.
3. Verify tightness of electrical connections.
4. Inspect cover gasket, cover glass, condition of spiral spring, disc clearance, contacts, and case-shorting contacts, as applicable.
5. Verify mechanically for freedom of movement, correct travel and alignment, and tightness of mounting hardware.

B. Electrical Tests

1. Check calibration of meters at all cardinal points.
2. Calibrate watt-hour meters according to manufacturer's published data.
3. Verify all instrument multipliers.

C. Electrically confirm that current transformer and voltage transformer secondary circuits are intact.

3.08 GROUNDING SYSTEMS

A. Visual and Mechanical Inspection

1. Verify ground system is in compliance with drawings and specifications.

B. Electrical Tests

1. Perform fall-of-potential test or alternative in accordance with IEEE Standard 81-1991 on the main grounding electrode or system.
2. Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and/or derived neutral points.

C. Test Values

1. The resistance between the main grounding electrode and ground should be no greater than five ohms for commercial or industrial systems and one ohm or less for generating or transmission station grounds unless otherwise specified by the owner. (Reference: IEEE Standard 142.)
2. Investigate point-to-point resistance values which exceed 0.5 ohm.

3.09 GROUND-FAULT PROTECTION SYSTEMS

A. Visual and Mechanical Inspection

1. Compare equipment nameplate data with drawings and specifications.
2. Visually inspect the components for damage and errors in polarity or conductor routing.
 - a. Verify that ground connection is made ahead of neutral disconnect link and on the line side of any ground fault sensor.
 - b. Verify that neutral sensors are connected with correct polarity on both primary and secondary.
 - c. Verify that all phase conductors and the neutral pass through the sensor in the same direction for zero sequence systems.
 - d. Verify that grounding conductors do not pass through zero sequence sensors.
 - e. Verify that the grounded conductor is solidly grounded.
3. Verify tightness of all electrical connections including control circuits.
4. Verify correct operation of all functions of the self-test panel.
5. Verify that the control power transformer has adequate capacity for the system.
6. Set pickup and time-delay settings in accordance with the settings provided in the Owner's specifications. Record appropriate operation and test sequences as required by NEC Article 230-95.

B. Electrical Tests

1. Measure the system neutral-to-ground insulation resistance with the neutral disconnect link temporarily removed. Replace neutral disconnect link after testing.
2. Perform the following pickup tests using primary injection:
 - a. Verify that the relay does not operate at 90 percent of the pickup setting.

- b. Verify pickup is less than 125 percent of setting or 1,200 amperes, whichever is smaller.
3. For summation type systems utilizing phase and neutral current transformers, verify correct polarities by applying current to each phase-neutral current transformer pair. This test also applies to molded-case breakers utilizing an external neutral current transformer.
 - a. Relay should operate when current direction is the same relative to polarity marks in the two current transformers.
 - b. Relay should not operate when current direction is opposite relative to polarity marks in the two current transformers.
4. Measure time delay of the relay at 150 percent or greater of pickup.
5. Verify reduced control voltage tripping capability: 55 percent for ac systems and 80 percent for dc systems.
6. Verify blocking capability of zone interlock systems.

C. Test Values

1. System neutral-to-ground insulation shall be a minimum of one megohm.
2. Insulation resistance values shall be in accordance with NETA standards.
3. Relay timing shall be in accordance with manufacturer's specifications but must be no longer than one second at 3,000 amperes.

3.10 INDUCTION MOTORS

A. Visual and Mechanical Inspection

1. Compare equipment nameplate data with drawings and specifications.
2. Inspect physical and mechanical condition.
3. Inspect for correct anchorage, mounting, grounding, connection, and lubrication.
4. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
5. When applicable, perform special tests such as air gap spacing and pedestal alignment.
6. Verify the absence of unusual mechanical or electrical noise or signs of overheating during initial test run.

B. Electrical Tests

1. Perform insulation-resistance tests in accordance with ANSI/IEEE Standard 43.
 - a. For motors larger than 200 horsepower, Test duration shall be for ten minutes. Calculate polarization index.
 - b. For motors 200 horsepower and less, Test duration shall be for one minute. Calculate the dielectric-absorption ratio.
2. Perform dc overpotential tests on motors rated at 1,000 horsepower and greater and at 4,000 volts and greater in accordance with ANSI/IEEE Standard 95.
3. Perform insulation-resistance test on pedestal in accordance with manufacturer's published data.
4. Test surge protection devices as indicated elsewhere in these specifications.
5. Test motor starter as indicated elsewhere in these specifications.

6. Verify that resistance temperature detector (RTD) circuits conform to drawings. Verify that metering or relaying devices using the RTD's have the correct rating.
7. Verify that the motor space heater is functional.
8. Perform a rotation test to insure correct shaft direction.
9. Measure running current and evaluate relative to load conditions and nameplate full-load amperes.
10. Perform vibration tests:
 - a. For motors larger than 200 horsepower, Perform vibration baseline test. Plot amplitude versus frequency.
 - b. For motors 200 horsepower and less, Perform vibration amplitude test.

C. Test Values

1. Bolt-torque levels shall be in accordance with manufacturers published data.
2. Insulation-resistance test results should comply with values listed NETA standards. Investigate dielectric absorption ratios less than 1.4 and polarization index ratios less than 2.0 for Class B and Class F insulation.

NOTE: Overpotential, high-potential, and surge comparison tests shall not be made on motors having values lower than those indicated above.

3. Stator winding dc overpotential test voltage shall be in accordance with NEMA publication MG 1, paragraph 3.01. Test results are dependent on ambient conditions, and evaluation is on a withstand basis. If phase windings can be separately tested, values of leakage current may be compared for similar windings.
4. Vibration amplitudes shall not exceed values shown in MG 1-1987.
5. Salient pole voltage drop should be equal for each pole. Investigate values that differ by more than ten percent.
6. The measured resistance values of motor-field winding, exciter-stator winding, exciter-rotor windings, and field-discharge resistors shall be compared to manufacturer's recommended values.

3.11 LOW-VOLTAGE SURGE PROTECTION DEVICES

A. Visual and Mechanical Inspection

1. Compare equipment nameplate data with drawings and specifications.
2. Inspect physical and mechanical condition.
3. Inspect for correct mounting and adequate clearances.
4. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
5. Verify that the ground lead on each device is individually attached to a ground bus or ground electrode.

B. Electrical Tests

1. Perform insulation-resistance tests. Use manufacturer's recommended values.

C. Test Values

1. Bolt-torque levels shall be in accordance with manufacturers published data.
2. Insulation-resistance values shall be in accordance with NETA standards.

3.12 AUTOMATIC TRANSFER SWITCHES

A. Visual and Mechanical Inspection

1. Compare equipment nameplate data with drawings and specifications.
2. Inspect physical and mechanical condition.
3. Confirm correct application of manufacturer's recommended lubricants.
4. Verify that manual transfer warnings are attached and visible.
5. Verify tightness of all control connections.
6. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
7. Perform manual transfer operation.
8. Verify positive mechanical interlocking between normal and alternate sources.

B. Electrical Tests

1. Measure contact-resistance.
2. Perform insulation-resistance tests, phase-to-phase and phase-to-ground, with switch in both source positions.
3. Verify settings and operation of control devices.
4. Calibrate and set all relays and timers as indicated elsewhere in these specifications.
5. Perform automatic transfer tests:
 - a. Simulate loss of normal power.
 - b. Return to normal power.
 - c. Simulate loss of emergency power.
 - d. Simulate all forms of single-phase conditions.
6. Verify correct operation and timing of the following functions:
 - a. Normal source voltage-sensing relays.
 - b. Engine start sequence.
 - c. Time delay upon transfer.
 - d. Alternate source voltage-sensing relays.
 - e. Automatic transfer operation.
 - f. Interlocks and limit switch function.
 - g. Time delay and retransfer upon normal power restoration.
 - h. Engine cooldown and shutdown feature.
7. Perform phase arrangement check to ensure the bus bars are arranged "A", "B", "C", from front-to-back and/or top-to-bottom and/or left-to-right as viewed from the front of the equipment. In addition, ensure correct bus phasing from each source.

C. Test Values

1. Bolt-torque levels shall be in accordance with manufacturers published data.
2. Insulation-resistance test voltages and minimum values shall be in accordance with NETA standards.
3. Compare microhm values to adjacent poles and similar switches. Investigate deviations of more than 25 percent.

3.13 SYSTEM FUNCTION TESTS

- A. Perform system function tests upon completion of equipment tests. It is the purpose of system function tests to prove the correct interaction of all sensing, processing, and action devices.
- B. Implementation
 - 1. Develop test parameters for the purpose of evaluating performance of all integral components and their functioning as a complete unit within design requirements. Perform these tests.
 - 2. Verify the correct operation of all interlock safety devices for fail-safe functions in addition to design function.
 - 3. Verify the correct operation of all sensing devices, alarms, and indicating devices.
 - 4. Testing of emergency distribution systems shall be performed with normal building power off. Time and duration of test shall be coordinated and scheduled with the Owner.

END OF SECTION

SECTION 260584

THROUGH-PENETRATION FIRESTOP SYSTEMS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Section 26 0510 and Division 1 Specification Sections, apply to this Section.

1.02 WORK INCLUDED

- A. Through-penetration firestop systems for penetrations through the following fire-resistance-rated assemblies, including both empty openings and openings containing penetrating items:
 - 1. Floors
 - 2. Roofs
 - 3. Walls and partitions
 - 4. Smoke barriers
 - 5. Construction enclosing compartmentalized areas.
 - 6. Other rated assemblies.

1.03 RELATED SECTIONS

- A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

- A. American Society for Testing and Materials Standards (ASTM):
 - 1. ASTM E84: Standard Test Method for Surface Burning Characteristics of Building Materials
 - 2. ASTM E814: Standard Test Methods for Fire Tests of Through-Penetration Firestops
 - 3. ASTM E119: Standard Test Methods for Fire Tests of Building Construction Materials
 - 4. ASTM E1399: Standard Test Methods for Cyclic Movement and Measuring of Joint Systems
 - 5. ASTM E1725: Standard Test Methods for Fire Tests of Fire-Resistive Barrier Systems of Electrical Systems Components
 - 6. ASTM E1966: Standard Test Methods for Fire Tests of Joints
- B. Underwriters Laboratories, Inc. (UL):
 - 1. UL 723 Surface Burning Characteristics of Building Materials
 - 2. UL 1479 Fire Tests of Through-Penetration Firestops, including optional air leak test
 - 3. UL 2079 Fire Test of Building Joint Firestop systems
 - 4. UL Fire Resistance Directory (Component Listing Test Criterion)
- C. National Fire Protection Agency (NFPA)
 - 1. NFPA 80 Standard for Fire Doors and Other Opening Protectives

2. NFPA 252 Standard Method of Fire Tests of Doors Assemblies
3. NFPA 257 Standard on Fire Test for Windows and Glass Block Assemblies
4. NFPA 101 Life Safety Code
5. NFPA 70 National Electrical Code

1.05 PERFORMANCE REQUIREMENTS

- A. General: For the following constructions, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assembly penetrated.
1. Fire-resistance-rated load-bearing walls, including partitions, with fire-protection-rated openings.
 2. Fire-resistance-rated non-load-bearing walls, including partitions, with fire-protection-rated openings.
 3. Fire-resistance-rated floor assemblies.
 4. Fire-resistance-rated roof assemblies.
- B. F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, as determined per ASTM E 814, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.
- C. T-Rated Systems: For the following conditions, provide through-penetration firestop systems with T-ratings indicated, as well as F-ratings, as determined per ASTM E 814, where systems protect penetrating items exposed to potential contact with adjacent materials in occupiable floor areas.
1. Penetrations located outside wall cavities.
 2. Penetrations located outside fire-resistive shaft enclosures.
 3. Penetrations located in construction containing fire-protection rated openings.
 4. Penetrating items larger than 4-inch diameter normal pipe or 16 sq. in. in overall cross-sectional area.
- D. For through-penetration firestop systems exposed to view, traffic, moisture, and physical damage, provide product that after curing do not deteriorate when exposed to these conditions both during and after construction.
1. For floor penetrations with annular spaces exceeding 4 inches in width and exposed to possible loading and traffic, provide firestop systems capable of supporting floor loads involved either by installing floor plates or by other means.
 2. For penetrations involving insulated piping, provide through-penetration firestop systems not requiring removal of insulation.
- E. For through-penetration firestop systems exposed to view, provide products with flame-spread ratings of less than 25 and smoke-development ratings of less than 50, as determined per ASTM E 84.

1.06 SUBMITTALS

- A. Prepare and submit shop drawings in accordance with the requirements hereinbefore specified, and with Section 01 3300 – Submittal Procedures in the manner described therein, modified as noted hereinafter.

- B. See Section 26 0510 and General Conditions for additional requirements.
- C. Product Data: For each type through-penetration firestop system product indicated.
- D. Shop Drawings: For each through-penetration firestop system show each kind of construction condition penetrated, relationships to adjoining construction, and kind of penetrating items. Include firestop design designation of testing and inspecting agency acceptable to authorities having jurisdiction that evidences compliance with requirements for each condition indicated.
 - 1. Submit documentation, including illustrations, from a qualified testing and inspecting agency that is applicable to each through-penetration firestop system configuration for construction and penetrating items.
 - 2. Where Project conditions require modification of qualified testing and inspecting agency's illustration to suit a particular through-penetration firestop condition, submit illustration, with modifications marked, approved by through-penetration firestop system manufacturer's fire-protection engineer.
- E. Submit complete plans indicating clearly where all seals are located and the type of seal to be used at that location
- F. Qualification Data: For firms and persons specified to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- G. Product Certificates: Signed by manufacturers of through-penetration firestop system products certifying that products furnished comply with requirements.
- H. Product Test Reports: From a qualified testing agency indicating through-penetration firestop system complies with requirements, based on comprehensive testing of current products.

1.07 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed through-penetration firestop systems similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- B. Source Limitations: Obtain through-penetration firestop systems, for each kind of penetration and construction condition indicated, from a single manufacturer.
- C. Fire-Test-Response Characteristics: Provide through-penetration firestop systems that comply with the following requirements and those specified in "Performance Requirements" Article:
 - 1. Through-Penetration Firestop Systems tests are performed by a qualified testing and inspecting agency. A qualified testing and inspecting agency is UL, ITS, or another agency performing testing and follow-up inspection services for firestop systems acceptable to authorities having jurisdiction.
 - 2. Through-penetration firestop systems are identical to those tested per ASTM E 814. Provide rated systems complying with the following requirements:
 - a. Through-penetration firestop system products bear classification marking of qualified testing and inspecting agency.

- b. Through-penetration firestop systems correspond to those indicated by reference to through-penetration firestop system designations listed by the following:

- 1) UL in "Fire Resistance Directory."
- 2) ITS in "Directory of Listed Products."

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Deliver through-penetration firestop system products to Project site in original, unopened containers or packages with intact and legible manufacturers' labels identifying product and manufacturer, date of manufacture; lot number; shelf life, if applicable, qualified testing and inspecting agency's classification marking applicable to Project; curing time; and mixing instructions for multi-component materials.
- B. Store and handle materials for through-penetration firestop systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.09 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install through-penetration firestop systems when ambient or substrate temperatures are outside limits permitted by through penetration firestop system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.
- B. Ventilate through-penetration firestop systems per manufacturer's written instructions by natural means or, where this is inadequate, forced-air circulation.

1.10 COORDINATION

- A. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.
- B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.
- C. Notify Owner's inspecting agency at least seven days in advance of through-penetration firestop system installations; confirm dates and times on days preceding each series of installations.
- D. Do not cover up through-penetration firestop system installations that will become concealed behind other construction until Owner's inspecting agency and building inspector, if required by authorities having jurisdiction, have examined each installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable manufacturers subject to compliance with the specifications shall be one of following:
 - 1. A/D Fire Protection Systems, Inc.
 - 2. Hilti Construction Chemicals, Inc.
 - 3. Nelson Firestop Products
 - 4. RectorSeal Corporation (The)
 - 5. Specified Technologies Inc.

6. 3M Fire Protection Products
7. Tremco
8. United States Gypsum Company

2.02 FIRESTOPPING GENERAL

- A. **Compatibility:** Provide through-penetration firestop systems that are compatible with one another, with the substrates forming openings, and with the items, if any, penetrating through-penetration firestop systems, under conditions of service and application, as demonstrated by through-penetration firestop system manufacturer based on testing and fired experience.
- B. **Accessories:** Provide components for each through-penetration firestop system that are needed to install fill materials and to comply with "Performance Requirements" Article. Use only components specified by through-penetration firestop system manufacturer and approved by the qualified testing and inspecting agency for firestop systems indicated. Accessories include, but are not limited to, the following items:
 1. Permanent forming/damming/backing materials, including the following:
 - a. Slag-/rock-wool-fire insulation.
 - b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
 - c. Fire-rated form board
 2. Temporary forming materials
 3. Substrate primers
 4. Collars
 5. Steel sleeves

2.03 MIXING

- A. For those products requiring mixing before application, comply with through-penetration firestop system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Surface Cleaning: Clean out openings immediately before installing through-penetration firestop systems to comply with written recommendations of firestop systems manufacturer and the following requirements:
 - 1. Remove from surfaces of openings substrates and from penetrating items foreign materials that could interfere with adhesion of through-penetration firestop systems.
 - 2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with through-penetration firestop systems. Remove loose particles remaining from cleaning operation.
 - 3. Remove laitance and form-release agents from concrete.
- B. Priming: Prime substrates where recommended in writing by through-penetration firestop system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.
- C. Masking Tape: Use masking tape to prevent through-penetration firestop systems from contacting adjoining surfaces that will remain exposed on completion of Work and that would otherwise be permanently stained or damaged by such contactor by cleaning methods used to remove smears from firestop systems materials. Remove tape as soon as possible without disturbing firestop system's seal with substrates.

3.03 THROUGH-PENETRATION FIRESTOP SYSTEM INSTALLATION

- A. General: Install through-penetration firestop systems to comply with "Performance Requirements" Article and firestop system manufacturer's written installation instructions and published drawings for products and applications indicated.
- B. Install forming/damming/backing materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
 - 1. After installing fill materials, remove combustible forming materials and other accessories not indicated as permanent components of firestop systems.
- C. Install fill materials for firestop systems by proven techniques to produce the following results:
 - 1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
 - 2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
 - 3. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.04 FIELD-QUALITY CONTROL

- A. Inspecting Agency: Owner will engage a qualified independent inspecting agency to inspect through-penetration firestop systems and to prepare test reports.
 - 1. Inspecting agency will state in each report whether inspected through-penetration firestop systems comply with or deviate from requirements.

- B. Proceed with enclosing through-penetration firestop systems with other construction only after inspection reports are issued.
- C. Where deficiencies are found, repair or replace through-penetration firestop systems so they comply with requirements.

3.05 IDENTIFICATION

- A. Identify through-penetration firestop systems with pressure-sensitive, self-adhesive, preprinted vinyl labels. Attach labels permanently to surfaces of penetrated construction on both sides of each firestop system installation where labels will be visible to anyone seeking to remove penetrating items or firestop systems. Include the following information on labels.
 - 1. The words: "Warning-Through-Penetration Firestop System-Do Not Disturb. Notify Building Management of Any Damage."
 - 2. Contractor's name, address, and phone number.
 - 3. Through-penetration firestop systems designation of applicable testing and inspecting agency.
 - 4. Date of installation.
 - 5. Through-penetration firestop systems manufacturer's name.
 - 6. Installer's name.

3.06 CLEANING AND PROTECTION

- A. Clean off excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not damage materials in which openings occur.
- B. Provide final protection and maintain conditions during and after installation that ensure through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce through-penetration firestop systems complying with specified requirements.

END OF SECTION

SECTION 262010

LOW VOLTAGE DISTRIBUTION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. All of the Contract Documents, as listed on the Table of Contents and including General and Supplementary Conditions and Division 01, General Requirements, shall be included in, and made part of, this Section.

1.02 DESCRIPTION OF WORK

- A. The Electrical Subcontractor shall furnish and install the low voltage distribution equipment as specified herein and as shown on the contract drawings.
- B. The following low voltage distribution equipment shall be provided for the renovated areas of the existing building, as a minimum, but not necessarily limited to the following:

1. Normal distribution system.
2. Life safety distribution system
3. Critical branch distribution system
4. Equipment branch distribution system
5. Grounding.
6. Hoisting, rigging, setting of all equipment.
7. Testing, cleaning and adjusting.
8. Power company related work and backcharges.
9. Shop drawings.
10. Power system studies and trip settings.
11. Phasing of construction and power interruptions.
12. Busway.
13. Enclosed circuit breakers.
14. Fuses
15. Motor controllers - magnetic starters.
16. Motor disconnect devices.
17. Panelboards - branch circuit and distribution. (100A-1200A)
18. Safety switches.
19. Switchboards (1600-4000A).
20. Transformers - dry type.

1.03 RELATED WORK

- A. For work to be included as part of this Section, to be furnished and installed by the Electrical Subcontractor, refer to the Related Work section of Specification Section 26 0510.
- B. Carefully examine all of the Contract Documents, criteria sheets and all other Sections of the specifications for requirements which affect work under this Section, whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

- A. Low voltage distribution equipment and all components shall be designed, manufactured and tested in accordance with the latest applicable standards of ANSI, NEMA and UL as follows:
1. Busway
 - a. NEMA BU.1.
 - b. ANSI/UL 857.
 - c. CSA
 2. Molded Case Circuit Breakers
 - a. UL 489 - Molded Case Circuit Breakers
 - b. NEMA AB1 - Molded Case Circuit Breakers
 - c. NEMA 250 - Enclosures for Electrical Equipment
 - d. Fed. Spec. W-C-375a
 3. Low Voltage Switchboards
 - a. UL 891
 - b. NEMA PB-2
 4. Motor Starters
 - a. NEMA
 - b. ANSI
 - c. UL 845
 5. Panelboards
 - a. UL 67 – Panelboards
 - b. UL 50 – Cabinets and boxes
 - c. NEMA PB-1
 - d. Fed. Spec. W-P115C
 - e. Fed. Spec. W-C-375a
 - f. Circuit Breaker – Type I, class I
 - g. Fusible Switch – Type II, class I

1.05 QUALITY ASSURANCE

- A. The manufacturers listed within this specification have been preselected for use on this project. No submittal will be accepted from a manufacturer other than specified.
- B. To ensure system compatibility, all low voltage distribution equipment shall be the products of one manufacturer.

1.06 WARRANTY

- A. Attention is directed to provisions of the General Requirements, Supplementary General Requirements and Section 26 0510 regarding guarantees and warranties for the work under this Contract.

1.07 QUALIFICATIONS

- A. The manufacturer of the low voltage distribution equipment shall be the manufacturer of the major components within the equipment.
- B. For the equipment specified herein, the manufacturer shall be ISO 9000, 9001 or 9002 certified.
- C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
- D. The low voltage distribution equipment shall be suitable for and certified to meet all applicable seismic requirements of the latest accepted edition of the Connecticut State Building Code for seismic zone 2 application. Guidelines for the installation consistent with these requirements shall be provided by the switchgear manufacturer and be based upon testing of representative equipment. The test response spectrum shall be based upon a 5% minimum damping factor, with a peak acceleration and ZPA as required per the Code. The tests shall fully envelope the response spectrum for all equipment natural frequencies up to at least 35 Hz.

1.08 DELIVERY, STORAGE AND HANDLING

- A. Manufacturer's directions shall be followed completely in the delivery, storage, protection and installation. Promptly notify the Architect in writing of any conflict between any requirements of the Contract Documents and the manufacturer's directions. Obtain the Architect's written instructions before proceeding with the work. Should Electrical Subcontractor perform any work that does not comply with the manufacturer's directions or written instructions from the Architect, he shall bear all costs arising in correcting any deficiencies that should arise.
- B. Equipment and materials shall be delivered to the site and stored in original sealed containers, suitably sheltered from the elements, but readily accessible for inspection by the Architect until installed. All items subject to moisture damage such as controls shall be stored in dry, heated spaces. Equipment such as switchgear with heater elements installed shall have the heater elements energized after the equipment is received by the Electrical Subcontractor.
- C. The Electrical Subcontractor shall be responsible to fully inspect all shipments for damage and report damage to the manufacturer and the Architect.
- D. Equipment shall be tightly covered and protected against dirt, water, and chemical or mechanical injury and theft. At the completion of the work, equipment and materials shall be cleaned and polished thoroughly and turned over to the Owner in a condition satisfactory to the Architect. Damage or defects that develop before acceptance of the work shall be made good at the Electrical Subcontractor's expense.
- E. The Electrical Subcontractor shall make necessary field measurements to ascertain space requirements, for equipment and connections to be provided under his respective Trade and shall furnish and install such sizes and shapes of equipment to allow for the final installation to conform to the drawings and specifications.

- F. The low voltage distribution equipment shall be split into shipping groups for handling as directed by the Electrical Subcontractor or as the manufacturer's limitations dictate. Shipping groups shall be designed to be shipped by truck, rail or ship. Shipping groups shall be bolted to skids. Accessories shall be packaged and shipped separately. Each switchgear shipping group shall be equipped with lifting eyes for handling solely by crane.
- G. The low voltage distribution equipment being stored prior to installation shall be stored so as to maintain the equipment in a clean and dry condition. If stored outdoors, indoor gear shall be covered and heated, and outdoor gear shall be heated.

1.09 ACCEPTABLE MANUFACTURERS

- A. Eaton
- B. General Electric
- C. Square D

1.10 SELECTIVE COORDINATION

- A. The emergency distribution system, the elevator distribution system and the fire pump distribution system shall be selectively coordinated to meet the requirements of the National Electrical Code, Articles 620.62, 700.28, and 701.27 and NFPA 20.
- B. For system reliability, the entire normal distribution system shall be coordinated down to 0.10 seconds to the extent practicable.
- C. The switchgear manufacturer shall be responsible to select appropriate overcurrent protective device, fuse and/or circuit breaker frame, sensor and trip sizes for all devices upstream of other devices for a completely coordinated system. Refer to specification 26 0570 for additional information.

1.11 WITHSTAND AND INTERRUPTING RATINGS OF ELECTRICAL COMPONENTS

- A. Calculated available 3 phase and single phase to ground short circuit currents indicated on the drawings are provided for information only to assist in the selection of withstand and interrupting ratings and coordination of devices and equipment.
- B. Prior to submission of shop drawings, the manufacturer shall perform short circuit calculations in accordance with specification section 26 0570 to determine actual available 3 phase and single line to ground short circuit current at each component in the system based on actual equipment, feeder lengths, impedances, etc. of the equipment proposed for this project. Failure to perform the study prior to submission of shop drawings shall not relieve the manufacturer from providing devices that meet the requirements of the final study report.
- C. Each component shall be UL listed and labeled and shall be fully rated to withstand and interrupt calculated available 3 phase and single phase to ground short circuit current levels. Series ratings will not be acceptable.

1.12 SUBMITTALS

- A. Prepare and submit shop drawings in accordance with the requirements hereinbefore specified, and with Section 01 3300 – Submittal Procedures in the manner described therein, modified as noted hereinafter.
- B. All shop drawings shall have clearly marked the appropriate specification number of drawing designation, for identification of the submittal.
- C. Disposition of shop drawings shall not relieve the Electrical Subcontractor from the responsibility for deviations from drawing or specifications, unless he has submitted in writing a letter itemizing or calling attention to such deviations at time of submission and secured written approval from the Engineer, nor shall such disposition of shop drawings relieve the Electrical Subcontractor from responsibility for errors in shop drawings or schedules.
- D. Power system study report shall be submitted in advance, or in conjunction with low voltage distribution equipment shop drawings. If formal completion of the studies may cause delay in equipment manufacture, approval from the Architect may be requested to select device ratings and characteristics based on a preliminary submittal of the study using available data and reasonable assumptions. Any changes required as a result of the final power system study shall be made at no additional cost to the Owner
- E. Shop drawings shall include, but shall not be limited to, the following:
1. Busway.
 2. Enclosed circuit breakers.
 3. Fuses
 4. Motor controllers - magnetic starters.
 5. Motor disconnect devices.
 6. Panelboards - branch circuit and distribution. (100A-1200A)
 7. Power system studies and trip settings.
 8. Safety switches.
 9. Switchboards (1600-4000A).
 10. Transformers - dry type.
- F. The following equipment rooms, drawn at ¼"=1'-0" scale, with all the electrical equipment laid out including dimensions, Code clearances, etc., shall be submitted with the equipment shop drawings. Acceptance of these shop drawings shall be obtained prior to installation of feeder conduits:
1. Main electric room
 2. Main emergency electric room
 3. All satellite normal and emergency electrical rooms and closets.

Notes:

Equipment shop drawings will not be reviewed without the room/equipment layouts.

The Architect/Engineer reserve the right to rearrange equipment in electrical equipment rooms or spaces once final equipment dimensional information is known and prior to installation of the equipment. Install equipment in the final location selected by the Architect/Engineer at no additional cost to the Owner.

G. The switchgear manufacturer shall submit the following information with each submittal:

1. Master drawing index.
2. Front view elevation.
3. Floor plan.
4. Top view.
5. Single line.
6. Control schematics and wiring diagrams.
7. Nameplate schedule.
8. Component list/bill of material.
9. Conduit entry/exit locations.
10. Assembly ratings including:
 - a. Short circuit rating.
 - b. Information regarding series short circuit ratings.
 - c. Voltage.
 - d. Continuous current.
 - e. Basic Impulse level for equipment over 600 volts.
 - f. KVA.
11. Major component ratings including:
 - a. Voltage.
 - b. Continuous current.
 - c. Interrupting ratings.
12. Cable terminal sizes.
13. Connection details between close-coupled assemblies.
14. Composite floor plan of close-coupled assemblies.
15. Impedance for transformers.
16. Manufacturer's catalog data sheets.
17. Test reports.
18. The following additional information shall be submitted to the Engineer:
 - a. Busway connection.
 - b. Key interlock scheme drawing and sequence of operations.
19. The following product information shall be submitted:
 - a. Descriptive bulletins.
 - b. Product sheets.

1.13 CLOSEOUT SUBMITTALS AND O & M MANUALS

A. The following information shall be submitted for record purposes, in a binder, prior to final payment:

1. Final as-built drawings and information for items listed above.
2. Operation and maintenance manuals with the following information:
 - a. Instruction books and/or instruction leaflets
 - b. Recommended renewal parts
3. Wiring diagrams.

4. Certified production test reports.
5. Installation information.
6. Seismic certification and equipment anchorage details.

PART 2 PRODUCTS

2.01 BUSWAY - LOW-VOLTAGE

A. Ratings

1. The busway shall be 3 phase, 4 wire, with voltage and current ratings as indicated on the Contract Drawings. Busway shall have an available fault current rating of 65,000 amperes symmetrical at rated voltage.

B. Construction

1. The busway housing shall be totally enclosed and non-ventilated, and shall be available in three (3) forms: outdoor feeder, indoor feeder, and indoor plug-in. They shall be interchangeable (in the same rating) without adapters or special splice plates. One set of fittings, elbows, tees, flanges, etc. shall be provided for use with both the plug-in and feeder types of busway giving added flexibility to the system.
2. The busway housing shall be capable of being mounted flatwise, edgewise, or vertical positions without being derated. The busway shall consist of standard 10 foot sections with special sections and fittings provided to suit the installation. Horizontal runs shall be suitable for hanging on 10 foot maximum support centers. On vertical runs, one adjustable vertical hanger per floor shall be supplied.

C. Bus

1. Bus bars shall be fabricated from high strength, 98% conductivity copper and suitably plated at all electrical contact surfaces.
2. Bus bars shall be insulated over their entire length, except at joints and contact surfaces, with an Underwriters Laboratories listed insulating material consisting of Epoxy applied by fluidized bed process. Tape or heat-shrink sleeve insulation, or any other method of insulation which can allow air-gaps or insulation breakdown, is not acceptable.
3. Bus bars shall be arranged "A", "B", "C", from front-to-back and/or top-to-bottom and/or left-to-right as viewed from the front of the equipment.
4. The busway shall be capable of carrying rated current continuously without exceeding a temperature rise of 55 degrees C based on a 40 degrees C ambient.
5. A ground bus shall be furnished and shall consist of a 50% rated housing ground bus.
6. A neutral bus shall be furnished and shall consist of 100% rated bus of the same composition as the phase bus.
7. Each busway section shall be furnished complete with joint hardware and covers. The joints for 600 through 5,000 amperes shall be of the single-bolt, non-rotating design and shall permit safe, practical testing of bolt tightness without de-energizing the busway. Access to only one side of the duct shall be required for tightening or inspection of the joint. Any one section of the duct shall be removable without disturbing adjacent sections. Joint covers shall be provided with captive hardware.

D. Housing

1. The indoor busway housing shall be constructed of extruded aluminum or shall meet NEC Gauge Steel Specifications with a suitable UL approved protective finish consisting of a iron phosphate pretreatment inside and out, and a medium-light gray ANSI 49 or 61 baked acrylic enamel applied by the electrostatic process.
2. Housing shall be provided with identification every ten feet along its length indicating designation indicated on the electrical drawings.

E. Plug-in Busway

1. Where indicated on the drawings, busway shall be of the plug-in type with provisions for four (4), usable plug-in openings per floor with a suitable outlet cover provided for each. Plug-in covers shall prohibit dirt and debris from entering plug-in openings in the busway.

F. Plug-in Units

1. Plug-in units shall be factory pre-assembled, and shall be of the types and ratings indicated on the plans and specifications.
2. Plug-in units shall be mechanically interlocked with the busway housing to prevent their installation or removal while the switch is in the ON position. The enclosure of any plug-in unit shall make positive ground connection to the duct housing before the stabs make contact with the bus bars. All plug-in units shall be equipped with a defeatable interlock to prevent the cover from being opened while the switch is in the ON position and to prevent accidental closing of the switch while cover is open. The plugs shall be provided with a means for padlocking the cover closed and padlocking the disconnect device in the OFF position.
3. The operating handle and mechanism of the plug-in unit shall remain in control of the disconnect device at all times permitting its easy operation from the floor by means of a hookstick or chain. Plug-in units shall be equipped with a means for direct positioning or hanging, so that the weight is borne by the duct before the stabs make contact with the bus bars. For safety reasons, no projections shall extend into the busway housing other than the plug-in stabs. All plug-in units shall be interchangeable without alteration or modification of plug-in duct.
4. Plug-in units shall be circuit breaker type with integral time delay/thermal trip protection in one assembly and shall meet all requirements of UL Standard 489. Circuit breakers connected to normal power busways shall be solid state type with ground fault protection.

2.02 ENCLOSED CIRCUIT BREAKERS

A. Molded Case Circuit Breakers

1. Molded case circuit breakers shall provide circuit overcurrent protection with inverse time and instantaneous tripping characteristics.
2. Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make, quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the handle position. Contacts shall be non-welding silver alloy, and arc extinction shall be accomplished by means of arc chutes. A push-to-trip button on the front of the circuit breaker shall provide a local manual means to exercise the trip mechanism.

3. Circuit breakers 600 ampere frame and below shall be of the thermal-magnetic type with inverse time-current characteristics or shall be of the solid state type.
4. Circuit breakers over 600 ampere frame shall be microprocessor-based with true RMS sensing trip units.
 - a. Each molded case circuit breaker microprocessor-based tripping system shall consist of three current sensors, a microprocessor, and a flux-transfer shunt trip. True RMS sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time delay settings are reached.
 - b. Interchangeable rating plugs shall establish the continuous trip ratings of each circuit breaker. Rating plugs shall be interlocked so they are not interchangeable between frames, and interlocked such that a breaker cannot be closed and latched with the rating plug removed.
 - c. The microprocessor-based trip system shall have thermal memory capabilities to prevent the breaker from being reset following an overload condition until after a preset time delay.
 - d. Molded Case Circuit Breaker Trip Units
 - 1) System coordination shall be provided by the following microprocessor-based time-current curve shaping adjustments:
 - a) Adjustable long time pick-up and delay
 - b) Adjustable short time pick-up and delay, with selective curve shaping
 - c) Adjustable instantaneous pick-up

B. Accessories

1. Provide shunt trips, bell alarms, and auxiliary switches as shown on the contract drawings.

C. Enclosures

1. All enclosed circuit breakers shall have NEMA 1 general purpose enclosures unless otherwise noted. Provide enclosures suitable for locations as indicated on the drawings and as described below.
 - a. NEMA 1 surface or flush-mounted general purpose enclosures primarily intended for indoor use.
 - b. NEMA 12 dust-tight enclosures intended for indoor use primarily to provide protection against circulating dust, falling dirt, and dripping non-corrosive liquids.
 - c. NEMA 3R raintight enclosures intended for outdoor use primarily to provide protection against rain, sleet, and damage from external ice formation.
 - d. NEMA 4 watertight stainless steel intended for indoor or outdoor use primarily to provide protection against windblown dust and rain, splashing rain, hose-directed water, and damage from external ice formation.
 - e. NEMA 7, Class I, Group D hazardous location cast aluminum intended for indoor use in locations classified as Class I, Group D as defined in the National Electrical Code.
 - f. NEMA 9, Class II, Groups E, F, G hazardous location cast aluminum intended for indoor use in locations classified as Class II, Groups E, F, and G as defined in the National Electrical Code.

2. All enclosed circuit breakers shall have metal nameplates, front cover mounted, that contain a permanent record of catalog number and maximum rating. Provide handle mechanisms that are padlockable in the "OFF" position.

2.03 FUSES

- A. All fuses shall be rated for proper voltage in which they are applied. Interrupting ratings shall be greater than the short circuit current available at the terminals of the switch.
- B. Fuse Types
 1. Fuses for motor branch circuits shall be time delay Type J.
 2. Fuses for equipment other than motor loads shall be general fast acting RK-5.
 3. Medium voltage fuses for primary protection for transformers shall be as specified in switchgear specifications.
 4. Control power transformers for motor controller circuits shall be as recommended by motor starter and motor control center manufacturer.
 5. Fuses for motors shall be sized at 250% of the motor FLA
 6. Fuses for non-motor loads shall be sized at 125% of rated FLA of equipment served.
 7. Fuses for elevator lifts shall be dual element type and sized in accordance with elevator manufacturers recommendations.
- C. Spare Fuses
 1. Provide spare fuses in the amount of 20% (not less than three (3) nor more than nine (9) of all sizes and types).
 2. Spare fuses shall include general purpose fuses, motor fuses, and control fuses used in motor control centers, starters, etc.
 3. A complete list and quantity of spare fuses shall be submitted with record drawings for review.
- D. Spare Fuse Cabinet
 1. Furnish and install a heavy duty steel cabinet 2'-0" wide by 3'-0" high by 1'-0" deep with shelves.
 2. Cabinet shall be provided with hinged lockage cabinet door.
- E. Manufacturers
 1. Gould Shawmut
 2. Bussman
 3. CEFCO

2.04 MOTOR CONTROLLERS – MAGNETIC STARTERS

- A. Wiring
 1. Wiring shall be NEMA Class I, Type B.
 2. All control wiring internal to the assembly shall be done at the factory by the manufacturer. Field control wiring shall terminate at pull-apart terminal blocks in the wiring gutter.

3. The manufacturer shall submit wiring diagram(s) for each type of starter assembly. Prior to submission for approval by the Engineer, the Electrical Subcontractor shall submit these drawings to the HVAC/Automatic Temperature Control (ATC) Subcontractors to determine suitability in their system(s). Following this review, the Electrical Subcontractor may submit the drawings to the Engineer for review. The submittal shall clearly indicate that the HVAC/ATC Subcontractors have reviewed the wiring diagrams and have accepted them for use with their systems.

B. Combination Motor Controllers

1. Combination starter units through NEMA size 3 shall be full voltage, non-reversing. Combination starters NEMA size 4 and above shall be auto-transformer type reduced voltage, closed transition starters with starting taps at 65%, 80% and 90% of full voltage. All accessories for reduced voltage starters shall be the same as full voltage starters. All starters shall utilize magnetic only breakers.
2. All 480 volt starters sizes shall be as follows:

a.	1/2 to 10 HP:	NEMA Size 1
b.	15 to 25 HP:	NEMA Size 2
c.	30 to 50 HP:	NEMA Size 3
d.	60 to 100 HP:	NEMA Size 4 - Reduced Voltage
e.	125 to 200 HP:	NEMA Size 5 - Reduced Voltage
3. All 208 volt starters sizes shall be as follows:

a.	1/2 to 7½ HP:	NEMA Size 1
b.	10 HP:	NEMA Size 2
c.	15 to 25 HP:	NEMA Size 3
d.	30 to 40 HP:	NEMA Size 4 - Reduced Voltage
e.	50 to 75 HP:	NEMA Size 5 - Reduced Voltage
4. All starters shall utilize magnetic only breakers/motor circuit protectors and shall be sized by the equipment manufacturer based on the motor horsepower size indicated on the accepted mechanical equipment shop drawings (also refer to nameplate rating of motors). The manufacturer shall replace, at no cost to the Owner any breaker that is not coordinating with the motor starter.
5. Thermal magnetic devices with solid state overload devices may be provided to obtain specified short circuit rating. If the overloads require power, redundant power supplies shall be provided.
6. The magnetic only breaker shall provide adjustable magnetic protection up to, but not over 1,700% motor nameplate full load current to comply with NEC requirements. All magnetic only breaker/combination starter units shall have a "tripped" position on the unit disconnect and a push-to-test button on the magnetic only breaker.
7. For all 480 volt normal power motors, provide ground fault protection, with pick-up of approximately 20% of device rating for all starters.
8. Line starters shall be electrically operated, electrically held, three pole assemblies with arc extinguishing characteristics and shall have silver-to-silver renewable contacts. They shall have provisions for a total of five normally open or five normally closed auxiliary contacts wired to a terminal block with two normally open and two normally closed unused spare auxiliary contacts.

9. The overload relay assembly shall be of the thermal bimetallic ambient compensated type. Overload relays shall be reset from outside the enclosure by means of an insulated button. Overload heaters for each motor shall be determined by the actual nameplate ampere rating of the motor. The Electrical Subcontractor shall obtain this information from the final accepted shop drawings for each motor to be served and shall provide this information to the motor control center manufacturer. The overload relay shall have a built-in push-to-test button, electrically isolated normally open - normally closed contacts and single phase protection.
10. Each starter shall be equipped with the following:
 - a. A primary and secondary fused control power transformer sized 50 VA above the minimum rating.
 - b. Two LED indicating lights, red for run; green for stop.
 - c. A mechanical H-O-A selector switch. Electronic or touch pad type H-O-A switches will not be acceptable.
 - d. Device panel with space to accommodate five (5) oil-tight, pilot-control devices or indicating ammeters, voltmeters, or elapsed time meters.
11. For all motors 3.0 HP and above, provide a combination current transformer with a transducer with a 4-20 milliampere analog output mounted on Phase B of output of starter. Wire current transformer /transducer to shorting time terminal board for remote use by HVAC Subcontractor. Provide power supply for transducer as required.
12. No IEC control devices shall be used.
13. Time delay relays shall be provided as follows:
 - a. All motors 15 HP and above to delay starting of motor upon energization.
 - b. All timers shall be adjustable between 1 and 60 seconds continuous. Final adjustment shall be made by the Electrical Subcontractor to coordinate with system conditions. List of settings shall be provided to the Owner and Electrical Engineer for review.

C. Manual Starters

1. Manual starters shall be provided with thermal overload protection in each phase, quick-break operating mechanism, silver contacts, pressure type terminal contacts, bimetallic type overload device, H/O/A selector switch, etc.

2.05 MOTOR DISCONNECT DEVICES

A. Ratings

1. All motor disconnect devices shall be heavy duty type
2. Motors under 15 HP
 - a. 30 to 60 Amperes.
 - b. 250 Volts AC, DC; 600 Volts AC.
 - c. 2, 3 or 6 Poles.
 - d. Non-Fusible
 - e. Copper-Aluminum Terminals.

3. Motors 15 HP and above
 - a. 30 to 1,200 Amperes.
 - b. 600 Volts AC.
 - c. 3 or 6 Poles.
 - d. Fusible
 - e. Copper-Aluminum Terminals.
- B. Enclosures
1. Types
 - a. NEMA 1 General Purpose.
 - b. NEMA 3R Raintight.
 - c. NEMA 4 Watertight Stainless Steel.
 - d. NEMA 12 Dust-tight and Oil-tight Special Industry.
 2. Switches shall have NEMA 1 general purpose enclosures or enclosure as indicated on the drawings. NEMA Type 3R enclosures shall be used where the disconnect switch is exposed to the weather or in wet areas.
- C. Construction
1. All switches shall have metal nameplates, front cover mounted, that contain a permanent record of switch type, catalog number and Hp ratings (with both standard and time delay fuses); handle whose position is easily recognizable and is padlockable in the "OFF" position; visible blades; reinforced fuse clips; nonteasible, positive, quick-make quick-break mechanisms; and switch assembly plus operating handle as an integral part of the enclosure base.
 2. All switches shall be Underwriters Laboratories, Inc. listed, HP rated, meet Federal Specification WS-865c, and NEMA Specifications KSI-1975.
 3. All switches shall have defeatable door interlocks that prevent the door from opening when the operating handle is in the "ON" position.
 4. Heavy-duty switches shall have line terminal shields.
 5. All fused switches shall have Class J time delay fuses.
- D. Special Configurations
1. Where motor disconnect devices are installed between variable speed drives and their associated motor, an interlock switch shall be provided on the motor disconnect devices and 2#14-1/2"C. shall run from the interlock switch to the associated variable speed drive to turn off the drive while the motor disconnect switch is in the off position.
 2. All two speed motors shall be provided with 6 pole motor disconnect devices.
 3. For all motors under 1/2 HP, furnish and install a manual starting thermal type switch with pilot light as a disconnecting means, unless otherwise indicated on the drawings. These thermal switches shall be toggle operated and shall be rated 1 HP, motor overload protection shall be provided by means of a bimetallic type thermal relay in combination with interchangeable heaters. Heaters shall be installed without removing the starter from the housing or disturbing the wiring. Toggle shall be trip free. Thermal switches shall be furnished in a NEMA, Type 1 enclosure in mechanical and utility areas and flush in walls with stainless steel plates in Architecturally finished areas. All heaters shall be sized per the horsepower of the motor code letter. Coordinate with HVAC and Plumbing Trades.

4. All motors/pumps/air handling units shall be provided with proper size/rating motor disconnect device whether indicated on drawings or not to comply with NEC. Install and connect motor disconnect devices furnished by other Trades.

E. General

1. All power wiring shall be furnished and installed between disconnect switches, control cabinets, contactors and motor terminals required by equipment furnished by other Trades.
2. All motor disconnect devices shown on the drawings shall be furnished and installed by the Electrical Subcontractor.

2.06 PANELBOARDS - BRANCH CIRCUIT AND DISTRIBUTION (100A – 1,200A)

A. Ratings

1. Panelboards shall be 240 volt or 600 volt class suitable for operation on a three phase, 60 Hertz system. The panelboard phase, voltage and current ratings shall be as indicated on the Contract Drawings.

B. Construction

1. Interiors shall be completely factory assembled with bolt-on devices. They shall be designed such that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors.
2. Trims for distribution, lighting and appliance panelboards shall be supplied with a door-in-door trim. The inner door shall be a hinged door over all circuit breaker handles. The outer door shall be the entire trim with a piano hinge to expose wiring gutters. Inner door in panelboard trim shall not uncover any live parts. Inner doors shall have a semiflush cylinder lock and catch assembly. Doors over 48 inches in height shall have auxiliary fasteners. Switching device handles in distribution panelboards shall be accessible.
3. Surface trims shall be same height and width as box. Flush trims shall overlap the box by 3/4 of an inch on all sides.
4. Where double tub panels are indicated on the drawings, each tub shall contain the same number of breakers and spaces. Box and trim sizes shall be identical.
5. Where auxiliary gutters are indicated for feed through lugs, a separate gutter shall be attached to the panelboard, sized as required based on conductor size. The auxiliary gutter shall contain a separate cover and the panel shall contain a door-in-door trim.
6. A directory card with a clear plastic cover shall be supplied and mounted on the inside of each door.
7. All locks shall be keyed alike.

C. Bus

1. Main bus bars shall be copper sized in accordance with UL standards to limit temperature rise on any current carrying part to a maximum of 65 degrees C above an ambient of 40 degrees C maximum.
2. Bus bars shall be arranged "A", "B", "C", from front-to-back and/or top-to-bottom and/or left-to-right as viewed from the front of the equipment.
3. A bolted copper ground bus shall be included in all panels.
4. In addition to the bolted ground bus, an isolated copper ground bus shall be included in panels as indicated on the drawings.

5. Bus bar taps for panels with single pole branches shall be arranged for sequence phasing of the branch circuit devices.
6. Neutral Bus
 - a. Full-size insulated copper neutral bars shall be included for panelboards shown with neutral.
 - b. Neutral busing shall have a suitable lug for each outgoing feeder requiring a neutral connection.
 - c. For panels 600 amperes and below, fed directly via "K" factor transformers, neutral bus shall be 200% of phase busses.
 - d. For panels over 600 amperes, fed directly by "K" factor transformers, switchboards shall be provided with 200% neutral bus. Refer to Switchboard section of these specifications.

D. Power Distribution Panelboards, Circuit Breaker Type

1. Molded case circuit breakers shall provide circuit overcurrent protection with inverse time and instantaneous tripping characteristics.
2. Circuit breakers shall be bolt-on, operated by a toggle-type handle and shall have a quick-make, quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the handle position. Contacts shall be non-welding silver alloy, and arc extinction shall be accomplished by means of arc chutes.
3. Circuit breakers below 100 ampere frame shall be of the thermal-magnetic type with inverse time-current characteristics or shall be microprocessor based, as specified below.
4. Circuit breakers 100 ampere frame and above shall be microprocessor-based with true RMS sensing trip units.
 - a. Each molded case circuit breaker microprocessor-based tripping system shall consist of three current sensors, a microprocessor, and a flux-transfer shunt trip. True RMS sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time delay settings are reached.
 - b. Interchangeable rating plugs shall establish the continuous trip ratings of each circuit breaker. Rating plugs shall be interlocked so they are not interchangeable between frames, and interlocked such that a breaker cannot be closed and latched with the rating plug removed.
 - c. The microprocessor-based trip system shall have thermal memory capabilities to prevent the breaker from being reset following an overload condition until after a preset time delay.
 - d. Molded Case Circuit Breaker Trip Units
 - 1) System coordination shall be provided by the following microprocessor-based time-current curve shaping adjustments:
 - a) Adjustable long time pick-up and delay
 - b) Adjustable short time pick-up and delay, with selective curve shaping
 - c) Adjustable instantaneous pick-up
5. Provide shunt trips, bell alarms, and auxiliary switches as shown on the contract drawings.

E. Provide IR view ports for the cable-to-breaker connections for all breakers in switchboards and large distribution panelboards. View ports shall be round and manufactured by Fluke, Iriss or approved equal. Three-inch or four-inch shall be provided. The view ports shall be installed at the factory by the equipment manufacturer. The environmental rating of the IR ports shall be equal to or higher than that of the enclosure and must be installed per manufacturer's instructions. In order to allow for proper installation of the view ports, spacing between the feeder breakers may need to be adjusted.

F. Branch Circuit Panelboards

1. Bolt-on type, heavy-duty, quick-make, quick-break, single- and multi-pole circuit breakers of the types specified herein, shall be provided for each circuit with toggle handles that indicate when unit has tripped.
2. Circuit breakers shall be thermal magnetic type with common type handle for all multiple pole circuit breakers. Circuit breakers shall be minimum 100 ampere frame and through 100 ampere trip sizes shall take up the same pole spacing. 20 ampere, single pole circuit breakers shall be UL listed as type SWD for lighting circuits.
3. Circuit breaker handle locks shall be provided for all circuits that supply exit signs, emergency lights, energy management and control system (EMCS) panels and fire alarm panels.

G. Enclosure

1. Enclosures shall be at least 20 inches wide and 5 3/4 inches deep made from galvanized steel. Provide minimum gutter space in accordance with the National Electric Code. Where feeder cables supplying the mains of a panel are carried through its box to supply other electrical equipment, an auxiliary gutter shall be provided, sized to include the additional required wiring space. At least four interior mounting studs with adjustable nuts shall be provided.
2. Enclosures shall be provided with removable blank ends.
3. All panelboards shall have NEMA 1 general purpose enclosures unless otherwise noted. Enclosure types

H. Nameplates

1. Each panel shall have an engraved nameplate for each section. Engraved nameplate shall include panel designation, voltage, phase, ampere rating of upstream feeder breaker or main circuit breaker, and designation of upstream panel or other device similar to:

PANEL _____
 100 AMPERE, 480/277 VOLT, 3 PHASE, 4 WIRE
 FED FROM PANEL _____

2. Where panel is fed directly from an upstream transformer, nameplate shall be similar to:

PANEL _____
 800 AMPERE, 208/120 VOLT, 3 PHASE, 4 WIRE,
 FED FROM PANEL _____ VIA 225 kVA TRANSFORMER

3. Nameplates shall be laminated plastic, black characters on white background for normal, white characters on red back ground for emergency, and secured with screws. Characters shall be 3/16 inch high, minimum.

4. Panelboards shall be provided with typewritten directories with plastic protector indicating circuit numbers, equipment served and room number of the area served. All room numbers used for directory cards shall be the room numbers assigned by the Owner and not necessarily room numbers indicated on the drawings. Coordinate all room numbers with Architect prior to final printing of directory cards. Directory cards shall be edited and maintained during the course of construction to keep an accurate, up to date record of each feeder or branch circuit.

I. Finish

1. Surfaces of the trim assembly shall be properly cleaned, primed, and a finish coat of gray ANSI 49 or 61 paint applied.

2.07 SAFETY SWITCHES

A. Ratings

1. All safety switches shall be heavy duty type.
2. Safety Switches 60 amperes and below
 - a. 30 to 60 Amperes.
 - b. 250 Volts AC, DC; 600 Volts AC.
 - c. 2, 3 or 6 Poles.
 - d. Fusible or Non-Fusible
 - e. Copper-Aluminum Terminals.
3. Safety Switches over 60 amperes
 - a. 100 to 1,200 Amperes.
 - b. 600 Volts AC.
 - c. 3 or 6 Poles.
 - d. Fusible
 - e. Copper-Aluminum Terminals.

B. Enclosures

1. Types
 - a. NEMA 1 General Purpose.
 - b. NEMA 3R Raintight.
 - c. NEMA 4 Watertight Stainless Steel.
 - d. NEMA 12 Dust-tight and Oil-tight Special Industry.
2. All interior safety switches shall have NEMA 1 general purpose enclosures. All exterior safety switches shall have NEMA 3R raintight enclosures unless otherwise noted.

C. All switches shall have the following:

1. Metallic nameplates mounted on the front cover with:
 - a. A permanent record of switch type
 - b. Catalog number

- c. HP ratings (with both standard and time delay fuses);
 - 2. Handle whose position is easily recognizable and is padlockable in the "OFF" position
 - 3. Visible blades when door is in the open position.
 - 4. Reinforced fuse clips
 - 5. Non-teasible, positive, quick-make quick-break mechanisms
 - 6. Defeatable door interlocks that prevent the door from opening when the operating handle is in the "ON" position.
 - 7. Line terminal shields.
 - 8. Switch assembly and operating handle shall be an integral part of the enclosure base.
 - D. All switches shall be Underwriters Laboratories, Inc. listed, HP rated, meet Federal Specification WS-865c, and NEMA Specifications KSI-1975.
 - E. All fused switches shall have Class J time delay fuses.
- 2.08 SWITCHBOARDS (1,600A – 4,000A)
- A. Ratings
 - 1. Switchboards shall be 600 volt class suitable for operation on a three phase, 60 Hertz system. The switchboard phase, voltage and current ratings shall be as indicated on the Contract Drawings.
 - B. Construction
 - 1. Switchboard shall consist of the required number of vertical sections bolted together to form a rigid assembly. The sides and rear shall be covered with removable bolt-on covers. All edges of front covers or hinged front panels shall be formed. Provide adequate ventilation within the enclosure.
 - 2. All sections of the switchboard shall be rear aligned. All protective devices shall be group mounted. Devices shall be front removable and load connections front accessible enabling switchboard to be mounted against a wall.
 - 3. The assembly shall be provided with adequate lifting means.
 - 4. Where indicated on drawings, the switchboard shall be suitable for use as service entrance equipment and be labeled in accordance with UL requirements.
 - C. Bus
 - 1. All bus bars shall be tin plated aluminum. Main horizontal bus bars shall be mounted with all three phases arranged in the same vertical plane. Bus sizing shall be based on NEMA standard temperature rise criteria of 65 degrees C over a 40 degrees C ambient (outside the enclosure).
 - 2. Bus bars shall be arranged "A", "B", "C", from front-to-back and/or top-to-bottom and/or left-to-right as viewed from the front of the equipment.
 - 3. Where indicated on the drawings, provide a full capacity neutral bus.
 - 4. A copper ground bus (minimum 1/4 X 2 inch) shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the switchboard.
 - 5. All hardware used on conductors shall be high-tensile strength and zinc plated. All bus joints shall be provided with conical spring type washers.

D. Wiring/Terminations

1. Small wiring, necessary fuse blocks and terminal blocks within the switchboard shall be furnished as required. Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams.
2. Mechanical type terminals shall be provided for all line and load terminations suitable for copper or aluminum cable rated for 75 degrees C of the size as indicated on the drawings.
3. Lugs shall be provided in the incoming line section for connection of the main grounding conductor. Additional lugs for connection of other grounding conductors shall be provided.
4. All control wire shall be type SIS, bundled and secured with nylon ties. Insulated locking spade terminals shall be provided for all control connections, except where saddle type terminals are provided integral to a device. All current transformer secondary leads shall first be connected to conveniently accessible short circuit terminal blocks before connecting to any other device. All groups of control wires leaving the switchboard shall be provided with terminal blocks with suitable numbering strips. Provide wire markers at each end of all control wiring.

E. Molded Case Circuit Breakers

1. Molded case circuit breakers shall provide circuit overcurrent protection with inverse time and instantaneous tripping characteristics.
2. Ground fault protection shall be provided on all breakers. (Normal Power Systems Only)
3. Circuit breakers shall be bolt-on, operated by a toggle-type handle and shall have a quick-make, quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the handle position. Contacts shall be non-welding silver alloy, and arc extinction shall be accomplished by means of DE-ION arc chutes. A push-to-trip button on the front of the circuit breaker shall provide a local manual means to exercise the trip mechanism.
4. Circuit breakers below 100 ampere frame shall be of the thermal-magnetic type with inverse time-current characteristics or shall be microprocessor based, as specified below.
5. Circuit breakers 100 ampere frame and above shall be microprocessor-based with true RMS sensing trip units.
 - a. Each molded case circuit breaker microprocessor-based tripping system shall consist of three current sensors, a microprocessor, and a flux-transfer shunt trip. True RMS sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time delay settings are reached.
 - b. Interchangeable rating plugs shall establish the continuous trip ratings of each circuit breaker. Rating plugs shall be interlocked so they are not interchangeable between frames, and interlocked such that a breaker cannot be closed and latched with the rating plug removed.
 - c. The microprocessor-based trip system shall have thermal memory capabilities to prevent the breaker from being reset following an overload condition until after a preset time delay.

d. Molded Case Circuit Breaker Trip Units

1) System coordination shall be provided by the following microprocessor-based time-current curve shaping adjustments:

- a) Adjustable long time pick-up and delay
- b) Adjustable short time pick-up and delay, with selective curve shaping
- c) Adjustable instantaneous pick-up
- d) Adjustable ground fault pick-up and delay, with selective curve shaping

6. Circuit breakers, 1,200 amp frame and larger, shall be equipped with Arc Flash Reduction Maintenance System (ARMS). The ARMS shall allow the operator to enable a maintenance mode which enables a pre-set accelerated instantaneous override trip to reduce arc flash energy. A blue LED on the trip unit shall indicate the trip unit is in the maintenance mode.

7. Provide shunt trips, bell alarms, and auxiliary switches as shown on the contract drawings.

F. Breakers, 1,600 amp frame and larger, shall be insulated case. They shall be 100% rated, manually operated, and fixed mount. Include the Eaton Digitrip 520MC trip unit, with Long, Shunt, Instantaneous and Ground Fault (normal only) protective functions.

G. Provide IR view ports for the cable-to-breaker connections for all breakers in switchboards and large distribution panelboards. View ports shall be round and manufactured by Fluke, Iriss or approved equal. Three-inch or four-inch shall be provided. The view ports shall be installed at the factory by the equipment manufacturer. The environmental rating of the IR ports shall be equal to or higher than that of the enclosure and must be installed per manufacturer's instructions. In order to allow for proper installation of the view ports, spacing between the feeder breakers may need to be adjusted.

H. Miscellaneous Devices

1. Control power transformers with primary and secondary protection shall be provided and factory wired as required for proper operation of the equipment.

I. Enclosures

1. NEMA 1 indoor, ventilated enclosure

J. Nameplates

1. Each switchboard shall have an engraved nameplate on the door of each section. Engraved nameplate shall include switchboard designation, voltage, phase, ampere rating of upstream feeder breaker or main circuit breaker, and upstream panel feeder as follows:

SWITCHBOARD " _____"
1,600 AMPERE, 480/277 VOLT, 3 PHASE, 4 WIRE,
FED FROM SERVICE PROTECTOR "SP# _____" OR SWITCHBOARD " _____"

2. Engraved nameplates shall also be provided for all feeder breakers, mounted on the face of the assembly, with panel/equipment designations as indicated on the drawings.

3. Nameplates shall be laminated plastic, black characters on white background for normal and white characters on red background for emergency, and secured with screws. Characters shall be 3/16 inch high, minimum. Nameplates shall give item designation and circuit number as well as frame ampere size and appropriate trip rating.
4. Furnish Master nameplate giving switchboard designation, voltage ampere rating, short circuit rating, manufacturer's name, general order number and item number.
5. Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams.

K. Finish

1. All exterior and interior steel surfaces of the switchboard shall be properly cleaned and provided with a rust-inhibiting phosphatized coating. Color and finish of the switchboard shall be ANSI 61 light gray.

2.09 TRANSFORMERS - DRY TYPE DISTRIBUTION

A. Ratings

1. kVA and voltage ratings shall be as shown on the drawings.
2. Transformers shall be designed for continuous operation at rated kVA, for 24 hours a day, 365 days a year operation, with normal life expectancy as defined in ANSI C57.96.
3. Transformer sound levels shall not exceed the following ANSI and NEMA levels for self-cooled ratings:

a. Up to 9 kVA:	40 dB
b. 10 to 50 kVA:	45 dB
c. 51 to 150 kVA:	50 dB
d. 151 to 300 kVA:	55 dB
e. 301 to 500 kVA:	60 dB
f. 501 to 700 kVA:	62 dB
g. 701 to 1,000 kVA:	64 dB
4. Transformers shall meet or exceed efficiency levels per DOE 2016 requirements, or the latest adopted edition.

B. Insulation Systems

1. Transformers shall be insulated as follows:
 - a. 2 kVA and below: 150 degrees C insulation system based upon 80 degree C rise.
 - b. 3 to 15 kVA: 185 degrees C insulation system based upon 115 degree C rise.
 - c. 15 kVA and above: 220 degrees C insulation system based upon 150 degree C rise.
2. Required performance shall be obtained without exceeding the above indicated temperature rise in a 40 degrees C maximum ambient with a 30 degrees C average ambient over 24 hours.
3. All insulation materials shall be flame-retardant and shall not support combustion as defined in ASTM Standard Test Method D635.

C. Core and Coil Assemblies

1. Transformer core shall be constructed with high-grade, nonaging, grain-oriented silicon steel with high magnetic permeability, and low hysteresis and eddy current losses. Maximum magnetic flux densities shall be substantially below the saturation point. The transformer core volume shall allow efficient transformer operation at 10% above the highest tap voltage. The core laminations shall be tightly clamped and compressed.
2. Coils shall be wound of electrical grade copper with continuous wound construction.
3. On units rated 15 kVA and below the core and coil assembly shall be completely encapsulated in a proportioned mixture of resin and aggregate to provide a moistureproof, shock-resistant seal. The core and coil encapsulation system shall minimize the sound level. Taps shall be two steps below nominal voltage in 5% increments.
4. On units rated 30 kVA and above the core and coil assembly shall be impregnated with non-hydroscopic, thermosetting varnish and cured to reduce hot spots and seal out moisture. The assembly shall be installed on vibration-absorbing pads and securely bolted to the base to minimize sound transmission. Taps shall be two steps above and 4 steps below nominal voltage in 2.5% increments.
5. Transformers 112.5 kVA and above shall have impedance levels of 5% or higher. If the transformer impedance levels are below 5%, it shall be the Electrical Subcontractor's responsibility to adjust the short circuit ratings of all panelboards downstream of the transformer to a rating higher than the maximum theoretical let-thru current of the proposed transformer.

D. Wiring/Terminations

1. Recommended external cable shall be rated 90 degrees C for encapsulated and 75 degrees C for ventilated designs. Connectors should be selected on the basis of the type and cable size used to wire the specific transformer.

E. Enclosure

1. The enclosure shall be made of heavy-gauge steel. All transformers shall be equipped with a wiring compartment suitable for conduit entry and large enough to allow convenient wiring. The maximum temperature of the enclosure shall not exceed 90 degrees C. The core of the transformer shall be grounded to the enclosure.
2. On units rated 15 kVA and below the enclosure construction shall be totally enclosed, non-ventilated, NEMA 3R, with lifting eyes.
3. On units rated 30 kVA and above the enclosure construction shall be ventilated, NEMA 2, drip-proof, with lifting holes. All ventilation openings shall be protected against falling dirt.
4. Fan assisted convection cooling/ventilation shall not be acceptable

F. Finish

1. Enclosures shall be finished with ANSI 61 color weather-resistant enamel.

2.10 NEW SERVICE PROTECTOR "SP#22"

A. Ratings

1. Voltage rating shall be 480/277 volts, 3 phase, 4 wire.

2. The assembly shall be rated to withstand mechanical forces exerted during short circuit conditions when connected directly to a power source having available fault current of 200,000 amperes symmetrical at rated voltage.

B. Construction

1. Service protector sides and rear shall be covered with removable bolt-on covers. All edges of front covers or hinged front panels shall be formed. Provide adequate ventilation within the enclosure.
2. The assembly shall be provided with adequate lifting means.
3. The service protector shall be suitable for use as service entrance equipment and be labeled in accordance with UL requirements.

C. Bus

1. All bus bars shall be silver plated copper. Main horizontal bus bars shall be mounted with all three phases arranged in the same vertical plane. Bus shall be density rated, 1,000 amperes per square inch.
2. Provide a full capacity neutral bus.
3. A copper ground bus (minimum 1/4 X 2 inch) shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the switchboard.
4. All hardware used on conductors shall be high-tensile strength and zinc plated. All bus joints shall be provided with conical spring type washers.

D. Wiring/Terminations

1. Small wiring, necessary fuse blocks and terminal blocks within the switchboard shall be furnished as required. Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams.
2. Mechanical set screw type terminals shall be provided for all line and load terminations suitable for copper or aluminum cable rated for 75 degrees C of the size as indicated on the drawings.
3. Lugs shall be provided in the incoming line section for connection of the main grounding conductor. Additional lugs for connection of other grounding conductors shall be provided.
4. All control wire shall be type SIS, bundled and secured with nylon ties. Insulated locking spade terminals shall be provided for all control connections, except where saddle type terminals are provided integral to a device. All current transformer secondary leads shall first be connected to conveniently accessible short circuit terminal blocks before connecting to any other device. All groups of control wires leaving the switchboard shall be provided with terminal blocks with suitable numbering strips. Provide wire markers at each end of all control wiring.

E. Power Circuit Breakers

1. Protective devices shall be fixed low-voltage power air-circuit breakers, Eaton type Magnum DSX or approved equal. Frame ratings shall be 4000 amperes. All breakers shall be UL listed for application in their intended enclosures for 100% of their continuous ampere rating.

2. Breaker shall be manually operated (MO) as indicated on the drawings.
3. All circuit breakers shall have a minimum symmetrical interrupting capacity of 200,000 amperes.
4. All power circuit breakers shall be constructed and tested in accordance with ANSI C37.13, C37.16, C37.17, C37.50, UL 1066 and NEMA SG-3 standards. The circuit breakers shall carry a UL label.
5. All power circuit breakers shall be provided with trip units as specified in Paragraph F, 1 through 10.
6. Provide all Digitrip 520MC trip units with Arc Flash Reduction Maintenance Switch accessory. The Arc Flash Reduction Maintenance Switch (ARMS) shall allow the operator to enable a maintenance mode with a preset accelerated instantaneous override trip to reduce arc flash energy. A separate 22 mm selector switch to turn the ARMS on and off shall be provided. A separate blue LED-type indicating light for ARMS on or off shall also be included.
7. Power circuit breakers shall be Magnum MSDX fuse-less current limiting type with fast opening reverse loop contacts. Current limiting power circuit breakers shall have a 200,000-ampere rms symmetrical interrupting capacity at 508 volts and below.
8. To facilitate lifting, the power circuit breaker shall have integral handles on the side of the breaker. The power circuit breaker shall have a closing time of not more than 3 cycles. The primary contacts shall have an easily accessible wear indicator to indicate contact erosion.
9. The power circuit breaker shall have three windows in the front cover to clearly indicate any electrical accessories that are mounted in the breaker. The accessory shall have a label that will indicate its function and voltage. The accessories shall be plug and lock type and UL listed for easy field installation. They shall be modular in design and shall be common to all frame sizes and ratings.
10. The breaker control interface shall have color-coded visual indicators to indicate contact open or closed positions as well as mechanism charged and discharged positions. Manual control pushbuttons on the breaker face shall be provided for opening and closing the breaker. The power circuit breaker shall have a "Positive On" feature. The breaker flag will read "Closed" if the contacts are welded and the breaker is attempted to be tripped or opened.

F. Trip Units – Magnum Breakers

1. Each low-voltage power circuit breaker shall be equipped with a solid-state tripping system consisting of three current sensors, microprocessor-based trip device and flux-transfer shunt trip. Current sensors shall provide operation and signal function. The trip unit shall use microprocessor-based technology to provide the basic adjustable time-current protection functions. True RMS sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time delay settings are reached. Interchangeable current sensors with their associated rating plug shall establish the continuous trip rating of each circuit breaker. The trip unit shall be Eaton type Digitrip RMS 520MC.
2. The trip unit shall have an information system that provides LEDs to indicate mode of trip following an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip. A reset button shall be provided to turn off the LED indication after an automatic trip.
3. The trip unit shall be provided with a display panel, including a representation of the time/current curve that will indicate the protection functions. The unit shall be continuously self-checking and provide a visual indication that the internal circuitry is being monitored and is fully operational.

4. The trip unit shall be provided with a making-current release circuit. The circuit shall be armed for approximately two cycles after breaker closing and shall operate for all peak fault levels above 25 times the ampere value of the rating plug.
 5. Trip unit shall have selectable thermal memory for enhanced circuit protection.
 6. Protective device coordination shall be provided by the addition of the following individually adjustable time/current curve shaping solid-state elements:
 - a. All circuit breakers shall have adjustments for long delay pickup and time.
 - b. All circuit breakers shall have individual adjustments for short delay pickup and time, and include I^2t settings.
 - c. All circuit breakers shall have an adjustable instantaneous pickup.
 - d. Circuit breakers, where indicated on the drawings, shall have individually adjustable ground fault current pickup and time, and include I^2t settings or ground alarm only.
 7. The trip unit shall have provisions for a single test kit to test each of the trip functions.
 8. The trip unit shall be capable of zone interlocking for the short-time delay and ground fault delay trip functions for improved system coordination. The zone interlocking system shall restrain the tripping of an upstream breaker and allow the breaker closest to the fault to trip with no intentional time delay. In the event that the downstream breaker does not trip, the upstream breaker shall trip after a preset time delay.
 9. The trip unit shall have an information system that utilizes battery backup LEDs to indicate mode of trip following an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip. A test pushbutton shall energize a LED to indicate the battery status.
 10. The trip unit shall have a 4-character LCD display showing phase, neutral, and ground current. The accuracy of these readings shall be +/- 2% of full scale.
- G. Provide IR view ports for the cable-to-fuse connections for all fuse compartments in switchboards and large distribution panelboards. View ports shall be round and manufactured by Fluke, Iriss or approved equal. Three-inch or four-inch shall be provided. The view ports shall be installed at the factory by the equipment manufacturer. The environmental rating of the IR ports shall be equal to or higher than that of the enclosure and must be installed per manufacturer's instructions. In order to allow for proper installation of the view ports, spacing between the feeder breakers may need to be adjusted.
- H. Miscellaneous Devices
1. Each section of the switchboard shall be provided with a space heater thermostatically controlled. Power for the space heaters shall be obtained from a control power transformer within the switchboard. Supply voltage shall be 120 volts AC. Space heaters shall be wired to provide temporary heating during storage.
 2. Control power transformers with primary and secondary protection shall be provided as required for proper operation of the equipment.
- I. Customer Metering
1. Provide customer metering devices as specified herein. Provide a separate customer metering compartment with front hinged door. Include associated instrument transformers.
 2. Current transformers shall be wired to shorting type terminal blocks.
 3. Provide potential transformers including primary and secondary fuses with disconnecting means or fused potential taps as the potential source for metering as required.

4. Microprocessor-based metering system.
 - a. Provide a full function electronic meter on all low voltage main devices as indicated on the drawings. The meter shall have the features and functions specified below. The meter shall be UL recognized, CSA certified and also meet ANSI Standard C37.90.
 - b. The meter shall provide direct reading metered or calculated values of the items listed below and shall auto range between Units, Kilo-units, and Mega-units for all metered values. Accuracy indicated below to be of read or calculated values.
 - 1) AC Current (Amperes) in A, B, and C phase, 3 Phase Average and Neutral (N). Accuracy +/- 0.2% (provide phase and neutral current transformer).
 - 2) AC Voltage (Volts) for A-B, B-C, and C-A, Phase Average, A-N, B-N, and C-N and Average Phase to N. Accuracy +/-0.2%.
 - 3) Real Power (WATTS), Reactive Power (VARs), Apparent Power (VA), for each phase and system (system shall apply only for 3 wire applications). Accuracy +/- 0.4%. Forward/Reverse indication shall be provided.
 - 4) Real Energy (WHR), Reactive Energy (VARHR), Apparent Energy (VAHR) for each phase and system (system shall apply only for 3 wire applications). Accuracy +/- 0.4%. Forward/Reverse indication shall be provided.
 - 5) Frequency (HERTZ) Accuracy +/- 0.04%.
 - 6) Demand values for System Current (AMPERES), System Real Power (WATTS), System Reactive Power (VARs), and System Apparent Power (VA).
 - 7) Power Factor both Displacement only 60 cycle fundamental WATTS to VA and Apparent total WATTS to total VARs including harmonics for A, B, and C phase and system. Accuracy +/- 0.4%.
 - 8) Current Percent Total Harmonic Distortion (THD) in A, B, and C phase, and N.
 - 9) Voltage percent THD in A-B, B-C, and C-A phase, A-N, B-N, and C-N.
 - c. Provide an addressable communication card capable of transmitting all data, remotely controlling and programming the meter over a compatible local area network to a central personal computer for storage, analysis, display and printout. Coordinate tie-in to building automation system with UCHC. The network shall also be capable of transmitting data in RS232c or RS485 format.
 - d. Provide current transformers as required for each phase and neutral circuit with ratings sized for incoming service or associated feeder. Provide potential transformers as required for proper operation of the meter.
 - e. The meter control power shall be capable of being supplied from the monitored incoming AC line without the need for a separate AC control circuit unless a separate 120 or 240 volt source is indicated on the drawings.

J. Enclosures

1. The switchgear shall be enclosed in an indoor NEMA 1 Enclosure.

K. Nameplates

1. Engraved nameplates, mounted on the face of the assembly, shall be furnished for all main and feeder circuits as indicated on the drawings. Nameplates shall be laminated plastic, black characters on white background, and secured with screws. Characters shall be 3/16 inch high, minimum. Nameplates shall give item designation and circuit number as well as frame ampere size and appropriate trip rating. Furnish Master nameplate giving switchboard designation, voltage ampere rating, short circuit rating, manufacturer's name, general order number and item number.

L. Finish

1. All exterior and interior steel surfaces of the switchboard shall be properly cleaned and provided with a rust-inhibiting phosphatized coating. Color and finish of the switchboard shall be ANSI 61 light gray.

2.11 LOW VOLTAGE DISTRIBUTION SWITCHBOARDS – “SWBDHGR” GROUP-MOUNTED (FUSIBLE)

A. Ratings

1. Voltage rating shall be 480/277 volts, 3 phase, 4 wire.
2. The assembly shall be rated to withstand mechanical forces exerted during short circuit conditions when connected directly to a power source having available fault current of 200,000 amperes symmetrical at rated voltage.

B. Construction

1. Switchboard shall consist of the required number of vertical sections bolted together to form a rigid assembly. The sides and rear shall be covered with removable bolt-on covers. All edges of front covers or hinged front panels shall be formed. Provide adequate ventilation within the enclosure.
2. All sections of the switchboard shall be front and rear aligned. All protective devices shall be group mounted. Devices shall be front removable and load connections front accessible enabling switchboard to be mounted against a wall.
3. The assembly shall be provided with adequate lifting means.
4. The switchboard shall be suitable for use as service entrance equipment and be labeled in accordance with UL requirements.

C. Bus

1. All bus bars shall be silver plated copper. Main horizontal bus bars shall be mounted with all three phases arranged in the same vertical plane. Bus sizing shall be based on NEMA standard temperature rise criteria of 65 degrees C over a 40 degrees C ambient (outside the enclosure).
2. Provide a full capacity neutral bus.
3. A copper ground bus (minimum 1/4 X 2 inch) shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the switchboard.
4. All hardware used on conductors shall be high-tensile strength and zinc plated. All bus joints shall be provided with conical spring type washers.

D. Wiring/Terminations

1. Small wiring, necessary fuse blocks and terminal blocks within the switchboard shall be furnished as required. Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams.
2. Mechanical set screw type terminals shall be provided for all line and load terminations suitable for copper or aluminum cable rated for 75 degrees C of the size as indicated on the drawings.
3. Lugs shall be provided in the incoming line section for connection of the main grounding conductor. Additional lugs for connection of other grounding conductors shall be provided.
4. All control wire shall be type SIS, bundled and secured with nylon ties. Insulated locking spade terminals shall be provided for all control connections, except where saddle type terminals are provided integral to a device. All current transformer secondary leads shall first be connected to conveniently accessible short circuit terminal blocks before connecting to any other device. All groups of control wires leaving the switchboard shall be provided with terminal blocks with suitable numbering strips. Provide wire markers at each end of all control wiring.

E. Bolted Pressure Switches/High Pressure Contact Switches

1. Main and Feeder protective devices shall be bolted pressure/high pressure contact type and shall be UL listed.
2. Fusible switches shall be furnished with Class L fuse clips. Switch contact interrupting capacity shall be 12 times the continuous rating of the switch.
3. Fuse access door shall be mechanically interlocked with the operating handle and shall have provisions for padlocking the switch in the open position.
4. The switch shall utilize a stored energy dead front operating mechanism compressed and released by the operating handle, to provide quick positive switching action independent of the speed of the operating handle.
5. Switches shall be manually operated unless electrically tripped as shown on the drawings. Electrically tripped switches shall be designed to be closed only after the opening spring has been charged, ready for electrical opening by solenoid or manual opening by the mechanical pushbutton.
6. Supply electrically tripped switch(es) with the following accessories where indicated on the drawings:
 - a. Ground fault protection including Test Panel.
 - b. Single phase protection to open the switch(es) upon loss of any phase from the source.
 - c. Blown Fuse Protection to open the switch upon blowing of one or more of the fuses.
7. Provide class L fuses.

F. Quick-Make, Quick-Break Fusible Switches

1. Protective devices shall be quick-make, quick-break fusible switches. Fusible switches 100 amperes through 600 amperes frames shall be furnished with rejection class "R" or "T" type fuse clips unless otherwise scheduled. Fusible switches 800 amperes through 1200 amperes shall be furnished with Class L fuse clips.

- Switches shall incorporate safety cover interlocks to prevent opening the cover with the switch in the "ON" position or prevent placing the switch in the "ON" position with the cover open. Provide defeater for authorized personnel. Handles shall have provisions for padlocking and shall clearly indicate the "ON" or "OFF" position. Front cover doors shall be padlockable in the closed position.
2. The 400 through 1200 ampere switches shall be designed to accommodate UL listed shunt trip. Where shown on the drawings, furnish the following accessories:
 - a. UL listed 120 volt AC shunt trip.
 - b. Zero sequence ground protection system including test panel. Ground fault relay shall include separate time and current pick-up adjustments.
- G. Provide IR view ports for the cable-to-terminal connections for all fuse compartments in switchboards and large distribution panelboards. View ports shall be round and manufactured by Fluke, Iriss or approved equal. Three-inch or four-inch shall be provided. The view ports shall be installed at the factory by the equipment manufacturer. The environmental rating of the IR ports shall be equal to or higher than that of the enclosure and must be installed per manufacturer's instructions. In order to allow for proper installation of the view ports, spacing between the feeder breakers may need to be adjusted.
- H. Miscellaneous Devices
1. Each section of the switchboard shall be provided with a space heater thermostatically controlled. Power for the space heaters shall be obtained from a control power transformer within the switchboard. Supply voltage shall be 120 volts AC. Space heaters shall be wired to provide temporary heating during storage.
 2. Control power transformers with primary and secondary protection shall be provided as required for proper operation of the equipment.[Control power transformers shall have adequate capacity to supply power to the transformer cooling fans.
- I. Customer Metering
1. Provide customer metering devices as specified herein. Provide a separate customer metering compartment with front hinged door. Include associated instrument transformers.
 2. Current transformers shall be wired to shorting type terminal blocks.
 3. Provide potential transformers including primary and secondary fuses with disconnecting means or fused potential taps as the potential source for metering as required.
 4. Microprocessor-based metering system.
 - a. Provide a full function electronic meter on all low voltage main devices as indicated on the drawings. The meter shall have the features and functions specified below. The meter shall be UL recognized, CSA certified and also meet ANSI Standard C37.90.
 - b. The meter shall provide direct reading metered or calculated values of the items listed below and shall auto range between Units, Kilo-units, and Mega-units for all metered values. Accuracy indicated below to be of read or calculated values.
 - 1) AC Current (Amperes) in A, B, and C phase, 3 Phase Average and Neutral (N). Accuracy +/- 0.2% (provide phase and neutral current transformer).
 - 2) AC Voltage (Volts) for A-B, B-C, and C-A, Phase Average, A-N, B-N, and C-N and Average Phase to N. Accuracy +/-0.2%.

- 3) Real Power (WATTS), Reactive Power (VARs), Apparent Power (VA), for each phase and system (system shall apply only for 3 wire applications). Accuracy +/- 0.4%. Forward/Reverse indication shall be provided.
- 4) Real Energy (WHR), Reactive Energy (VARHR), Apparent Energy (VAHR) for each phase and system (system shall apply only for 3 wire applications). Accuracy +/- 0.4%. Forward/Reverse indication shall be provided.
- 5) Frequency (HERTZ) Accuracy +/- 0.04%.
- 6) Demand values for System Current (AMPERES), System Real Power (WATTS), System Reactive Power (VARs), and System Apparent Power (VA).
- 7) Power Factor both Displacement only 60 cycle fundamental WATTS to VA and Apparent total WATTS to total VARs including harmonics for A, B, and C phase and system. Accuracy +/- 0.4%.
- 8) Current Percent Total Harmonic Distortion (THD) in A, B, and C phase, and N.
- 9) Voltage percent THD in A-B, B-C, and C-A phase, A-N, B-N, and C-N.
- 10) K-Factor (sum of the squares of harmonic currents times the square of their harmonic numbers).
- 11) Transformer Derating Factor (1.414 divided by the Crest Factor)
- 12) Crest Factor (ratio of peak current to RMS current).
- 13) Waveform capture and display.
- 14) Three (3) 4-20 milliampere outputs, assignable.

- c. Provide an addressable communication card capable of transmitting all data, remotely controlling and programming the meter over a compatible local area network to a central personal computer for storage, analysis, display and printout. The network shall also be capable of transmitting data in RS232c or RS485 format.
- d. Provide current transformers as required for each phase and neutral circuit with ratings sized for incoming service or associated feeder. Provide potential transformers as required for proper operation of the meter.
- e. The meter control power shall be capable of being supplied from the monitored incoming AC line without the need for a separate AC control circuit unless a separate 120 or 240 volt source is indicated on the drawings.

J. Enclosures

1. The switchgear shall be enclosed in an indoor NEMA 1 Enclosure.

K. Nameplates

1. Engraved nameplates, mounted on the face of the assembly, shall be furnished for all main and feeder circuits as indicated on the drawings. Nameplates shall be laminated plastic, black characters on white background, and secured with screws. Characters shall be 3/16 inch high, minimum. Nameplates shall give item designation and circuit number as well as frame ampere size and appropriate trip rating. Furnish Master nameplate giving switchboard designation, voltage ampere rating, short circuit rating, manufacturer's name, general order number and item number.

L. Finish

1. All exterior and interior steel surfaces of the switchboard shall be properly cleaned and provided with a rust-inhibiting phosphatized coating. Color and finish of the switchboard shall be ANSI 61 light gray.

PART 3 - EXECUTION

3.01 COOPERATION AND WORK PROGRESS

- A. The Electrical work shall be carried on under the usual construction conditions, in conjunction with all other work at the site. The Electrical Subcontractor shall cooperate with the Architect, General Contractor, all other Subcontractors and equipment suppliers working at the site. The Electrical Subcontractor shall coordinate the work and proceed in a manner so as not to delay the progress of the project.
- B. The Electrical Subcontractor shall coordinate his work with the progress of the building and other Trades so that he will complete his work as soon as conditions permit and such that interruptions of the building functions will be at a minimum. Any overtime hours worked or additional costs incurred due to lack of or improper coordination with other Trades or the Owner by the Electrical Subcontractor shall be assumed by him without any additional cost to the Owner.
- C. The Electrical Subcontractor shall furnish information on all equipment that is furnished under this Section but installed under another Section to the installing Subcontractor as specified herein.
- D. The Electrical Subcontractor shall provide all materials, equipment and workmanship to provide for adequate protection of all electrical equipment during the course of construction of the project. This shall also include protection from moisture and all foreign matter. The Electrical Subcontractor shall also be responsible for damage which he causes to the work of other Trades, and he shall remedy such injury at his own expense.
- E. Waste materials shall be removed promptly from the premises. All material and equipment stored on the premises shall be kept in a neat and orderly fashion. Material or equipment shall not be stored where exposed to the weather. The Electrical Subcontractor shall be responsible for the security, safekeeping and damages, including acts of vandalism, of all material and equipment stored at the job site.
- F. The Electrical Subcontractor shall be responsible for unloading all electrical equipment and materials delivered to the site. This shall also include all large and heavy items or equipment which require hoisting. Consult with the General Contractor for hoisting/crane requirements. During construction of the building, the Electrical Subcontractor shall provide additional protection against moisture, dust accumulation and physical damage of the main service and distribution equipment. This shall include furnishing and installing temporary heaters within these units, as approved, to evaporate excessive moisture and ventilate it from the room, as may be required.
- G. It shall be the responsibility of the Electrical Subcontractor to coordinate the delivery of the electrical equipment to the project prior to the time installation of equipment will be required; but he shall also make sure such equipment is not delivered too far in advance of such required installation, to ensure that possible damage and deterioration of such equipment will not occur. Such equipment stored for an excessively long period of time (as determined in the opinion of the Architect) on the project site prior to installation may be subject to rejection by the Architect.
- H. The Electrical Subcontractor shall erect and maintain, at all times, necessary safeguards for the protection of life and property of the Owner, Workmen, Staff and the Public.

- I. Prior to installation, the Electrical Subcontractor has the responsibility to coordinate the exact mounting arrangement and location of electrical equipment to allow proper space requirements as indicated in the NEC. Particular attention shall be given in the field to group installations. If it is questionable that sufficient space, conflict with the work of other Subcontractors, architectural or structural obstructions will result in an arrangement which will prevent proper access, operation or maintenance of the indicated equipment, the Electrical Subcontractor shall immediately notify the Contractor and not proceed with this part of the Contract work until definite instructions have been given to him by the Architect.
- J. The Electrical Subcontractor shall not allow any equipment or piping foreign to the electrical installation to be installed or pass through any room in which electrical systems or equipment are located, such as electric rooms, electric closets, telephone or data closets. The Electrical Subcontractor shall notify the Contractor of such violations and request immediate removal.

3.02 INSTALLATION

A. General

1. Unless specifically noted or indicated otherwise, all equipment and material specified in Part 2 of this specification or indicated on the drawings shall be installed under this Contract whether or not specifically itemized herein. This Section covers particular installation methods and requirements peculiar to certain items and classes or material and equipment.
2. The Electrical Subcontractor shall obtain detailed information from manufacturers of equipment provided under Part 2 of this specification as to proper methods of installation.
3. The Electrical Subcontractor shall obtain final roughing dimensions and other information as needed for complete installation of items furnished under other Sections or furnished by the Owner.
4. The Electrical Subcontractor shall keep fully informed of size, shape and position of openings required for material and equipment provided under this and other Sections. Ensure that openings required for work of this Section are coordinated with work of other Sections. Provide cutting and patching as necessary.
5. The Electrical Subcontractor shall coordinate the electric service installation with the Owner.
6. All miscellaneous hardware and support accessories, including support rods, nuts, bolts, screws and other such items, shall be of a galvanized or cadmium plated finish or of another approved rust-inhibiting coating.
7. Throughout this Section where reference is made to steel channel supports, it shall be understood to mean that the minimum size shall be 1 5/8" mild strip steel with minimum wall thickness of 0.105", similar to Unistrut P1000 or equal products manufactured by Kindorf or Husky Products Co.

B. Concrete Housekeeping Pads

1. Concrete pads shall be installed for all freestanding low voltage distribution equipment.
2. The General Contractor shall provide the concrete work. Electrical Subcontractor shall supervise and coordinate concrete work to ensure that proper grounding cable, rods, conduit, etc., are located as detailed and as required. The electrical Subcontractor shall also ensure that the concrete is level to within manufacturers published tolerances.

3. All concrete housekeeping pads shall extend a minimum of 6" on each side from the equipment mounted on it. Mounting height of each overcurrent/disconnect device in the above equipment shall not exceed 6'-6" above finished floor. If overcurrent devices exceed 6'-6" above finished floor as a result of the housekeeping pad, the pad shall extend in front of the gear a minimum of 4'-0".

C. Electrical Distribution Equipment

1. The Electrical Subcontractor shall install the low voltage distribution equipment per the manufacturers recommendations and the Contract Drawings.
2. The installation of all equipment, including working space requirements, shall conform to all NEC and local codes.
3. All necessary hardware to secure the assembly in place shall be provided by the Electrical Subcontractor.
4. The Electrical Subcontractor shall ensure that no piping, ductwork or other equipment foreign to the electrical trade passes through the area extending from the floor to the structural ceiling with the width and depth equal to that of the electrical distribution equipment plus 6" on either side of panel.
5. Floor mounted assemblies shall be installed on concrete housekeeping pads and shall be provided with adequate lifting means. Floor mounted assemblies shall be capable of being moved into installation position and bolted directly to the floor without the use of floor sills. The Electrical Subcontractor shall ensure the floor is level to 1/8 inch per 3-foot distance in any direction.
6. All electrical equipment shall be installed such that the handle of the highest circuit breaker does not exceed 6'-6" above finished floor.
7. The location of all electrical distribution equipment installed in mechanical or plumbing equipment rooms shall be coordinated with the respective Subcontractor.
8. The equipment shall be installed and checked in accordance with the manufacturer's recommendations prior to first energization. This shall include but not limited to:
 - a. Checking to ensure that the pad location is level to within .125 inches.
 - b. Checking to ensure that all bus bars are torqued to the manufacturer's recommendations.
 - c. Assemble all shipping sections, remove all shipping braces and connect all shipping split mechanical and electrical connections.
 - d. Secure assemblies to foundation or floor channels.
 - e. Measure and record megger readings phase-to-phase, phase-to-ground, and neutral-to-ground (four-wire systems only).
 - f. Inspect and install all circuit breakers, components, etc. in their proper compartments.
9. Identification shall be provided for all electrical distribution equipment. The electrical system identification shall clearly describe the equipment connected. For additional information, refer to specification section 26 0520.
10. Points of access for all rooms and spaces containing equipment and wiring operating at 600 volts and above shall be kept locked and shall include conspicuously posted warning signs. The warning sign shall be legible and permanent and shall contain the following verbiage: DANGER – HIGH VOLTAGE – KEEP OUT.
11. Control wiring shall be provided as required. Interface all local and remote control wiring and operational systems for each load.
12. Recessed and surface mounted equipment shall be mounted on walls with studs and cross-bracing, as required to assure sufficient strength so as to restrict any movement of the equipment.

13. Dry Type Transformers

- a. Floor mounted transformers shall be mounted a minimum of 6" from walls with proper clearance in front. Floor mounted transformers shall be installed on non-metallic, vibration isolating pads meeting seismic requirements and selected for at least 0.2" deflection. Panelboards shall not be mounted on wall above transformers.
- b. Trapeze mounted transformers shall be supported with threaded rods and channel and shall be isolated with hanger isolators meeting seismic requirements and suitable for the weight and size of the transformer.

14. Busway

- a. Coordinate busway penetrations through floor slabs and provide a 3 1/2" high, minimum concrete curb around all busways at each floor penetration. Provide floor flanges for all busway penetrations through floor. Flanges shall be designed for a minimum 2 hour fire rating. Only UL listed firestops shall be used.
- b. Busway shall be permitted to run directly to the substation feeder circuit breaker provided that the load side lugs for all feeder breakers, spare breakers and provisions for future breakers in the same switchgear cubicle are accessible and unobstructed for conductor terminations.
- c. All sections of busway within 40'-0" of a connected substation or transformer shall be vibration isolated at each support.
- d. Use non-metallic vibration isolators made of material suited for the service, and selected for at least 0.1" deflection.

3.03 REQUIREMENTS FOR EMERGENCY SYSTEMS WIRING

- A. All feeder wiring for the life safety and critical branch shall be installed within dedicated 2-hour fire rated rooms, closets or shafts or shall be a listed 2 hour fire rated assembly, such as MI cable.
- B. All feeder and branch circuit wiring for each system of the life safety and critical branch shall be kept entirely independent of all other wiring, devices and equipment, and shall not enter the same raceways, boxes or cabinets with each other or other wiring, except as specifically allowed by the Code.
- C. Where multiple transfer switches are provided for the same branch of emergency power, all wiring between the multiple systems shall be kept entirely independent of each other and all other branches of emergency power.

3.04 MATERIALS AND WORKMANSHIP

- A. All materials and equipment shall be new and unused and shall meet requirements of the latest Standards of NEMA, UL, IPCEA, ANSI and IEEE. Equipment shall have components required or recommended by OSHA, applicable NFPA documents and shall be UL listed and labeled.
- B. Despite references in the specifications or on the drawings to materials or pieces of equipment by name, make or catalog number, such references shall be interpreted as establishing standards of quality for materials and performance.

- C. Finish of materials, components and equipment shall not be less than Industry good practice. When material or equipment is visible or subject to corrosive or atmospheric conditions, the finish shall be as approved by the Architect.
- D. Provide proper access to material or equipment that requires inspection, replacement, repair or service. If proper access cannot be provided, confer with the Architect as to the best method of approach to minimize effects of reduced access.
- E. All work shall be installed in a neat and workmanlike manner and shall be done in accordance with all Local and State Codes.
- F. The Owner will not be responsible for material, equipment or the installation of same before testing and acceptance.

3.05 FACTORY TESTING

- A. Standard factory tests shall be performed on the low voltage distribution equipment provided under this section. All tests shall be in accordance with the latest version of ANSI and NEMA standards.
- B. Switchboards
 - 1. Switchboards shall be completely assembled, wired, adjusted and tested at the factory. After assembly, the complete switchboard will be tested for operation under simulated service conditions to assure the accuracy of the wiring and the functioning of all equipment.
 - 2. The bus system shall be given a dielectric test of 2200 Volts for one minute between live parts and ground, and between opposite polarities.
 - 3. The wiring and control circuits shall be given a dielectric test of 1500 Volts for one minute or 1800 Volts for one second between live parts and ground in accordance with ANSI C37.20.1.
- C. Dry type Transformers
 - 1. Ratio tests at the rated voltage connection and at all tap connections.
 - 2. Polarity and phase relation tests on the rated voltage connection.
 - 3. Applied potential tests.
 - 4. Induced potential test.
 - 5. No-load and excitation current at rated voltage on the rated voltage connection.
 - 6. Resistance measurements on all windings at the rated voltage connection of each unit and at the tap extremes of the first unit made of a new design.
- D. Factory tests as outlined above shall be witnessed by the owner's representative.
 - 1. The manufacturer shall notify the owner two (2) weeks prior to the date the tests are to be performed.
 - 2. The manufacturer shall include the cost of transportation and lodging for up to three (3) owner's representatives. The cost of meals and incidental expenses shall be the owner's responsibility.
- E. The manufacturer shall provide three (3) certified copies of factory test reports.

3.06 FIELD SETTINGS

- A. The Electrical Subcontractor shall perform field adjustments of the circuit breakers as required to place the equipment in final operating condition. The settings shall be in accordance with the approved protective device coordination study or as directed by the Engineer.
- B. For transformers, adjust taps to deliver appropriate voltage and measure primary and secondary voltage to confirm proper setting.
- C. Field Adjustments for Motor Control Centers/Starters
 - 1. Follow the manufacturer's instructions and the contract documents concerning any short circuit device settings, heater selection, timing relays, or startup of components.
 - 2. Heater installation and overload relay adjustment shall be the responsibility of the Electrical Subcontractor after field installation of the motor control center and verification of all motor full load amperes.

3.07 FIELD QUALITY CONTROL

- A. Provide the services of a qualified factory-trained manufacturer's representative to assist the Electrical Subcontractor in installation and start-up of the equipment specified under this section for a period of 2 working days. The manufacturer's representative shall provide technical direction and assistance to the Electrical Subcontractor in general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained therein.
- B. The Electrical Subcontractor shall provide three (3) copies of the manufacturer's field start-up report before final payment is made.

3.08 MANUFACTURER'S CERTIFICATION

- A. A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted, and tested in accordance with the manufacturer's recommendations.
- B. The Electrical Subcontractor shall provide three (3) copies of the manufacturer's representative's certification before final payment is made.

3.09 TRAINING

- A. The Electrical Subcontractor shall provide a training session for up to 2 Owner's representatives for 2 normal workdays at a jobsite location determined by the Owner.
- B. The training session shall be conducted by a manufacturer's qualified representative. The training program shall consist of the instruction on the operation of the assembly, circuit breakers, and major components within the assembly.
- C. The training program shall include the following:
 - 1. Review of the project one-line drawings and schedules.
 - 2. Review of the factory record shop drawings.
 - 3. Review of all equipment in the electrical distribution system.
 - 4. Discuss the maintenance timetable and procedures to be followed in an ongoing maintenance program.

5. Provide three ring binders to participants complete with copies of drawings and other course material covered.

END OF SECTION

SECTION 263010

EMERGENCY POWER DISTRIBUTION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. All of the Contract Documents, as listed on the Table of Contents and including General and Supplementary Conditions and Division 01, General Requirements, shall be included in, and made part of, this Section.

1.02 DESCRIPTION OF WORK

- A. Furnish an Essential (Life Safety, Critical and Equipment) power distribution and automatic transfer system to automatically sense the loss of utility power, start the generator set and transfer the critical load between the normal and backup power source. The system shall also sense the return of utility power and automatically restore the system to its normal operating state.
- B. The following general systems and equipment shall be provided for the renovated areas of the existing building, as a minimum, but not necessarily limited to the following:
 - 1. Emergency distribution system.
 - 2. Hoisting, rigging, setting of all equipment.
 - 3. Testing, cleaning and adjusting.
 - 4. Shop drawings.
 - 5. Automatic transfer switches.

1.03 RELATED WORK

- A. For work to be included as part of this Section, to be furnished and installed by the Electrical Subcontractor, refer to the Related Work section of Specification Section 26 0510.
- B. Carefully examine all of the Contract Documents, criteria sheets and all other Sections of the specifications for requirements which affect work under this Section, whether or not such work is specifically mentioned in this Section.
- C. For work related to, and to be coordinated with, the electrical work, but not included in this Section and required to be performed under other designated Sections, see the following:
 - 1. Division 03 – Concrete housekeeping pad

1.04 REFERENCES

- A. The electrical power generation and transfer equipment covered by these specifications shall be designed, tested and assembled in strict accordance with the latest edition of all applicable standards including, but not limited to, the following:
 - 1. National Electrical Code (NEC) 700, 701, 702
 - 2. NEC 517
 - 3. National Fire Protection Association (NFPA) 110

4. NFPA 101
5. NFPA 99
6. American National Standards Institute (ANSI)
7. Underwriters Laboratories (UL)
8. Institute of Electrical and Electronics Engineers (IEEE)

1.05 QUALITY ASSURANCE

- A. The manufacturers listed within this specification have been preselected for use on this project. No submittal will be accepted from a manufacturer other than specified.
- B. To ensure system compatibility, the automatic transfer switches, bypass isolation switches and emergency generators shall be furnished to the Electrical Subcontractor by the generator set manufacturer for single source responsibility.
- C. The manufacturer shall have a local, authorized dealer who can provide factory trained servicemen, the required stock of replacement parts, technical assistance and warranty administration within a reasonable distance from the project.

1.06 WARRANTY

- A. Attention is directed to provisions of the General Requirements, Supplementary General Requirements and Section 26 0510 regarding guarantees and warranties for the work under this Contract.
- B. In addition to the requirements above, the manufacturer of the automatic transfer switches shall provide a full five (5) year extended warranty starting from the date of the accepted job site testing. The warranty shall include the following:
 1. Repair parts
 2. Labor
 3. Travel expenses
 4. Expendables including:
 5. Other service items made unusable by the defect.
 6. In the event the transfer switch require replacement, the warranty shall also cover the following, including installation, hoisting and rigging:
 - a. Removal of the defective unit.
 - b. Installation of the new unit.
 - c. Temporary transfer switch to maintain occupancy of the facility.
 - d. All required electrical disconnections and connections to restore the system to its original condition.
- C. Warranty Nameplate
 1. A warranty nameplate, 6" x 8" shall be affixed to the generator set with the following data:
 - a. Warranty period
 - b. Start-up date
 - c. Termination date
 - d. Supplier name
 - e. Supplier address
 - f. 24 hour emergency telephone number

g. Preventative maintenance to be performed by:

D. Field Service

1. The combination transfer bypass/isolation switch manufacturer shall employ a nationwide factory-direct, field service organization, available on a 24 hour a day, 365 days a year, call basis.
2. The manufacture shall include an 800 telephone number, for field service contact, affixed to each enclosure.
3. The manufacturer shall maintain records of each transfer bypass/isolation switch, by serial number, for a minimum 20 years.

1.07 MAINTENANCE AND REPAIR CONTRACT

- A. The automatic transfer switch supplier shall provide a one (1) year maintenance and repair contract, which shall begin following final acceptance by the Owner, which shall guarantee all support costs of the specified system. It shall include routine and 24 hour emergency access to a factory account manager to expedite emergency repairs.
- B. The automatic transfer switch supplier shall offer, to the Owner, an extended maintenance and repair contract, upon expiration of the initial one (1) year maintenance contract, to be renewed annually which shall guarantee all support costs of the specified system for the duration of the contract, as indicated above. It shall include routine and 24 hour emergency access to a factory account manager to expedite emergency repairs.

1.08 SELECTIVE COORDINATION

- A. The emergency distribution system, the elevator distribution system and the fire pump distribution system shall be selectively coordinated to meet the requirements of the National Electrical Code, Articles 517.26, 517.30 (G), 620.62, 700.28, and 701.27 and NFPA 20.
- B. The switchgear manufacturer shall be responsible to select appropriate circuit breaker frame, sensor and trip sizes for all devices upstream of other devices for a completely coordinated system. Refer to specification 260570 for additional information.

1.09 WITHSTAND AND INTERRUPTING RATINGS OF ELECTRICAL COMPONENTS

- A. Calculated available 3 phase and single phase to ground short circuit currents indicated on the drawings are provided for information only to assist in the selection of withstand and interrupting ratings and coordination of devices and equipment.
- B. Prior to submission of shop drawings, the automatic transfer switch manufacturer shall obtain short circuit calculations from the low voltage distribution equipment manufacturer in accordance with specification section 26 0570 to determine actual available 3 phase and single line to ground short circuit current at each component in the system based on actual equipment, feeder lengths, impedances, etc. of the equipment proposed for this project. Failure to obtain the calculated short circuit values prior to submission of shop drawings shall not relieve the generator switchgear manufacturer from providing devices that meet the requirements of the final study report.
- C. Each component shall be UL listed and labeled and shall be fully rated to withstand and interrupt calculated available 3 phase and single phase to ground short circuit current levels. Series ratings will not be acceptable.

1.10 SUBMITTALS

- A. Prepare and submit shop drawings in accordance with the requirements hereinbefore specified, and with Section 01 3300 – Submittal Procedures in the manner described therein, modified as noted hereinafter.
- B. All shop drawings shall have clearly marked the appropriate specification number of drawing designation, for identification of the submittal.
- C. Disposition of shop drawings shall not relieve the Electrical Subcontractor from the responsibility for deviations from drawing or specifications, unless he has submitted in writing a letter itemizing or calling attention to such deviations at time of submission and secured written approval from the Engineer, nor shall such disposition of shop drawings relieve the Electrical Subcontractor from responsibility for errors in shop drawings or schedules.
- D. Shop drawings shall include, but shall not be limited to, the following:
 1. Component List - A breakdown of all components and options including transfer switches.
 2. Automatic transfer switches:
 - a. Descriptive literature
 - b. Ratings
 - c. Sequence of operation
 - d. Plan, elevation, side and front view arrangement drawings with overall dimensions and clearance requirements
 - e. Mounting and anchoring requirements
 - f. Conduit entrance locations
 - g. Equipment weights
 - h. Schematic diagrams
 - i. Wiring diagrams
 - j. Accessories list
 - k. UL Listings
 3. The following equipment rooms with all the electrical equipment laid out with dimensions, Code clearances, etc., indicated shall be submitted with the equipment shop drawings. Acceptance of these shop drawings shall be obtained prior to installation of feeder conduits:
 - a. All emergency electrical rooms and closets.
 - b. Automatic transfer switches/distribution switchgear.

Notes:

Equipment shop drawings will not be reviewed without the room/equipment layouts.

The Architect/Engineer reserve the right to rearrange equipment in electrical equipment rooms or spaces once final equipment dimensional information is known and prior to installation of the equipment. Install equipment in the final location selected by the Architect/Engineer at no additional cost to the Owner.

PART 2 PRODUCTS

2.01 AUTOMATIC TRANSFER BYPASS/ISOLATION SWITCH

A. Manufacturers

1. Combination automatic transfer bypass/isolation switches ESATSH and ECATSH shall be single operator automatic transfer switches as manufactured by Russelectric or ASCo.
2. Combination automatic transfer bypass/isolation switch EQATSH shall be dual operator automatic transfer switch as manufactured by Russelectric or equivalent product as manufactured by ASCo.

B. Ratings

1. 480 Volt Class Automatic Transfer Switches shall have a 30 cycle close and withstand rating of 100,000 amperes as indicated on the drawings. The transfer switch manufacturer may be required to supply higher ampacity rated automatic transfer switch(es) in order to meet the minimum withstand rating required.
2. As a condition of approval, the manufacturer of the automatic transfer switches shall verify that their switches are listed by Underwriters Laboratories, Inc., Standard UL-1008 with fully rated 30 cycle short circuit closing and withstand values.
 - a. During the 30 cycle closing and withstand tests, there shall be no contact welding or damage. The 30 cycle tests shall be performed without the use of current limiting fuses. The test shall verify that contacts separation has not occurred, and there is contact continuity across all phases. Test procedures shall be in accordance with UL 1008, and testing shall be certified by Underwriters' Laboratories, Inc.
 - b. When conducting temperature rise tests to UL 1008, the manufacture shall include post-endurance temperature rise tests to verify the ability of the transfer switch to carry full rated current after completing the overload and endurance tests.
3. The microprocessor controller shall meet the following requirements:
 - a. Storage conditions - 25 degrees C to 85 degrees C
 - b. Operation conditions - 20 degrees C to 70 degrees C ambient
 - c. Humidity 0 to 99% relative humidity, non-condensing
 - d. Capable of withstanding infinite power interruptions
 - e. Surge withstand per ANSI/IEEE C-37.90A-1978

C. Construction

1. The automatic transfer switch (ATS) and its associated bypass/isolation switch (BPS) shall be furnished as shown on the drawings. Voltage and continuous current ratings and number of poles shall be as shown.
2. Each automatic transfer switch shall have the number of poles as shown on the drawings. Where 4 pole switches are indicated, a true 4 pole switch shall be supplied with all four poles mounted on a common shaft. The continuous current rating and the closing and withstand rating of the fourth pole shall be identical to the rating of the main poles.
3. The automatic transfer bypass/isolation switch shall be mounted in a NEMA 1 enclosure, unless otherwise indicated. Enclosures shall be fabricated from 12 gauge steel. The enclosure shall be sized to exceed minimum wire bending space required by UL 1008.

4. The transfer switch shall be equipped with an internal welded steel pocket, housing an operations and maintenance manual.
5. The automatic transfer bypass/isolation switch shall have top and bottom cable access.
6. The main contacts shall be capable of being replaced without removing the main power cables.
7. The main contacts shall be visible for inspection without any major disassembly of the transfer switch.
8. All bolted bus connections shall have Belleville compression type washers.
9. When a solid neutral is required, a fully rated bus bar with required AL-CU neutral lugs shall be provided.
10. Control components and wiring shall be front accessible. All control wires shall be multi-conductor 18 gauge, 600 volt SIS switchboard type with point to point harness. All control wire terminations shall be identified with tubular sleeve-type markers.
11. The switch shall be equipped with 90 degrees C rated copper/aluminum solderless Burndy compression type lugs. Lugs shall be sized to accommodate conductor sizes as indicated on the drawings.
12. The complete automatic transfer bypass/isolation switch assembly shall be factory tested to ensure proper operation and compliance with the specification requirements. A copy of the factory test report shall be available upon request.
13. The automatic transfer switch shall be bused with silver plated copper bus. Aluminum bus, and/or cable interconnections are not acceptable. Construction shall be such that the Electrical Subcontractor needs to install only the power and control connections.
 - a. Bus bars shall be arranged "A", "B", "C", from front-to-back and/or top-to-bottom and/or left-to-right as viewed from the front of the equipment.

D. Bypass/Isolation Construction

1. Each transfer switch shall include a bypass/isolation switch to provide a safe and convenient means for manually bypassing and isolating the automatic transfer switch, regardless of the condition or position of the ATS, with the ability to be used as an emergency back-up system in the event the transfer switch should fail. In addition, the bypass/isolation switch shall be utilized to facilitate maintenance and repair of the automatic transfer switch.
2. The automatic transfer switch shall be completely isolated from the bypass/isolation switch by means of insulating barriers and separate access doors to positively prevent hazard to operating personnel while servicing the automatic transfer switch.
3. All main contacts and operating linkages of the bypass/isolation section shall be identical to the ATS, except that the operation shall be manual.
4. The bypass/isolation switch shall have the same electrical ratings of ampacity, voltage, short circuit withstand, and temperature rise capability as the associated ATS. The main contacts of the bypass switch shall be mechanically locked in both the normal bypass and emergency bypass positions without the use of hooks, latches, magnets, or springs and shall be silver-tungsten alloy, protected by arcing contacts with magnetic blowouts on each pole. The switching mechanism shall provide "quick-break," "quick-make" operation of the contacts.
5. The automatic transfer switch and bypass/isolation switch shall be bused together with silver plated copper bus to provide a complete pre-tested assembly. Aluminum bus, and/or cable interconnections are not acceptable. Construction shall be such that the Electrical Subcontractor needs to install only the power and control connections.

6. The primary buswork of the draw-out automatic transfer switch shall be connected to the stationary bus stabs in the freestanding cubicle by silver plated, segmented, self-aligning, primary disconnect fingers to facilitate proper alignment between the removable draw-out when the ATS is withdrawn and shall be available for inspection without disturbing or de-energizing the main bus.
7. The secondary control disconnect contacts mounted on the ATS shall be self-aligning and shall plug into the stationary elements mounted on the freestanding cubicle. Separate, manual, secondary control disconnect plugs are not acceptable.
8. The isolating portion of the bypass/isolation shall allow the automatic transfer switch to be disconnected from all sources of power and control without opening the enclosure door. The transfer switch shall have a true draw-out configuration which does not require disconnection of any electrical or mechanical device by maintaining personnel. The automatic transfer switch shall be provided with rollers or casters to allow it to be removed from its enclosure simply by rolling it out. Positive mechanical interlocks shall be provided to insure that the bypass/isolation functions can be accomplished without the danger of a short circuit.
9. A fourth pole, switched neutral shall be provided if the associated automatic transfer switch is designed as 4 pole. Basic 4 pole, bypass/isolation switch construction shall be identical to the associated automatic transfer switch construction.
10. Necessary controls shall be provided to ensure that the "engine run" circuit remains closed when the switch is in the bypass-to-emergency position, even though the associated transfer switch is in the "normal" position or completely removed from the enclosure.

E. Automatic Transfer Switch

1. Single operator transfer switch(es) (life safety and critical branch) shall be double throw, actuated by a single electrical operator momentarily energized, and connected to the transfer mechanism by a simple over center type linkage. Total transfer time shall not exceed one half second. For transfer switches utilizing in-phase monitors, passive synchronization will not be acceptable.
2. Dual operator transfer switch(es) (equipment branch) shall be double throw, actuated by two electric motor operators or electric solenoids momentarily energized, and connected to the transfer mechanism by a simple over center type linkage. Minimum transfer time shall be 400 milliseconds. Transfer between two energized sources shall have an adjustable time delay of 0 to 120, factory set at 3 seconds to allow for motor wind-down. Single operator transfer switches with passive in-phase monitors will not be acceptable.
3. The normal and emergency contacts shall be positively interlocked mechanically and electrically to prevent simultaneous closing. Main contacts shall be mechanically locked in both the normal and emergency positions without the use of hooks, latches, magnets, or springs, and shall be silver-tungsten alloy. Separate arcing contacts with magnetic blowouts shall be provided on all transfer switches. Interlocked, molded case circuit breakers or contactors are not acceptable.
4. The transfer switch shall be equipped with a safe, manual operator, designed to prevent injury to operating personnel. The manual operator shall provide the same contact to contact transfer speed as the electrical operator to prevent a flashover from switching the main contacts slowly.

F. Automatic Transfer Switch Controls

1. The transfer switch shall be equipped with a microprocessor controller with a Power Supply Module, CPU and I/O Modules for all voltage and ampere ratings. The controller shall be capable of both Serial and Ethernet communications.

2. The controller shall contain voltage sensing modules capable of direct single phase or three phase sensing of each source from 120 VAC to 600 VAC. The Power Supply Module shall accept a 24VDC external power source allowing controller communications in the event of a power outage
3. Voltage sensing shall be true RMS type and accurate to +/- 1% of nominal voltage. Frequency sensing shall be accurate to +/- 0.5Hz. The operating temperature range shall be -20 to +50 degrees C and storage from -40 to +90 C.
4. The controller shall connect to the transfer switch through an interconnecting wiring harness. Interfacing relays shall be provided to isolate the controller from abnormal voltages applied to any and all customer input and output wiring terminals
5. All customer interface connections shall be wired to a common DIN rail Cage Clamp terminal block. Sufficient space shall be provided to allow for future modifications and upgrades.
6. The controller shall include a 20 character, LCD display, with a keypad, which allows access to the system.
7. The controller shall include three phase over/under voltage, over/under frequency, phase sequence detection and phase differential monitoring on both normal and emergency sources.
8. The Controller Display and Keypad
 - a. A color ¼ VGA minimum, graphical display shall be provided for viewing data remotely and limited control through a front accessible USB communications port.
 - b. The Controller shall include high intensity LED's for:
 - 1) Source Availability - Indicated the source voltage and frequency are within preset parameters
 - 2) Source Connected - Indicates the source main contacts closed and the load being served from the source
 - 3) XFER Inhibit - Indicates that the ATS is being inhibited for Automatic operation to the connected source
 - 4) Alarm - Indicates Alarm condition active
 - 5) TD Active - Indicates that a transfer switch time delay is actively timing
9. Power Quality Metering:
 - a. The ATS shall be able to supply metering for current, voltage, real power, reactive power, energy use power factor and frequency. Metering shall be true RMS type, 1% accuracy for voltage and 0.5% currents and with 5 amp secondary current transformer
 - b. The following parameters shall be provided: Phase Current, Phase Voltage, Voltage and Current unbalance, Hz, PF, W, Var, VA WH, Vah, VARh, Voltage and Current Harmonics, Phase rotation, Synchsopce.
 - c. The ATS shall be capable of monitoring and capturing waveform data in the event of a utility power outage or other user specified event.
 - d. The controller shall be capable of logging digital and analog measured parameters and storing the data in non- volatile memory. The controller shall contain a 10 channel Data Logger. Each channel shall be capable of being configured to monitor a digital on/off or analog measured parameter. The sampling rate of each channel shall be configurable from 1 cycle to 60 minutes per sample. The data shall be stored in non-volatile memory in a first in, first out method.
 - e. Alarm- Indicates Alarm condition active TD Active- Indicates that a transfer switch time delay is actively timing

G. Sequence of Operation

1. When the voltage on any phase of the normal source drops below 80% or increases to 120%, or frequency drops below 90%, or increase to 110%, or 20% voltage differential between phases occurs, after a programmable time delay period of 0-120 seconds factory set at 3 seconds to allow for momentary dips, the engine starting contacts shall close to start the generating plant.
2. The transfer switch shall transfer to the emergency source when the generating plant has reached 90% of rated voltage and frequency on all phases.
3. After restoration of normal power on all phases to a preset value of at least 90% to 110% of rated voltage, and at least 95% to 105% of rated frequency, and voltage differential is below 20%, an adjustable time delay period of 0-9,999 seconds (factory set at 300 seconds) shall delay retransfer to allow stabilization of normal power. If the emergency power source should fail during this time delay period, the switch shall automatically return to the normal source.
4. After retransfer to normal, the engine generator shall be allowed to operate at no load for a programmable period of 0-3,600 seconds, factory set at 300 seconds.

H. Automatic Transfer Switch Accessories

1. Programmable three phase sensing of the normal source set to pickup at 90% and dropout at 80% of rated voltage and over-voltage sensing to pickup at 120% and dropout at 110% of rated voltage. Programmable under-frequency pickup at 95% and dropout at 90% and over frequency to pickup at 110% and dropout at 105% of rated frequency. Programmable voltage differential between phases set at 20%, and phase sequence monitoring.
2. Programmable three phase sensing of the emergency source set to pickup at 90% and dropout at 80% of rated voltage and over-voltage sensing to pickup at 120% and dropout at 110% of rated voltage. Programmable under-frequency pickup at 95% and dropout at 90% and over frequency to pickup at 110% and dropout at 105% of rated frequency. Programmable voltage differential between phases set at 20%, and phase sequence monitoring.
3. Time delay for override of momentary normal source power outages (delays engine start signal and transfer switch operation). Programmable 0-10 seconds. Factory set at 3 seconds, if not otherwise specified.
4. For dual operator automatic transfer switches, time delay to control contact transition time on transfer to either source shall be provided. Programmable 0-120 seconds, factory set at 3 seconds.
5. Time delay on retransfer to normal, programmable 0-120 seconds, factory set at 300 seconds if not otherwise specified, with overrun to provide programmable 0-3,600 second time delay, factory set at 300 seconds, unloaded engine operation after retransfer to normal.
6. A two position, password protected, maintained type, load or no load test switch shall be included to simulate a normal power failure. The test function shall be activated via pushbutton on the display or remotely via a dry contact, voltage signal or a network signal
7. Contacts for a remote type load test switch shall be included to simulate a normal power failure.
8. A time delay bypass on retransfer to normal shall be included.
9. Contact, rated 10 amperes, 30 volts DC, to close on failure of normal source to initiate engine starting.
10. Contact, rated 10 amperes, 30 volts DC, to open on failure of normal source for customer functions.

11. Light emitting diodes shall be mounted on the microprocessor panel to indicate:
 - a. Switch is in normal position
 - b. Switch is in emergency position
 - c. Source availability
12. A plant exerciser shall be provided with seven (7), 7 day, 14 day or 28 day exercise periods. The exerciser shall also be configurable as a full 365 day exerciser with up to 24 independent exercise events. programmable for any day of the week and twenty-four (24) calendar events, programmable for any month/day, to automatically exercise generating plant programmable in one minute increments. Also include selection of either "no load" (switch will not transfer) or "load" (switch will transfer) exercise period.
13. Three auxiliary contacts rated 10 ampere, 120 volts AC (for switches 100 to 800 amps), 15 ampere, 120 volts AC (for switches 1,000 to 4,000 amps), shall be mounted on the main shaft, closed on normal. Contacts shall be wired to a terminal strip for ease of customer connections.
14. Three auxiliary contacts rated 10 ampere, 120 volts AC (for switches 100 to 800 amps), 15 ampere, 120 volts AC (for switches 1,000 to 4,000 amps), shall be mounted on the main shaft, closed on emergency. Contacts shall be wired to a terminal strip for ease of customer connections.
15. Diagnostics - The controller shall contain self-diagnostic screen for the purpose of detecting and troubleshooting abnormal system events
16. Communications Interface - The controller shall be capable of interfacing via serial RS/485 or optional Ethernet TCP/IP communications ports integral to the controller. All communications parameters (baud rate, parity, IP address, etc.) shall be accessible and programmable via the front keypad. Both serial and Ethernet TCP/IP network connection
17. An LCD readout shall display normal source and emergency source availability.
18. All automatic transfer switches shall be capable of communicating with the building automation system. Coordinate with Owner.

I. Field Wiring

1. The Electrical Subcontractor shall run control wiring between each transfer switch engine start circuit and the respective generator to be started.
2. The Electrical Subcontractor shall run control wiring between the transfer switch(es) serving the elevators and each elevator controller. Control wiring shall indicate when the transfer switch is in the emergency position for selective operation of elevators. Control wiring shall also be provided to indicate when the transfer switch will transfer between two live sources via accessory contacts indicated above to allow elevators to stop prior to transfer.
3. Control wiring indicated in paragraphs 1. and 2. above shall be installed in two (2) hour fire rated construction or shall be Pyrotex System 1850 MI cable for its entire length.

PART 3 EXECUTION

3.01 COOPERATION AND WORK PROGRESS

- A. The Electrical work shall be carried on under the usual construction conditions, in conjunction with all other work at the site. The Electrical Subcontractor shall cooperate with the Architect, General Contractor, all other Subcontractors and equipment suppliers working at the site. The Electrical Subcontractor shall coordinate the work and proceed in a manner so as not to delay the progress of the project.

- B. The Electrical Subcontractor shall coordinate his work with the progress of the building and other Trades so that he will complete his work as soon as conditions permit and such that interruptions of the building functions will be at a minimum. Any overtime hours worked or additional costs incurred due to lack of or improper coordination with other Trades or the Owner by the Electrical Subcontractor shall be assumed by him without any additional cost to the Owner.
- C. The Electrical Subcontractor shall furnish information on all equipment that is furnished under this Section but installed under another Section to the installing Subcontractor as specified herein.
- D. The Electrical Subcontractor shall provide all materials, equipment and workmanship to provide for adequate protection of all electrical equipment during the course of construction of the project. This shall also include protection from moisture and all foreign matter. The Electrical Subcontractor shall also be responsible for damage which he causes to the work of other Trades, and he shall remedy such injury at his own expense.
- E. Waste materials shall be removed promptly from the premises. All material and equipment stored on the premises shall be kept in a neat and orderly fashion. Material or equipment shall not be stored where exposed to the weather. The Electrical Subcontractor shall be responsible for the security, safekeeping and damages, including acts of vandalism, of all material and equipment stored at the job site.
- F. The Electrical Subcontractor shall be responsible for unloading all electrical equipment and materials delivered to the site. This shall also include all large and heavy items or equipment which require hoisting. Consult with the General Contractor for hoisting/crane requirements. During construction of the building, the Electrical Subcontractor shall provide additional protection against moisture, dust accumulation and physical damage of the main service and distribution equipment. This shall include furnishing and installing temporary heaters within these units, as approved, to evaporate excessive moisture and ventilate it from the room, as may be required.
- G. It shall be the responsibility of the Electrical Subcontractor to coordinate the delivery of the electrical equipment to the project prior to the time installation of equipment will be required; but he shall also make sure such equipment is not delivered too far in advance of such required installation, to ensure that possible damage and deterioration of such equipment will not occur. Such equipment stored for an excessively long period of time (as determined in the opinion of the Architect) on the project site prior to installation may be subject to rejection by the Architect.
- H. The Electrical Subcontractor shall erect and maintain, at all times, necessary safeguards for the protection of life and property of the Owner, Workmen, Staff and the Public.
- I. Prior to installation, the Electrical Subcontractor has the responsibility to coordinate the exact mounting arrangement and location of electrical equipment to allow proper space requirements as indicated in the NEC. Particular attention shall be given in the field to group installations. If it is questionable that sufficient space, conflict with the work of other Subcontractors, architectural or structural obstructions will result in an arrangement which will prevent proper access, operation or maintenance of the indicated equipment, the Electrical Subcontractor shall immediately notify the Contractor and not proceed with this part of the Contract work until definite instructions have been given to him by the Architect.

3.02 INSTALLATION

A. General

1. Unless specifically noted or indicated otherwise, all equipment and material specified in Part 2 of this specification or indicated on the drawings shall be installed under this Contract whether or not specifically itemized herein. This Section covers particular installation methods and requirements peculiar to certain items and classes or material and equipment.
2. The Electrical Subcontractor shall obtain detailed information from manufacturers of equipment provided under Part 2 of this specification as to proper methods of installation.
3. The Electrical Subcontractor shall obtain final roughing dimensions and other information as needed for complete installation of items furnished under other Sections or furnished by the Owner.
4. The Electrical Subcontractor shall keep fully informed of size, shape and position of openings required for material and equipment provided under this and other Sections. Ensure that openings required for work of this Section are coordinated with work of other Sections. Provide cutting and patching as necessary.
5. All miscellaneous hardware and support accessories, including support rods, nuts, bolts, screws and other such items, shall be of a galvanized or cadmium plated finish or of another approved rust-inhibiting coating.
6. Throughout this Section where reference is made to steel channel supports, it shall be understood to mean that the minimum size shall be 1 5/8" mild strip steel with minimum wall thickness of 0.105", similar to Unistrut P1000 or equal products manufactured by Kindorf or Husky Products Co.

B. Concrete Housekeeping Pads

1. Concrete pads shall be installed for all freestanding electrical distribution equipment, including:
 - a. Automatic transfer switches
2. The General Contractor shall provide the concrete work. Electrical Subcontractor shall supervise and coordinate concrete work to ensure that proper grounding cable, rods, conduit, etc., are located as detailed and as required. The electrical Subcontractor shall also ensure that the concrete is level to within manufacturers published tolerances.
3. All concrete housekeeping pads shall extend a minimum of 6" on each side from the equipment mounted on it. Mounting height of each overcurrent/disconnect device in the above equipment shall not exceed 6'-6" above finished floor. If overcurrent devices exceed 6'-6" above finished floor as a result of the housekeeping pad, the pad shall extend in front of the gear a minimum of 4'-0".

C. Electrical Distribution Equipment

1. The Electrical Subcontractor shall install all emergency electrical distribution equipment per the manufacturer's recommendations and the Contract Drawings.
2. The installation of all equipment, including working space requirements, shall conform to all NEC and local codes.
3. All necessary hardware to secure the assembly in place shall be provided by the Electrical Subcontractor.

4. The Electrical Subcontractor shall ensure that no piping, ductwork or other equipment foreign to the electrical trade passes through the area extending from the floor to the structural ceiling with the width and depth equal to that of the electrical distribution equipment plus 6" on either side of panel.
5. Floor mounted assemblies shall be installed on concrete housekeeping pads and shall be provided with adequate lifting means. Floor mounted assemblies shall be capable of being moved into installation position and bolted directly to the floor without the use of floor sills. The Electrical Subcontractor shall ensure the floor is level to 1/8 inch per 3-foot distance in any direction.
6. All floor and wall mounted electrical equipment shall be installed such that the handle of the highest circuit breaker does not exceed 6'-6" above finished floor.
7. The equipment shall be installed and checked in accordance with the manufacturer's recommendations prior to first energization. This shall include but not limited to:
 - a. Checking to ensure that the pad location is level to within .125 inches.
 - b. Checking to ensure that all bus bars are torqued to the manufacturer's recommendations.
 - c. Assemble all shipping sections, remove all shipping braces and connect all shipping split mechanical and electrical connections.
 - d. Secure assemblies to foundation or floor channels.
 - e. Measure and record megger readings phase-to-phase, phase-to-ground, and neutral-to-ground (four-wire systems only).
 - f. Inspect and install all circuit breakers, components, etc. in their proper compartments.
8. Identification shall be provided for all electrical distribution equipment. The electrical system identification shall clearly describe the equipment connected. Method of identification shall be by laminated nameplate made of bakelite or similar material with engraved letters at least 1/4" high and securely attached to the equipment with galvanized screws. Adhesives or cements shall not be used. A list of nameplates shall be submitted to the Architect for approval prior to fabrication.
9. Control wiring shall be provided as required. Interface all local and remote control wiring and operational systems for each load.

3.03 REQUIREMENTS FOR EMERGENCY SYSTEMS WIRING

- A. All feeder wiring for the life safety and critical branch shall be installed within dedicated 2-hour fire rated rooms, closets or shafts or shall be a listed 2 hour fire rated assembly, such as MI cable.
- B. All feeder and branch circuit wiring for each system of the life safety and critical branch shall be kept entirely independent of all other wiring, devices and equipment, and shall not enter the same raceways, boxes or cabinets with each other or other wiring, except as specifically allowed by the Code.
- C. Where multiple transfer switches are provided for the same branch of emergency power, all wiring between the multiple systems shall be kept entirely independent of each other and all other branches of emergency power.

3.04 MATERIALS AND WORKMANSHIP

- A. All materials and equipment shall be new and unused and shall meet requirements of the latest Standards of NEMA, UL, IPCEA, ANSI and IEEE. Equipment shall have components required or recommended by OSHA, applicable NFPA documents and shall be UL listed and labeled.
- B. Despite references in the specifications or on the drawings to materials or pieces of equipment by name, make or catalog number, such references shall be interpreted as establishing standards of quality for materials and performance.
- C. Finish of materials, components and equipment shall not be less than Industry good practice. When material or equipment is visible or subject to corrosive or atmospheric conditions, the finish shall be as approved by the Architect.
- D. Provide proper access to material or equipment that requires inspection, replacement, repair or service. If proper access cannot be provided, confer with the Architect as to the best method of approach to minimize effects of reduced access.
- E. All work shall be installed in a neat and workmanlike manner and shall be done in accordance with all Local and State Codes.
- F. The Owner will not be responsible for material, equipment or the installation of same before testing and acceptance.

3.05 TRAINING

- A. The Electrical Subcontractor shall provide a training session for up to 2 Owner's representatives for 2 normal workdays at a jobsite location determined by the owner.
- B. The training session shall be conducted by a manufacturer's qualified representative. The training program shall consist of the instruction on the operation of the assembly, circuit breakers, and major components within the assembly.
- C. The training program shall include the following:
 - 1. Review of the project one-line drawings and schedules.
 - 2. Review of the factory record shop drawings.
 - 3. Review of all equipment in the emergency electrical distribution system.
 - 4. Discuss the maintenance timetable and procedures to be followed in an ongoing maintenance program.
 - 5. Provide three ring binders to participants complete with copies of drawings and other course material covered.

3.06 OPERATION INSTRUCTIONS AND MAINTENANCE MANUALS

- A. After completion of work and start-up of the equipment at the jobsite, deliver to the Contracting Officer, copies of operating instructions, maintenance manuals and drawings presenting full details for care and maintenance of each item of equipment furnished and/or installed under this Contract.

- B. Each manual shall contain the operating and maintenance information and parts lists furnished by the manufacturer, for all equipment provided in the Contract. When necessary, provide supplemental drawing to show system operation and servicing and maintenance points. For all electrical components, furnish wiring and connection diagrams. Manuals shall include instructions required to accomplish specified operation and functions. Data shall be neat, clean, legible copies. Drawings shall be accordion folded. Non-applicable information shall not be included. Five (5) sets of manuals shall be furnished to the Owner.
- C. Switchgear drawings and wiring diagrams shall be furnished complete and up to date at the completion of start-up and system acceptance by the Owner. Drawings and wiring diagrams shall include any field modifications or changes to reflect actual as built conditions.

END OF SECTION

SECTION 264110

LIGHTNING PROTECTION SYSTEM

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. All of the Contract Documents, as listed on the Table of Contents and including General and Supplementary Conditions and Division 01, General Requirements, shall be included in, and made part of, this Section.

1.02 DESCRIPTION OF WORK

- A. Provide a complete lightning protection system with all component parts as indicated and/or specified, and as manufactured by one of the following:
 - 1. Boston Lightning Rod, Inc.
 - 2. Northeast Lightning Protection Systems, Inc., Bloomfield, Connecticut
 - 3. National Lightning Protection Corporation
 - 4. Warren Lightning Rod Co., Collingwood, New Jersey
- B. Equipment furnished by one of the above manufacturers or an independent protection company shall be considered as equals.
- C. The system shall include air terminals on the roof; bonding of roof mounted mechanical equipment and stacks; bonding of structure and other metal parts, ground conductors and ground rods; with necessary connectors, bonding straps, fasteners, clamps and all other equipment and materials necessary for a complete system for the building.

1.03 RELATED WORK

- A. For work to be included as part of this Section, to be furnished and installed by the Electrical Subcontractor, refer to the Related Work section of Specification Section 26 0510.
- B. Carefully examine all of the Contract Documents, criteria sheets and all other Sections of the specifications for requirements which affect work under this Section, whether or not such work is specifically mentioned in this Section.
- C. For work related to, and to be coordinated with the electrical work, but not included in this Section and required to be performed under other designated Sections, see the following:
 - 1. Section 07 5000 – Membrane Roofing

1.04 REFERENCES

- A. The lightning protection system and all components shall be designed, manufactured and installed in accordance with the latest applicable standards as follows:
 - 1. ANSI/NFPA 780 – Standard for the Installation of Lightning Protection Systems
 - 2. ANSI/UL 96 - Lightning Protection Components
 - 3. UL 96A - Installation Requirements for Lightning Protection

- B. The system shall be designed and installed in accordance with the requirements of NFPA 780 and UL 96A to obtain Master Label on the building.

1.05 WARRANTY

- A. Attention is directed to provisions of the General Requirements, Supplementary General Requirements and Section 26 0510 regarding guarantees and warranties for work under this Contract.

1.06 QUALIFICATIONS

- A. Manufacturer shall be a company specializing in lightning protection equipment, with minimum of (10) years documented experience and listed in UL's Electrical Construction Materials Directory or Supplement under Lightning Protection - Lightning Conductor, Air Terminals and Fittings.
- B. Installer shall be an authorized installer or manufacturer with the following qualifications:
 1. Minimum of (10) years of documented experience
 2. Listed in UL's Electrical Construction Materials Directory or Supplement under Lightning Protection - Lightning Protection Installation, or
 3. LPI Certified Lightning Protection System Master Designer / Installer
- C. The Lightning Protection System drawings shall be stamped by an LPI Certified Lightning Protection System Master Designer/Installer with a minimum 10 years of lightning protection experience.

1.07 SUBMITTALS

- A. Prepare and submit shop drawings in accordance with the requirements hereinbefore specified, and with Section 01 3300 – Submittal Procedures in the manner described therein, modified as noted hereinafter.
- B. Submit shop drawings showing layout of air terminals, grounding electrodes, and bonding connections to structure and other metal objects. Include terminal, electrode and conductor sizes, and connection and termination details.
- C. Submit product data showing dimensions and materials of each component, and include indication of listing in accordance with ANSI/UL 96.
- D. The manufacturer/installer shall submit for approval one reproducible drawing of installation drawings of each building, indicating all work required for this item including ground rod locations, air terminal locations and cable locations. Catalog cuts of all components shall also be submitted for approval to the Architect/Engineer. Three (3) prints of drawings shall be submitted for approval and (5) prints shall be submitted after approval.

1.08 PROJECT RECORD DOCUMENTS

- A. Submit project Record Documents.
- B. Accurately record actual locations of air terminals, grounding electrodes, bonding connections, and routing of system conductors.

1.09 SEQUENCE AND SCHEDULING

- A. Coordinate the work of this Section with roofing and exterior and interior finish installation.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Materials shall be new and first quality commercial products. Standard fittings shall be used where practicable, in preference to special fittings.
- B. Materials shall comply in weight, size and composition with the requirements of ANSI/UL 96 and the NFPA Code relating to this type of structure.
- C. Lightning rod equipment and fittings shall bear the UL label.

2.02 AIR TERMINALS

- A. Air terminals shall be Class 2, one-piece, lead coated, solid copper.
- B. Air terminals mounted on flat roofs shall be minimum 24" in height and include a 2" x 1" UV resistant, extruded white nylon "safety top" personnel protector.

2.03 AIR TERMINAL BASES

- A. Air terminal bases shall provide a secure attachment to the structure, the air terminal and the conductor cable. The base shall be compatible with all (3) items in contact with it.

2.04 CONDUCTORS

- A. Ground and bonding conductors shall be soft drawn copper with a conductivity of at least 95% of pure copper.

2.05 CONNECTOR FITTINGS

- A. A connector fitting shall be constructed so that a minimum of 1 1/2" of each conductor can be secured within the connector. It shall be compatible with the material being secured.
- B. Water pipe connectors shall be constructed so as to provide at least 1 1/2" contact with the water pipe and conductor. It shall be compatible with the water pipe and conductor materials or be lead coated to form a bimetallic connection.

2.06 CLIPS

- A. Clips for securing copper conductors shall be not less than 0.032" thick and not less than 3/8" wide. Clips shall be placed not more than 3'-0" apart along a conductor.

2.07 GROUND ELECTRODES

- A. Ground electrodes shall be as specified of proper size and material compatible with ground conditions and to obtain the desired minimum ground resistance.

2.08 FASTENERS

- A. Fasteners shall be compatible with the materials being secured and of a size and type specified.

2.09 EXOTHERMIC WELDING

- A. All bonding of lightning protection systems to building steel, ground rods, cable connections, connections below grade, etc. shall utilize exothermic welding grounding connections

PART 3 EXECUTION

3.01 COOPERATION AND WORK PROGRESS

- A. The Electrical work shall be carried on under the usual construction conditions, in conjunction with all other work at the site. The Electrical Subcontractor shall cooperate with the Architect, General Contractor, all other Subcontractors and equipment suppliers working at the site. The Electrical Subcontractor shall coordinate the work and proceed in a manner so as not to delay the progress of the project.
- B. The Electrical Subcontractor shall coordinate his work with the progress of the building and other Trades so that he will complete his work as soon as conditions permit and such that interruptions of the building functions will be at a minimum. Any overtime hours worked or additional costs incurred due to lack of or improper coordination with other Trades or the Owner by the Electrical Subcontractor, shall be assumed by him without any additional cost to the Owner.
- C. The Electrical Subcontractor shall furnish information on all equipment that is furnished under this Section but installed under another Section to the installing Subcontractor as specified herein.
- D. The Electrical Subcontractor shall provide all materials, equipment and workmanship to provide for adequate protection of all electrical equipment during the course of construction of the project. This shall also include protection from moisture and all foreign matter. The Electrical Subcontractor shall also be responsible for damage which he causes to the work of other Trades, and he shall remedy such injury at his own expense.
- E. Waste materials shall be removed promptly from the premises. All material and equipment stored on the premises shall be kept in a neat and orderly fashion. Material or equipment shall not be stored where exposed to the weather. The Electrical Subcontractor shall be responsible for the security, safekeeping and damages, including acts of vandalism, of all material and equipment stored at the job site.
- F. The Electrical Subcontractor shall be responsible for unloading all electrical equipment and materials delivered to the site. This shall also include all large and heavy items or equipment which require hoisting. Consult with the General Contractor for hoisting/crane requirements. During construction of the building, the Electrical Subcontractor shall provide additional protection against moisture, dust accumulation and physical damage of the main service and distribution equipment. This shall include furnishing and installing temporary heaters within these units, as approved, to evaporate excessive moisture and ventilate it from the room, as may be required.

- G. It shall be the responsibility of the Electrical Subcontractor to coordinate the delivery of the electrical equipment to the project prior to the time installation of equipment will be required; but he shall also make sure such equipment is not delivered too far in advance of such required installation, to ensure that possible damage and deterioration of such equipment will not occur. Such equipment stored for an excessively long period of time (as determined in the opinion of the Architect) on the project site prior to installation may be subject to rejection by the Architect.
- H. The Electrical Subcontractor shall erect and maintain, at all times, necessary safeguards for the protection of life and property of the Owner, Workmen, Staff and the Public.
- I. Prior to installation, the Electrical Subcontractor has the responsibility to coordinate the exact mounting arrangement and location of electrical equipment to allow proper space requirements as indicated in the NEC. Particular attention shall be given in the field to group installations. If it is questionable that sufficient space, conflict with the work of other Subcontractors, architectural or structural obstructions will result in an arrangement which will prevent proper access, operation or maintenance of the indicated equipment, the Electrical Subcontractor shall immediately notify the Contractor and not proceed with this part of the Contract work until definite instructions have been given to him by the Architect.

3.02 INSTALLATION

A. General

1. Unless specifically noted or indicated otherwise, all equipment and material specified in Part 2 of this specification or indicated on the drawings shall be installed under this Contract whether or not specifically itemized herein. This Section covers particular installation methods and requirements peculiar to certain items and classes or material and equipment.
2. The Electrical Subcontractor shall obtain detailed information from manufacturers of equipment provided under Part 2 of this specification as to proper methods of installation.
3. The Electrical Subcontractor shall obtain final roughing dimensions and other information as needed for complete installation of items furnished under other Sections or furnished by the Owner.
4. The Electrical Subcontractor shall keep fully informed of size, shape and position of openings required for material and equipment provided under this and other Sections. Ensure that openings required for work of this Section are coordinated with work of other Sections. Provide cutting and patching as necessary.
5. All miscellaneous hardware and support accessories, including support rods, nuts, bolts, screws and other such items, shall be of a galvanized or cadmium plated finish or of another approved rust-inhibiting coating.
6. The lightning protection system shall be installed in accordance with the current edition of UL 96A "Installation Requirements for Master Labeled Lightning Protection Systems".
 - a. No ferrous fasteners (except stainless steel), nor ferrous holding devices of any kind shall be employed as permanent fasteners.
 - b. Individual anchor bolts, employed in this installation, shall each have a pull-out resistance of not less than 200 pounds as determined by actual test.
 - c. The installation shall be made in the most inconspicuous manner. Conductors shall be coursed on the back side of architectural construction to conceal equipment as much as possible.

B. Air Terminal Installation

1. Air terminals shall be installed as required by UL.
2. Air terminals shall have their points aligned vertically
3. Bases shall be bolted or welded to the building or shall be installed using approved adhesives and/or alternate means where required by building structure and/or materials.

C. Conductor Installation

1. Down conductors shall be installed on buildings at intervals of 100'-0" on center, maximum. When structural building steel is used instead of down conductors, the ground conductor interval shall not average over 60'-0" on center.
2. Conductors shall be connected to the ground rods with exothermic welding allowing a reasonable amount of slack conductor to allow for expansion and contraction. Steel surfaces shall be clean and bright before applying connector plates or exothermic welding. Bends in these conductors shall have no angle less than 90°. Bends shall have a radius of not less than 8". Connectors shall, when fixed to conductors, be capable of withstanding a pull of 200 pounds.
3. Bonding conductors shall be connected to the bonding clamps allowing a reasonable amount of slack for expansion and contraction, and the conductor bonds shall be limited as stated above.
4. All metal fascia, television masts, ventilators, vents, roof drains, stacks, etc. shall be bonded and grounded as required by UL 96A and NFPA 780.

D. Ground Installation

1. Ground terminal installation shall be made at all locations indicated on the drawings and at such other points as may be found necessary to properly ground the system.
2. All grounds shall be made by means of rods driven into the soil which shall penetrate vertically not less than 10'-0" below the finished surface of the ground and passing approximately 2'-0" away from the building foundations. Where required by soil conditions, alternate and/or supplemental means, such as electrolytic ground electrodes and/or flat copper plates may be required to achieve ground system resistance goals.
3. The Electrical Subcontractor shall add to the ground system in case the measured resistance exceeds 25 ohms per electrode, at the direction of the Architect/Engineer and at no additional cost to the Owner.
4. A stamped tag of non-corrosive metal shall be attached to the metal support for each building adjacent to each ground connection, to indicate the location and arrangement of the rods and final value of the resistance at time of installation. An as-built drawing and record of resistance values shall be submitted in addition to the stamped tag.

E. Grounding Cable Connections

1. All grounding cable connections to ground rods, structural steel and splices shall be of the exothermic welding process.

F. Where cables penetrate the roofing membrane, penetrations shall be permanently sealed per roof manufacturer's recommended methods by the Roofing Subcontractor.

3.03 EXAMINATION

- A. Verify that surfaces are ready to receive work.

- B. Verify that field measurements are as shown on the drawings.
- C. Beginning of installation shall mean installer accepts existing conditions.

3.04 PROTECTION OF SURROUNDING ELEMENTS

- A. Protect elements surrounding work of this Section from damage or disfiguration.

3.05 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Section 014000.
- B. Obtain the services of UL to provide inspection and certification of the lightning protection system under provisions of UL 96A.
- C. Obtain UL Master Label and retain Master Label Certificate of Inspection for lightning protection system.
- D. Attach label to building at the location prescribed by UL 96A.

END OF SECTION

SECTION 264310

SURGE PROTECTIVE DEVICES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. All of the Contract Documents, as listed on the Table of Contents and including General and Supplementary Conditions and Division 01, General Requirements, shall be included in, and made part of, this Section.

1.02 DESCRIPTION OF WORK

- A. The work required under this section shall include all materials, labor and auxiliaries required to install a complete surge protective device system for the protection of building electrical and electronic systems from the effects of line and electromagnetic induced transient voltage surges and coupled lightning discharged transients as specified in this section.

1.03 RELATED WORK

- A. For work to be included as part of this Section, to be furnished and installed by the Electrical Subcontractor, refer to the Related Work section of Specification Section 260510.
- B. Carefully examine all of the Contract Documents, criteria sheets and all other Sections of the specifications for requirements which affect work under this Section, whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

- A. The following standards and publications referenced in various parts of this specification shall apply:
 1. UL 1449 3rd Edition – UL Standard for Safety for Surge Protective Devices, Dated May 2008
 2. UL 1283 – Electromagnetic Interference Filters
 3. IEEE C62.41.1 - 2002 – IEEE Guide on the Surge Environment in Low-Voltage (1000 V and Less) AC Power Circuits
 4. IEEE C62.41.2 - 2002 – IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits
 5. IEEE C62.45 - 2002 – IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits
 6. IEEE C62.72 - 2007 – IEEE Guide for the Application of Surge-Protective Devices for Low-Voltage (1000 V or Less) AC Power Circuits
 7. National Electrical Code – Article 285

1.05 WARRANTY

- A. Attention is directed to provisions of the General Requirements, Supplementary General Requirements and Section 26 0510 regarding guarantees and warranties for the work under this Contract.

- B. All surge protective devices shall be warranted to be free from defects in materials and workmanship under normal use in accordance with the instructions provided for a period of ten (10) years.
- C. Any surge protective device, which exhibits evidence of failure or incorrect operation during the warranty period, shall be repaired or replaced by the manufacturer.

1.06 QUALIFICATIONS

- A. All surge protective devices shall be manufactured by a single ISO-9001 or 9002 certified company normally engaged in the design, development and manufacture of such devices for electrical and electronic system equipment protection. The said firm shall offer a ten-year (10) warranty for its hard-wired surge protective devices.
- B. The surge protective device manufacturer shall offer at no cost technical assistance through support from factory representatives and local authorized distributors and maintain a 24 hour toll free technical support hotline.
- C. Equipment certification: Items shall be "Listed" by Underwriters Laboratories, Inc. and shall exhibit the Listing Mark of the third party certification agency for the category "Surge Protective Devices" or SPD's. UL Listing Card under category VZCA shall be provided to confirm compliance to UL1449 Third Edition Standard and assigned Voltage Protection Ratings.
- D. Surge Protective Devices shall be installed and located in accordance with the requirements of all applicable National Fire Protection Association (NFPA) codes. The device shall be installed on the load-side of the main service disconnect per the scope of UL 1449 Standard for Safety for Surge Protective Devices.
- E. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of ten (10) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
- F. The SPD shall be compliant with the Restriction of Hazardous Substances (RoHS) Directive 2002/95/EC.
- G. Manufacturers must provide third party Nationally Recognized Testing Laboratory verification of performance data.

1.07 ACCEPTABLE MANUFACTURERS

- A. Eaton - Cutler Hammer
- B. Square D
- C. General Electric

1.08 SUBMITTALS

- A. Prepare and submit shop drawings in accordance with the requirements hereinbefore specified, and with Section 01 3300 – Submittal Procedures in the manner described therein, modified as noted hereinafter.
- B. All shop drawings shall have clearly marked the appropriate specification number of drawing designation, for identification of the submittal.

- C. Disposition of shop drawings shall not relieve the Electrical Subcontractor from the responsibility for deviations from drawing or specifications, unless he has submitted in writing a letter itemizing or calling attention to such deviations at time of submission and secured written approval from the Engineer, nor shall such disposition of shop drawings relieve the Electrical Subcontractor from responsibility for errors in shop drawings or schedules.
- D. The equipment manufacturer shall submit the following information with each submittal:
 - 1. Front view elevation.
 - 2. Top view.
 - 3. Single line.
 - 4. Control schematics and wiring diagrams.
 - 5. Nameplate schedule.
 - 6. Component list/bill of material.
 - 7. Conduit entry/exit locations.
 - 8. Assembly ratings
 - 9. Major component ratings
 - 10. Cable terminal sizes.
 - 11. Manufacturer's catalog data sheets.
 - 12. Test reports.
 - 13. The following product information shall be submitted:
 - a. Descriptive bulletins.
 - b. Product sheets.

PART 2 PRODUCTS

2.01 ELECTRICAL REQUIREMENTS

- A. Unit Operating Voltage – Refer to drawings for operating voltage and unit configuration.
- B. Maximum Continuous Operating Voltage (MCOV) – The MCOV shall not be less than 125% of the nominal system operating voltage.
- C. The suppression system shall incorporate thermally protected metal-oxide varistors (MOVs) as the core surge suppression component for the service entrance and all other distribution levels. The system shall not utilize silicon avalanche diodes, selenium cells, air gaps, or other components that may crowbar the system voltage leading to system upset or create any environmental hazards.
- D. Protection Modes – The SPD must protect all modes of the electrical system being utilized. The required protection modes are indicated by bullets in the following table:

Configuration	Protection Modes			
	L-N	L-G	L-L	N-G
Wye	•	•	•	•
Delta	N/A	•	•	N/A
Single Split Phase	•	•	•	•
High Leg Delta	•	•	•	•

- E. Nominal Discharge Current (I_n) – All SPDs applied to the distribution system shall have a 20kA I_n rating regardless of their SPD Type (includes Types 1 and 2) or operating voltage. SPDs having an I_n less than 20kA shall be rejected.
- F. ANSI/UL 1449 3rd Edition Voltage Protection Rating (VPR) – The maximum ANSI/UL 1449 3rd Edition VPR for the device shall not exceed the following:

Modes	208Y/120	480Y/277	600Y/347
L-N; L-G; N-G	700	1200	1500
L-L	1200	2000	3000

2.02 SPD DESIGN

- A. Maintenance Free Design – The SPD shall be maintenance free and shall not require any user intervention throughout its life. SPDs containing items such as replaceable modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.
- B. Balanced Suppression Platform – The surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance. The surge suppression platform must provide equal impedance paths to each matched MOV. Designs incorporating replaceable SPD modules shall not be accepted.
- C. Electrical Noise Filter – Each unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be up to 50 dB from 10 kHz to 100 MHz using the MIL-STD-220C insertion loss test method. Products unable able to meet this specification shall not be accepted.
- D. Internal Connections – No plug-in component modules shall be used as surge current conductors. All internal components shall be soldered, hardwired with connections utilizing low impedance conductors.
- E. Monitoring Diagnostics – Each SPD shall provide the following integral monitoring options:
 - 1. Protection Status Indicators - Each unit shall have a green / red solid-state indicator light that reports the status of the protection on each phase.
 - a. For wye configured units, the indicator lights must report the status of all protection elements and circuitry in the L-N, L-G and N-G modes. SPDs that indicate only the status of the L-N and L-G modes shall not be accepted.
 - b. For delta configured units, the indicator lights must report the status of all protection elements and circuitry in the L-G and L-L modes.
 - c. The absence of a green light and the presence of a red light shall indicate that damage has occurred on the respective phase or mode. All protection status indicators must indicate the actual status of the protection on each phase or mode. If power is removed from any one phase, the indicator lights must continue to indicate the status of the protection on all other phases and protection modes. Diagnostics packages that simply indicate whether power is present on a particular phase shall not be accepted.

2. Remote Status Monitor – The SPD must include Form C dry contacts (one NO and one NC) for remote annunciation of its status. Both the NO and NC contacts shall change state under any fault condition.
3. Audible Alarm and Silence Button – The SPD shall contain an audible alarm that will be activated under any fault condition.
4. Surge Counter – The SPD shall be equipped with an LCD display that indicates to the user how many surges have occurred at the location. The surge counter shall trigger each time a surge event with a peak current magnitude of a minimum of $500 \pm 20A$ occurs. A reset pushbutton shall also be standard, allowing the surge counter to be zeroed. The reset button shall contain a mechanism to prevent accidental resetting of the counter via a single, short-duration button press. In order to prevent accidental resetting, the surge counter reset button shall be depressed for a minimum of 2 seconds in order to clear the surge count total.
 - a. The ongoing surge count shall be stored in non-volatile memory. If power to the SPD is completely interrupted, the ongoing count indicated on the surge counter's display prior to the interruption shall be stored in non-volatile memory and displayed after power is restored. The surge counter's memory shall not require a backup battery in order to achieve this functionality.

F. Overcurrent Protection

1. The unit shall contain thermally protected MOVs. These thermally protected MOVs shall have a thermal protection element packaged together with the MOV in order to achieve overcurrent protection of the MOV. The thermal protection element shall disconnect the MOV(s) from the system in a fail-safe manner should a condition occur that would cause them to enter a thermal runaway condition.

G. Fully Integrated Component Design – All of the SPD's components and diagnostics shall be contained within one discrete assembly. SPDs or individual SPD modules that must be ganged together in order to achieve higher surge current ratings or other functionality shall not be accepted.

H. Safety Requirements

1. The SPD shall minimize potential arc flash hazards by containing no user serviceable / replaceable parts and shall be maintenance free. SPDs containing items such as replaceable modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.

2.03 SYSTEM APPLICATION

- A. The SPD applications covered under this section include distribution and branch panel locations, busway, motor control centers (MCC), switchgear, and switchboard assemblies as indicated on the drawings. All SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C, B, and A environments.

- B. Surge Current Capacity – The minimum surge current capacity the device is capable of withstanding shall be as shown in the following table:

Minimum surge current capacity based on ANSI / IEEE C62.41 location category			
Category	Application	Per Phase	Per Mode
C	Service Entrance Locations (Switchboards, Switchgear, MCC, Main Entrance)	250 kA	125 kA
B	High Exposure Roof Top Locations (Distribution Panelboards)	160 kA	80 kA
A	Branch Locations (Panelboards, MCCs, Busway)	100 kA	50 kA

- C. SPD Type – all SPDs installed on the line side of the service entrance disconnect shall be Type 1 SPDs. All SPDs installed on the load side of the service entrance disconnect shall be Type 1 or Type 2 SPDs.

2.04 SWITCHBOARD REQUIREMENTS

- A. The SPD application covered under this section is for switchgear, switchboard, MCC, and busway locations. Service entrance located SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C environments.
1. The SPD shall be factory installed inside the switchgear, switchboard, MCC, and/or bus plug at the assembly point by the original equipment manufacturer
 2. Locate the SPD on the load side of the main disconnect device, as close as possible to the phase conductors and the ground/neutral bar.
 3. The SPD shall be connected through a disconnect (30A circuit breaker). The disconnect shall be located in immediate proximity to the SPD. Connection shall be made via bus, conductors, or other connections originating in the SPD and shall be kept as short as possible.
 4. The SPD shall be integral to switchboard as a factory standardized design.
 5. All monitoring and diagnostic features shall be visible from the front of the equipment.
 6. The complete assembly including the SPD shall be UL listed for the application.

2.05 LIFE SAFETY BRANCH DISTRIBUTION PANELS

- A. All life safety branch switchboards, distribution panels and panelboards shall include an SPD as follows:
1. Emergency distribution panel, upstream of transfer switch(es): Category C

2.06 ENCLOSURES

- A. All enclosed equipment shall have NEMA 1 general purpose enclosures, unless otherwise noted. Provide enclosures suitable for locations as indicated on the drawings and as described below:
1. NEMA 1 – Constructed of a polymer (units integrated within electrical assemblies) or steel (sidemount units only), intended for indoor use to provide a degree of protection to personal access to hazardous parts and provide a degree of protection against the ingress of solid foreign objects (falling dirt).

2. NEMA 4 – Constructed of steel intended for either indoor or outdoor use to provide a degree of protection against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (dirt and windblown dust); to provide a degree of protection with respect to the harmful effects on the equipment due to the ingress of water (rain, sleet, snow, splashing water, and hose directed water); and that will be undamaged by the external formation of ice on the enclosure. (sidemount units only)
3. NEMA 4X – Constructed of stainless steel providing the same level of protection as the NEMA 4 enclosure with the addition of corrosion protection. (sidemount units only)

PART 3 EXECUTION

3.01 COOPERATION AND WORK PROGRESS

- A. The Electrical work shall be carried on under the usual construction conditions, in conjunction with all other work at the site. The Electrical Subcontractor shall cooperate with the Architect, General Contractor, all other Subcontractors and equipment suppliers working at the site. The Electrical Subcontractor shall coordinate the work and proceed in a manner so as not to delay the progress of the project.
- B. The Electrical Subcontractor shall coordinate his work with the progress of the building and other Trades so that he will complete his work as soon as conditions permit and such that interruptions of the building functions will be at a minimum. Any overtime hours worked or additional costs incurred due to lack of or improper coordination with other Trades or the Owner by the Electrical Subcontractor shall be assumed by him without any additional cost to the Owner.
- C. The Electrical Subcontractor shall furnish information on all equipment that is furnished under this Section but installed under another Section to the installing Subcontractor as specified herein.
- D. The Electrical Subcontractor shall provide all materials, equipment and workmanship to provide for adequate protection of all electrical equipment during the course of construction of the project. This shall also include protection from moisture and all foreign matter. The Electrical Subcontractor shall also be responsible for damage which he causes to the work of other Trades, and he shall remedy such injury at his own expense.
- E. Waste materials shall be removed promptly from the premises. All material and equipment stored on the premises shall be kept in a neat and orderly fashion. Material or equipment shall not be stored where exposed to the weather. The Electrical Subcontractor shall be responsible for the security, safekeeping and damages, including acts of vandalism, of all material and equipment stored at the job site.
- F. The Electrical Subcontractor shall be responsible for unloading all electrical equipment and materials delivered to the site. This shall also include all large and heavy items or equipment which require hoisting. Consult with the General Contractor for hoisting/crane requirements. During construction of the building, the Electrical Subcontractor shall provide additional protection against moisture, dust accumulation and physical damage of the main service and distribution equipment. This shall include furnishing and installing temporary heaters within these units, as approved, to evaporate excessive moisture and ventilate it from the room, as may be required.

- G. It shall be the responsibility of the Electrical Subcontractor to coordinate the delivery of the electrical equipment to the project prior to the time installation of equipment will be required; but he shall also make sure such equipment is not delivered too far in advance of such required installation, to ensure that possible damage and deterioration of such equipment will not occur. Such equipment stored for an excessively long period of time (as determined in the opinion of the Architect) on the project site prior to installation may be subject to rejection by the Architect.
- H. The Electrical Subcontractor shall erect and maintain, at all times, necessary safeguards for the protection of life and property of the Owner, Workmen, Staff and the Public.
- I. Prior to installation, the Electrical Subcontractor has the responsibility to coordinate the exact mounting arrangement and location of electrical equipment to allow proper space requirements as indicated in the NEC. Particular attention shall be given in the field to group installations. If it is questionable that sufficient space, conflict with the work of other Subcontractors, architectural or structural obstructions will result in an arrangement which will prevent proper access, operation or maintenance of the indicated equipment, the Electrical Subcontractor shall immediately notify the Contractor and not proceed with this part of the Contract work until definite instructions have been given to him by the Architect.
- J. The Electrical Subcontractor shall not allow any equipment or piping foreign to the electrical installation to be installed or pass through any room in which electrical systems or equipment are located, such as electric rooms, electric closets, telephone or data closets. The Electrical Subcontractor shall notify the Contractor of such violations and request immediate removal.

3.02 INSTALLATION

- A. Surge Protectors shall be installed within or as close as practical to the electrical panel or dedicated electronic equipment to be protected. The SPD shall be close coupled to the panel in a position near the panelboard neutral bus bar or positioned so that the overall lead length is less than 24 inches.
- B. The Surge Protector shall be installed in accordance NEC Article 285 and per manufacturer's instructions in a manner consistent with proper and acceptable industry practice. SPD connection leads shall be as short and straight as possible and shall avoid sharp bends.
- C. Prior to, and during electrical acceptance testing, surge protective devices shall be de-energized. Surge protective devices shall not be energized and connected to the distribution system until electrical acceptance testing is complete and the system has been determined to be safe and stable.
- D. Surge Protectors provided with terminals shall be wired with largest stranded conductor permitted within rating of lugs, minimum #10 AWG.
- E. The Surge Protector shall be installed with a means for disconnecting the device for servicing via an integral disconnect switch or a dedicated three-pole 15 amp minimum circuit breaker.
- F. Surge Protective Devices shall be provided at the following locations as per panel schedule and drawings:
 - 1. Main Electrical Service Entrance.
 - 2. Distribution Panels.
 - 3. Fire Alarm, Security and Energy Management Panels.
 - 4. PBX Communications & Intercom Power Supply Systems.

5. Automatic Transfer Switches for Emergency Back-up Generators.

3.03 MATERIALS AND WORKMANSHIP

- A. All materials and equipment shall be new and unused and shall meet requirements of the latest Standards of NEMA, UL, IPCEA, ANSI and IEEE. Equipment shall have components required or recommended by OSHA, applicable NFPA documents and shall be UL listed and labeled.
- B. Despite references in the specifications or on the drawings to materials or pieces of equipment by name, make or catalog number, such references shall be interpreted as establishing standards of quality for materials and performance.
- C. Finish of materials, components and equipment shall not be less than Industry good practice. When material or equipment is visible or subject to corrosive or atmospheric conditions, the finish shall be as approved by the Architect.
- D. Provide proper access to material or equipment that requires inspection, replacement, repair or service. If proper access cannot be provided, confer with the Architect as to the best method of approach to minimize effects of reduced access.
- E. All work shall be installed in a neat and workmanlike manner and shall be done in accordance with all Local and State Codes.
- F. The Owner will not be responsible for material, equipment or the installation of same before testing and acceptance.

END OF SECTION

SECTION 265010
 LIGHTING FIXTURES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. All of the Contract Documents, as listed on the Table of Contents and including General and Supplementary Conditions and Division 01, General Requirements, shall be included in, and made part of, this Section.

1.02 DESCRIPTION OF WORK

- A. The work under this Section shall include furnishing, installing and final aiming, and adjustment, under the supervision of the Architect, all interior and exterior lighting fixtures.
- B. The work under this Contract shall also include all labor, materials, tools, equipment, transportation, insurance, temporary protection, supervision and incidental items essential for proper installation and operation, even though not specifically mentioned or indicated on the drawings, but which are usually provided or are essential for proper installation and operation of all systems as indicated on the drawings and specified herein.
- C. The specifications and drawings describe the minimum requirements that must be met by the Contractor for the installation of all work as shown on the drawings and as specified herein under.
- D. The following general systems and equipment shall be provided for the renovated areas of the existing building, as a minimum, but not necessarily limited to the following:
 - 1. Lighting fixtures
 - 2. Lamps
 - 3. Ballasts

1.03 RELATED WORK

- A. For work to be included as part of this Section, to be furnished and installed by the Electrical Contractor, refer to the Related Work section of Specification Section 260510.
- B. Carefully examine all of the Contract Documents, criteria sheets and all other Sections of the specifications for requirements which affect work under this Section, whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

- A. All lighting fixtures including custom fixtures and modified standard products shall comply with all applicable provisions of the following Codes and Trade Standard Publications, and are hereby incorporated into, and made a part of, the Contract Documents:
 - 1. NFPA 70: National Electrical Code
 - 2. UL: Underwriters' Laboratories
 - 3. NEC: National Electrical Code
 - 4. CBM: Certified Ballast Manufacturers Association

- | | | |
|----|-------|--|
| 5. | IES: | Illuminating Engineering Society |
| 6. | ASTM: | American Society for Testing and Materials |
| 7. | ANSI: | American National Standards Institute |
| 8. | FS | Federal Specifications |
| 9. | ROHS | Restriction of Hazardous Substances in LED |

1.05 QUALITY ASSURANCE

- A. The manufacturers listed within this specification have been preselected for use on this project. No submittal will be accepted from a manufacturer other than specified.

1.06 WARRANTY

- A. In addition to the provisions of the General Requirements, Supplementary General Requirements and Section 260510 regarding guarantees and warranties for the work under this Contract, lighting fixture manufacturer(s) shall provide a total system warranty that includes the fixture, lamps, ballasts and all associated wiring and appurtenances provided with each fixture.
- B. For a period of one year after Owner's initial acceptance and establishment of the beginning date of the warranty period, and at no additional cost, promptly provide and install replacements for fixtures or components (except for lamps) which, in the opinion of the Owner, are defective in materials or workmanship under normal operating conditions. If approved to do so by the Owner, repair installed equipment at the job site to Owner's satisfaction, provided that the Contractor repairs any damage to adjacent Work. For any time during the warranty period that fixtures are not fully functional due to defects in materials or workmanship, provide or pay for and install and remove suitable and adequate temporary lighting fixtures. All replacement fixtures or components shall be warranted to be free of defects in workmanship or materials for a period of one year following replacement, and shall replace any defective replacements during their warranty period.

1.07 SUBMITTALS

- A. Prepare and submit shop drawings in accordance with the requirements hereinbefore specified, and with Section 01 3300 – Submittal Procedures in the manner described therein, modified as noted hereinafter.
- B. Submit samples of each fixture type under this Section as may be requested by the Architect for approval. Samples shall be in size and form requested by the Architect, and reasonable to show characteristics, color and finishes of the materials.
- C. Submit complete manufacturer's product data of all materials and systems to the Architect for approval, consisting of complete product description and specifications, complete performance test data, complete preparation and installation instructions, and all other pertinent technical data required for complete product and product use information.
- D. All shop drawings shall have clearly marked the fixture type, the appropriate specification number and/or drawing designation for identification of the submittal.
- E. Disposition of shop drawings shall not relieve the Contractor from the responsibility for deviations from drawings or specifications unless he has submitted, in writing, a letter itemizing or calling attention to such deviations at time of submission and secured written approval from the Architect, nor shall such disposition of shop drawings relieve the Contractor from responsibility for errors in shop drawings or schedules.

- F. Shop drawings, samples, test data and certificates shall be submitted for approval in accordance with the requirements of the Contract Documents. Fixtures or other materials shall not be shipped, stored or installed into the work unless prior approval has been received, based upon the submittal of shop drawings, samples, catalogue cuts, test data, certificates or other materials submitted for approval. Make modifications to fixtures in accordance with Architect's comments concerning submittals, as a part of the work of this Section.
- G. Submittal Schedule
1. Within 30 calendar days after award of General Contract, a List of Intended Manufacturers and estimated fabrication lead times shall be submitted to Architect. "Lead times" shall be measured in weeks, beginning from the manufacturer's receipt of approved shop drawings and release, and ending at shipment. Architect shall approve or disapprove each manufacturer.
 2. Within 15 days after Contractor's receipt of Architect's response to the List of Intended Manufacturers, copies of purchase orders and manufacturers' acknowledgements for all fixtures specified, conforming to Architect's responses, shall be forwarded to Architect. The purchase orders and the manufacture acknowledgements need not list prices but shall contain a warranted fabrication lead time, in weeks, as defined above. These fabrication times shall be adequate for the timely completion of the job.
 3. Within 30 days after date of manufacturer's acknowledgement of order, Contractor shall forward to Architect complete shop drawings, and/or catalogue cuts for all specified fixtures.
 4. Within 15 days after receipt of reviewed shop drawings marked with "no exceptions taken" or "revise as indicated – no resubmittal required", Contractor shall forward to Architect a warranted shipment date for each specified fixture, as well as forwarding samples, texts, or any outstanding data required for approval.
 5. Within 15 days after Contractor's receipt of reviewed shop drawings marked with "resubmittal required", revised shop drawings shall be resubmitted to Architect.
 6. Contractor shall call to the attention of Architect any submittals that have not been returned to him in a timely manner and that might affect the appropriate delivery of fixtures.
- H. Shop Drawings
1. Indicate on shop drawings, materials, finishes, metal gauges, overall and detail dimensions, sizes, electrical and mechanical connections, fasteners, welds, joints, end conditions, provisions for the work of others, and similar information. Include pertinent mounting details including hung ceiling construction. Indicate complete details of the fixture, including manufacturer's catalogue numbers for sockets, ballasts, light shields, switches and type of wiring, and targeting and locking devices for adjustable fixtures. Indicate type and extent of approved inert insulating materials to prevent electrolytic corrosion at junctions of dissimilar metals shall be supplemented by additional drawings if information or descriptions listed above are not included in the cuts.
 2. Provide shop drawings for each type of lamp, ballast, driver, power supply, controller, etc. specified and cross-referenced to the associated lighting fixture type.
 3. Submit independent laboratory photometric data in the directed number of copies and in format as directed by Architect. Photometric data shall be submitted for standard, "off-the-shelf" units, at the time the manufacturer's cuts are submitted. Photometric testing and reporting shall conform to IES procedures.
 4. Manufacturer's Catalogue Sheets shall indicate input and load electrical characteristics, ambient temperature rating, noise level rating, mounting methods and UL listing for use with required lamp.

5. Fluorescent fixture manufacturer shall submit (with fixture shop drawing or Catalogue Sheet) thermal test data for the fixture to prove that nuisance tripping of the Class "P" ballast shall not occur when fixture is operating under the following conditions:
 - a. Voltage not exceeding 5 percent above nominal 120 or 277 volts.
 - b. Room ambient of 77°F (25°C).
 - c. Ceiling cavity ambient temperature for recessed installation shall not exceed 113°F (45°C).
6. LED fixture manufacturer shall submit, with fixture Shop Drawing or Catalogue Sheet the following information:
 - a. IESNA LM-79 and LM-80 test reports including, but not limited to, testing agency, report number, date, catalog number, type of equipment, LED source tested and ambient temperature.
 - b. Certification that the manufacturer is in compliance with all standards and IESNA documentation.
 - c. Certification that the fixture meets recyclability requirements

1.08 SUBSTITUTIONS

- A. No substitutions shall be permitted. The Contractor shall submit one of the fixtures listed for each fixture type as indicated on the lighting fixture schedule.

1.09 COORDINATION

- A. The work of this Section shall be coordinated with other work of the Contractor. The placement of all access panels shall be coordinated with all other Trades and with the Architect.

PART 2 PRODUCTS

2.01 GENERAL

- A. Provide materials, equipment, appurtenances and workmanship for the work of this Section conforming to the highest commercial Standards as specified and indicated on the drawings. Make fixture parts and components not specifically identified or indicated on the drawings, of materials most appropriate to their use or function, and resistant to corrosion and to thermal and mechanical stresses encountered in the normal application and function of the fixtures.
- B. Provide recessed fixtures that are constructed to be suitable for and compatible with the ceiling, wall or pavement materials and construction in which they shall be installed.
- C. All recessed incandescent lighting fixtures shall be provided with thermal cutoff devices which shall conform to the requirements rated for control of incandescent lamps, as indicated by the NEC Article 410-65(c) and as specified by UL.
- D. Each and every lighting fixture ballast shall be complete with accessible, individual fuse holder such as Bussman NLR fuse holder or approved equal.

2.02 MARKING OF FIXTURES

- A. Plainly mark fixtures equipped with ballasts for operation of rapid start lamps "Use Rapid Start Lamps Only". Similarly, mark other fixtures according to proper lamp type. Clearly mark ballasts that have multi-level outputs as such, and indicate proper terminals for the various outputs. Provide markings that are clear and readily visible to service personnel, but invisible from normal viewing angles when lamps are in place.

2.03 MATERIALS AND FABRICATION

- A. Provide fixtures, completely factory assembled, wired, and equipped with necessary sockets, ballasts, wiring, shielding, reflectors, channels, lenses and other parts and appurtenances necessary to complete the fixture installation and deliver to project site ready for installation.

2.04 FINISHES

- A. Lighting fixture finishes shall be selected by the Architect. The Architect shall select finishes and indicate the color selections on the shop drawing submittals.

2.05 FIXTURE WIRING

- A. Provide wiring channels and wireways free from projections and rough or sharp edges throughout. At points or edges over which conductors shall pass and may be subject to injury or wear, round bush to make a smooth contact surface with the conductors.
- B. For all ballasted lighting fixtures, provide an accessible disconnecting means internal to the fixture per NEC Article 410.130. Disconnecting means shall simultaneously break all the supply conductors to the ballast, including the grounded conductor (neutral). The line side terminals of the disconnecting means shall be guarded.
- C. Install insulated bushings at points of entrance and exit of flexible wiring.

2.06 FLUORESCENT BALLASTS (T8 AND ABOVE)

- A. Fluorescent ballasts shall be electronic type and operate lamps at a frequency above 20k Hz with no visible flicker (<5% flicker index).
- B. Ballast manufacturer shall have been producing electronic ballasts for at least ten (10) years with a low failure rate.
- C. Ballast shall be specifically designed to operate the number and type of lamps for each fixture as indicated on the Lighting Fixture Schedule.
- D. Ballasts shall operate at an input frequency of 60 Hz and an input voltage of 108 volts to 305 volts with no damage to the ballast.
- E. Ballasts shall provide transient immunity as specified by the latest adopted edition of ANSI C82.41, Location Category A1.
- F. Ballasts shall provide starting sequence consistent with the latest adopted edition of ANSI standard C82.11.

- G. For lighting fixtures controlled by occupancy or vacancy sensors, ballasts shall be program start and may operate lamps in series. All other ballasts shall operate lamps in parallel, allowing remaining lamp(s) to maintain full light output if one or more lamps fail.
 - H. Ballasts shall tolerate sustained open circuit and short circuit output conditions without damage to the ballast.
 - I. Ballasts shall be UL Listed as Class P, and for use in indoor or Type 1 outdoor applications and shall contain a temperature sensing device that shall switch the ballast off if excessive internal temperature develops.
 - J. Ballasts shall tolerate operation in ambient temperatures up to 105 degrees F (40 degrees C) without damage.
 - K. Ballasts shall comply with limits of FCC Part 18, Subpart C Limits for Non-Consumer Equipment for EMI and RFI.
 - L. Ballasts shall have Power Factor greater than 0.90.
 - M. Lamp Current Crest Factor (ratio of peak to RMS lamp current) shall be 1.7 or less in accordance with lamp manufacturers recommendation and the latest adopted edition of ANSI C82.11.
 - N. All ballast shall have a normal Ballast Factor, unless indicated otherwise on the drawings, per the latest adopted edition of ANSI C82.11. Ballast Factor shall be as follows:
 - 1. Low Ballast Factor: 0.77
 - 2. Normal Ballast Factor: 0.87 – 0.90
 - 3. High Ballast Factor: 1.18 – 1.20
 - O. Input current Total Harmonic Distortion shall not exceed 10%.
 - P. Ballasts shall be fully encapsulated (potted) to ensure maximum thermal and structural integrity and shall contain no PCBs.
 - Q. Ballasts shall not be affected by lamp failure and shall deliver normal lamp life.
 - R. Operating temperature shall not exceed 75°C at any point on the case during normal operation.
 - S. Ballasts shall be marked with manufacturer's name, part number, supply voltage, power factor, open circuit voltage, current draw for each lamp type and UL listing.
 - T. Ballast shall be high efficiency type as manufactured by:
 - 1. Universal,
 - 2. Osram Sylvania
 - 3. Advance
 - 4. General Electric
- 2.07 FLUORESCENT BALLASTS (T5 AND SMALLER)
- A. Fluorescent ballasts shall be electronic type and operate lamps at a frequency above 20k Hz with no visible flicker (<5% flicker index).

- B. Ballast manufacturer shall have been producing electronic ballasts for at least ten (10) years with a low failure rate.
- C. Ballast shall be specifically designed to operate the number and type of lamps for each fixture as indicated on the Lighting Fixture Schedule.
- D. Ballasts shall operate at an input frequency of 60 Hz and an input voltage of 108 volts 305 volts with no damage to the ballast.
- E. Ballasts shall provide transient immunity as specified by the latest adopted edition of ANSI C82.41, Location Category A1.
- F. Ballasts shall provide starting sequence consistent with the latest adopted edition of ANSI standard C82.11.
- G. Ballasts shall operate lamps in series, allowing remaining lamp(s) to maintain full light output if one or more lamps fail.
- H. Ballasts shall tolerate sustained open circuit and short circuit output conditions without damage to the ballast.
- I. Ballasts shall be UL Listed as Class P, and for use in indoor or Type 1 outdoor applications and shall contain a temperature sensing device that shall switch the ballast off if excessive internal temperature develops.
- J. Ballasts shall tolerate operation in ambient temperatures up to 105 degrees F (40 degrees C) without damage.
- K. Ballasts shall comply with limits of FCC Part 18, Subpart C Limits for Non-Consumer Equipment for EMI and RFI.
- L. Ballasts shall have Power Factor greater than 0.90.
- M. Lamp Current Crest Factor (ratio of peak to RMS lamp current) shall be 1.7 or less in accordance with lamp manufacturers recommendation and ANSI C82.11-1993.
- N. Ballast shall have a Ballast Factor of 1.0 per the latest adopted edition of ANSI C82.11.
- O. Input current Total Harmonic Distortion shall not exceed 10%.
- P. Ballasts shall be encapsulated (potted) to ensure maximum thermal and structural integrity and shall contain no PCBs.
- Q. Operating temperature shall not exceed 75°C at any point on the case during normal operation.
- R. Ballasts shall be marked with manufacturer's name, part number, supply voltage, power factor, open circuit voltage, current draw for each lamp type and UL listing.
- S. Electronic ballasts operating T5 or smaller diameter lamps (including linear T5, compact fluorescent twin tube, triple tube or quad tube or T5 compact fluorescent) shall be high power factor IC type with integral, auto-resetting end-of-lamp-life detection circuitry.

T. Ballast shall be as manufactured by:

1. Universal,
2. Osram Sylvania
3. Advance
4. General Electric

2.08 FLUORESCENT LAMPS

- A. Fluorescent lamps shall be Osram Sylvania Octron type, Philips "Octolume" or General Electric "Trimline", with ratings and lamp color as indicated on the lighting fixture schedule.
- B. Compact fluorescent lamps shall have ratings as indicated on the lighting fixture schedule.
- C. Fluorescent lamps shall have a color temperature of 4,100 degrees Kelvin. Compact fluorescent lamps shall have a minimum color rendition index (CRI) of 82. Biax fluorescent lamps and T8 fluorescent lamps shall have a minimum CRI of 80.
- D. Lamps shall be as manufactured by Osram Sylvania, General Electric or Phillips Lighting.
- E. Fluorescent lamps shall have the following minimum rated life span and maximum mercury content:

Fluorescent Lamp Type	Minimum Rated Hours	Ballast Type	Maximum Mercury Content (mg)
T-8 Eight-foot (Standard Output)	24,000*	Instant Start Program Start	10.0
T-8 Eight-foot (High Output)	20,000*	Instant Start Program Start	10.0
T-8 Four-foot (both Standard and High Output)	30,000*	Instant Start	3.5
T-8 Four-foot (both Standard and High Output)	36,000*	Program Start	3.5
T-8 Two-foot and Three-foot	24,000*	Instant Start Program Start	3.5
T-5 (both Standard and High Output)	25,000*	Program Start	2.5
Compact fluorescent lamps	12,000	Non-integral	3.5
Compact fluorescent lamps	10,000	Integral, bare bulb	3.5
Compact fluorescent lamps	8,000	Integral, covered with globes, reflectors, etc.	3.5

* Based on 3 hour start.

2.09 LED DRIVERS

- A. Provide drivers for LED lamps that are suitable for the electrical characteristics of the supply circuits to which they are to be connected, and which are suitable for operating the specified lamps. Provide ballasts which, unless specifically indicated otherwise or are not available for the specified lamp, have the following characteristics:
1. Constant Current/Voltage.
 2. Power factor $\geq .90$
 3. Total harmonic distortion $\leq 20\%$
 4. Lamp current crest factor ≤ 1.7
 5. UL Class 2
 6. Sound Rating A
- B. Provide drivers conforming to UL, and ANSI specifications and displaying labels or symbols of approval by the UL, and of certification by the CBM. Design, fabricate and assemble component parts of drivers in accordance with the latest requirements of the NEC. Mark drivers "Class 2" indicating approved integral driver protection. This driver protection is provided by a built-in self-resetting thermally actuated device that will remove the driver from line when excessive driver temperature is reached.
- C. Rigidly mount drivers, unless specifically indicated otherwise, to the inside of the top of the fixture housing, with driver surfaces and housing in complete contact for efficient conduction of driver heat. Permanently affix driver mounting screws to the fixture housing. Provide only fixtures whose design, fabrication, and assembly prevent overheating or cycling of lamps and drivers under any condition of use.
- D. Dimming drivers shall be compatible with 3-wire (Line Voltage), Electronic Low Voltage (ELV) or Digital Addressing as required by lighting control vendor and fixture manufacturer. Provide identical drivers within each fixture type.
- E. Provide drivers having the lowest sound-rating available for the lamps specified and clearly showing their respective sound ratings. Replace drivers found by Architect or Engineer to be unduly noisy, without charge, prior to acceptance of the job. Inform Architect in writing if drivers with a sound rating other than A are to be provided.
- F. For outdoor use and wherever drivers are used outside a heated environment provide fluorescent drivers capable of lamp-starting at any temperature down to 0 degrees F.
- G. Approved Driver Manufacturers
1. Advance
 2. General Electric
 3. Hatch
 4. Lutron
 5. Sylvania (Osram)
 6. Universal
 7. Thomas Research
 8. Eldo
- H. Drivers shall have a 5-year warranty from date of acceptance of the completed installation.

2.10 LIGHT EMITTING DIODE ASSEMBLIES

- A. These requirements refer to the LED assembly, including diodes, integrated circuit boards, lenses and remote-phosphor panels, heat sinks and assembly frames, and drivers or power supplies (if integrated with driver).
- B. LED diode arrays, unless otherwise specified:
1. Shall be 4000°K correlated color temperature with a maximum 3-step MacAdam ellipse variation
 2. CRI \geq 85
 3. Lamp life \geq 50,000 hours, and maintain \geq 70% of initial lamp lumen output throughout this period.
 4. Have a minimum efficacy of 50 lumens per watt.
 5. LED arrays shall meet all applicable IESNA and ANSI standards relating to measurement and construction in effect at their time of purchase.
- C. Manufacturer shall provide LED arrays and components that comply with the criteria listed above and meet or exceed the current technology or standards at the time of production. 3 months prior to production, manufacturer shall provide re-submittal of specified fixtures documenting specific LED arrays to be installed that match the performance, specified color temperature, lumen output, photometric distribution and method of control. Any variance between the submitted fixture type and specified model shall be clearly documented by the Contractor and included with the fixture submittal.
- D. All LED assemblies shall be covered by a (5) year full manufacturer's warranty covering the assembly and its replacement in case of failure, provided that operating conditions (thermal and electrical) are maintained within the manufacturer's stated limits.
- E. For each LED fixture type, the vendor shall provide a photometric performance analysis report by a recognized independent testing laboratory. Test procedures and data presentation shall be as per IESNA LM-79.
- F. All LED diode arrays shall be field replaceable with minimal labor, and shall be maintainable without removal of the fixture housing from its location. The fixture manufacturer shall keep a record of the physical bin, color temperature, chromaticity and efficacy rating for each array series in order to provide future replacement units that match the originally furnished array in color and photometric performance.
- G. For each LED fixture type, the vendor shall submit an illustrated manual documenting how the fixture LED array and associated electronics are replaced in the field in case of failure. The report shall also document the steps taken by the fixture vendor to stock replacement LED components for minimum period of (10) years after the date of the project's substantial completion, and the appropriate contact information to obtain replacements.
- H. For other fixtures, provide lamps as specified, or if not specified, as rated by the manufacturer. If specification is not complete, contact Architect for clarification.
- I. The following LED lamp manufacturers are approved:
1. Cree
 2. General Electric
 3. Philips

4. Sylvania (Osram)

2.11 LENSES/FACEPLATES/TRIM

- A. Where plastic lenses are indicated provide lenses of virgin methyl methacrylate, unless otherwise indicated.
- B. Make lenses, louvers, or other light diffusing elements contained in frames removable, but positively held within the frames so that hinging or other motion of the frame shall not cause the diffusing element to drop out.
- C. All recessed downlights in painted dry wall ceilings or acoustic tile ceilings shall have self-trimming reflectors with white flanges. All recessed downlights in perforated metal ceilings shall have self-trimming reflectors with no paint trim.
- D. Refer to architectural plans to match trim styles. Coordinate trim styles with ceiling type.

2.12 LIGHTING FIXTURES

- A. Refer to lighting fixture schedule on the drawings.

PART 3 EXECUTION

3.01 COOPERATION AND WORK PROGRESS

- A. The Electrical work shall be carried on under the usual construction conditions, in conjunction with all other work at the site. The Electrical Contractor shall cooperate with the Architect, Construction Manager, all other Subcontractors and equipment suppliers working at the site. The Electrical Contractor shall coordinate the work and proceed in a manner so as not to delay the progress of the project.
- B. The Electrical Contractor shall coordinate his work with the progress of the building and other Trades so that he will complete his work as soon as conditions permit and such that interruptions of the building functions will be at a minimum. Any overtime hours worked or additional costs incurred due to lack of or improper coordination with other Trades or the Owner by the Electrical Contractor shall be assumed by him without any additional cost to the Owner.
- C. The Electrical Contractor shall furnish information on all equipment that is furnished under this Section but installed under another Section to the installing Subcontractor as specified herein.
- D. The Electrical Contractor shall provide all materials, equipment and workmanship to provide for adequate protection of all electrical equipment during the course of construction of the project. This shall also include protection from moisture and all foreign matter. The Electrical Contractor shall also be responsible for damage which he causes to the work of other Trades, and he shall remedy such injury at his own expense.
- E. Waste materials shall be removed promptly from the premises. All material and equipment stored on the premises shall be kept in a neat and orderly fashion. Material or equipment shall not be stored where exposed to the weather. The Electrical Contractor shall be responsible for the security, safekeeping and damages, including acts of vandalism, of all material and equipment stored at the job site.

- F. The Electrical Contractor shall be responsible for unloading all electrical equipment and materials delivered to the site. This shall also include all large and heavy items or equipment which require hoisting. Consult with the Construction Manager for hoisting/crane requirements. During construction of the building, the Electrical Contractor shall provide additional protection against moisture, dust accumulation and physical damage of the main service and distribution equipment. This shall include furnishing and installing temporary heaters within these units, as approved, to evaporate excessive moisture and ventilate it from the room, as may be required.
- G. It shall be the responsibility of the Electrical Contractor to coordinate the delivery of the electrical equipment to the project prior to the time installation of equipment will be required; but he shall also make sure such equipment is not delivered too far in advance of such required installation, to ensure that possible damage and deterioration of such equipment will not occur. Such equipment stored for an excessively long period of time (as determined in the opinion of the Architect) on the project site prior to installation may be subject to rejection by the Architect.
- H. The Electrical Contractor shall erect and maintain, at all times, necessary safeguards for the protection of life and property of the Owner, Workmen, Staff and the Public.
- I. Prior to installation, the Electrical Contractor has the responsibility to coordinate the exact mounting arrangement and location of electrical equipment to allow proper space requirements as indicated in the NEC. Particular attention shall be given in the field to group installations. If it is questionable that sufficient space, conflict with the work of other Subcontractors, architectural or structural obstructions will result in an arrangement which will prevent proper access, operation or maintenance of the indicated equipment, the Electrical Contractor shall immediately notify the Contractor and not proceed with this part of the Contract work until definite instructions have been given to him by the Architect.

3.02 INSTALLATION

A. General

- 1. Unless specifically noted or indicated otherwise, all equipment and material specified in Part 2 of this specification or indicated on the drawings shall be installed under this Contract whether or not specifically itemized herein. This Section covers particular installation methods and requirements peculiar to certain items and classes or material and equipment.
- 2. The Electrical Contractor shall obtain detailed information from manufacturers of equipment provided under Part 2 of this specification as to proper methods of installation.
- 3. The Electrical Contractor shall obtain final rough-in dimensions and other information as needed for complete installation of items furnished under other Sections or furnished by the Owner.
- 4. The Electrical Contractor shall keep fully informed of size, shape and position of openings required for material and equipment provided under this and other Sections. Ensure that openings required for work of this Section are coordinated with work of other Sections. Provide cutting and patching as necessary.
- 5. All miscellaneous hardware and support accessories, including support rods, nuts, bolts, screws and other such items, shall be of a galvanized or cadmium plated finish or of another approved rust-inhibiting coating.
- 6. Throughout this Section where reference is made to steel channel supports, it shall be understood to mean that the minimum size shall be 1 5/8" mild strip steel with minimum wall thickness of 0.105", similar to Unistrut P1000 or equal products manufactured by Kindorf or Husky Products Co.

Where reference to channel supports is made under "Lighting Fixtures" paragraph of this Section, the maximum length of span shall be 10'-0". If longer spans are required, the size and wall thickness of the steel channel support shall be as specifically approved by the Engineer.

B. Lighting Fixtures

1. Furnish, assemble, hang and connect all lighting fixtures. Lighting fixtures shall be as indicated on the drawings.
2. Install each fixture properly and safely. Provide hangers, rods, mounting brackets, supports, frames, yokes, support bars and any other equipment required for a complete installation. Refer to Section 260510 for Hangers and Supports.
3. Lay-in recessed fixtures in grid type ceilings shall be supported from the underside of roof or floor slab, and utilize hangers, as indicated in Section 260510, with attachments to building construction independent of other systems. All fluorescent fixtures shall have a minimum of (2) hangers supports and all incandescent fixtures shall have at least one hanger support. Hanger wire will not be acceptable.
4. All lighting fixtures shall be supported from the slab above and shall not be suspended from ducts, piping, equipment, ceiling support system, etc.
5. Where continuous rows of lighting fixtures are installed (pendant mounted), the Electrical Contractor shall furnish and install appropriate mounting channels to properly align fixtures. Use Kindorf or Unistrut channels.
6. Before ordering fixtures, the Electrical Contractor shall verify with the Construction Manager the type of ceilings which shall be used in the various spaces.
7. Coordinate fixture locations and mounting heights with Architectural plans, reflected ceiling plans and other reference data prior to installation.
8. Do not scale electrical drawings for exact location of the lighting fixtures. Consult the architectural reflected ceiling plans for the proper locations of lighting fixtures.
9. Prior to fabrication and submittal of shop drawings, check for adequate headroom and non-interference with other equipment such as ducts, pipes or openings.
10. Pendant or surface mounted fixtures shall be provided with required mounting devices and accessories, including hickies, stud extensions, ball aligners, canopies and stems. Locations of fixtures in mechanical areas shall be coordinated with the Mechanical Contractor. Mounting stems of pendant fixtures shall be of the correct length to uniformly maintain the fixture heights shown on the drawings. Variation in mounting individual fixtures shall not exceed 1/4 inch. Height shall not vary more than 1/2 inch from the floor mounting height shown on the drawings. Fixtures hung in continuous runs shall be installed absolutely level and in line with each other. Hanging devices shall comply with Code requirements. Use single stem hangers (double stem hangers shall not be acceptable). Threaded rods shall be used to support lighting fixtures in those spaces where no other means of support is attainable, and only if fixtures are installed absolutely level with no looseness for movement, and only if approved by Code.
11. Rigidly align continuous rows of lighting fixtures for true in-line appearance, subject to Architect's approval.
12. Install pendant lighting fixtures plumb and at a height from the floor as specified or indicated on the drawings. In cases where conditions make this impractical, refer to the Architect and install as directed. Use ball aligners and canopies on pendant fixtures unless noted otherwise.
13. Do not install fixtures and/or parts such as finishing plates and trims for recessed fixtures until all plastering and painting that may mar fittings finish has been completed.
14. Housings shall be rigidly installed and adjusted to a neat flush fit with the ceiling or other finished mounting surface.
15. The housings of recessed lighting fixtures shall be adequately protected during installation.

16. Install reflector cones, baffles, aperture plates, light controlling element for air handling fixtures, and decorative elements after completion of ceiling tiles, painting and general cleanup.
17. All adjustable and aimable fixtures shall have final adjustment and aiming performed in the presence of and per the direction of the Architect.
18. Replace blemished, damaged or unsatisfactory fixtures as directed.
19. Exterior poles, bases and any other fixture or fixture components with scratched or damaged finish shall be repainted to match specified color. Pole mounted fixtures shall be provided with inline fuses located in base.
20. Any lamps, ballasts, reflectors, lens, diffusers, side panels or other parts damaged prior to the final inspection shall be replaced at no expense to the Owner.
21. At time of final inspection, all fixtures and equipment shall be fully lamped, and shall be complete with required lenses or diffusers, reflectors, side panels, louvers or other components necessary.
22. Each lighting fixture shall be packaged with complete instructions and illustrations showing how to install. Install lighting fixtures in strict conformance with manufacturer's recommendation and instructions.
23. Provide fixtures constructed, wired and installed in compliance with the current edition of applicable City, State and National Codes. Provide fixtures conforming to UL Standards, and to provisions of applicable Codes which exceed those Standards. In addition, provide fixtures which conform to additional Regulations necessary to obtain approval for use of specified fixtures in locations shown. Use only electrical components UL listed.
24. Particular attention is called to Article 410 of the NEC. Provide only fixtures that meet these requirements, as interpreted by local agencies. As manufacturers' catalogue numbers may not include thermal protection devices, it is Contractor's responsibility to coordinate the fixture provided with the ceiling construction in accordance with Local Code enforcement practice.
25. Mounting of all lighting fixtures shall conform to seismic requirements.

3.03 MATERIALS AND WORKMANSHIP

- A. All materials and equipment shall be new and unused and shall meet requirements of the latest Standards of NEMA, UL, IPCEA, ANSI and IEEE. Equipment shall have components required or recommended by OSHA, applicable NFPA documents and shall be UL listed and labeled.
- B. Despite references in the specifications or on the drawings to materials or pieces of equipment by name, make or catalog number, such references shall be interpreted as establishing standards of quality for materials and performance.
- C. Finish of materials, components and equipment shall not be less than Industry good practice. When material or equipment is visible or subject to corrosive or atmospheric conditions, the finish shall be as approved by the Architect.
- D. Provide proper access to material or equipment that requires inspection, replacement, repair or service. If proper access cannot be provided, confer with the Architect as to the best method of approach to minimize effects of reduced access.
- E. All work shall be installed in a neat and workmanlike manner and shall be done in accordance with all Local and State Codes.

- F. The Owner will not be responsible for material, equipment or the installation of same before testing and acceptance.

END OF SECTION

DIVISION 27

COMMUNICATIONS TABLE OF CONTENTS

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270510	TELECOMMUNICATIONS

SECTION 270510

TELECOMMUNICATIONS

PART 1 GENERAL

1.01 PROVISIONS INCLUDED

- A. All of the Contract documents, as listed on the Table of Contents and including General Conditions, Supplemental Conditions and Division 1, General Requirements, shall be included in, and made part of, this Section.
- B. Examine all drawings and criteria sheets and all other Sections of the specifications for requirements which affect work under this Section, whether or not such work is specifically mentioned in this Section.
- C. Coordinate work with that of all other Trades affecting or affected by the work of this Section. Cooperate with such Trades to assure the steady progress of all work under the Contract.
- D. The Contractor shall be a certified installer as registered with the structured cabling system product manufacturer (Hubbell) and shall submit in wiring proof of such membership as an up-to-date status with mentioned manufacturer and shall offer a minimum of twenty-five (25) year product and application "Hubbell Mission Critical" warranty of the structured cabling system. The structured cabling system shall, at a minimum, guarantee functionality for the following applications:
 - 1. 10/100/1000Megabits per second (Mb/s) or 1 Gigabit per second (Gb/s) Ethernet, Ethernet applications - Horizontal Distribution Subsystem
 - 2. 10,000Megabits per second (Mb/s) for Wireless Access Points
 - 3. 10,000Megabits per second (Mb/s) or 10 Gigabit per second (Gb/s) Ethernet applications – Backbone Distribution Subsystem
- E. The Contractor shall be an active member of Corning Cable Systems Certified Network of Preferred Installers Program and provide a full 25 year extended warranty program.
- F. All Contractors shall be approved by the University of Connecticut Health Center (UCHC) Communications Cabling Contractors.
- G. Each installation crewmember shall be individually certified as having successfully completed the manufacturer's training program for the Structured Cabling System proposed – Category 6 and fiber optic cabling.
- H. Technicians on the job must be T-2 licensed and be an employee of your company. Subcontracting of the work is not permitted without the written permission of the UConn Health Center. Each technician will require a background check by UCHC.
- I. The Contractor shall provide separate costs for the copper cabling and the fiber optic cabling.

1.02 DEFINITIONS

- A. Words in the singular shall also mean and include the plural, wherever the context so indicates, and words in the plural shall mean the singular, wherever the context so indicates.

- B. Wherever the terms “shown on drawings” are used in the specifications, they shall mean “noted”, “indicated”, “scheduled”, “detailed”, or any other diagrammatic or written reference made on the drawings.
- C. Wherever the term “provide” is used in the specifications it will mean “furnish” and “install”, “connect”, “apply”, “erect”, “construct”, or similar terms, unless otherwise indicated in the specifications.
- D. Wherever the term “material” is used in the specifications it will mean any “product”, “equipment”, “device”, “assembly”, or “item” required under the Contract, as indicated by trade or brand name, manufacturer’s name, standard specification reference or other description.
- E. The terms “approved” or “approval” shall mean the written approval of the Architect.
- F. The term “Contract Documents” shall mean the entire set of Drawings and Specifications as listed in the Table of Contents of the General Conditions including all bound and unbound material and all items officially issued to date such as addenda, bulletins, job modifications, etc.
- G. The term “specification” shall mean all information contained in the bound or unbound volume, including all “Contract Documents” defined therein, except for the drawings.
- H. The term “horizontal distribution cabling” shall mean all cabling that extends between and includes the horizontal cross-connect Telecommunication Rooms (TRs) and the telecommunications outlet.
- I. The term “horizontal cross-connect” shall mean all cabling that forms a connection scheme between each horizontal and backbone cabling subsystems, using patch cords or jumpers that attach to connecting hardware on each end.
- J. The term “intra-building backbone” shall mean all cabling used to connect the telecommunications rooms, cross-connects, entrance facilities and equipment rooms, creating a backbone communication system within a building.
- K. The term “inter-building backbone” shall mean all cabling used to connect the telecommunications rooms, cross-connects, entrance facilities and equipment rooms, between more than one building in a campus environment, creating a backbone communication system between buildings.
- L. The term “firestop” shall mean a specific construction of approved materials and methods that fill the opening in a wall or floor assembly, and around and between any items that penetrate the wall or floor, including termination devices (outlet box) and also the termination device means of support.
- M. The term “wire basket” system shall mean a primary cable tray support system located at every floor level and inclusive of straight sections of continuous wire mesh, field formed horizontal and vertical bends, tees, drop outs, supports and accessories.
- N. The term “specification” shall mean all information contained in the bound or unbound volume, including all “Contract Documents” defined therein, except for the drawings.

- O. The terms "directed", "required", "permitted", "ordered", "designated", "prescribed", and similar words shall mean the direction, requirement, permission, order, designation or prescription of the Architect; the terms "approved", "acceptable", "satisfactory", and similar words shall mean approved by, acceptable or satisfactory to the Architect; and, the terms "necessary", "reasonable", "proper", "correct", and similar words shall mean necessary, reasonable, proper or correct in the judgment of the Architect.
- P. "Accessible" indicates ease of access with or without the use of ladders and without requiring extensive removal of other equipment, such as ductwork, piping, etc. to gain access. "Accessible ceiling" indicates acoustic tile type hung ceilings. Concealed spline or gypsum ceilings with access panels shall not be considered accessible ceilings.
- Q. "Concealed" means hidden from sight in chases, furred spaces, shafts, hung ceilings, embedded in construction or in crawl spaces.
- R. "Exposed" means not installed underground or "concealed" as defined above.
- S. "Architect" shall refer to the Architect "Architectural Resources Cambridge (ARC)" and "Svigals + Partners".
- T. "Owner" shall refer to the Owner "UCHC" or its designated representative.
- U. "Other Work Contractor" (O.W.C.) refers to the Contractor(s), or Subcontractor(s) performing work under other Sections of the Contract Documents.

1.03 CODES, STANDARDS AND REFERENCES

- A. Perform work strictly as required by rules, regulations, standards, codes, ordinances, and laws of local, state, and Federal governments, and other authorities that have legal jurisdiction over the site.
- B. In case of difference between regulations, standards, codes, ordinance and laws of local, state, and Federal governments, and other authorities that have legal jurisdiction over the site, and the Contract Documents, the Contractor shall promptly notify the Architect in writing of any such difference.
- C. In case of conflict between the Contract Documents and the requirements of any Code or Authorities having jurisdiction, the most stringent requirements of the aforementioned shall govern.
- D. Should the Contractor perform any work that does not comply with the requirements of the applicable Building Codes, State Laws, Local Ordinances, Industry Standards and Utility Company Regulations, he shall bear all costs arising in correcting the deficiencies, as approved by the Architect/Owner.
- E. Applicable provisions of the latest editions of the following Codes and Trade Standard Publications shall apply to the work of this Section and are hereby incorporated into, and made part of, the Contract Documents:
 - 1. NFPA 70: National Electric Code;
 - 2. Occupational Safety and Health Act (OSHA).
 - 3. UL Listing of Communications Cabling and Hardware
 - 4. BICSI Current Version Telecommunications Distribution Methods Manual
 - 5. ANSI/TIA/EIA-568-C - "Commercial Building Telecommunication Standard"

6. ANSI/TIA/EIA-569-C - "Commercial Building Standard for Telecommunications Pathways and Spaces"
7. ANSI/EIA/TIA-526-14 "Method B: Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant".
8. ANSI/EIA/TIA-526-7 "Method 1: Optical Power Loss Measurements of Installed Single-mode Fiber Cable Plant".
9. ANSI/TIA/EIA-606 –B "Administration Standard for the Telecommunications Infrastructure of Commercial Buildings".
10. ANSI/TIA/EIA-607 –B "Commercial Building Grounding and Bonding Requirements for Telecommunications".
11. IEC – International Electrotechnical Commission
12. FCC – Part 67, for Communications Interconnection Devices
13. TIA/EIA-598 – "Optical Fiber Cable Color Coding"
14. ANSI/NFPA-70B – "Recommended Practice for Electrical Equipment Maintenance" pertaining to installation of cable tray systems.
15. National Electrical Manufacturers Association (NEMA) "NEMA VE-2"
16. UCHC IT Communication Design Guidelines

1.04 SCOPE OF WORK

- A. These specifications and drawings describe the minimum requirements that must be met by the Contractor for all work as specified herein for the furnishing and installation of the Telecommunications (voice, data and CATV) cabling and associated hardware. Upon award of a contract for the work as described herein, the Contractor assumes all liability for a complete structured cabling system, including all quantities, materials, labor, project management, documentation, labeling and warranty of the work.
1. The Contractor is to furnish and install all horizontal distribution cabling and horizontal distribution cable terminations within each Telecommunications Room (TR(CGT1,CMT1,C1T1,CGT2,CMT2,C1T2,C2T2,) and Entrance facility(CBT1) and as required herein and on the Contract Documents.
 2. The Contractor is to furnish and install all intrabuilding backbone cabling and intrabuilding backbone cable terminations within each Telecommunications Room (TR) and Entrance Facility room (CBT1) and as required herein and on the Contract Documents.
 3. The Contractor is responsible for labeling all cables at both ends of the cable and termination hardware and as follows:
 - a. Faceplates and port positions shall be properly labeled and shall correlate exactly with the patch panel position labeling within TR/IDF rooms.
 - b. Wiring block and connector housing positions shall be properly labeled and shall correlate exactly with wiring block and connector housing positions at associated TR/IDF rooms.
 - c. All faceplates, patch panels, connector housings, wiring blocks, racks and port/connector positions and pathway systems shall be labeled for a complete administration system.
- B. The Contractor will furnish and install the cable infrastructure, subsystems and all associated hardware necessary to provide a workable and fully compliant Structured Cabling System, as described in these specifications and in the drawings, and to the satisfaction of the Owner.
- C. The Contractor shall label all cable at both ends and at the communication outlets and cross-connects, in accordance with ANSI/EIA/TIA Standards and as specified herein.

- D. The Contractor shall test all copper cable (Cat 6A [4PR] and Cat 3 High PR count, coax cable) and all fiber optic cable strands in accordance with ANSI/EIA/TIA Standards and as specified herein.
- E. Drawings and Specifications form complimentary requirements; provide work specified and not shown, and work shown and not specified as though explicitly required by both. Provide all supplementary and miscellaneous items, appurtenances, devices and materials necessary for a sound secure and complete system installation.
- F. The specifications and drawings describe the minimum requirements that must be met by the Contractor for the installation of all work.
- G. The work under this Contract shall include all labor, materials, tools, equipment, transportation, insurance, temporary protection, supervision and incidental items essential for proper installation and operation, even though not specifically mentioned or indicated on the drawings, but which are usually provided or are essential for proper installation and operation, of all systems as indicated on the drawings and specified herein.
- H. The Specifications and Drawings describe the minimum requirements that must be met by the Contractor for the installation of all work as shown on the drawings and as specified herein.
- I. The following general systems and equipment shall be provided as a minimum, for the new building and renovated areas of the existing building, including but not limited to the following:
 - 1. Provide intra-building backbone cabling system. (Voice Copper, Fiber Optic, and Coax)
 - 2. Provide horizontal cabling system. Voice, Data, wireless LAN, CATV, IP cameras, Category 6 cabling.
 - 3. Provide Category 6A Cabling for "new" Wireless Access Points (WAPs)
 - 4. Patch Panels angled, Cat 6 and Cat 6A (Wireless)
 - 5. Category 6 patch cords
 - 6. Singlemode patch cords
 - 7. Wiring blocks (110)
 - 8. Pathways and spaces (raceway, runway and conduit)
 - 9. Grounding and bonding
 - 10. Cable management hardware
 - 11. Equipment racks
 - 12. Pull rope
 - 13. Hook and loop cable management
 - 14. Nameplates and labeling
 - 15. Fire seal and fire stopping
 - 16. Testing of all cabling systems (Provide Owner, UCHC, Electronic copy and hard copy of all test results).
 - 17. Supervision and approval
 - 18. Shop drawings
 - 19. As-built documentation

1.05 GUARANTEE

- A. Refer to provisions of the General Requirements and Supplementary General Requirements regarding guarantees and warranties for work under this Contract.

- B. In addition to the specific guarantee requirements of the General Conditions, the Contractor shall obtain, in the Owner's name; the standard written manufacturer's guarantee of all materials furnished under this Section where such guarantees are offered in the manufacturer's published product data. All these guarantees shall be in addition to, and not in lieu of, other liabilities which the Contractor may have by law or other provisions of the Contract Documents.
- C. The Contractor shall be thoroughly familiar with the cabling methods set forth in the latest release of the BICSI TDMM (Building Industry Consulting Services International, Telecommunications Distribution Methods Manual) and shall be recognized by BICSI as being a certified installer of structured cabling systems.
- D. All installer certifications shall be current. Contractor shall also show proof of continuously maintaining the installation certifications for a minimum of one (1) year.
- E. The structured cabling system shall at minimum guarantee functionality for 10/100/1000Mb/s Ethernet applications for horizontal ceiling. (10,000 Mb/s; wireless only).
- F. The structural cabling system shall at minimum guarantee functionality for 10/100/1000/10,000 Mb/s Ethernet applications for backbone cabling.
- G. The Contractor will leave the entire installed wiring system in proper working order and shall, without additional charge, replace any work, materials or equipment furnished and/or installed by him under this contract which develops defects, except from ordinary wear and tear, within one year from the date of acceptance by the Owner.
- H. Manufacturers shall provide their standard guarantees for work under the Trades. However, such guarantees shall be in addition to, and not in lieu of, all other liabilities which the manufacturer and Contractor may have by law or by other provisions of the Contract Documents.
- I. The Contractor shall guarantee that all elements of the systems which are to be provided under his Contract are of sufficient capacity to meet the specified performance requirements as set forth herein or as indicated.
- J. Upon receipt of notice from the Owner's representative or Architect of failure of any part of the systems or equipment during the guarantee period, the affected part or parts shall be replaced by the Contractor for his work or any other work affected by the failure(s).
- K. The Contractor shall furnish, before the final payment is made, a written guarantee covering the Hubbell and Corning warranties above requirements.

1.06 THE CONTRACTOR

- A. The Contractor shall visit the site of the proposed new facility and base his bids from his own site examinations and estimates. The Contractor shall not hold the Architect, Engineer, Owner's representative or their agents or employees responsible for, or bound by, any schedule, estimate or of any plan thereof. The Contractor shall study the Contract Documents included under this Contract to determine exactly the extent of work provided under this Contract, as well as to ascertain the difficulty to be encountered in performing the work, in installing new equipment and systems and coordinating the work with the other Trades and existing building conditions.

- B. The Contractor shall faithfully execute his work according to the terms and conditions of the Contract and specifications, and shall take all responsibility for and bear all losses resulting to him in the execution of his work.
- C. The Contractor shall be responsible for the location and performance of work provided under his Contract as indicated on the Contract Documents. All parties employed directly or indirectly by the Contractor shall perform their work according to all the conditions as set forth in these specifications.
- D. The Contractor shall furnish all materials and do all work in accordance with these specifications, and any supplementary documents provided by the Architect.
- E. The work shall include everything shown on the drawings and/or required by the specifications as interpreted by the Architect, regardless of where such information is indicated in the Contract Documents (Architectural, HVAC, Plumbing, Fire Protection, etc.). Unless specifically indicated otherwise, all work and materials furnished and installed shall be new, unused and of the best quality and workmanship.
- F. The Contractor shall cooperate with the Architect so that no error or discrepancy in the Contract Documents shall cause defective materials to be used or poor workmanship to be performed.

1.07 COORDINATION OF WORK

- A. The Contractor shall compare his drawings and specifications with those of other Trades as well as the Architectural drawings and specifications, and report any discrepancies between them to the Architect and obtain from the Architect written instructions for changes necessary in the work.
- B. The Contractor shall coordinate work of this Section with the work of other Sections.
- C. The placement of all cabling and equipment required to support all systems as indicated on the drawings and specified shall be coordinated by the Contractor with all other Trades, and with the Architect.
- D. The Contractor must include in his bid sufficient dollar amounts to coordinate the work of this Contract. This project is complex and will require additional time to coordinate all Trades and allow implementation of the Owner's representatives Standards and maintenance serviceability requirements. This requirement shall include, but not be limited to, producing the coordination drawings, as many times and as many drawings as required, to ensure serviceability of equipment, as approved by the Architect.
- E. Locations of conduits, boxes distribution equipment, systems, etc. shall be adjusted to accommodate the work with interferences anticipated and encountered. The Contractor shall determine the exact routing and locations of his systems prior to fabrication or installation of any system component.
- F. It is the Contractors responsibility to ensure that cabling and cabling pathways are installed such that each cable run from each Telecommunications Room (TR) to each telecommunications outlet will not exceed a total electrical length of 295 linear feet, including all cable ups, downs, and slack requirements as specified herein. If a cable length is an issue, the Contractor shall notify the Architect and/or Engineer prior to installation.
- G. Accurate measurements and coordination drawings shall be completed to verify dimensions and characteristics of the various systems installations.

- H. All work shall be installed in a way to permit removal (without damage to other parts) of pull and junction box covers, cabling, and all other system components provided under this Contract requiring periodic replacement or maintenance. All pull and junction boxes shall be arranged in a manner to enable unobstructed openings of swinging overhead access doors and ceiling tiles. All work shall be done to allow easy access for maintaining equipment. The Owner's representative and Engineer will require proof via the preparation of large-scale sections and part plans that pull and junction boxes, etc. are accessible after the work is completed. Any items in the field discovered to be in non-compliance shall be removed and relocated, as required, and as directed by the Architect.
- I. The Contract Drawings are diagrammatic only intending to show general runs and locations of conduits and distribution equipment and not necessarily showing all required offsets, details and accessories to be connected. All work shall be accurately laid out with other Trades to avoid conflicts and to obtain a neat and workmanlike installation, which will afford maximum accessibility for operations and maintenance and observe the critical distance limitations of the horizontal distribution cable.
- J. In case of conflict between the Contract Documents and the requirements of any Code or Authorities having jurisdiction, the most stringent requirements of the aforementioned shall govern.

1.08 GIVING INFORMATION

- A. The Contractor shall keep himself fully informed as to the shape, size and position of all openings required for his apparatus and shall give information to the General Contractor and other Subcontractors sufficiently in advance of the work so that all openings may be built in advance.

1.09 EQUIPMENT AND MATERIALS

- A. Equipment shall be tightly covered and protected against dirt, water, and chemical or mechanical injury and theft. At the completion of the work, equipment and materials shall be cleaned and polished thoroughly and turned over to the Owner's representative in a condition satisfactory to the Architect. Damage or defects that develop before acceptance of the work shall be made good at the Contractor's expense.
- B. The Contractor shall make necessary field measurements to ascertain space requirements, for equipment and connections to be provided under his respective Trade and shall furnish and install such sizes and shapes of equipment to allow for the final installation to conform to the Drawings and Specifications.
- C. The Contractor shall furnish and install all equipment, accessories, connections and incidental items necessary to fully complete the work under his Contract for use, occupancy and operation by the Owner's representative.
- D. Where equipment of a substitute manufacturer differ from that specified and require different arrangement or connections from those shown, it shall be the responsibility of the Contractor responsible for the substitution to modify the installation of the equipment to operate properly and in harmony with the original intent of the drawings and specifications. When directed by the Architect, the Contractor shall submit drawings showing the proposed, substitute installation. If the proposed installation is approved, the Contractor shall make all necessary changes in all affected related work provided under his and other Sections including location of roughing-in connections by other Trades, conduit, supports, etc.

All changes shall be made at no increase in the Contract amount or additional cost to the Owner's representative. The General Contractor shall be responsible to assure that the Contractor responsible for the substitution bears the cost arising to all other Trades as a result of the substitution.

- E. Unless specifically indicated otherwise, all equipment and materials required for installation under these specifications shall be new, unused and without blemish or defect. Equipment and materials shall be products which will meet with the acceptance of the Authorities having jurisdiction over the work and as specified hereinbefore. Where such acceptance is contingent upon having the products listed and/or labeled by FM or UL or another testing laboratory, the products shall be so listed and/or labeled. Where no specific indication as to the type or quality of material or equipment is indicated, a first class standard article shall be provided.
- F. All equipment of one type, such as cabling, wiring blocks, faceplates, outlets connectors, protection etc., shall be the products of one manufacturer and shall be acceptable by the manufacturer governing the warranty/certification for the entire Structured Cabling System.

1.10 USE OF PREMISES

- A. The Contractor shall confine all apparatus, storage of materials and construction to the limits as directed by the Architect and he shall not encumber the premises with his materials. The Contractor shall be held responsible for repairs, patching, or cleaning arising from any unauthorized use of premises.
- B. Notwithstanding any approvals or instructions which must be obtained by the Contractor from the Architect in connection with the use of the premises, the responsibility for the safe working conditions at the site shall remain that of the Contractor. The Architect, Engineer or Owner's representative shall not be deemed to have any responsibility or liability in connection with safe working conditions at the site.

1.11 PROTECTION

- A. The Contractor shall furnish, place and maintain proper safety guards for the prevention of accidents that might be caused by the workmanship, materials, equipment or telecommunications systems provided under his Contract.

1.12 DAMAGE TO OTHER WORK

- A. The Contractor shall be held responsible and shall pay for all damages caused by his work to the building structures, equipment, conduits, systems, etc., and all work and finishes installed under this Contract. Repair of such damage shall be done by the General Contractor at the expense of the Contractor, to the Architect's satisfaction.

1.13 CORRECTION OF WORK

- A. The Contractor shall promptly correct all work provided under his Contract and rejected by the Architect as defective or as failing to conform to the Contract Documents, whether observed before or after completion of work, and whether or not fabricated, installed or completed.

1.14 EXTRA WORK

- A. No claim for extra work will be allowed unless it is authorized by the Architect before commencement of the extra said work.

1.15 FIRESTOPPING AND SMOKEPROOFING

- A. Where conduits pass through masonry or concrete walls or floors, the Contractor shall provide and set individual sleeves for each conduit and all other work under his charge, as necessary for passage of all raceways. Sleeves shall be of sufficient size to provide 1/2" air space around the conduit passing through the floor or walls. All openings shall be sealed, smokeproofed and made tight. The Contractor shall be responsible for the exact location of sleeves provided under this Contract and shall coordinate all requirements for conduit sleeves. Refer to Section 07842 – Firestopping and Smokestopping.
- B. The Contractor shall review firestop or smokestop systems provided under Section 07842 – Firestopping and Smokestopping and coordinate the system installation.
- C. Except as otherwise specified, underground piping passing through exterior walls, foundation slabs on grade, or manhole walls, shall have penetration closures of the modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the conduit and wall opening. Links shall be loosely assembled with bolts to form a continuous belt around the conduit and with a pressure plate under each bolt head and nut.
- D. After the seal assembly is positioned in the sleeve, tightening of the bolts shall cause the rubber sealing elements to expand and provide an absolutely watertight seal between the conduit and wall, reducing chances of cathodic reaction between these members.

1.16 CONNECTIONS TO ARCHITECTURAL MILLWORK, MODULAR FURNITURE AND/OR OWNER FURNISHED EQUIPMENT

- A. The Contractor shall provide all conduit connections and/or backbox devices to equipment provided under other sections of the Specifications, as required, resulting in a complete system, fully operational.
- B. Coordinate location of all equipment with the General Contractor prior to installation. Obtain installation diagrams and methods of installation of all equipment, from manufacturers. Follow instructions explicitly. Obtain additional information from the Architect if required.
- C. All connections that transition to isolated casework, furniture etc. that can not be concealed from view as determined by the Architect, shall utilize an appropriate sized (inside diameter) flexible conduit and shall be "liqua-tite" or equivalent. Each flexible conduit shall be 24-inches in length maximum. All such connections shall be approved by the Architect prior to installation.

1.17 COORDINATION DRAWINGS

- A. Before materials are purchased, fabricated or work is begun, each Subcontractor shall prepare and obtain approval of coordination drawings, and sections for all floors/areas, including buried system/services, resulting in (1) set of all-Trade-composite at 3/8" scale drawings, showing the size and location of all equipment, in the manner described herein and in the General Requirements. Architects review and approval of coordination drawings must be obtained prior to any fabrication or installation of any equipment or systems.
- B. The coordination drawings shall comply with requirements specified under Section 26 05 10, Coordination.
- C. All costs associated with all aspects of coordination drawings, regardless as to how long they take to produce and how many times they have to be redrawn, shall be borne by the Contractor.

- D. The Contractor may purchase the telecommunication AutoCAD computer drawing files from the Contract drawing set on disk or via modem from the Engineer at the nominal cost of \$35.00 per drawing file, if he so chooses.
- E. The Contractor shall be responsible for coordinating the AutoCAD coordination drawings, including, but not limited to, the drawing lists, layering system, producing copies of the drawings for the Architect as directed, etc.

1.18 RECORD DRAWINGS/AS-BUILT DRAWINGS

- A. The Contractor shall maintain current at the site a set of his drawings on which he shall accurately show the actual installation of all work provided under his Contract indicating hereon any variation from the Contract Drawings, in accordance with Section 26 05 10, Contract Closeout.
- B. The Contractor shall indicate progress by coloring-in various conduits, equipment and associated appurtenances exactly as they are erected. This process shall incorporate both the changes noted above and all other deviations from the original drawings whether resulting from job conditions encountered or from any other causes.
- C. The marked-up and colored-up prints will be used as a guide for determining the progress of the work installed. They shall be inspected periodically by the Architect and Owner's representative and they shall be corrected immediately if found either inaccurate or incomplete. This procedure is mandatory.
- D. As-built drawings shall indicate actual locations of voice and data communication devices, with distribution and backbone cable routes and unique and sequential labeling of all devices and terminations.
- E. At the completion of the job, these prints shall be submitted to the General Contractor and then to the Architect for final review and comment. The prints will be returned with appropriate comments and recommendations. These corrected prints, together with corrected prints indicating all the revisions, additions and deletions of work, shall form the basis for preparing a set of As-built Record Drawings.
- F. The Contractor shall be responsible for generating as-built Record Drawings utilizing CAD based documents in AutoCAD Release 12 DWG or DXF format. A bound set of plans, as well as the computer files, on disk, shall be turned over to the Architect for review. After acceptance of the as-built documents by the Architect, the Contractor shall make any corrections necessary to the as-built documents and prepare one reproducible set of drawings as well as bound blueprint set(s) (quantity as determined by the Architect) for distribution to the Owner's representative via the Architect.
- G. Included with the above shall be a complete drawing list and a standard layering system, which shall be required to be maintained within the as-built Record CAD documents.
- H. The as-built CAD documents required shall be in addition to other requirements stated elsewhere.

1.19 RELATED WORK SPECIFIED ELSEWHERE

- A. For work to be included as part of this Section, to be furnished and installed by the Contractor, refer to the following Sections:
1. Installation of access panels by Trades as determined by the General Contractor
 2. Cutting and patching in masonry
 3. Finish painting
 4. Fire Protection – Section 211000
 5. Electrical Special Conditions – Section 260510
 6. Basic Materials and Methods – Section 260520
 7. Wiring Methods – Section 260530

1.20 SUBMITTALS

- A. Prepare and submit shop drawings in accordance with the requirements hereinbefore specified, and with the Shop Drawings, Product Data and Samples Section 01300 in the manner described therein, modified as noted hereinafter.
- B. Submit manufacturers product and data sheets of all materials and systems to the Architect for approval, consisting of complete product description and specifications, complete performance test data, complete preparation and installation instructions, and all other pertinent technical data required for complete product and use information.
- C. All shop drawings shall have clearly marked the appropriate specification number of drawing designation for identification of the submittal.
- D. Disposition of shop drawings shall not relieve the Contractor from the responsibility for deviations from drawings or specifications unless he has submitted in writing, a letter itemizing or calling attention to such deviation at the time of submission and secured written approval from the Engineer, nor shall such disposition of shop drawings relieve the Contractor from responsibility for errors in shop drawings or schedules.
- E. The Contractor shall show proof of having a sufficient number of trained personnel on staff for all telephone and data systems, cabling, and connector installation as required by the specific manufacturer of equipment being provided for by the Contractor.
- F. The Contractor shall show proof of membership in a certified cabling installation program and must warrant the cabling system specified herein, for a minimum of 25 years. Warranty shall be Hubbell Mission critical for the Category 6 System and Corning Cable Systems for the Fiber Optic System.
- G. Do not order materials or begin installation until written approval of submittals by the Architect and Engineer has been obtained.
- H. Submittals shall contain information specific to systems, equipment and materials required by Contract Documents for this project only. 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.

- I. Intent of Submittal review is to check for capacity, rating and certain construction features. Contractor shall ensure that work meets requirements of Contract Documents regarding information that pertains to fabrication processes or means, methods, techniques, sequences and procedures of construction and for coordination of work of this and other Sections. Work shall comply with submittals marked "REVIEWED" to extent that they agree with Contract Documents. Submittal review shall not diminish responsibility under this Contract for dimensional coordination, quantities, installation, wiring, supports and access for service, nor the shop drawing errors or deviations from requirements of Contract Documents. The Engineer's noting of some errors while overlooking others will not excuse the contractor from proceeding in error. Contract Documents requirements are not limited, waived nor superseded in any way by review.
- J. All shop drawings shall have clearly marked the appropriate specification number of drawing designation, for identification of the submittal. All products shall be highlighted or have indicating arrows.

PART 2 PRODUCTS

2.01 GENERAL

- A. All products shall meet applicable NEMA, ANSI and UL, FCC and IEEE Standards.
- B. Refer to Drawings for outlet locations, service types, and configurations required.
- C. All products shall be "NEW".
- D. Category 6 System and voice backbone shall be by Hubbell, with Berk-Tek cable.
- E. Category 6A horizontal cabling for wireless.
- F. Fiber optic cabling products shall be Corning Cable Systems.
- G. Coax cable shall be CommScope.

2.02 CABLING

- A. General
 1. Manufacturer's cable markings shall consist of manufacturer's name, cable type/catalog No., NFPA type code compliance, and the NEC code compliance.
 2. All cable shall be listed for its use per NEC Article 800.
 3. All cables shall meet performance specifications as required herein, with regards to ANSI/TIA/EIA 568-C.
 4. All optical fibers in each cable shall be usable and each optical fiber shall be sufficiently free of surface imperfections and inclusions in order to meet the optical, mechanical and environmental requirements of this specification.
 5. Singlemode optical fiber shall meet EIA/TIA-492CAAA, "Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers," and ITU recommendation G.652, "Characteristics of Single-Mode Optical Fiber Cable."
 - a. Maximum dispersion at 1310 nm wavelength shall be 2.8 PS/nm*km.
 - b. Maximum dispersion at 1550 nm wavelength shall be 18 PS/nm*km.

6. The maximum tensile load on optical fiber cable during installation shall not exceed the following:
 - a. 180 lbf for 2-strand cables
 - b. 250 lbf for 12-strand cables
 - c. 900 lbf for 36-strand cables

7. The maximum tensile loading of the installed fiber optic cable shall not exceed the following:
 - a. 45 lbf for 2-strand cables
 - b. 84 lbf for 12-strand cables
 - c. 450 lbf for 36-strand cables

8. The minimum bend radius on the fiber optic cable during installation shall not exceed the following:
 - a. 2.8-inches for 2-strand cables
 - b. 3.9-inches for 12-strand cables
 - c. 9.0-inches for 36-strand cables

9. The minimum bend radius on the installed fiber optic cable shall not exceed the following:
 - a. 1.9-inches for 2-strand cables
 - b. 2.4-inches for 12-strand cables
 - c. 6-inches for 36-strand cables

10. All 4-pair Unshielded Twisted Pair (UTP) Category 6 copper distribution cabling shall be 23 AWG solid bare copper, 100-Ohm with ripcord and shall be terminated using the ANSI/TIA/EIA-568-C, T568B wiring scheme and pin-out configuration.
 - a. UTP cable shall be UL type CMP, Plenum rated.
 - b. Minimum bend radius shall be 1-inch.
 - c. Maximum pulling tension shall be 25 lbs.
 - d. Bend radius is (4 X Cable OD)

B. Horizontal Distribution

1. 4-Pair Unshielded Twisted Pair (UTP)
 - a. Data grade Horizontal Distribution cable shall exceed ANSI/TIA/EIA Category 6 minimum requirements and shall be ETL Verified for electrical performance, and shall be as manufactured by Berk-Tek 4 pair Category 6, the color of the cable shall be green, P/N LANmark 1000 Category 6, CMP, 10032096.
 - b. The voice and data horizontal cable sheaths used shall be as follows:
 - 1) Port position #1 Green Jacket
 - 2) Port position #2 Green Jacket
 - 3) Port position #3 Green Jacket
 - 4) Port position #4 Green Jacket

- c. Internet Protocol (IP) camera horizontal cables shall be Category 6, plenum rated (CMP), pink, Berk-Tek P/N 10032120.
- d. Wireless Access Point (WAP) horizontal cable shall be Category 6A, plenum rated (CMP), violet, Berk-Tek P/N 101381182.

2. Coaxial

- a. RG6 CATV, 75-Ohm cable with 18 AWG copper-clad steel center conductor with foam dielectric, Quad Shield, 100% foil shield and 40% braid shield coverage under a riser-rated jacket CommScope Inc., P/N 2227V.
- b. RG-6 cable shall be terminated with Corning Gilbert Connector.
- c. F-Connector bulkhead at the TV outlet shall be Hubbell F-Connector P/N SFFGW.
- d. RG11 CATV, 75 Ohm shall be Plenum rated by CommScope, P/N 2287K.
- e. Installer shall terminate horizontal RG-6 cable at TV outlet with a Corning/Gilbert F-connector for quad shielded riser rated coax cable. Voice grade, (2) runs 200 pair cable shall be run from the basement EF CBT1 Room to Building A, Room AB053 and a location TBD. Coordinate termination location with UCHC IT.

C. Intrabuilding Backbone

1. Multipair Unshielded Twisted Pair (UTP)

- a. Voice grade cable shall be 50-pair, 24 AWG, plenum-rated (CMP), Category 3 type multiconductor cable riser rated, CMP, Berk-Tek P/N 10032112.
- b. Voice grade 50 pair cable shall be run from AB053 to new CRC Room on the main level.
- c. Provide a run of 50 pair cable from new basement EF/MDF wall field to a voice patch panel in all IDFs.
- d. Voice grade 200-pair, Category 3 cable shall be Berk-Tek, P/N 10032123.
- e. Provide two (2) runs of Category 3 voice cable from the "new" EF/MDF on the basement level to AB053.

2. Optical Fiber Cables

- a. 48-Strand Singlemode Fiber Optic Armored cables shall be 900 μ m tight buffered with OFCP, plenum-rated outer jacket, ribbon construction, Corning Cable Systems P/N 048EC8-14101-A3, shall be run from EF/MDF (CBT1) to all New BLFDG C Telecommunications Rooms/IDFs
- b. 216-strand singlemode indoor/outdoor, plenum rated, OFCP, armored, ribbon Corning Cabling System Freedom P/N 216EC8-14101-A3. Two (2) runs of singlemode fiber optic armored, ribbon indoor/outdoor rated cable shall be run from the sub-basement EF/MDF (CBT1) to AB012 and LB062.
- c. Ribbon cables shall be fusion spliced with Corning Cable Systems ribbon splicer P/N Opti Splice Ribbon.
- d. All armored fiber optic cables shall be grounded at both ends in TRs and EF/MDF, AB012, LB061.
- e. All indoor/outdoor riser rated armored fiber optic cables shall be grounded at one (1) end in the EF CER Room.
- f. Refer to Corning SRP 004-210 for additional information all splices shall be A-A straight through.

3. Coaxial

- a. 75-Ohm coaxial cable with copper clad aluminum center conductor, expanded polyethylene dielectric and continuous aluminum outer conductor under flame retardant jacket shall be RG-11 CommScope P/N 2287K.
- b. RG-11 coax cable shall be run from the sub-basement EF/MDF (CBT1) to all new BLDG C Telecommunications Rooms.

D. Quantity

1. Horizontal Distribution

- a. The Contractor shall provide one (1) 4-pair Enhanced Category 6 cable to each designated telecommunication outlet port location as indicated on the Drawings and as specified herein. All eight conductors shall be terminated at both ends.
- b. The Contractor shall provide one (1) RG6 coaxial cable to each designated multimedia (CATV) outlet port location as indicated on the Drawings and as specified herein. Cable shall be terminated at with F-connectors at TV end only.

2.03 TELECOMMUNICATION OUTLETS

A. General

1. Each faceplate shall be the same color and height above the floor as the electrical faceplate. All outlets/faceplates shall be provided with "machine-generated" labels. Handwritten labels will not be accepted. All telecommunication outlet identification shall be labeled using approved standards. The Contractor shall coordinate exact labeling scheme and nomenclature with the UCHC IT Technology prior to installation.
2. All work area outlet faceplates shall utilize Category 6, 8-position, 8-conductor type "T568B" modular jacks. Modular jacks shall be color coded green, and as shown on Drawings, unless otherwise specified.
3. Modular jacks at work area outlet ports shall be 8-position, 8-conductor shall be Category 6, 110 style with IDC type contacts.
4. Category 6 modular inserts shall be the color green, Hubbell, P/N HXJ6G-N.
5. Category 6A modular inserts shall be purple, Hubbell Next Speed P/N HJ6AP.

B. Wall-Mounted Voice Only

1. Each Voice only outlet used for wall mounted telephone locations shall consist of one (1) single gang, single port, stainless steel faceplate with integral telephone device mounting tabs. Hubbell wall mount telephone outlet. Hubbell, P/N P630S1GJC6.

C. Standard Wall-Mounted Telecommunications Outlet

1. Each standard work area outlet shall consist of one (1) single gang, flush mounted, 4-port faceplate manufactured by Hubbell with four (4) Hubbell Category 6 modular inserts. Each jack shall be green. Faceplate shall be Hubbell, P/N IFP14W.

D. 2-Port Wall-Mounted Telecommunications Outlet

1. Each 2-port work area outlet shall consist of one (1) single gang, flush mounted, 2-port faceplate manufactured by Hubbell with two (2) Hubbell Category 6 modular inserts. Each jack shall be green. Faceplate shall be Hubbell, P/N IFP12W.

E. 4-Port Floor Box Device Mounted Outlet (Poke-Thru)

1. Each floor-mounted poke-thru shall have four (4) Hubbell Category 6 inserts. Each jack shall be green.

F. 1-Port Wall Mount Telecommunications Outlet

1. Each 1-port telecommunications outlet shall consist of one (1) port single gang flush-mounted 1-port faceplate manufactured by Hubbell with one (1) Hubbell Category 6 modular insert. Each jack shall be green. Faceplate shall be Hubbell, P/N IFP11W.

G. 2-Port Ceiling-Mounted Wireless LAN Telecommunications Outlet

1. Each 2-port wireless LAN, Telecommunications Outlet shall consist of 1 single gang faceplate manufactured by Hubbell with two (2) Hubbell Category 6A modular inserts. Each jack shall be purple. Faceplate shall be Hubbell, P/N IFP12W.
2. Provide 2-port wireless LAN outlets with two (2) Category 6A cables. Terminated and tested to Cat 6A.
3. Provide, install and terminate Wireless Access Points with Berk-Tek, Category 6A, plenum rated, violet, P/N 10138182. Hubbell Jack P/N HJ6AP.

H. 4-Port Wall-Mounted CATV Outlet

1. Each 4-port CATV outlet shall consist of a four (4) port single gang, flush-mounted faceplate manufactured by Hubbell with one (1) Hubbell Category 6 insert and one (1) F-connector insert. The jack insert shall be green. Faceplate shall be Hubbell, P/N IFP14W.

I. 4-port and 2-port Telecommunications Outlets

1. Each 4-port Telecommunications outlet mounted on Wiremold 4000 metal raceway provided by Electrical Contractor. Provide four (4) Hubbell Category 6 modular inserts. Each jack shall be green. Faceplate shall be Hubbell P/N IFP14W.
2. Each 2-port Telecommunications outlet mounted on Wiremold 4000 metal raceway provided by Electrical Contractor. Provide two (2) Category 6 modular inserts. Each jack shall be green. Faceplate shall be Hubbell P/N IFP12W.

2.04 FIBER OPTIC HARDWARE

- A. 1 RMU fiber optic hardware shall hold 12 modules and splice trays shall be Corning Cable Systems P/N EDGE-01U-SP. Note: Used in TRs.
- B. 4 RMU fiber optic hardware shall hold 48 modules and splice trays shall be Corning Cable Systems P/N EDGE-04U. Note: Used in EF/MDF (basement), AB012 and LB061.
- C. Ribbon fiber optic splice trays shall be Corning Cable Systems P/N SCF-ST-077.

- D. 12 Strand ribbon module with 12 LC single mode fiber connectors shall be Corning Cable Systems P/N ESM-UM12-04G-R3M.
- E. Heat shrink shall be Corning Cable Systems P/N 2806031-012. Refer to Corning SRP001-281.
- F. Armor cable grounding kit shall be Corning Cable Systems P/N HDWR-GRND-KIT. Note: All armored cables shall be grounded at both ends.
- G. Refer to Corning SRP 004-210 for additional information on splicing.
- H. Ribbon termination kit shall be Corning Cable Systems P/N RBN-TERM-FMS. Refer to Corning SRP-603-528 for ribbon termination kits.

2.05 FIBER OPTIC PATCH CORDS

- A. Provide singlemode fiber optic patch cords with LC connectors. Coordinate quantity and length with UCHC IT.

2.06 PATCH PANELS

A. UTP Horizontal Distribution

1. The Contractor shall provide 2RMS rack mounted 48-port, angled, modular patch panels for the purpose of terminating horizontal distribution cabling. 48-port patch panels shall be Category 6, 110 Style with IDC type contacts and universal T568A/T568B wiring, Hubbell P/NHP648A.
2. The Contractor shall provide 2RMS rack mounted 48-port, angled, modular patch panels for the purpose of terminating horizontal Wireless Access Points (WAPs). 48-port patch panels for wireless shall be Category 6A, Hubbell P/N HP648A.
3. Provide color coded icons and labeling strip for each port position at the front and rear of each panel. Port position icon colors shall correspond with work area jack colors.
4. 48-port metal, modular patch panels shall be EIA-322D compliant for 19-inch racks as shown on drawings with labeling space for identification of each port position.

2.07 CATEGORY 6 PATCH CORDS

A. The Contractor shall provide the following Category 6 green, Hubbell Patch Cords:

1. 3-foot green Hubbell P/N PCX6GN03;-TBD.
2. 6-foot green Hubbell P/N PCX6GN06; quantity –TBD
3. 8-foot green Hubbell P/N PCX6GN08; quantity – TBD
4. 12-foot green Hubbell P/N PCX6GN12; quantity – TBD
5. 16-foot green Hubbell P/N PCX6GN16; quantity – TBD

B. Coordinate quantity and length with UCHC-IT.

2.08 WALL-MOUNTED TERMINATION BLOCKS

- A. All voice grade Intra-building Backbone Distribution cables, and cable pairs within the EF/MDF and Telecommunication Rooms shall terminate on wall mount backboard system with category 3 100-pair, 110 style wiring blocks, manufactured by Hubbell. Each cable pair shall be sequentially terminated on the appropriate block position with labeling.
 - 1. Provide wall mounted cable management at each wiring block column as indicated on the drawings manufactured by Hubbell.
 - a. 900 pair in MDF (basement)
 - b. 100 pair in TRs

2.09 WALL MOUNT BACKBOARD (TELECOMMUNICATION ROOMS)

- A. Wall mounted backboards shall be void free, A/C grade, 3/4" x 4' x 8' plywood sheets, mounted vertically. All plywood backboards will be painted with two (2) coats of fire-retardant, non-conductive, white paint.
- B. Plywood backboards shall be rigidly installed, and permanently attached to the wall as shown on the telecommunications drawings and in accordance with Miscellaneous Carpentry Section of the Specifications.

2.10 EQUIPMENT RACKS

- A. General
 - 1. Where indicated on the Drawings, equipment racks shall be provided and installed for mounting cable terminations, LAN switches and concentrator hubs, and other equipment. Each equipment rack shall be epoxy-polyester hybrid black powder coat finish and each shall include four (4) full height vertical U-channel cable managers. Each full height vertical cable manager shall be equipped with four (4) vertical cable manager covers. Equipment racks shall be securely bolted to the floor at the base and fastened to the wall or an overhead support system that in turn is directly secured to a wall. Additional cable management devices, shelves, and other accessories shall be provided as specified herein as shown on drawings.
- B. Telecommunication Rooms
 - 1. Provide 7'-0"H x 19"W x 6.5 deep channel integrated rack/cable management rack system. Mighty Mo 10 Racks, Ortronics, P/N OR-MM20706-B.
 - 2. Air baffle shall be Ortronics, P/N OR-MM10AB71612.

2.11 CABLE MANAGEMENT

- A. Provide vertical cable management at dual rail between equipment racks and as shown on the drawings. Vertical management shall be installed at each side of each vertical dual rail and shall include covers 13" x 12.", manufactured by Ortronics, P/N OR-MM10VMD712.
- B. Provide vertical cable management on the end of each rack, Ortronics P/N OR-MM6VMD706.
- C. All edges and pass-through openings shall be grommeted and the cable section shall have seven plastic latches evenly spaced for active cable administration.

- D. Provide 2-RMS Horizontal management panels shall be 19" EIA standard width and double rack mounting unit (3.50") in height, manufactured by Hubbell. Attachment to relay rack shall be made with standard rack mount hardware. Provide Velcro tie wraps for neatly bundling cables. Plastic cable ties will not be accepted. Hook and loop tie wraps shall be listed for the intended use and shall be color coded. Horizontal managers shall be provided above and below each rack mounted patch panel and as indicated on the Contract Documents. Hubbell P/N HC219CE3P.
- E. Wall-Mounted (Backboards)
1. The Contractor shall provide one cable management backboard between each voice wiring block located on the wall mount backboard system and in accordance with the Drawings.
 2. All cabling within the Telecommunication Rooms and MDF shall utilize steel D-rings mounted every 12", for proper routing of bundled cables entering and/or exiting the termination area and/or where a conduit or runway support system is not otherwise required.
 3. D-rings shall be provided from the feeder and horizontal cable conduits to the backboards on each floor and at 12-inches on center vertically between wiring blocks and as shown on drawings.
 - a. Provide 6-inch metal D-ring for routing and supporting of patch cords (Chatsworth Products #10942-000 or equal).
 - b. Provide 8-inch metal D-ring for bundling and supporting distribution cabling (Chatsworth Products #10943-000 or equal).
- F. Hook and loop tie wraps will be used exclusively for neatly bundling cables. Plastic cable ties will not be accepted.

2.12 POWER DISTRIBUTION UNITS

- A. Provide and install PDU units American Power Conversion (APC), P/N AP8841.
- B. Provide and install APC temperature and humidity sensor in each TR/IDF and EF/MDF, APC P/N AP9335TH.
- C. Coordinate location on Ortronics Racks in EF/MDF and TR/IDFs with UCHC IT and Electrical Contractor.

Note: The PDU part number noted above in A, may change by time of construction. Coordinate in field with UCHC IT and Electrical Contractor.

2.13 CABLE RUNWAY SYSTEM (MDF, TRs/IDFs)

- A. Where indicated on the Drawings, a cable runway system shall be provided and installed for cable support and routing. All cable runway system components within the telecommunications rooms shall be Chatsworth manufactured product (or approved equal) and are the responsibility of the Contractor.

- B. Cable Runway within the telecommunication spaces shall be fastened directly to wall and/or equipment racks as shown on detail drawings.
 - 1. Coordinate exact location and mounting heights relative to Owner provided equipment racks or cabinets with Owner.
- C. Contractor shall provide Cable runway and all necessary associated hardware (Chatsworth or approved equal) for a complete installation, including but not limited to the following:
- D. All cable runway system components within the telecommunications spaces shall be Chatsworth manufactured product and shall be installed in accordance with manufacturer guidelines.
- E. All necessary components for a complete and safe cable runway system are the responsibility of the Contractor and include but are not limited to the following:
 - 1. Cable runway product shall be Chatsworth manufactured P/N 11252-718 series or approved equal.
 - 2. Butt-splice kits shall be Chatsworth manufactured P/N 11301-001 or approved equal.
 - 3. Junction splice kits shall be Chatsworth manufactured P/N 11302-001 or approved equal.
 - 4. J-Bolt kit shall be Chatsworth manufactured P/N 11308-001 or approved equal.
 - 5. 3" channel rack to runway plate shall be Chatsworth manufactured P/N 10595-012 or approved equal.
 - 6. Protective end caps for all cable runway sections that terminate and therefore are independent of other sections of cable runway shall be Chatsworth manufactured P/N 10642-001 or approved equal.
 - 7. Radius waterfall shall be Chatsworth P/N 12100-718.
 - 8. Cable Runway Movable Cross Member shall be Chatsworth P/N 12115-718.
 - 9. Cable retaining post shall be 8 inch Chatsworth P/N 10596-708. Provide on side of cable runway to hold in cables.

2.14 RACEWAY SUPPORT SYSTEMS

A. General

- 1. Furnish and install a complete raceway support system for the voice and data system as specified herein and as shown on the drawings.
- 2. Additional requirements for the following equipment are included elsewhere in these specifications:
 - a. Boxes
 - b. Supports
 - c. Mechanical Suspension Channel
 - d. Conduit
 - e. Sleeves
 - f. Outlet Boxes
- 3. The completed system installation shall meet the approval of the Owners Telecommunications Departments and be in accordance with all applicable sections of the NEC.

B. Conduit and Pull Boxes

1. Where areas have non-accessible ceilings, provide conduit pathways covering the entire length of the non-accessible cavity. The number and size of conduits shall be per Section 3.2 "Installation".
2. Where conduits cross smoke partitions or fire rated partitions, provide conduit sleeves, minimum (1) per system extending 6" beyond partition in both directions. Number and size of sleeves shall be per "approved" and "listed" equivalent firestop system manufacturer's requirements.
3. Telecommunication/data outlets shall consist of 4-11/16" square x 4-11/16" x 3" depth, 2-gang box with single gang adapter and device plate as indicated on the drawings. 1.0-inch conduit with plastic bushing shall run from each outlet to within accessible ceiling area.
4. Telecommunication backboards in telecommunication/data rooms shall consist of 3/4" plywood sheets with a finished side primed and painted with two coats of fire retardant paint and as shown on the drawings and in accordance with Miscellaneous Carpentry Section of the Specifications.
5. Install conduit runs in the most direct route possible with no more than two 90 degree bends between pull points or pull boxes.
6. 90-degree condulets or "LB" fittings shall not be used for telecommunications cabling installations.
7. Continuous conduit sections shall not be greater than 100 linear feet in length without an adequately sized pull box.
8. Conduits shall be bonded to ground on one or both ends in accordance with national and local requirements.
9. Telecommunications conduits shall withstand the environment to which they will be exposed.
10. The total distance of installed conduit runs for telecommunications use shall not exceed 150 feet.
11. Do not install conduits over or adjacent to boilers, incinerators, hot water lines, steam lines or hazardous and explosive use areas.
12. The bend radius of any portion of the conduit pathway shall be six (6) times the internal diameter of the conduit for all conduits 2-inches in diameter or less.
13. The bend radius of any portion of the conduit pathway shall be ten (10) times the internal diameter of the conduit for all conduits with an internal diameter greater than 2-inches.
14. Where a conduit run requires a reverse bend (between 100 degrees and 180 degrees) a pull box shall be installed at each bend having such angle, within ten feet of the bend.
15. If a conduit run requires a third 90 degree bend between pull points or pull box, the overall design capacity of the conduit system shall have a derated total capacity of 15 percent.
16. All Conduit ends shall be reamed and fitted with an insulating bushing to eliminate sharp edges that can damage cables during installation.
17. Conduits that protrude through walls and floors shall be extended 3-inches beyond the surface penetration.
18. All conduits shall be equipped with nylon fish tape or pull cords with a minimum test rating of 200lbs.
19. Install pull boxes in accessible locations. Direct access to pull boxes is required. Provide labeled, hinged access panel door. Pull boxes shall be listed for the purpose.
20. The length of pull box shall be 12-times the diameter of the largest conduit.

C. Power and Grounding Requirements

1. Provide a 12" by 1/4" by 4" by 20" copper ground bus in the EF/MDF (CBT! and each new BLDG C TR, Erico P/N B544A027 or approved equal.

2. Provide type LA-offset ground bar lugs as manufactured by Erico Caddy "Cadweld" or approved equal.
3. Provide #6AWG insulated ground wire and connections.

2.15 FIRESTOP UNITS FOR MULTICABLE AND CABLE TRAY PENETRATIONS

- A. All firestop products and systems shall be provided such that the basic sealing system will allow the full restoration of the thermal and fire resistance properties of the barrier being penetrated with minimal repair if penetrants are subsequently removed.
- B. Penetrations containing loose cabling shall be protected using firestopping products that allow unrestricted cable changes without damage to seal.
- C. Materials and systems must be intumescent or capable of filling through openings created by the burning or melting of combustible insulating materials or cable jacketing.
- D. Firestop sealants must be elastomeric or flexible and shall have F and T ratings suitable for intended service, and UL tested.
- E. Materials shall not affect or derate the properties of cables in energized cable applications.
- F. Firestop materials shall not contain flammable or toxic solvents and shall not produce toxic or flammable outgassing during the drying or curing process.
- G. Provide firestop (FSP) two-piece enclosure device with steel casing, angle brackets, fixation plate and cover, as manufactured by CSD Sealing Systems or approved equal.
- H. Provide cavity filling materials as required for approved FSP system and rating as manufactured by CSD Sealing Systems or approved equal, including but not limited to the following:
 1. Fire Resistant Rubber Sponge
 2. Fire Resistant Rubber/Halogen Free Gaskets
 3. Fire Resistant, Water Repellant Sealant
 4. Forming or damming material
 5. Weather Shields

2.16 ELEVATOR TELEPHONE/WIRELESS DATA CABLING

- A. Furnish and install all telecommunications cabling as required by the elevator manufacturer. Consult Elevator Subcontractor and obtain final accepted elevator shop drawings prior to installation of cable, conduit, junction boxes, etc., for the elevator machine room.
- B. Provide one (1) 4-pair UTP, Category 6 cable within ¾" conduit, for each elevator phone required, unless otherwise specified. Each voice cable shall be routed from the elevator machine room to within the nearest Telecommunications Room and shall terminate on the voice wall mounted termination blocks. Coordinate the exact location with the Owner.
- C. Junction box(s) within the elevator machine room and conduit(s) entering Telecommunication Rooms shall be labeled as "ELEVATOR PHONE". Elevator phone cables within the conduits shall be labeled at both ends in accordance with the labeling requirements specified elsewhere within these specifications.

2.17 ACCESS DOORS

- A. Furnish, for installation by the designated Trade as determined by the General Contractor, all access doors in locations wherever pull or junction boxes, equipment, etc., are installed behind gypsum wallboard or masonry walls or ceilings and where such devices would be inaccessible for inspection, maintenance or servicing. Access doors shall be a minimum of 18" by 18" and shall be sized to suit the access requirement to service the equipment and located in a manner approved by the Architect and to meet requirements specified here and elsewhere, for specific applications. Refer to Architectural Section 08305 for additional information.
- B. Doors shall be set square and flush in cooperation with the designated Subcontractors performing the work. Particular attention shall be exercised in the selection of doors for masonry walls in order that frame sizes used will match the courses of brick or block. All access panels shall be located in closets, storage rooms and/or other non-public areas where possible, positioned so that the junction can be easily reached and shall be constructed in a workmanlike manner. When access panels are required in corridors, lobbies or other habitable areas, they will be located as directed by Architect.
- C. Access panels shall be flush type with 14 gauge panels and 16 gauge frames, minimum, unless otherwise noted. Each access panel shall be furnished complete with continuous piano hinge and flush screwdriver operated cam latch, with factory applied prime finish. Access panels shall be as manufactured by Inryco/Milcor, Karp Associates Inc., Birmingham Ornamental Iron Co., Miami-Carey, Babcock-Davis or equal approved by the Architect.
- D. Access panels shall be installed in gypsum wallboard ceilings only where specifically approved by the Architect. Where possible, all access requirements for raceways and equipment shall be beyond the gypsum wallboard ceilings.
- E. Access panels shall be specifically designed for each type of wall, ceiling finish and construction with which they are used, as follows:
1. Suspended latch and gypsum wallboard ceilings: Style K with 16 gauge frame, 14 gauge panel and flush screwdriver operated camlocks.
 2. Masonry rated walls: Style M with 16 gauge frame, 14 gauge panel and flush screwdriver operated camlocks.
 3. Masonry fire rated walls and at shafts: Fire rated with UL, 1.5-hour "B" rating, 16 gauge frame, 20 gauge sandwich type insulated panel, self-latching lock having interior release mechanism, and flush screwdriver operated camlocks.
 4. Where installed at fire rated walls or ceilings, access panels shall be of fire-resistive construction with mineral core panel faced both sides and edges with 20 gauge sheet steel, and shall bear the UL label required to meet the fire rating of the wall.
 5. Where installed in surfaces finished with ceramic tile or glazed coatings, access panels shall be of stainless steel with No. 4 finish.
 6. Where installed in acoustical ceilings, access panels shall be of type which will accept adhesive mounted acoustical panels flush with surrounding surfaces (acoustical panels to be provided by Acoustical Ceiling Trade).
 7. Where installed in gypsum wallboard walls or ceilings, access panels shall be of type with 14 gauge face panels and 16 gauge frames equipped with integral perforated, textured metal casing bead edge which will receive drywall compound for flush finishing. (Compound finishing shall be provided by Gypsum Drywall Trade.)

2.18 HANGERS AND SUPPORTS

- A. Provide all required hangers, supports, sleeves, clamps, etc., as required for all telecommunications raceway and support system equipment.
- B. In areas where there is no cable tray and conduit is not used, the contractor must provide a cable management system from the telecommunication rooms to the work area location conduit stubs.
- C. The cable management system must be Category 6 compliant; Erico Cable Cat Category 6 Cable Management "sling" system or equivalent.
- D. The cable management system shall be supported throughout at distances not exceeding 48-inches, and shall be installed such that 25% spare capacity is afforded minimum.
- E. All horizontal runs of conduits shall be properly grouped, aligned, using substantial hangers, straps, etc. Hangers and supports shall be installed at intervals not exceeding NEC requirements.
- F. Supporting rods shall be threaded at ends with allowance for adjustments. Wire and strap hangers will not be permitted. All conduit and fittings shall be supported by hangers, straps, etc., using bolts.
- G. Structural Support Interface
 - 1. All conduit, cable tray, raceways and other similar system components which are supported by roof or floor joists shall be hung from the top chord or bottom chord panel point or a panel point shall be provided by applying a vertical web member. The maximum load shall not exceed 250 pounds.
 - 2. All conduit, cable tray, raceways and other similar system components which are supported by roof/floor beams shall be hung from the beams with clamp attachments which engage both edges of the beam flange.
 - a. The hanger shall be located directly below the web of the beam and the hanger load shall be limited to 1000 pounds in area above mechanical room and 250 pounds in remaining areas, unless otherwise approved by the Architect.
 - 3. All additional supports, clamps, web members, etc., required to comply with the above requirements shall be provided by the Contractor, as applicable, for the work furnished and installed under this Contract.

2.19 MECHANICAL SUSPENSION CHANNEL

- A. Mechanical suspension channel shall be furnished and installed to support equipment, (raceways, conduits, pull boxes, etc.) independent of walls. Where walls back up to occupied spaces, the suspension channels shall be at least 1/2" clear of the wall and shall not be connected or braced to the wall.
- B. Channel shall be Unistrut, Type P3000 or approved equal. All fasteners and fittings shall be supplied to provide a complete installation as required. Channel shall be sized and mounted to allow for future conduits.
- C. All channel and fittings shall be furnished with the manufacturer's standard rustproofed finish.

- D. Channel shall be manufactured by one of the following: Unistrut Products Co., Kindorf, or B-Line.

PART 3 EXECUTION

3.01 COOPERATION AND WORK PROGRESS

- A. The work shall be carried on under the usual construction conditions, in conjunction with all other work at the site. The Contractor shall cooperate with the Architect and all other Subcontractors and equipment suppliers working at the site. The Contractor shall coordinate the work and proceed in a manner so as not to delay the progress of the project.
- B. The Contractor shall coordinate his work with the progress of the building and other Trades so that he will complete his work as soon as conditions permit and such that interruptions of the building functions will be at a minimum. Any overtime hours worked or additional costs incurred due to lack of or improper coordination with other Trades, the Architect or the Owner's representative by the Contractor shall be assumed by him without any additional cost to the Owner's representative.
- C. The Contractor shall provide information on all equipment that is furnished under this Section but installed under another Section to the installing Subcontractor as specified herein.
- D. The Contractor shall furnish all materials, equipment and workmanship to provide for adequate protection of all equipment during the course of construction of the project. This shall also include protection from moisture and all foreign matter. The Contractor shall also be responsible for damage which he causes to the work of other Trades, and he shall remedy such injury at his own expense.
- E. Waste materials shall be removed promptly from the premises. All material and equipment stored on the premises shall be kept in a neat and orderly fashion. Material or equipment shall not be stored where exposed to the weather. The Contractor shall be responsible for the security, safekeeping and any damages, including acts of vandalism, of all material and equipment stored at the job site.
- F. The Contractor shall be responsible for unloading all materials delivered to the site. This shall also include all large and heavy items or which require hoisting. Consult with the General Contractor for hoisting/crane requirements.
- G. It shall be the responsibility of the Contractor to coordinate the delivery of the materials for the project prior to the time installation of such materials will be required.
- H. The Contractor shall erect and maintain, at all times, necessary safeguards for the protection of life and property of the Owner's representative(s), Personnel and the Public.
- I. Prior to installation, the Contractor has the responsibility to coordinate the exact mounting arrangement and location of equipment to allow proper space requirements as indicated in the NEC. If it is questionable that sufficient space, architectural or structural obstructions, or a conflict with the work of other Subcontractors will result in an arrangement which will prevent proper access, operation or maintenance of the indicated equipment, the Contractor shall immediately notify the General Contractor and shall not proceed with this part of the work until definite instructions have been given to him by the Architect.

- J. The Contractor shall not allow any equipment or piping foreign to the telecommunications installation to be installed or pass through any telecommunication rooms in which communication systems and equipment are located, such as computer equipment, PBX and distribution frames. The Contractor shall notify the General Contractor of such violations and request immediate removal.
- K. The Contractor shall obtain from the other Trades, copies of all shop drawing prints showing ductwork and piping installations as they will be put in place on the project. These drawings shall be thoroughly checked by the Contractor and used for the routing of all cable tray, cable runway, conduits and innerduct installations.
- L. Location of all outlets shall be verified with the Architect prior to roughing in conduits or routing of cables. Refer to details and wall elevations on the Architectural drawings. Mounting heights indicated on these drawings and/or specific dimensional information given to the Contractor by the Architect shall take precedence over such information indicated on the Telecommunication drawings.

3.02 INSTALLATION

- A. The Contractor shall be licensed in the State of Connecticut with the low voltage certification if required.
- B. The Contractor shall provide five (5) references with contact names and telephone numbers regarding successful completion of Tel/Data communication cabling projects within the last year.
- C. The Contractor shall Furnish and Install in accordance with manufacturer's instructions, all wiring, conduit, outlet boxes, pull boxes, etc., as required for the erection of a complete telecommunications system as described herein and as indicated on the drawings.
- D. All wiring at the work area outlet box shall be concealed in conduit and shall be routed to above an accessible ceiling. A pull rope shall also be included with the installed cabling for pulling additional services in the future.
- E. Where ceiling construction is drywall or concealed spline type and/or is inaccessible as determined by the Architect, telecommunications conduit shall be installed in and shall be terminated beyond these areas in order to act as a dedicated pathway for telecommunications cabling.
- F. Where areas have non accessible ceilings, provide conduit(s), minimum one (1) per system, covering the entire length of the non-accessible cavity, ensuring access to each end of the conduit sleeve(s). Conduit sleeves shall be sized in accordance with the following unless otherwise specified:

- 1. Horizontal Distribution Cable
 - a. 0-4 cables 1" Trade Size Conduit Category 6
 - b. 7-10 cables 1-1/4" Trade Size Conduit
 - c. 11-15 cables 1-1/2" Trade Size Conduit
 - d. 16-25 cables 2" Trade Size Conduit
 - e. 26-42 cables 2-1/2" Trade Size Conduit
 - f. 43-55 cables 3" Trade Size Conduit
 - g. 56-63 cables 3-1/2" Trade Size Conduit
 - h. 64-80 cables 4" Trade Size Conduit

- G. Where corridors or necessary cable access pathway routes cross smoke partitions or fire-rated partitions, provide conduit sleeves, minimum one (1) per system, extending 6" beyond partition in both directions, and firestop.

3.03 TELECOMMUNICATIONS CABLING PRACTICE

- A. All cable installation and termination shall adhere to the provisions in ANSI/TIA/EIA 568-C standards.
- B. All cable and equipment shall be installed in a neat and workmanlike manner. Methods of construction that are not specifically described or indicated in the Contract Documents shall be subject to the control and approval of the Owner or Owner Representative.
- C. All horizontal cable designated as Category 6 on the Drawings shall be 100 Ohm, Unshielded Twisted Pair (UTP), 23 AWG, plenum rated, with solid copper conductors. The horizontal cable shall run from each work area telecommunication outlet to the appropriate cross-connect or patch panel in the Telecommunications Rooms (TR).
- D. The physical length of each horizontal cable run (length of cable sheathing) shall not exceed 295 linear feet. Each Horizontal cable shall be a continuous run with no splices, bridges, or other discontinuities.
- E. The horizontal distribution cable installed for "Port #1" shall be green in color (outer jacket) and will differentiate it from the cable used for other ports within the faceplate and associated TR patch panel. All horizontal cable on this project shall be from the same manufacturer.
- F. The horizontal distribution cable installed for "Port #2" shall be green in color (outer jacket) and will differentiate it from the cable used for other ports within the faceplate and associated TR patch panel. All horizontal cable on this project shall be from the same manufacturer.
- G. The horizontal distribution cable installed for "Port #3" shall be green in color (outer jacket) and will differentiate it from the cable used for other ports within the faceplate and associated TR patch panel. All horizontal cable on this project shall be from the same manufacturer.
- H. The horizontal distribution cable installed for "Port #4" shall be green in color (outer jacket) and will differentiate it from the cable used for other ports within the faceplate and associated TR patch panel. All horizontal cable on this project shall be from the same manufacturer.
- I. The cable to be used for "Wall Phone Locations" shall be green in color (outer jacket).
- J. The Contractor shall provide one (1) 4-pair Enhanced Category 6 cable to each work area outlet port position/modular jack location as configured and indicated on the Drawings.
- K. All horizontal distribution cables within the telecommunications rooms shall be terminated on the 48-port, 2-RMS, angled Category 6, rack-mounted patch panels.
- L. Interconnections and or cross-connections between coaxial backbone and horizontal systems are "by Owner". Splitters, amplifiers and head-end electronics are by Owner's Contractor.
- M. All cables shall be clearly labeled at each end, with the location number machine-labeled at 4" to 6" from the points of termination.

- N. All wall and floor penetrations and cable sleeves greater than 1" in diameter shall be firestopped.
- O. Backbone cables shall not be exposed; cable running between non-adjacent Telecommunication Rooms shall be run in conduit.
- P. Backbone cables shall be secured to building structure every 48-inches and in accordance with ANSI/NFPA-70; The National Electrical Code.
- Q. Each fiber optic backbone cable strand shall be terminated at both ends, using "LC" type connectors.
- R. In Telecommunication Room (TR) locations where cables originate from different floors, the cables are to be separately bundled so that each bundle contains cable from the originating floor only.
- S. Maintain cable twist-rate at all termination points. The amount of cable untwist shall be no more than ½". Do not strip back the cable jacket any more than is necessary to terminate the individual conductors.
- T. Provide a 12-foot service loop, neatly coiled in the ceiling above each modular furniture area, CE cameras, for all horizontal distribution cables serving these areas.
- U. Provide a 25-foot service loop for the voice grade multiconductor backbone cable at the voice termination backboard, within each IC Room.
- V. Provide a 25-foot service loop for the optical fiber backbone at the equipment rack, within the overhead runway within each IC Room.
- W. Provide minimum 12-inches of cable slack at the work area outlet for all horizontal copper UTP distribution cabling.
- X. The Cabling Contractor must provide protective covering for any horizontal cables (4-Pair) left exposed in occupied areas using 1/2" Panduit Spiral-wrap (PN# T50R-C) or 3/4" Panduit Spiral-wrap (PN# T75F-C) as required, for the entire length of the exposed cabling. Exposed cable (with Spiral-wrap) in such areas shall not exceed 18". Use of an approved equal method will be considered.
- Y. Conduit bends must have a radius of not less than 6 times the internal diameter of conduits 2 inches or smaller; or 10 times the internal diameter of conduits larger than 2 inches.
- Z. Cables shall be supported at 48-inches on center minimum and shall not be tie wrapped to other utilities such as electrical conduit or sprinkler pipes.
- AA. Cable shall not lie on ceiling tiles, plumbing or steam pipes, high voltage conduits or trays, fluorescent lights or any other known source of heat, moisture or electrical magnetic interference (EMI).
- BB. Cable cannot be strapped or tied to any electrical conduits, raceways, plumbing or any type of incorrectly supported loose wiring.
- CC. A 5-inch clearance and/or separation must be maintained between any communications and electrical conduits.

- DD. Provide a minimum of 10-foot cable slack, to neatly route the horizontal cable through the "D" rings to the appropriate 110-type block.
- EE. No communication or data circuit shall be run in the same conduit or raceway with power conductor except where the raceway is separated by a full height, integral divider.
- FF. Installation of the cable shall be in accordance with the marked floor plan. All deviations to the cable route shall be approved by the Owner prior to installation.
- GG. Cable routing shall follow physical separation guidelines and shall avoid locations of high RFI/EMI radiation or adverse environmental conditions. Cable shall be a minimum of 4 feet from any electric motor or light ballast
- HH. The telecommunications cable plant shall be grounded and bonded in accordance with ANSI/TIA/EIA-607-B and 2011 NEC Article 250.

3.04 CABLE TRAY AND CABLE RUNWAY INSTALLATION

- A. Inspect areas to receive cable management system. Notify the engineer of conditions that would adversely affect the installation or subsequent utilization of the system. Do not proceed with installation until unsatisfactory conditions are corrected.
- B. Install cable tray and cable runway systems in accordance with recognized industry practices and in accordance with manufacturer's instructions and ensure that the cable support system equipment complies with requirements of NEC and applicable portions of NFPA-70B and NECA "Standards of Installation" pertaining to installation practice.
- C. Coordinate "wire basket" cable tray systems with other work as necessary to properly interface installation of wire basket cable tray with other work.
- D. Install and support cable tray management system in accordance with span load criteria.
- E. Install cable tray management system using hardware, splice connectors, support components, and accessories available from and in accordance with manufacturer.
- F. Provide sufficient space encompassing the cable tray system to permit access for installing and maintaining cables.
 - 1. Maintain a minimum of 12-inches clear space above the top edge of the cable tray side rail(s).
 - 2. Obstructions occurring above the cable tray side rail shall only be permitted provided the obstruction does not occur for more that 18-inches above the side rail and does not extend into the cable tray area.

3.05 FIRESTOPPING

- A. Examine the areas and conditions where firestops are to be installed and notify the architect of conditions detrimental to the proper and timely completion of the work. Do not proceed to enclose firestopping with the other construction until local building inspectors have inspected the work and given the approval to close the work.

3.06 TESTING AND CERTIFICATION

- A. 100% of the installed cabling shall be tested and must pass the requirements of the standards mentioned above and as defined herein.
- B. Any failing link must be diagnosed and corrected. The corrective action shall be followed with a new test to prove that the corrected link meets the performance requirements.
- C. The Contractor shall provide proof that the tester(s) used have been calibrated for accuracy in accordance with the manufacturer's requirements.
- D. The PASS or Fail condition for the link tested shall be determined by the results of the individual tests. Any Fail or Fail*, or Pass* (with asterisk) result shall yield a fail for the tested link.
- E. Each Category 6 cable link shall be tested for the parameters listed below and shall be verified for acceptable length, in accordance with ANSI/TIA/EIA-568-C. Commercial Balanced Twisted Pair Telecommunication Cabling and Components Standard.
- F. All Category 6 cables shall be certified end to end from the user station outlet to the Distribution Frame. Tests shall be performed using an ANSI/TIA/EIA Level IV cable tester. The Owner shall be supplied documentation (Hard and Electronic copy) with the following test results:
 - 1. Line map continuity
 - 2. NEXT (Near End Cross Talk)
 - 3. PSNEXT (Power Sum Near End Cross Talk)
 - 4. Insertion Loss (dB)
 - 5. ACR-F Loss
 - 6. PS ACR-F Loss
 - 7. Return Loss
 - 8. Propagation Delay
 - 9. Delay Skew
 - 10. Length
 - 11. Loop Resistance
- G. All Category 3 Backbone Distribution cables and tie cables for Voice shall be tested for:
 - 1. Wiremap
 - 2. Length
- H. All fiber optic cables shall be tested after termination of both ends (EF/MDF to TRs) (TRs-to-TRs) and tests shall be conducted in both directions (EF/MDF to AB012, LB061). Each Multimode fiber shall be tested at the 850nm and 1300nm wavelengths, and each Singlemode cable shall be tested at the 1310nm and 1550nm wavelength for decibel loss utilizing a stabilized lightsource and optical power meter. Fiber testing must conform to ANSI/TIA/EIA 526, Optical Power Loss Measurements. The maximum loss of each strand shall not exceed 2.0dB. The Owner shall be supplied documentation with the following test results:
 - 1. End to end attenuation testing for each fiber strand using a calibrated Power meter and Light source. Mandrel wrap is required on multimode fiber optic testing.
 - 2. OTDR (Optical Time Domain Reflectometer) Signature traces of fiber runs in excess of 300 feet.
 - 3. Certificate of Compliance for Connector and Splice Loss

4. The length of each fiber shall be measured using an Optical Time Domain Reflectometer (OTDR). A hard copy of the OTDR screen and the OTDR setting shall be provided to the Owner. Hand written test results will not be accepted.
- I. All coaxial cable segments shall be tested for impedance, time domain and structural return loss in accordance to manufacturer minimum performance values using a Time Domain Reflectometer (TDR).
- J. Cable Tray
 1. Test wire basket systems to ensure electrical continuity of bonding and grounding connections and verify compliance with specified maximum grounding resistance in accordance with NFPA-70B.
 2. Provide manufacturer test reports as witnessed by an independent testing laboratory, of the "worst case" loading conditions outlined in this specification and performed in accordance with the latest revision of NEMA VE-1.

3.07 GROUNDING, BONDING AND ELECTRICAL PROTECTION

A. General

1. A suitable telecommunications ground (for equipment) is required. Each Telecommunications room, Main Cross-Connect and each Intermediate Cross-Connect (MC/TR/EF/Demarc) shall be equipped with an approved grounding busbar. Each equipment rack shall be bonded to the local grounding busbar with an insulated, green, #6AWG, bonding conductor.
2. All Main Cross-connects, Intermediate Cross-connects, and telecommunications closets must be bonded to a known or established telecommunications ground within the building.
 - a. If a known telecommunications ground does not exist, the Contractor shall work with the Electrical Contractor(s) to establish a telecommunications ground at the main electrical grounding point.
3. The established communications ground shall be in accordance with NFPA 70 (NEC) requirements.
4. All grounding and bonding connections shall be filed to BEAR clean metal for proper continuity.

3.08 AS-BUILT DRAWINGS AND RECORDS

- A. Provide detailed and accurate documentation of the distribution system upon completion of the installation in order to facilitate system administration, system maintenance, and future system changes.
- B. Maintain a clean set of Blueline Contract Documents on site at all times and note any deviations in installation on a day-to-day basis. The markup set shall serve as the basis for the Contractor to provide an AutoCAD file of all As-Built Drawings, which shall be turned over to the Owner at final inspection.

- C. Contractor shall provide all necessary testing equipment to test all cables. And maintain a complete set of test records on site at all times and note any deviations in installation on a day-to-day basis. The tests shall indicate results in accordance with ANSI/TIA/EIA-568-C for every cable and port installed per the terms and conditions as set forth herein. These test records shall serve as the basis for the Contractor to provide final test results which shall be turned over to the Owner at final inspection. Test results in Hard copy and Electronic copy are due seven (7) days after completion of project.
- D. Both a hard copy and a 3.5" floppy disk electronic file (*.csv formatted) of the test results for each cable run shall be provided to the Owner. The Owner and Contractor shall agree upon acceptable test results prior to testing. It is the Contractor's responsibility to replace, repair, or modify any cable run which tests outside the agreed-upon ranges, in such a manner as to be acceptable to the Owner.
- E. Before the system is accepted by the Owner, the Contractor will be required to "walk-through" the installation with the Owner and verify proper installation and conformance to specifications, Drawings, and other agreed upon, written details.

3.09 LABELING

A. General

- 1. All labeling schemes shall be approved in writing, by a designated UCHC IT representative prior to installation.
- 2. All labels shall be clearly printed on machine generated (i.e., Brother P-Touch System) clear or opaque tape and meet the following requirements:
 - a. The font shall be approximately 1/8 inch in height; with block type characters and shall be clearly legible.
 - b. Hand written labels will not be accepted.
 - c. The text color shall contrast with the label background color (e.g., black text on a white background).
 - d. Provide nameplates in or on the faceplates, wiring blocks, patch panels and equipment racks. Wiring block(s) labeling shall exhibit all station numbers in sequential order.
 - e. Nameplates shall be securely attached to the equipment.
 - f. Each Horizontal and Backbone cables shall be clearly labeled at each end.
 - g. Label all cables that are left un-terminated in walls or other pathways and/or spaces in accordance with ANSI/TIA/EIA-606-B or approved alternate.
 - h. Label all grounding and bonding conductors, backbone and busbars in accordance with ANSI/TIA/EIA-606-B or approved alternate.
 - i. Provide warning tags at each location where fiber optic cable is exposed to human intrusion. These tags shall be yellow or orange and shall contain the warning:
 - 1) "CAUTION FIBER OPTIC CABLE". The text shall be permanent, black, block type characters, and shall be a minimum 3/16-inch in height. A warning tag shall be permanently affixed to each exposed cable or bundle of cables at intervals of 5 feet, minimum. Any section of exposed cable that is less than 5 feet in length shall have at least one warning tag affixed.

B. Telecommunications Outlets

- 1. Each telecommunication outlet shall be labeled with its own unique identification number.

2. The labeling scheme will be sequential and shall coincide with the floor plan room identification numbers and locations.
3. Telecommunication outlet identification numbers shall begin with the architectural room tag identifier (which includes the floor designator) followed by a sequential numeric designator that identifies the outlet location within that room.

C. Telecommunications Outlet Labeling example:

1. 1/TR-N/B-34
 - a. Where:
1 = floor
TR-N is the TR the cable distributes from B indicates the 2nd patch panel in rack
34 is the data port number on the patch panel.

D. Distribution Frames (TRs and EF/MDF)

1. Each patch panel and wiring block position within the telecommunication Room(s) shall be labeled with its own unique identification number.
2. Each equipment rack and cabinet shall be labeled with unique and sequential identification labels.
3. The labeling scheme will be sequential and shall coincide with the floor plan communication outlet locations.
4. Patch panel identification numbers shall be sequential, and shall correlate exactly with the telecommunication outlet identification numbers.

3.10 CLEANING

A. General

1. This Section of the specifications shall include the cleaning materials on a day-to-day basis and final cleaning of all equipment and materials prior to turning building over to the Owner's representative. All necessary cleaning referred to herein shall be performed to the satisfaction of the Architect.
2. Ensure timely cleanup of all facilities and buildings related to this project, during construction and at completion.

B. Telecommunication Rooms

1. Upon completion of cleaning work areas as described in Paragraph A. above, but before energizing equipment, the entire room shall be swept clean and all garbage shall be removed from the site.
2. Once Telecommunication Rooms are cleaned, the area shall remain clean and doors shall remain closed until completion of job.

C. Final Cleaning

1. All Telecommunication devices, device plates, etc., shall be cleaned and left in "like new" condition to the satisfaction of the Architect, prior to occupancy.
2. All rubbish and discarded materials shall be disposed of and removed from the site on a day-to-day basis.

END OF SECTION

DIVISION 28

ELECTRONIC SAFETY AND SECURITY TABLE OF CONTENTS

<u>SECTION</u>	<u>TITLE</u>
280000	ELECTRONIC SAFETY AND SECURITY
280513	WIRE AND CABLE
281000	ELECTRONIC ACCESS CONTROL
281301	ACCESS CONTROL DOOR HARDWARE
282323	NETWORK VIDEO RECORDER
282329	IP FIXED VIDEO SURVEILLANCE CAMERAS
283110	FIRE ALARM – EXISTING SYSTEM EXTENSION

SECTION 28 00 00
 ELECTRONIC SAFETY AND SECURITY

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 document covers the general requirements for work to be performed to provide electronic security and surveillance.
- B. The contents of this document, along with related drawings and other documentary material are critical to the security of this project and Owner and shall remain secure and confidential.
 - 1. Confidential information shall not be deliberately or inadvertently disclosed to anyone other than the Contractor's personnel and subcontractors who require disclosure to perform their portion of the work.
 - 2. This confidential information shall be tracked to ensure that copies are accounted for and properly destroyed when no longer needed to perform the work.
- C. The security systems shall consist of the following systems as specified herein.
- D. Furnish labor, materials, inspections, supervision, etc., necessary for a turnkey installation and operation the equipment specified herein. Work includes furnishing all items and accessories required or necessary for the correct operation of the equipment as shown on plans and/or specified herein exception of those items noted within this specification as being provided by others.
- E. Related Sections include:
 - 1. **Section 08 06 71 Door Hardware Schedule**
 - 2. Section 08 71 00 Door Hardware (~~including related sub-sections~~)
 - 3. Section 26 00 00 Electrical (including related sub-sections)
 - 4. Section 21 00 00 Fire Supression
 - 5. Section 28 05 13 Wire and Cable
 - 6. Section 28 10 00 Electronic Access Control
 - 7. **Section 28 13 01 Access Control Door Hardware**
 - 8. Section 28 23 23 Network Video Recorder
 - 9. Section 28 23 29 IP Fixed Video Surveillance Cameras

1.3 GENERAL REQUIREMENTS

- A. This specification is developed by the UConn Health Building C renovation (UHC), the Owner, to procure and install an Electronic Security System (ESS) including an Access Control System (ACS), Video Management System and associated fixed IP cameras at UConn Health, Building C in Farmington, CT.
- A. The following general definitions shall apply.
 - 1. The Owner (Owner) is UConn Health.
 - 2. The Facility (Facility) is the UConn Health Building C.

3. The Owner's Engineering Technical Representative (Engineer) is Good Harbor Techmark, LLC.
 4. The Security Contractor (Security Contractor) is the firm selected by the Owner to perform the work outlined in this RFP and supporting documentation. The Security Contractor shall supply all equipment, labor, material and services necessary to complete the project construction in accordance with the Contract Documents.
- B. The following acronyms are used throughout this specification:
1. CCTV – Closed Caption Television
 2. EES – Electronic Security System
 3. GUI – Graphical User Interface
 4. IP – Internet Protocol
 5. NVS – Network Video Server
 6. PTZ – Pan / Tilt / Zoom
 7. UPS – Uninterruptable Power Supply
 8. VMS – Video Management System
- A. The following shall apply:
1. Security Contractor: This term designates the company, which conducts the Work and is responsible to ensure that others provide specified Work as described in the Drawings and Specifications for the security systems. This term specifically refers to a company that is qualified to perform the Work specified herein related to the integration of all electronic security access control systems and components and the fabrication and installation of all security equipment.
 2. The Security Contractor is responsible for the complete installation of the system as described in the documents and for assigning the specific tasks, within the scope, to contractors which hold the required certifications, licenses and credentials and which meet the qualification requirements stated herein. The Security Contractor shall be responsible for coordinating all work within this section of the specification as well as coordination between related trades.
 3. The Security Contractor shall supply all installation labor, equipment, materials, software, programming and supervision to configure, integrate, calibrate, adjust, demonstrate, test, train, warrant and maintain a complete ESS in accordance with the Contract Documents.
 4. The Security Contractor shall be certified by the manufacturer for the systems as stated herein and shall be responsible for the installation of the system such that a complete scope of work is provided. The Security Contractor shall furnish and install all security system interconnecting conduits and junction boxes, outlet boxes, cable ladders, plywood backboard and other associated mounting hardware. Interconnecting security conduits shall be installed with a nylon pull string for the installation for the security system. The Security Contractor shall refer to the security system drawings and specifications for installation requirements.
 5. This term shall be interchangeable with "Contractor"
- C. The items described herein shall not be modified or substituted without consent of the Engineer and the Owner.
- D. In cases where the term "provide" is used throughout this Specification and associated Contract Documents, it shall mean, "furnish, install and service".

- E. The Security Contractor:
1. Shall indemnify and hold harmless, to the fullest extent of the law, the Owner, the Architect, any of the Architect's Engineers and agents and employees from and against any claims, damages, losses and expenses arising from these Specifications and associated Contract Documents.
 2. Shall consider these plans and specifications as containing confidential information of the Owner and will ensure that these plans and specifications are kept secure at all times and not copied for any reason unless authorized by the Owner and Engineer. The Contractor shall restrict disclosure of specific ESS design information to any other duly assigned and authorized subcontractor personnel who require such disclosure to perform their work under this Contract.
 3. Will respect and protect the privacy and confidentiality of the Owner, his employees, processes, products, and intellectual property to the extent necessary, consistent with the legal responsibilities of the State of Connecticut and the Owner.
 - a. All Security Contractor submittals including any drawings shall be marked "Confidential" in the top and bottom of the page and all subsequent pages should have the restriction appearing as a footer at the bottom of the page. The outside back cover of the submission should also contain the "Confidential" header and footer.
 - b. If required, the Security Contractor shall sign a non-disclosure agreement and abide by its requirements to keep confidential all information concerning bid documents and this Project.
 4. Shall attend meetings arranged by the Architect, Owner or Engineer or other parties affected by the work of this Specification Section.
- F. Drawings and Specifications are to be used in conjunction with one another and to supplement one another.
5. In general, Specifications determine the nature and quality of the materials and tests, and drawings establish the quantities, details and give characteristics of performance that should be adhered to in the installation of the security system components.
 6. If there is an apparent conflict between the drawings and specifications, or within the specifications, the items with greater quantity or quality shall be estimated and installed.
 7. Clarification with the Engineer about these items shall be made prior to purchase and installation.
 8. Questions regarding the Specification or system requirements should be directed in writing to the Engineer.

1.4 REFERENCES AND CODE REQUIREMENTS:

- A. The ESS shall be installed in accordance with all applicable national, state, provincial, regional and local codes and standards, including, but not limited to the most current issue of the following publications, including all amendments thereto of the issue that is current on the date of the contract award. Where conflicts exist between the Contract Documents and the referenced publications, local codes shall govern. All equipment shall be U.L. listed or meet U.L. requirements for its intended use. Applicable requirements of the following publications shall apply to the work under this specification as if fully written herein.
1. Institute of Electrical and Electronic Engineers (IEEE)
 2. National Fire Protection Association National Electric Code® (NFPA 70)

3. National Fire Protection Association National Fire Alarm Code® (NFPA 72)
4. National Fire Protection Association Life Safety Code (NFPA 101)
5. Connecticut State Building Code
6. Americans with Disabilities Act (ADA)
7. Underwriters Laboratories (UL) Applicable Standards for Safety
8. Underwriters Laboratories (UL) Applicable Standards for Proprietary Security Systems
9. EIA/TIA Standards 569 and 606 (Commercial Building Wiring Standard and Administration Standard for the Telecommunications Infrastructure of Commercial Buildings)
10. National, State, and Municipal Building Codes and all other Authorities having Jurisdiction
11. Generally accepted good workmanship practices
12. Coordinate with the Farmington Fire Department prior to system turnover and commissioning to ensure that all systems functions perform in accordance with the department's requirements.

1.5 DESCRIPTION OF WORK

- A. It is the intent of this specification and associated contract drawings to describe the scope of work pertaining to the installation of an ESS for the Owner at the Facility.
- B. The work covered by this Specification shall include all installation labor, equipment, materials, software, programming and supervision to configure, integrate, calibrate, adjust, demonstrate, test, train, warrant and maintain to the Designer and Owner the following systems, including, but not limited to:
 1. A complete ESS and network system as described in the sections below and in the associated Contract Drawings. Requirements for the ESS shall be referenced to support the requirements of this Section and associated contract drawings.
- C. The Security Contractor shall furnish and install all cable and conduit as required. All cabling where installed in an underground environment must be installed on a raceway suitable for the environment in which it is installed and at a depth on accordance with NEC table 300.5.
- D. The Security Contractor shall obtain approval from the Engineer of the layout of all visible elements, stated below, of the security system in advance of the security system installation. Revise layouts as directed until approval is obtained for each typical installation. Coordinate with other trades in advance of installation to prevent schedule impacts including but not limited to:
 1. Cameras
- E. The responsibility of the security contractor shall include but not be limited to the following:
 1. Submittals on all Section 28 00 00 systems and equipment
 2. Provide and installation of all Section 28 00 00 systems and equipment
 3. Coordination of all Section 28 00 00 system and equipment (including all coordination required with other trades)
 4. Coordination of all conduit and wire for all Section 28 00 00 Systems and equipment.
 5. Termination of all wiring to Section 28 00 00 systems and equipment.

6. Power conditioning for all Section 28 00 00 systems and equipment.
7. Programming for all Section 28 00 00 systems and equipment.
8. Testing and checkout of all Section 28 00 00 systems and equipment.
9. Training for all Section 28 00 00 systems and equipment.
10. Warranty operation and maintenance manuals and all other closeout requirements for all Section 28 00 00 systems and equipment.

1.6 SCOPE OF WORK

- A. The Owner utilizes the Software House C-Cure 9000 system that will be used as the head end equipment for this project. All new equipment shall be tied into this existing system.
- B. The Security Contractor shall install new Electronic Access Control Field Panels as depicted on the Security Drawings.
- C. The Security Contractor shall install all hardwired, PoE and WiFi locks as depicted on the Security Drawings.
- D. The Security Contractor shall install a Network Video Recorder (NVR) to be tied into the existing American Dynamics Victor Video Management System.
- E. The Security Contractor shall install Fixed Cameras and PoE Network Switches as depicted on the Security Drawings.
- F. All security racks will be provided by others.

1.7 DRAWINGS:

- A. The security drawings are diagrammatic only and are not intended to show every detail of construction or arbitrary location of wiring. Each system shall be complete with minor parts not specifically noted on the drawings, but required for a properly functioning system conforming to state and local codes.
- B. In case of conflict with building parts or the work of other trades, the Engineer shall be notified immediately and requested to render a decision so that there will be no delay in ESS installation.
- C. List of Drawings:
 1. SE-000 COVER SHEET
 2. SE-100 BASEMENT A SECURITY FLOOR PLAN
 3. SE-101 BASEMENT B SECURITY FLOOR PLAN
 4. SE-102 GROUND FLOOR A FLOOR SECURITY FLOOR PLAN
 5. SE-103 GROUND FLOOR B SECURITY FLOOR PLAN
 6. SE-104 MAIN FLOOR A SECURITY FLOOR PLAN
 7. SE-105 MAIN FLOOR B SECURITY FLOOR PLAN
 8. SE-106 FIRST FLOOR A SECURITY FLOOR PLAN
 9. SE-107 FIRST FLOOR B SECURITY FLOOR PLAN
 10. SE-108 SECOND FLOOR A SECURITY FLOOR PLAN
 11. SE-109 SECOND FLOOR B FLOOR SECURITY FLOOR PLAN
 12. SE-110 SECOND FLOOR C SECURITY FLOOR PLAN
 13. SE-111 PENTHOUSE A SECURITY FLOOR PLAN
 14. SE-112 PENTHOUSE B SECURITY FLOOR PLAN

15.	SE-200	SECURITY SYSTEMS SCHEDULES
16.	SE-201	SECURITY SYSTEMS DEVICE SCHEDULES
17.	SE-202	SECURITY SYSTEMS DEVICE SCHEDULES
18.	SE-300	SECURITY SYSTEEMS RISER DIAGRAMS
19.	SE-301	SECURITY SYSTEEMS RISER DIAGRAMS
20.	SE-400	SECURITY SYSTEM DEVICE TYPICALS
21.	SE-401	SECURITY SYSTEM DEVICE TYPICALS

1.8 SUBMITTALS:

- A. All submittals including any drawings shall be marked "Confidential" in the top and bottom of the page and all subsequent pages shall have the restriction appearing in the footer at the bottom of the page. The outside back cover of the submission shall also contain the "Confidential" header and footer.
- B. Provide a description of system operation indicating the purpose and capability of each device/component of the system with a functional diagram indicating all interfaces to other systems, including any and all departures (exceptions, variances or substitutions).
- C. Provide manufacturer's printed product data, specifications, catalog pages and descriptions of installed equipment and any special installation procedures to be used for the ESS. Data sheets shall be printed double sided in full color, separated by individual component and where multiple models exist on one data sheet, a red arrow or circle shall clearly identify the exact model number proposed.
 - 1. Provide any special mounting details for cameras, power supplies, etc.
- D. Submit samples for review. Samples shall include:
 - 1. Cameras
- E. Provide complete manufacturer's operating equipment manuals, diagrams and other data for the operation and maintenance of this equipment.
 - 1. Closeout submittals shall include:
 - a. User Manuals.
 - b. Parts list.
 - c. System device locations on architectural floor plans.
 - d. Wiring and connection diagrams.
 - e. Maintenance requirements.
 - 2. A copy of the manufacturers standard warranty agreement must be provided.
- F. Prepare and submit complete Shop Drawings in the manner described herein and within Division 1. Shop Drawings shall include all necessary wiring diagrams and connectivity points of all equipment. Shop drawings shall be required of all ESS devices.
 - 1. Shop Drawings shall also include ESS System Descriptions and calculations on how the equipment will operate as a system to meet the performance of this specification. The data package shall include the following:
 - a. Description of site equipment and its configuration
 - b. Operating protocol description
 - c. Start up operations
 - d. System expansion capability and method of implementation

- e. System power requirements
 - f. A "one-line riser" diagram, which shall show the system as proposed, with device counts accurately depicted. "Typicals" will not be allowed.
- G. Provide a Wiring Schedule showing the individual ESS device type, wiring type, device location, associated panel(s) location, and alarm zone for wiring and connection of all interior and exterior ESS devices. The wiring schedule provided with the Contract Documents to may be used to facilitate this task. The wire schedule shall report the identification number of each wire or cable as they appear in the field.
- H. Provide Record Drawings that include the specific location of all components, wiring diagrams, and schematics to allow for the understanding and troubleshooting of the system. All plan based block drawings and riser diagrams shall accurately represent the true number of all major components. The digital images shall be provided in high quality PDF format and shall comprehensively represent both the facility and the security system.
- I. The Record Drawings shall include but not be limited to the following types of drawings:
- 1. Floor plans showing locations of all equipment installed under this contract.
 - 2. Panel wiring diagrams as installed under this contract.
- 1.9 COOPERATION AND COORDINATION WITH OTHER TRADES:
- A. The work shall be performed such that there is field coordination with all other trades to ensure no delays and that the work of other contractors is not interfered with. Materials and apparatus shall be installed as fast as conditions of the building will permit and must be installed promptly when and as directed. Coordination with different vendors includes, but not limited to, landscape, electrical, masonry, door and door hardware, storefront, carpentry, gypsum and communications contractors.
- B. Provide, install, program, troubleshoot, train and warranty service of all security systems devices and cabling, terminal equipment, control and display equipment specified in this section for a completely operational system.
- 1.10 WORKMANSHIP:
- A. It is the intent of this Specification to provide for the system equipment and installation of the ESS that complies in all respects with the requirements of all applicable codes and standards. Equipment, material, installation practices, etc., that do not meet requirements or do not meet the performance standards herein specified shall not be acceptable.
- B. The entire work provided in this Specification shall be constructed and finished in every respect in a workmanlike and substantial manner. It is not intended that the contract drawings shall show every installation support device, pipe, fitting or fixture associated with installation and operation. Furnish and install all parts as necessary to complete the ESS in accordance with the best trade practice and to the satisfaction of the Engineer.
- C. Coordinate with other subcontractors as to shape, size and position of all openings required for the ESS equipment.
- D. Hoisting and rigging specific to the installation of the security system is required in this scope of work.
- E. Obtain detailed information from the manufacturers of ESS equipment as to the proper method of installation and connection. Obtain all information from the other subcontractors that may be necessary to facilitate their work and the completion of the whole project.
- F. Remove daily to a centrally designated location on-site all rubbish and debris and all refuse from workmen's lunches and at completion, remove all surplus materials, and

temporary works, in addition to, complying with all cleanup requirements specified in Division 1.

- G. No chemical may be brought on the property, whether in the performance of this project or not, without being accompanied by the proper and current material safety data sheet. No hazardous materials or chemicals will be left unsecured or unattended at any time
- H. Provide all tools, materials, equipment, workmen and labor to successfully complete the project.
- I. All penetrations of floor slabs and fire walls shall be sleeved in appropriately sized rigid steel conduit and fire stopped in accordance to applicable building and fire codes.
- J. All penetrations of fire rated wall, floors or any other structural member must have that member sleeved by a suitably sized conduit or other approved sleeve. Such sleeve must extend at least one inch (1") beyond the surface of the member being penetrated (on both sides) to provide evidence to the inspectors that the sleeve is in code compliance.

1.11 MAINTENANCE AND SERVICE:

- A. Make ordering of new equipment for expansions, replacements and spare parts available.
- B. Provide factory direct technical support to the installing company.
- C. The Security Contractor shall provide all services required and equipment necessary to maintain the entire ESS in an operational state as specified for the time stated in section 1.17 WARRANTY, and shall provide all necessary material required for performing scheduled adjustments or other nonscheduled work.
- D. The adjustment and repair of the ESS includes all computer equipment, software updates, communications transmission equipment, local processors, and access control, facility interface, and support equipment. Provide the manufacturer's required adjustments and other work as necessary.
- E. The Security Contractors service personnel shall be qualified to accomplish all work promptly and satisfactorily. The Owner shall be advised in writing of the name of the designated service representative, and of any change in personnel.
- F. The Owner will initiate service calls to the Construction Manager when the ESS is not functioning properly. Qualified personnel shall be available to provide service to the complete ESS. Provide contact and backup contact information to the Owner to ensure immediate connection with a live representative 24/7/365 who will immediately initiate a response to any service calls made by the Owner during the warranty period. Service personnel shall be at the site within four (4) hours after a service request has been submitted and repairs must be performed immediately. The Contractor must be prepared to provide temporary capability to maintain security function of the facility in the event that repairs are unavoidably delayed. Lack of access to spare parts will not constitute an unavoidable delay.
- G. The Security Contractor shall maintain an inventory of security equipment spare parts, materials, consumables, and any other system item in order to meet the specified warranty maintenance requirements and keep the security equipment in a continuous operational mode during the warranty period.
 - 1. A list of spare equipment for the ESS stocked and available for immediate use at the owner's site, shall system impairment occur shall be provided with the project submittal.
- H. Maintenance service shall not be assigned or transferred to any agent or other Security Contractor.
- I. Performance of scheduled adjustments and repair shall include verification of operation of the ESS as demonstrated by the applicable tests of the performance verification test.

- J. The Security Contractor shall keep records and logs of each task, and shall organize cumulative records for each major component, and for the complete system chronologically. A continuous log shall be maintained for all devices. The log shall contain calibration, repair, and programming data. Complete logs shall be kept and shall be available for inspection on site, demonstrating that planned and systematic adjustments and repairs have been accomplished for the ESS.
- K. The Security Contractor shall separately record each service call request, as received. The form shall include the serial number identifying the component involved, its location, date and time the call was received, nature of trouble, names of the service personnel assigned to the task, instructions describing what has to be done, the amount and nature of the materials to be used, the time and date work started, and the time and date of completion. The Security Contractor shall deliver a record of the work performed within five (5) days after work is accomplished.
- L. The Security Contractor shall make recommendations for system modification in writing to the Owner. No system modifications, including operating parameters and control settings, shall be made without prior approval of the Owner. Modifications made to the systems shall be incorporated into the operations and maintenance manuals, and other documentation affected.
- M. The Security Contractor shall provide, at no additional cost, software updates and labor to install updates, automatically during the first warranty year. These updates shall be accomplished in a timely manner, fully coordinated with the Owner, and shall be incorporated into the operations and maintenance manuals, and software documentation. There shall be at least one scheduled update before the first year's warranty inspection, at which time the Security Contractor shall install and validate the latest released version of the manufacturer's software.
- N. The project will not be deemed "complete" until all phases are installed and fully operational, with the final testing completed and the clean up "punch list" compiled and completion dates assigned to each deficiency. In the event that a sizable punch list develops, at the option of the owner, it may be required that some, or all, unsatisfactory items are corrected prior to final.

1.12 OPERATING INSTRUCTIONS AND MAINTENANCE MANUALS:

- A. Provide the Owner with applicable Operations and Maintenance (O&M) manual(s), as specified in Division 1, which describe the equipment installed under this Contract. The O&M manual(s) shall, as a minimum, consist of an operations Section, a maintenance Section, and a drawings Section where necessary.
- B. Furnish a draft copy of the operation and maintenance manuals, which shall be delivered to the Engineer prior to beginning the performance verification test for use during site testing.
- C. All user licenses, software, original software media, manuals, etc. shall be turned over to the Owner at completion of the project. All project specific application software shall be transferred at the end of the warranty period.
- D. Except as otherwise specified, all documentation shall contain sufficient written text and illustrations necessary to present a full description of the equipment, including an overview, concept of operation or maintenance, operating instructions using all functions and capabilities, and interfaces with other systems/subsystems.
- E. The Security Contractor shall enter and program all ESS data needed to make the system operational. Deliver the data to the Engineer on data entry forms, utilizing data from the contract documents and all pertinent information in the Security Contractor 's possession required for complete installation of the database. The Security Contractor shall identify to the Engineer any additional data needed to provide a complete and operational ESS.

- F. The operating instructions shall be specific for each system and shall include copies of posted specific instructions.
- G. For maintenance purposes, provide shop drawings, parts lists, specifications and manufacturer's bulletins for each piece of ESS equipment.

1.13 DELIVERY, STORAGE AND HANDLING

- A. Equipment and components shall be delivered properly protected and undamaged with original containers, packaging, and labels intact.
- B. Store, handle, and protect all related materials and equipment in accordance with Manufacturer's recommendations.
- C. Provide additional protection during handling as necessary to prevent breaking, scraping, marring, or otherwise damaging products or surrounding areas.
- D. Equipment and components shall be protected from the weather, humidity, temperature variations, dirt, dust, or other contaminants.
- E. Equipment damaged prior to system acceptance shall be replaced at no cost to the owner.
- F. Protect all equipment and components that are to be installed from theft, vandalism, or use by unauthorized persons.

1.14 PROJECT/SITE CONDITIONS

- A. Security Contractor is responsible for conducting a site survey prior to the commencement of work to determine locations of all existing security devices and verify the proposed locations of the new components to be installed.
- B. Security Contractor will coordinate all work through the Contractor and schedule work to cause as little interference or interruption of existing services as possible.
- C. Security Contractor will arrange and pay for all necessary permits, licenses, and inspections.
 - 1. Security Contractor shall prepare all information necessary to obtain a permit in compliance with the project requirements.
- D. Verify and coordinate all conduits, power and special back box requirements.
- E. The Security Contractor shall make all requests for stakeouts and utility mapping prior to the initiation of any excavations, and shall ensure that all applicable parties suitably respond prior to any excavation. To be considered as included within the parameters of this subsection are requests for the movement of overhead or underground utilities, as well as the sleeving of any appropriate electrical conductors.

1.15 APPROVED EQUAL

- A. The materials specified within these contract drawings shall not be substituted. Products that may be substituted for will be noted as "*or approved equal.*"
- B. Approved equal shall mean that the use of all materials shall be submitted to the Engineer for approval, and that such approval shall be the sole discretion of the Engineer.
- C. The term "submit for approval" or similar expressions shall mean that work shall be contingent upon the specific approval of shop drawings, etc., by the Engineer in writing.

1.16 QUALITY ASSURANCE:

- A. The Security Contractor shall establish and maintain a quality assurance (QA) program and specific procedures which provide documented evidence of system compliance and ensures that all security related and manufactured components and ESS installation meet or exceed all contract requirements. All inspections and tests, which are conducted under this quality assurance program, shall be subject to review.

- B. The Security Contractor shall have local in-house engineering and project management capabilities consistent with the requirements of the project.
- C. The Security Contractor shall engage system manufacturers technical personnel to assist the Security Contractor to the satisfaction of the Engineer.
- D. Provide at the time of the installation the latest version, unless specified otherwise, of all equipment and software. Discontinued equipment will not be accepted and shall not be installed by the Security Contractor.
- E. Units of the same type of equipment shall be products of a single manufacturer. All material and equipment shall be new and currently in production. Each major component of equipment shall have the manufacturer's model and serial number in a conspicuous place. All parts, other than small hardware items and fittings, but not including locks, latches, strikes, card readers, etc., shall be of the same model throughout the course of this project.

1.17 WARRANTY:

- A. The complete ESS system including equipment, operations, programming shall be warranted for a period of one (1) year from Substantial Completion.
- B. The warranty shall guaranty that all security equipment and labor provided in the complete ESS system will, under normal use and service, be free from defects and faulty workmanship.
- C. The warranty shall provide for repair or replacement of defective equipment, parts including the associated labor at no additional cost to the Owner. Warranty shall guaranty that the replacement or repaired equipment furnished hereunder and labor shall be in accordance with current industry standards.
- D. The Owner is granted a nontransferable fully paid license to use all software furnished by the Security Contractor as part of the security equipment under terms established by the software manufacturer. The Owner will be provided with a copy of all applicable licenses. The Security Contractor shall warrant that it has the right to grant such licenses.

1.18 RECORD DRAWINGS:

- A. Furnish and keep on the job at all times, one (1) complete separate set of redline drawings, elementary diagrams and wiring diagrams of the ESS on which shall be clearly, neatly and accurately noted, promptly as the work progresses, all architectural and electrical/electronic changes, revisions and additions to the work. Wherever work is installed otherwise than as shown on the Contract Drawings, such changes shall be noted.
 - 1. Floor plans shall accurately depict all security devices as installed under this contract and their locations with system identification numbers and labels as they are programmed into the ESS
 - 2. Riser diagrams shall accurately depict all security devices as installed under this contract and wiring installed to each device with corresponding identification numbers and labels as they are programmed into the ESS
- B. Indicate daily progress on these prints by coloring in various devices as they are installed, wired and initially tested.
- C. No approval of requisition for work installed will be given unless supported by record prints as required above.
- D. At the conclusion of the work, prepare Record Drawings in accordance with the submittal requirements.

1.19 COMPLETION:

- A. The security system shall be fully operational with all specified features and function before acceptance. A point-to-point test of all parts of the system conducted by the Security Contractor and the Engineer will be required for acceptance. The schedule must reflect at least 30 days for inspection, demonstration and commissioning of the system in advance of the proposed acceptance date.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturer's are shown in individual specification sections.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install all proposed ESS system components in accordance with the manufacturers' instructions, and as shown on the Contract Drawings. Furnish all necessary interconnections, services, and adjustments required for a complete and operable ESS System as specified and shown during each phase of construction as shown on the Contract Drawings. Inspect locations where installation Work will be performed and verify that conditions found are in accordance with the Contract Drawings and are acceptable for installation Work. Report any discrepancies in writing to the Engineer stating suggested means of correction.
- B. Check all power and communications cabling for continuity before making connections.
- C. All exterior devices shall be sealed and protected against all weather conditions including heat, cold, moisture, dust and sand.
- D. All conduit, cable, and wire shall be installed parallel and square with building lines, including raised floor areas. Conduit fill shall not exceed forty percent (40%). All wires shall be gathered and tied up to create an orderly installation.
- E. All network switches shall be interconnected via multi-mode fiber SFP ports.
- F. The ESS shall support point identification from each device, access control transactions, where required, in a distributed processing format and communications interfaces, plus support all applicable wiring and cable between devices.

3.2 PREPARATION

- A. Coordinate with the work of other related Contractors, as required and as necessary, for the purposes of having the security installation progress as rapidly and as smoothly as possible with minimum interference.
- B. Before starting work, submit information to the Engineer any additional or reconfigured openings and/or penetrations into the core building that may be required for the work. In no case shall any core building penetration or opening in the building exterior without expressed approval of the General Contractor in writing.
- C. Examine area to receive devices and notify any adverse conditions affecting installation or subsequent operation.
- D. Do not begin installation until unacceptable conditions are corrected.

3.3 COMPLIANCE

- A. Install the equipment in accordance with the Contract documents, all applicable codes and standards and the manufacturer's written instructions. The installed ESS shall meet all applicable equipment and performance requirements.
- B. Standardize the installation practices and material to provide uniform materials and procedures to the maximum extent possible.

- C. Ensure that the location of pull boxes, wireways or other items requiring inspection, removal, or replacement area convenient and accessible with reference to the finished facilities.

3.4 INSTALLATION REQUIREMENTS

- A. Install devices in accordance with manufacturer's instruction at locations indicated on the floor drawing plans.
- B. Ensure selected location is secure and offers protection from accidental damage.
- C. Control signal, communications, and data transmission line grounding shall be installed as necessary to preclude ground loops, noise, and surges from adversely affecting system operation. Provide mounting hardware as required.
- D. The ESS shall utilize four state supervised input wiring with all functions to operate as described, referenced and as shown on the Contract Documents.
- E. Install the security equipment in accordance with the applicable local and national codes and standards for safety and the appropriate installation manual for each equipment type. Components within the system shall be configured with appropriate service points to pinpoint system trouble in less than 20 minutes.
- F. All wiring, including low voltage wiring, cabinets, boxes, and similar enclosures shall be plenum rated.
- G. All low voltage wiring outside the control console/control desk area, cabinets, boxes, and similar enclosures, shall be plenum rated wiring.
- H. All fasteners used in wet or damp locations shall be manufactured from stainless steel.
- I. All equipment connected to alternating current circuits shall be protected from power line surges. Equipment protection shall meet the requirements of ANSI C62.41. Fuses shall not be used for surge protection.
- J. Inspect each component, determine obvious defects, if any, and correct.
- K. Perform tests as recommended by manufacturer or as required to ensure the security equipment is operating properly and meets specified requirements.
- L. Correct all deficiencies detected and retest affected components.
- M. Record test data, tabulate, and write narrative describing tests, results, deficiencies found, corrective measures, and results of retesting. Certify to the Engineer that the security equipment has been tested and is ready for performance verification testing.
- N. All enclosure penetrations shall be from the bottom unless the system design requires penetrations from other directions. Penetrations of enclosures involving transitions of cable or cable from interior to exterior, and all penetrations on exterior enclosures shall be sealed with rubber silicone or similar sealant to preclude the entry of water.
- O. Penetrations through enclosures shall be bushed with a fitting or bushing approved for the purpose to provide physical protection for the cable sheathing.
- P. During and upon completion of the installation, all debris created by the installation shall be removed from the premises and disposed of as directed.

3.5 LABELING

- A. The guidance below shall be followed with regard to marking and labeling devices and cabling:
 - 1. All ESS System cables shall be marked by device location number based on the numbering sequencing designated on the ESS device schedule sheet(s).

2. All ESS System labels, whether installed on devices or cables shall be a machine printed label designed for the type of surface and environment in which it will be installed.
3. At the field device end, all cables shall be marked within six (6) inches of the termination.
4. At the panel location, all cables shall be marked within six (6) inches of entering the cabinet where the cable is to be terminated.
5. Where ESS related cables are terminated on an ESS network patch panel, these cables do not need to be marked with ESS System number.
6. Jumpers connecting ESS related cables terminated on ESS network patch panels to network switches shall be marked with the ESS System camera number as it is designated when programmed into the ESS System.

3.6 POWER REQUIREMENTS

- A. Back-up power for all equipment and devices shall be for at least 4 hours unless otherwise specified.
 1. When generator backup power is available, provide a UPS, rated to maintain the load for a minimum of 1 hour for all 120VAC equipment.
- B. Rack-mounted Uninterruptible Power Supply (UPS)
 1. To be provided by others.
- C. Connect to AC power and provide UL listed power supplies and transformers to distribute low voltage power to the system components as required.
 1. Provide uninterrupted battery backup power for the duration required above.
- D. All equipment connected to AC circuits shall be protected from power surges.
 1. The devices shall be installed and grounded per manufacturer instructions.
 2. Equipment protection shall meet requirements of ANSI C62.41.
 3. Fuses shall not be used for surge protection.
- E. All non-fiber optic data circuits that serve devices exterior to the buildings will be protected by surge protectors at the device and the termination.
 1. The devices shall be installed and grounded per manufacturer instructions.
 2. Equipment protection shall meet requirements of ANSI C62.41.
 3. Fuses shall not be used for surge protection.

3.7 SITE TESTING

- A. GENERAL:
 1. Provide all personnel, equipment, instrumentation, and supplies necessary to perform all testing of the ESS. The Engineer and the Owner's representative will witness all performance verification and endurance testing. Original copies of all data produced during performance verification and endurance testing shall be turned over to the Engineer for the Owner at the conclusion of each phase of testing.
 2. Calibrate and test all equipment, verify signal/control cable operation, place the integrated system in service, and test the integrated system.
- B. PERFORMANCE VERIFICATION TEST:

1. The Security Contractor shall demonstrate that the completed ESS complies with the Contract requirements. Using approved test procedures, all physical and functional requirements of the ESS project shall be demonstrated and shown.

C. ESS ENDURANCE TEST:

1. The ESS endurance test shall be conducted twenty-four (24) hours per day for two (2) consecutive calendar days, including holidays, and the system shall operate as specified. No repairs during this phase of testing are allowed unless authorized by the Engineer. If the system experiences no failures during testing, the Security Contractor may proceed directly to Acceptance Testing upon receipt of authorization from the Engineer.

3.8 SYSTEM COMMISSIONING:

A. GENERAL:

1. After all installation and acceptance test requirements specified have been complied with, the equipment shall be commissioned. After commissioning has been completed, the Engineer will recommend that the Owner take possession of the equipment and utilize it in accordance with the conditions described in the Contract documents.

B. PRE-COMMISSIONING:

1. Outstanding Work items that may exist, such as facility interfaces, project record drawings, and/or in-process change orders, shall be documented and submitted to the Engineer for review prior to the start of equipment commissioning. Documentation of outstanding Work items shall take the form of punch lists of critical action items lists that describe the Work, the expected completion schedule, and the impact upon operation. Depending upon the nature of the outstanding Work items, the Engineer may grant a waiver to accomplish partial commissioning of any of the equipment. Completion of waived outstanding Work items shall then be assigned to the post-commissioning operations and maintenance.

C. COMMISSIONING:

1. The ESS commissioning process shall be witnessed by the Engineer. The commissioning procedure shall be conducted by the Security Contractor and shall consist of a detailed inspection, and a physical accounting of each equipment item. An operational demonstration shall then be conducted in which the equipment shall function in the normal operational mode, and shall operate completely error-free in terms of hardware and software performance.
2. Occurrence of any equipment failure shall terminate the demonstration. The demonstration shall restart and run for a period of time designated by the Engineer after the failure has been corrected. Except for any outstanding Work items as previously described, this shall complete the commissioning procedure.

3.9 TRAINING:

- A. The Security Contractor shall conduct training courses for designated Owner personnel in the maintenance and operation of the Owner ESS as specified. The training shall be oriented to the specific system being installed under this contract.
- B. Training manuals shall be delivered for each trainee with two additional copies delivered for archiving at the project site.
- C. Videotaping is required for all training sessions. Each videotaped session shall be indexed to allow the user to access any specific section of the training.
- D. Schedule sufficient training segments to ensure that the required training can be attended by workers on all shifts. Scheduling of these sessions shall be coordinated with the

Owner so that the appropriate staff is made available to attend. Specified training session may be scheduled in separated sessions.

- E. The Security Contractor shall prepare, administer, and conduct a training program for designated Owner operator personnel to fully and efficiently operate the installed ESS and maintain configurable databases. At a minimum, the following training elements shall be incorporated into the training program and documented separately for individual training segments:
 - 1. Alarm management, monitoring and displays (Minimum of (10) ten hours)
 - 2. System back-up and restoration (Minimum of (8) eight hours)
 - 3. Badge administration (Minimum of (10) ten hours)
 - 4. VMS system interfaces and control (Minimum of (10) ten hours)
 - 5. Software access and operator tasks (Minimum of (10) ten hours)
 - 6. Maintenance and preventive maintenance (Minimum of (10) ten hours)
- F. Training shall be in sufficient scope and depth to ensure that all designated personnel who complete the program shall be fully qualified, certified, and capable of operating the system and subsystems as installed.
- G. The Security Contractor shall provide training, orientation, and "hands-on" practical familiarization necessary to ensure a smooth transition between system installation and operational activities.
- H. Operator training shall be provided for the topics and periods indicated in above at least one week prior to the scheduled turnover to the Owner of the system. Upon completion of training, each trainee, using appropriate documentation, shall be able to perform elementary operations with guidance and describe the general hardware architecture and functionality of the system.
- I. Upon completion of training outlined above, each trainee shall be able to start the system, operate the system, recover the system after a failure, and describe the specific hardware architecture and operation of the system. The course shall consist of hands-on training under the constant monitoring of the instructor.
- J. The instructor(s) shall be responsible for determining the appropriate password to be issued to the student commensurate with each trainee's acquired skills at the beginning of each of these individual training sessions.
- K. The Security Contractor shall provide and use all training aids such as films, slides, audio/video tapes, etc. as necessary to complement instruction and enhance learning.
- L. Provide a Training Manual for trainees' use during and after training. The Training Manuals shall include a list of recommended references useful for learning the details of ESS operation.

END OF SECTION

SECTION 28 05 13
WIRE AND CABLE

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 provides specifications for the installation of wire and cable for an Access Control and IP based Video Surveillance System and related components.
- B. Furnish labor, materials, inspections, supervision, etc., necessary for a turnkey installation and operation the equipment specified herein. Work includes furnishing all items and accessories required or necessary for the correct operation of the equipment as shown on plans and/or specified herein exception of those items noted within this specification as being provided by others.
- C. All security wiring shall be pink in color.
- D. Related Sections include:
 - 1. Section 28 00 00 Electronic Safety and Security
 - 2. Section 28 10 13 Electronic Access
 - 3. ~~Section 28 23 12 Video Management System~~
 - 4. Section 28 23 23 Network Video Recorder
 - 5. Section 28 23 29 IP Fixed Video Surveillance Cameras
 - 6. ~~Section 28 23 30 IP PTZ Video Surveillance Cameras~~

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference
- B. IDC: Insulation displacement connector
- C. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than D. 50V or for remote-control and signaling power limited circuits.
- D. Open Cabling: Passing telecommunications cabling through open space
- E. UTP: Unshielded twisted pair
- F. STP: Shielded twisted pair
- G. TIA/EIA: Telecommunication Industry Association/ Electronic Industries Association
- H. SLC- Signaling Line Circuits

1.4 SUBMITTALS

- A. Follow the provision of Section 28 00 00 Electronic Safety and Security.

1.5 QUALITY ASSURANCE

- A. Follow the provision of Section 28 00 00 Electronic Safety and Security.
- B. Testing Agency Qualifications: Underwriters Labs (UL) or Electrical Testing Labs (ETL).
- C. Manufacturers Independent Testing Data
 - 1. UTP Cabling

- a. Attenuation
- b. Near End Crosstalk (NEXT)
- c. PS-NEXT
- d. ACR
- e. Return Loss
- f. Impedance
- g. Capacitance

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Follow the provision of Section 28 00 00 Electronic Safety and Security.
- B. Test Cables upon receipt at Project site
 - 1. Test each pair of the UTP for shorts or opens
- C. Storage and handling of cables in ambient temperatures of 32 degrees F or less:
 - 1. Prior to installation, condition the cable for at least 24 hours at room temperature to provide the best flex properties for ease of installation

1.7 PROJECT/SITE CONDITIONS

- A. Follow the provision of Section 28 00 00 Electronic Safety and Security.
- B. Environmental Limitations: Do not deliver or install UTP and connecting materials in wet work in spaces until spaces are completely dry, and temporary HVAC or other air-controlled systems are operating and maintaining ambient temperature and humidity conditions.
 - 1. Exceptions:
 - a. Manufacturer's cable is Indoor/Outdoor Rated

1.8 WARRANTY

- A. Follow the provision of Section 28 00 00 Electronic Safety and Security.

1.9 MAINTENANCE AND SERVICE

- A. Follow the provision of Section 28 00 00 Electronic Safety and Security.

PART 2 - PRODUCTS

2.1 UTP Cable

- A. Belden
- B. Windy City Wire
- C. Allied Wire and Cable
- D. Or Approved Equal

2.2 UTP Description: 100 ohm, 4 Pair UTP

- A. Comply with TIA/EIA 568-B.1 for performance Specifications
- B. Comply with TIA/EIA 568-B.2, Category 5e, Category 6
 - 1. Category 5e
 - a. CMP: Plenum – 254245
 - b. CMR: Non-Plenum Riser – 4245
 - c. Indoor/Outdoor CM – 4245-IO

- d. CMP – Shielded – 254245F
- e. CMR – Shielded – 4245F
- 2. Category 6
 - a. CMP: Plenum – 254246
 - b. CMR; Non-Plenum Riser – 4246
- 3. Category 6 Shielded
 - a. CMP: 254246F – HDBaseT Certified
 - b. CMR: 4246F – HDBaseT Certified
- 4. Category 6A Shielded
 - a. CMP: 254246AF – HDBaseT Certified
 - b. CMR: 4246AF – HDBaseT Certified

2.3 UTP HARDWARE

- A. General Requirements for cable connecting hardware: Comply with TIA/EIA 568-B.2, IDC Type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of the same or higher category.
- B. Connecting Blocks: 110 Style IDC Category 5e, or Category 6.
- C. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.
- D. Patch Panels: Modular panels housings multiple-numbered jack units with IDC type connectors at each jack for permanent termination of pair groups of installed cables.
- E. Jacks: Modular, color coded, eight position modular receptacle units with IDC type terminals
- F. Patch Cords: Factory made, four pair cables with varied lengths, terminated with eight position modular plugs at each end.
- G. Patch cords meet Category 5e or Category 6 TIA/EIA specifications Color Coded for circuit identification

2.4 CABLE CONSTRUCTION

- A. Installed cable must comply with manufacturer recommendations.

PART 3 - EXECUTION

3.1 INSTALLATION OF PATHWAYS

- A. Cable Trays: UTP- Comply with NEMA and TIA/EIA 569-A-7.
- B. Comply with requirements for demarcation points, pathways, cabinets, and racks. Drawings indicate general arrangements of pathways and fittings.
- C. Comply with TIA/EIA 569-A- for pull box sizing and length of conduit and number of bends between pull points.
- D. Install manufactured conduit sweeps and long radius elbows whenever possible.
- E. Backboards: Install backboards with 96 inch dimension vertical. Butt adjacent sheets tightly, and form smooth gap free corners and joints.

3.2 INSTALLATION OF CONDUCTORS AND CABLES

- A. Comply with NECA 1
- B. General Requirements for cabling:

1. Comply with TIA/EIA 568-B.1 for UTP installations
 2. Comply with BICSI Manuals- Cable Termination Practices
 3. Install 110 style IDC termination hardware for UTP installations
 4. Cables may not be spliced- for Coaxial, Fire Alarm, and Access Control installations cables may have to be spliced.
 5. Secure and support cables at intervals not to exceed 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames and terminals for all UTP installations.
 6. Comply with manufacturer manuals technical section for pull tensions and minimum bend radius requirements for all cable installations.
 7. Do not install bruised, cut, scored, deformed, or abraded cable.
 8. Cold weather installation: Bring cables to room temperature before dereeling. Do not use heating equipment such as heat lamps to make the cable pliable.
 9. Pulling cables: Refer to manufacturer manuals.
 10. Plenum cables may be installed in all portions of the building cable routing and raceways. Do not place outdoor, or Riser rated cables in any building plenum areas.
 11. Separation from EMI Sources- Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment:
 - a. 2.5 inches – Electrical equipment – rating less than 2kVA
 - b. 6 inches- Electrical equipment- rating between 2-5kVA
 - c. 12 inches- Electrical equipment- rating more than 5kVA
 12. Separation from EMI Sources- Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures:
 - a. No requirements- Electrical equipment- rating less than 2.5kVA
 - b. 3 inches- Electrical equipment- rating between 2-5kVA
 - c. 6 inches- Electrical equipment- rating more than 5kVA
 13. Separation between communication cables and electrical motors/transformers, 5kVA or HP and Larger- min. 48 inches
 14. Separation between communication cables and fluorescent fixtures: min. 5 inches
- C. UTP installations
1. Comply with TIA/EIA 568B.2
 2. Refer to BICSI Manuals
- 3.3 FIRESTOPPING
- A. Follow the provision of SECTION 28 00 00 ELECTRONIC SAFETY AND SECURITY.
 - B. Comply with TIA/EIA 569-A- Firestopping Annex A.
 - C. Comply with BICSI TDMM
- 3.4 GROUNDING
- A. For communication wiring, comply with ANSI-J-STD-607-A and BICSI TDMM – Grounding, bonding, and electrical protection.

3.5 IDENTIFICATION

- A. Follow the provision of SECTION 28 00 00 ELECTRONIC SAFETY AND SECURITY.
- B. Identify system components, wiring, and cabling comply with TIA/EIA 606-A.

3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections
- B. Perform test and inspection of the cables upon delivery
- C. Test and inspection
 - 1. Visually inspect the cables for deformities
 - 2. Visually inspect the cable packaging for any damages
 - 3. Test for shorts or opens
- D. UTP testing shall be required for end – to – end verification

END OF SECTION

SECTION 28 10 00
ELECTRONIC ACCESS CONTROL

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 provides specifications for the installation of Electronic Access Control (ACS), Intrusion Detection (IDS), and related components.

B. Related Sections

1. **Section 08 06 71 Door Hardware Schedule**
2. Section 08 71 10 Door Hardware ~~(including related sub-sections)~~
3. Section 26 00 00 Electrical (including related sub-sections)
4. Section 21 00 00 Fire Suppression
5. Section 28 00 00 Electronic Safety and Security
6. Section 28 05 13 Wire and Cable
7. **Section 28 13 01 Access Control Door Hardware**
8. ~~Section 28 23 12 Video Management System~~
9. Section 28 23 23 Network Video Server
10. Section 28 23 29 IP Fixed Video Surveillance Cameras
11. ~~Section 28 23 30 IP PTZ Video Surveillance Cameras~~
12. ~~Section 28 60 00 Security Rack, Equipment and Accessories~~

1.3 GENERAL REQUIREMENTS

- A. See Section 28 00 00 Electronic Safety and Security.

1.4 REFERENCES

- A. See Section 28 00 00 Electronic Safety and Security.

1.5 SYSTEM COORDINATION

- A. The Security Contractor shall completely coordinate all relevant work of other trades/systems including, but not limited to:

1. Door Hardware
2. Fire Alarm System
3. Electrical Systems(s)
4. Communications System(s)

B. Electric Locking Mechanisms

1. The Security Contractor and Door Hardware Contractor shall coordinate all door hardware, door and doorframe design.
2. The Security Contractor shall verify all specified door hardware is appropriate for the security application and verify the sequence of operations for each access controlled opening.

- C. Fire Alarm and Life Safety
 - 1. The Security Contractor shall coordinate the (ACS) design with the life safety consultant to insure compliance with applicable codes and requirements.
 - 2. This includes, but is not limited to:
 - a. Fire alarm interface
 - b. Fail safe/fail secure locking mechanisms
 - c. Delayed egress

1.6 GENERAL SYSTEM DESCRIPTION

- A. General Requirements
 - 1. Furnish all labor, materials, tools, equipment, and services for a complete security system as indicated and in accordance with provisions of the contract documents.
 - 2. Although such work is not specifically indicated, furnish and install all supplementary or miscellaneous items, and devices incidental to or necessary for a sound, secure and complete installation.
 - 3. Comply with the provisions of Division 1 for General Requirements.
 - a. In the event of a conflict between the provisions of this Section and Division 1, the more stringent provisions shall apply.
 - 4. All system devices and components included shall be compatible.
 - 5. Units of the same type of equipment shall be products of a single manufacturer. All material and equipment shall be new and currently in production. Each major component of equipment shall have the manufacturer's model and serial number in a conspicuous place.
 - 6. Provide workstations for the security management system (SMS) and visitor management system with the minimum requirements as stated by the manufacturer or the IT department, whichever is greater, based on the design herein and within the Contract Documents.
- B. The Access Control System (ACS) / Intrusion Detection System (IDS) system shall be interfaced with the Fire Alarm System (by others) as required to comply with all building code requirements.
- C. Emergency power will be utilized to power the ACS/IDS system's field panels and control components as required throughout the facility.

1.7 ACCESS CONTROL SYSTEM

- A. Access control functions shall include validation based upon door access group, time of day, day of week, holiday scheduling, site code verification, automatic or manual retrieval of cardholder photographs, access validation based upon positive verification of card, and shunting and reactivation of alarm zones through multiple cardholder presentation of a valid card to an entry reader.
- B. The ACS system will consist of card readers, door status switches, and request-to-exit sensors operating in conjunction with associated electric door hardware.
- C. The ACS panels shall route the access and alarm transactions to the (SMS) file server.
- D. Field control panels:
 - 1. The field control panels will carry out the SMS main signal processing responsibilities. The SMS file server shall distribute the decision-making responsibility to the panel, which shall continue to operate in the event of a communications failure with the server. The database/operation of the panel(s)

shall include an on-board power supply and four (4) hour battery backup. When polled by the SMS File Server, the field panel(s) will communicate all status conditions and memory to the SMS File Server for display, printout, and archiving. All system connections between panels shall be accomplished via Ethernet LAN connection on a dedicated security network platform.

2. The distributed field control panels shall be intelligent, microprocessor-controlled solid-state electronic devices.
3. The panels shall include a real-time clock/calendar, which shall be updated at least once every 24 hours by the CPU.
4. The panels shall monitor security system portal status and associated SMS facility security devices and facility interface device status, intrusion detection system (IDS) zone status and associated sensors status. The panels shall communicate the status to the SMS access control CPU.
5. The panels shall include all relays, terminals and ancillary boards to make a complete system. This shall include but not be limited to a power distribution/isolation board to provide individually fused power to electric locking devices and provide for fire alarm release where applicable. This board shall also be provided with auxiliary contacts, which follow the fire alarm system general alarm condition. This auxiliary contact shall be connected to an input on the field control panel for fire alarm condition monitoring.
6. PTC protected outputs shall not be used in place of glass fuses.
7. The panel(s) shall be linked to the host computer (Central Monitoring Point) via RS-232 or RS-485 communications, and shall transfer data at 9,600 baud or greater. Each panel(s) shall contain its own processor and memory and shall be capable of supporting at a minimum:
 - a. Up to sixteen access control card readers
 - b. Up to 32 supervised monitored alarm points
 - c. Up to 16 outputs
 - d. At least 65,000 cardholders using various card reader technologies with on board memory of at 1 Megabyte.
 - e. 256 access levels
 - f. 99 time codes per access level
 - g. Two levels of fail safe
 - h. 1,000 event card reader transaction buffer
 - i. 32 alarm event buffer
 - j. Interface with various card reader and keypad technologies and manufacturers, including proximity, insertion and swipe readers and be compatible with the standard Wiegand 26 bit output protocol.
8. The field control panel(s) shall be configured to ensure a minimum of 25% spare capacity for future add-ons.
9. The controller shall have with an onboard INTEL 32-bit microprocessor, battery backup, database, user defined reports, and several communication ports.
10. The controller shall support one hardware module daughter-board for additional memory and/or for future feature enhancements.
11. The controller shall provide the following functions:
 - a. Provides central control for all devices attached.

- b. Makes decisions for access.
 - c. Responds to monitor activity.
 - d. Receives input to control its decision-making.
 - e. Reports activity to other devices.
12. The panel/controller shall be housed in UL rated enclosure. The enclosure shall be metallic.
 13. All terminal devices to be used in an interior environment shall be housed in an enclosure that provides protection against dust, falling dirt, and dripping noncorrosive liquids.
 14. Enclosures, cabinets, housings, boxes, and fittings of every description having hinged doors or removable covers, and which contain circuits or connections of the SMS equipment or power supplies, shall be provided with cover operated, corrosion resistant tamper switches, arranged to initiate an alarm signal when the door or cover is moved. Tamper switches shall be mechanically mounted to maximize the defeat time when enclosure covers are opened or removed.
 15. The field control panels shall be configured to support 1MB of on-board panel memory.
 16. Batteries shall be sized appropriately for the maximum intended connected load for a give power supply. In no case shall the batter be smaller than 12v/7ah and may be manufactured by either of the following manufacturers: Yuasa or Power Sonic. All batteries shall be by the same manufacturer. Additional batteries and battery cabinets may be required to achieve run-times stipulated elsewhere in this specification. All batteries shall be clearly labeled with the installation date.
 17. Field control panel capacities shall be furnished and configured for 25% capacity for card readers, input points and output points above all cumulative counts based on the contract documents. Additional capacities shall include all hardware, software, enclosures and power supplies necessary to meet the 25% additional capacity requirement for each closet.
 18. Intelligent system controllers and reader boards shall be housed in a separate enclosure from the enclosure in which electric lock power is derived from. Input and output boards are allowed to reside within the same enclosure, which derives the electric lock power.
- E. Card Readers:
1. Card readers and adjunct devices shall be provided as shown on the drawings.
 - a. Provide card readers, field panels and alarm input and output devices connected to the security management system via Local Area Network (LAN).
 - b. The Security Contractor shall coordinate network and IP address requirements with Owner to identify the Media Access Control (MAC) address (Layer 2) of each provided device, the location to be installed, and the port configuration needed for communication.
 - c. Furnish all labor, materials, tools, equipment, and services for a complete system as indicated and in accordance with provisions of the contract documents.
 - d. Although such work is not specifically indicated, furnish and install all supplementary or miscellaneous items, and devices incidental to or necessary for a sound, secure and complete installation.

2. Card readers shall use unique coded data stored in a compatible credential card as an identifier. Communications protocol shall be compatible with the local processor.
 3. The card readers shall include an LED or other visual indicator display. The display shall indicate power on/off, and whether user passage requests have been accepted or rejected.
 4. The card reader shall respond to passage requests by generating a signal to the local processor. The response time shall be 800 milliseconds or less from the time the card reader finishes reading the credential card until a response signal is generated.
 5. The card reader shall be powered from the location of the Security Contractor's panel(s) source as shown and shall not dissipate more than 150 watts.
 6. Card readers shall be suitable for appropriate mounting as indicated on the Contract Drawings and Schedules.
 7. Card readers will utilize proximity technology and work such that upon presentation of a valid ACS card, the unique card data shall be transmitted to an associated control panel where the data is compared to an authorized user database and access is approved or rejected accordingly.
 - a. A valid authorization will activate operation of the electric lock and shunt the door status switch. The alarm shunt will not affect supervision of the detection circuit.
 - b. Coordinate with owner on card format and other pertinent details.
 8. Card readers shall support 125 KHz prox and 13.56 MHz contactless smart card technologies.
- F. Door Position Switch (DPS)
1. Recessed door position switches shall be installed on select doors as indicated on the Contract Drawings.
 2. Each door position switch (except those on double doors) shall be configured as a separate alarm point.
 3. The contacts shall activate when a disturbance in the magnetic field occurs. The door position switches shall be rated for a minimum lifetime of one million operations.
 4. The DPS at card reader controlled locations serve to indicate the open/closed status of the associated door and shall establish the basis for reporting a door-propped or unauthorized entry condition.
 - a. Security contractor is responsible for coordinating the contact configuration (SPDT) (DPDT) and rating for door status switches, and for connection of switches with the ACS.
 - b. The Door Contractor shall be responsible for providing all flush and surface mounted door status switches as indicated on drawings.
- G. Electric Locking Devices
1. Electrified door hardware for card reader controlled doors will include electrified locksets, electric exit devices, **and associated power supplies** and electric power transfer as shown on the drawings.
 - a. All electrified door hardware shall be provided under the work of Division 08 unless otherwise noted.
 - b. ~~Security Contractor shall provide all security cables and, low voltage power supplies for operation of electrified door hardware associated with~~

~~card reader controlled doors.~~

- H. Electric Lock Power Supply
1. Lock power supplies shall be 24vdc and provide power to all security related electromagnetic locks, electric strikes, electrified trim and electric mortise locks and shall be provided by the Security Contractor, unless noted otherwise.
 2. The lock power supply shall be supplied with an auxiliary power supply board. The auxiliary power supply board shall be mounted and wired into the power supply panel assembly.
 3. Lock power supplies for delayed egress panic hardware and high in-rush current latch retraction panic hardware shall be provide by the locking hardware vendor.
- I. Request to Exit Devices (REX)
1. Request to exit devices (REX) shall be installed in selected protected areas of the facility having card access control, as indicated on the Contract Drawings and Schedule.
 2. The request to exit device shall shunt the alarm initiated from the door contact upon egress. Shunting of the alarm shall be accomplished by connection of the REX to an appropriate input on the field control panel. This input shall be programmed to shunt the door contact upon activation of the REX device.
 3. Request to exit devices, may depending upon location, be a power device or a mechanically activated micro switch located within a crash bar or mortise lockset.
 4. If the door at which the request to exit device is installed is forced or held open, an audible alarm shall sound. This may be accomplished by an integrated sounder within the request to exit device or may be a separate audible device as specified elsewhere in this specification.
- J. **Automatic Door Operator**
1. **The automatic door operations shall be coordinate with the electrified door hardware and access control system to ensure that the operator is not attempting to operate against a locked door.**
 2. **Sequence of Operation**
 - a. **The card reader initiates the open request.**
 - b. **The access control system closes a dry contact lined to the door operator interface circuit.**
 - c. **The door operator interface circuit sees the open request and released the electrified door lock.**
 - d. **After proper delay to ensure that the electrified lock has finished its action, the door operator interface circuit activates the automatic door operator.**
 - e. **When the door closes the door operator interface circuit senses that the door is closed and reactivates the electrified lock, securing the door.**
- K. Duress Sensors
1. Duress sensors shall be installed as indicated on the Contract Drawings and Schedules.
 2. Duress sensors shall be wired to the field panel input by individual device and shall not share any input with any other device.

3. Duress sensors shall be powered so that in the event of activation, the LED shall latch, indicating that the sensor has been activated. Reset of the LED shall only be by output activation from the field control panel by an SMS operator through the SMS software.
 4. Duress sensors shall receive their power from the auxiliary power supply and shall be connected to an individually fused output that shall be controlled by an auxiliary output from the field control panel. The controlled output shall be used to reset the duress sensor LED after the sensor has been activated.
- L. Auxiliary Power Supply:
1. An auxiliary power supply is a power supply which is intended to provide power to glass break detectors, duress buttons and audible alarms and shall be installed at any panel location supporting these devices.
 2. Where required by other sections of this specification, control of the auxiliary power supply outputs shall be wired to and controlled by auxiliary outputs from the field control panel in which the auxiliary power supply is associated with.
 3. The auxiliary power supply shall also be supplied with an auxiliary power supply board. The auxiliary power supply board shall be mounted and wired into the auxiliary panel assembly.
- M. Equipment Enclosures
1. Enclosures shall be NEMA 4X rated as specified herein.
 2. Enclosures shall be appropriately mounted using the manufacturer specified mounting equipment for each location specified on the contract documents.
 3. Enclosures shall be appropriately sized to provide adequate space for the mounting of all required equipment.
 4. Enclosures shall be rigid fiberglass or stainless steel and have a full gasketed raised lid.
 5. Latches shall be stainless steel and have padlock hasps.
- N. Tamper Switches
1. Typically closed tamper switches to monitor the secure status of all SMS field panels, power supplies, terminal cabinets, power distribution units, and other Security System cabinets and enclosures.
 2. Fasten tamper switches within the cabinet to provide no access to the switch and fasteners when the cabinet is closed.
 3. Provide independent monitoring of tamper conditions for each cabinet.
 - a. Include the number of tamper switches in the total alarm input figures.

1.8 SUBMITTALS

- A. Follow provisions of Section 28 00 00 Electronic Safety and Security.
- B. Field Test Reports
 1. Upon completion and testing of the installed system, test reports shall be submitted in booklet form and electronic media showing all field tests performed on, and adjustments made to each/any component and all field tests performed to prove compliance with the specified performance criteria.
 2. Indicate and interpret test results in written form and verbally to Engineer for compliance with performance requirements at a pre-scheduled meeting.
- C. Battery calculations to show the expected loads and backup duration for power supplies and UPS devices for all active AC/ID equipment.

- D. Security Contractor is responsible to prepare and submit as required to the Authority Having Jurisdiction (AHJ) any and all information to obtain an Electronic Locking Mechanics permit.

1.9 QUALITY ASSURANCE

- A. Follow provisions of Section 28 00 00 Electronic Safety and Security.
- B. Spare Parts:
 - 1. Provide two (2) spare components for every model and configuration of electronic components and devices used on the project as spare parts inventory.
 - a. The Security Contractor will turn over the new and unused components and devices to the owner at project closeout.

1.10 DELIVERY, STORAGE AND HANDLING

- A. Follow provisions of Section 28 00 00 Electronic Safety and Security.

1.11 PROJECT/SITE CONDITIONS

- A. Follow provisions of Section 28 00 00 Electronic Safety and Security.

1.12 WARRANTY

- A. Follow provisions of Section 28 00 00 Electronic Safety and Security.
- B. All devices and components shall comply with applicable U.L. standards.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Security Management System (SMS)
 - 1. Security Management System Platform Software - Existing
 - a. Software House
 - 2. Security Management System Base Software - Existing
 - a. C-Cure 9000 Enterprise
- B. Access Control SMS Field Panels
 - 1. Field Control Panel
 - a. Software House iStar Pro 64MB
 - 2. Input Control Module
 - a. Software House I8, AS0073-000
 - 3. Output Control Module
 - a. Software House R8, AS0074-000
 - 4. Enclosures
 - a. Software House iStar Enclosure - RM-DCM-CAN
 - i. Enclosures shall include all miscellaneous equipment including rails, terminal, lock isolation boards, AC outlet and switch.
 - 5. Power Supply
 - a. Software House apS
- C. Proximity Card Readers (CR)
 - 1. HID iCLASS SE Reader (wall)

- a. RP40
2. HID iClass SE Reader w/ Keypad (wall)
 - a. RPK40
3. HID ICLASS SE Reader (mullion)
 - a. RP15
- D. Power over Ethernet (PoE) Locks (By Division **28 13 01**)
- E. WiFi Locks (By Division **28 13 01**)
- F. Request to Exit (REX)
 1. REX (wall or ceiling)
 - a. Bosch DS160
 - b. Or approved equal
 2. REX Trim plates
 - a. Bosch TP160
 - b. Or approved equal
 3. Doors that due to their locking arrangements that cannot have the REX device contained within by means of a mechanically activated micro switch shall be the Dexter Research T-80 mounted in a Raco 264 box or equivalent.
- G. Door Position Switches (DPS)
 1. Concealed Magnetic Door Position Switch
 - a. Sentrol 1078
 - b. Or approved equal
 2. Industrial Surface Mount Door and Hatch Position Switch
 - a. Sentrol 2200
 - b. Or approved equal
- H. Electric Locking Devices (By Division **08 71 00**)
- I. Electric Power Transfer (By Division **08 71 00**)
- J. **Electric Power Supplies (By Division 08 71 00)**
- K. **Lock Power Supplies**
 1. Electric Locking Power Supply
 - a. Altronix Maximal77D.
 - b. Or approved equal
 2. Electric Locking Auxiliary Power Supply Board
 - a. Altronix PD16W.
 - b. Or approved equal
 3. Glass Break, Duress Button and Audible Alarm Auxiliary Power Supply
 - a. Altronix Maximal33
 - b. Or approved equal
 4. Glass Break, Duress Button and Audible Alarm Auxiliary Power Supply Board

- a. Altronix PD16W
- b. Or approved equal
- L. Tamper Switches
 - 1. Sentrol 3010
 - 2. Or approved equal
- M. Print Pocket
 - 1. Hammond Manufacturing PKT1212
 - a. Where panel assemblies are not of sufficient width, height or depth to accommodate the aforementioned PKT1212, a separate wall mounted enclosure shall be installed along with the SMS panel assembly to accommodate the print pocket and associated documentation.
 - 2. Or approved equal.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

- A. Power Supplies
 - 1. Power supply requirements
 - a. A switch and on/off indicator within the power supply cabinet.
 - b. Four (4) hours of sealed gel battery backup to provide continuous operation during power failure.
 - i. Provide batteries as required to provide specified battery backup time for a fully loaded power supply, regardless of the connected load.
 - c. A battery charger to maintain the battery.
 - d. Low battery and power fail contacts to monitor the status of the input power and the battery.
 - i. Connect each power supply low battery and power fail alarm as a separate alarm input into field panels.
 - e. Key lockable wall mount metal enclosure with tamper switch.
 - 2. Additional Power Supply Requirements
 - a. The SMS field panel power supply provides power only to field panels and shall not provide power for locks or any other low voltage device.
 - 3. Additional Electric Locking Mechanism Power Supply Requirements.
 - a. Fail secure electric locking mechanism shall remain locked during power failure and fire alarm conditions.
 - b. Connect fail safe locking devices in accordance with applicable life safety codes to unlock automatically under the following conditions:
 - i. Loss of power to the power supply.
 - ii. Failure of the power supply
 - iii. Fire alarm activation
 - c. Provide power distribution boards with independently fused output relays and fire alarm control panel interface.
 - 4. Additional Device Power Supply Requirements

- a. Provide device power supplies for other security system devices requiring power (e.g. card readers, local alarms, motion sensors, etc.)
 - b. Provide power distribution boards with independently fused outputs.
- B. Tamper Resistant Screws
1. Provide appropriate screw heads for each application (e.g. countersunk heads for recessed cover plate screws, flat head screws for standard junction box covers, etc.).
 2. The Security Contractor shall provide Torx® tamper resistant screws for:
 - a. Junction boxes located above doors.
 - b. Junction boxes located below ceiling height and/or within reach of hatch ladders.
 - c. Security device cover plates.
 - d. Surface mounted door position switches and armored cable.

3.2 INSTALLATION

- A. All security panels shall be wired through a dedicated power supply with battery backup.
- B. All panels shall be designed and built with the following requirements and guidelines:
1. Enclosures shall be lockable with a tamper switch and installed in a manner to be accessible with clearance to fully open enclosure door.
 2. Power to the data gathering panels is to be hardwired utilizing EMT or rigid conduit in accordance with the Electrical specifications.
 3. A circuit from the Fire Alarm panel must be installed to each lock power distribution panel.
 4. All panels and boards shall be installed in enclosure(s) suitable to their environment and have sufficient size and orientation to include all system components.
 5. Enclosures shall be installed on designated wall fields in a neat and compact manner to allow for future growth.
 6. Field cabling shall enter the enclosure through a metal conduit properly terminated in the top of the enclosure. In no case shall the surface metal raceway be smaller than 4" x 4" in width and height.
 7. Panels shall incorporate a metal backplane and/or fixed standoffs within the enclosure for the purpose of mounting all components. The backplane may be solid or perforated in nature and shall be one piece within the interior of the enclosure.
 8. Line voltage connections to the interior of the enclosure shall be concealed by metallic raceway and/or boxes or terminated on terminals designed to prevent accidental contact by service personnel. Line voltage conductors shall enter the enclosure at the point nearest where it will be terminated and shall not be run in any low voltage raceway within the enclosure or supporting cable management for low voltage cable around the enclosure.
 9. All components shall be mounted on the backplane. No components shall be mounted on the sides, top, bottom, or door of the enclosure. Exception: Indicator lights/LEDs showing the status of power or any fault conditions may be mounted on/in the door to facilitate viewing of status indicators without having to open the enclosure.
 10. All circuit board components shall be mounted to the backplane using metal or

plastic standoffs. No double sided adhesive tape or mounting pads shall be used for mounting components. Standoffs shall be mounted to the backplane in a captive fixed manner so that removal of the board supported by the standoff can be accomplished without removing the entire backplane and without loss of the standoff or mounting hardware. Where full population of support equipment is not required due to device counts, all standoffs shall be installed for a full configuration.

11. Raceways shall be provided within the enclosure for the purpose of routing and dressing cables within the enclosure. Raceways shall be plastic 'finger duct' appropriately sized for the amount of cable to be installed within. Covers for all internal raceways shall be provided and installed. Where full population of support equipment is not required due to device counts, all raceway shall be installed for a full configuration.
12. Each panel shall be labeled accordance with Owner standards. The label for each panel shall be posted on the exterior of the panel door.
 - a. Each panel shall have a list of devices connected to it located on the inside cover.
 - b. A detailed device layout drawing will be located on the inside of the panel door in an appropriate sleeve and keeper.
- C. Adhesive mounted devices and components such as tie wrap mounting pads, shall not rely solely on the adhesive to fasten the device or component. The addition of a bolt or screw shall be installed through the adhesive mounted device to prevent the adhesive of the device or component from failing.
- D. Field device cables shall only be run in metal raceway where not installed in a cable tray. No plastic raceway is permitted. *Exception: where run in an underground environment, Rigid PVC Conduit (RNC) is permissible and shall be either schedule 40 or schedule 80 RNC.*

3.3 FURTHER REQUIREMENTS

- A. Refer to provisions of Section 28 00 00 Electronic Safety and Security.
- B. Furnish and coordinate installation of all special device back boxes and ACS/IDS field devices as shown on the security drawings and as specified in this section.
- C. Provide low voltage power supplies for electric locking devices and ACS/IDS devices and components as shown on the security drawings and specified in this Section.
- D. Coordinate with the Telecommunications Subcontractor for data network connections, IP address requirements, and telephone circuits as required.
- E. Prepare all systems for user operation.
 1. The security system must be complete and ready to operate prior to Owner final acceptance of the system.
- F. Coordinate with the Owner for all system programming requirements.
- G. Perform database programming as required to support the card reader, alarm point, surveillance system integration, and control panel configuration as required.

END OF SECTION

SECTION 281301 - ACCESS CONTROL DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes access control door hardware for the following:

- 1. Swinging doors.

- B. Section includes, but is not necessarily limited to, the following for the integrated access control security and site management system:

- 1. Wireless access control door hardware.
- 2. IP-enabled integrated access control door hardware.

- C. Related Sections:

- 1. Division 08 Section - "Hollow Metal Doors and Frames".
- 2. Division 08 Section - "Interior Aluminum Doors and Frames".
- 3. Division 08 Section - "Flush Wood Doors".
- 4. Division 08 Section - "Door Hardware".
- 5. Division 28 Section - "Electronic Access Control".

- D. Codes and References: Comply with the current version year adopted by the Authority Having Jurisdiction.

- 1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
- 2. ICC/IBC - International Building Code.
- 3. NFPA 70 - National Electrical Code.
- 4. NFPA 80 - Fire Doors and Windows.
- 5. NFPA 101 - Life Safety Code.
- 6. NFPA 105 - Installation of Smoke Door Assemblies.
- 7. State Building Codes, Local Amendments.

1.3 SUBMITTALS

- A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.
- B. System Operational Descriptions: Complete system operational narratives for the integrated access controlled openings defining the owner's prescribed requirements for the opening functionality. Narratives include, but are not limited to, the following situations: normal secured/unsecured state of door; authorized access; authorized egress; unauthorized access; unauthorized egress; fire alarm and loss of power conditions, and interfaces with other building control systems.
- C. Shop Drawings: Details of electrified integrated locking hardware and access control firmware, indicating the following:
- D. Proof of Certification: Provide copy of manufacturer(s) official certification or accreditation document indicating proof of status as a qualified and authorized provider of the primary access control components.
- E. Keying Schedule: Reference Division 08 Section "Door Hardware".
- F. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.
- G. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete access control and site management installation in quantity as required in Division 01, Closeout Submittals. The manual to include the name, address, and telephone number of the supplier/integrator providing the installation and the nearest service representatives for each item of equipment included in the system. The final copies delivered after completion of the installation test to include "as built" modifications made during installation, checkout, and acceptance.
 - 1. As-Built Drawings: During system installation, the Contractor to maintain a separate hard copy set of drawings, elevation diagrams, and wiring diagrams of the access control system to be used for record drawings. This set to be kept up to date by the Contractor with all changes and additions to the access control system accurately recorded.
- H. Warranties and Maintenance: Special warranties and maintenance agreements specified in this Section.

1.4 QUALITY ASSURANCE

- A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum **[5]** years of documented experience in providing access control and security systems equipment and

software similar to that indicated for this Project and that have a proven record of successful in-service performance.

1. Software and access control systems components to have been previously and thoroughly tested together with proven installations similar in size and functionality to the design requirements indicated for this Project.
- B. Integrator Qualifications: Systems Integrators, verifiably factory trained and certified by the primary product manufacturers, with a minimum 3 years documented experience installing complete integrated access control systems similar in material, design, and scope to that indicated for this Project and whose work has resulted in construction with a proven record of successful in-service performance. Qualifications include, but are not necessarily limited, to the following:
1. References: Provide a list of references for similar projects including contact name, phone number, name and type of project.
 2. Professional Staffing: Firms to have a dedicated access control systems integration department with full time, experienced professionals on staff experienced in providing on site consulting services for both electrified door hardware and integrated access control systems installations.
 3. Factory Training: Installation and service technicians are to be competent factory trained and certified personnel capable of maintaining the system.
 4. Service Center: Firms to have a service center capable of providing training, in-stock parts, and emergency maintenance and repairs at the Project site with 24-hour/7-days a week maximum response time.
- C. Supplier/Dealer Qualifications: Supplier/Dealers, verifiably authorized and in good standing with the primary product manufacturers, with a minimum **[3]** years experience supplying integrated access control systems similar in material, design, and scope to that indicated for this Project and whose work has resulted in construction with a proven record of successful in-service performance.
- D. Wireless and IP-Enabled access control products are required to be supplied and installed only through designated ASSA ABLOY "Authorized Channel Partner" (ACP) and "Certified Integrator" (CI) accounts.
- E. Source Limitations: Obtain the access control door hardware, system firmware and application software specified in this Section from a single source, qualified supplier/integrator unless otherwise indicated.
1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.
 2. Provide integrated access control door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated.

- F. Regulatory Requirements: Comply with NFPA 70, NFPA 80, NFPA 101 and ANSI A117.1 requirements and guidelines as directed in the model building code including, but not limited to, the following:
1. Comply with NFPA 70 "National Electrical Code", including electrical components, devices, and accessories listed and labeled as defined in Article 100 by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
 2. Where indicated to comply with accessibility requirements, comply with Americans with Disabilities Act (ADA), "Accessibility Guidelines for Buildings and Facilities (ADAAG)," ANSI A117.1 as follows:
 - a. Handles, Pulls, Latches, Locks, and other Operating Devices: Shape that is easy to grasp with one hand and does not require tight grasping, tight pinching, or twisting of the wrist.
 - b. Door Closers: Comply with the following maximum opening-force requirements indicated:
 - 1) Interior Hinged Doors: 5 lbf applied perpendicular to door.
 - 2) Fire Doors: Minimum opening force allowable by authorities having jurisdiction.
 3. Comply with NFPA 101 "Life Safety Code" for doors in a means of egress.
 - a. Latches, Locks, and Exit Devices: Not more than 15 lbf to release the latch. Locks shall not require the use of a key, tool, or special knowledge for operation.
 4. Comply with NFPA 80 "Fire Doors and Windows" for fire labeled opening assemblies.
 5. The installed access control system shall conform to all local jurisdiction requirements.
- G. Keying Conference: Reference Division 08 Section "Door Hardware".
- H. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), Systems Integrator(s), and Contractor(s) to review proper methods and procedures for receiving, handling, and installing door and access control hardware to manufacturer's recommendations and according to specifications.
1. Prior to installation of door hardware, arrange for manufacturers' representatives to hold a project specific training meeting on the proper installation and adjustment of their respective products. Product training to be attended by the installers of access control hardware for the aluminum, hollow metal and wood door sections. Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.
 2. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.
 3. Review sequence of operation narratives for each unique access controlled opening.

4. Review and finalize construction schedule and verify availability of materials.
5. Review the required inspecting, testing, commissioning, and demonstration procedures.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.
 1. Access control firmware and software: Where approved and directed, inventory upon receipt and store electronic access control equipment in a secure, temperature and humidity controlled environment in original manufacturer's sealed containers.
- B. Tag each item or package separately with identification related to the final Access Control Door Schedule, and include basic installation instructions with each item or package.
- C. Deliver permanent keys, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner established at the "Pre-Submittal Conference".

1.6 COORDINATION

- A. Coordinate quantity and arrangement of assemblies with ceiling space configuration and with components occupying ceiling space, including structural members, pipes, air-distribution components, raceways, cable trays, recessed lighting fixtures, and other items.
- B. Integrated Access Control Door Hardware and Electrical Coordination: Coordinate the layout and installation of scheduled integrated access control door hardware, and related access control equipment, with required connections to source power junction boxes, power supplies, detection and monitoring hardware and fire alarm system.
 1. Door Hardware Interface: The access control system to interface and be connected to electrified and integrated access control door hardware as described under Division 08 Sections "Door Hardware" or "Access Control Door Hardware". Coordinate the installation and configuration of electrified door hardware being monitored or controlled with the controls, software and access control hardware specified in this Section.
- C. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing electrified door hardware and access control system components. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing access control system hardware to comply with indicated requirements.

D. Door and Frame Preparation: Related Division 08 Sections (Steel, Aluminum and Wood) doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

1.7 WARRANTY

A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article will not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and are in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of the installed access control system hardware and software that fails in materials or workmanship, including all related parts and labor, within specified warranty period after final testing and acceptance by the Owner. Failures include, but are not limited to, the following:

1. Structural failures including excessive deflection, cracking, or breakage.
2. Faulty operation of the hardware.
3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
4. Electrical component defects and failures within the systems operation.

C. Standard Warranty Period: One year from date of Substantial Completion, unless otherwise indicated.

D. Special Warranty Periods:

1. Two years for Integrated Access Control Door Hardware.

1.8 MAINTENANCE SERVICE

A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of standard and access control door hardware.

B. Maintenance Service: Beginning at Substantial Completion, and running concurrent with the specified warranty period, provide continuous (6) months full maintenance including repair and replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door opening operation. Provide parts and supplies as used in the manufacture and installation of original products.

C. Maintenance Support and Extended Service Agreement: Submit for Owner's consideration an optional extended Service Agreement for the installed access control system,

including support for software related issues. The extended Service Agreement is considered elective and is without manufacturer's requirement stipulating mandatory coverage for owner and/or vendor system support.

1. A published copy of this agreement to be included with the submittal package
2. Support for the installed access control system components is provided through the vendor under a 24 hour technical assistance program.
3. Access control and management system components are to be available on a one-day turn-around time frame from the manufacturer.

1.9 SCOPE OF WORK

A. **Access Control Door Hardware: Furnish and install at the indicated locations the specified integrated access control door hardware. All hardware furnished under this section must be bought through the owner's sole source vendor which is Software House. No other substitutions are allowed.**

1. Access Control System Integrator to provide the following:
 - a. Low voltage wiring (12/24VDC) and communication cabling (RS-232/RS-485) from network control processors to reader controllers, I/O monitor/control interface panels, electrified and integrated locking hardware, remote card readers, keypads, or display terminals, monitoring and signaling switches, and power supplies. Work includes related connectors, final terminations, and hook-ups required for a complete and functional access controlled opening in accordance with applicable codes and specified system operational narratives.
2. Provide permits, submittals and approvals required by the authority having jurisdiction, prior to commencing with work.

PART 2 - PRODUCTS

2.1 INTEGRATED IP-ENABLED ACCESS CONTROL DEVICES

- A. IP Enabled Power-over-Ethernet (PoE) Integrated Card Reader Mortise Lock: IP enabled, PoE ANSI/BHMA A156.13 Grade 1 mortise lockset with integrated proximity card reader, request-to-exit, latchbolt and deadbolt monitoring, and door position signaling in one complete unit. Motor driven locking/unlocking control of the lever handle trim, 3/4" deadlocking anti-friction latch, and 1" case-hardened steel deadbolt (optional). Lock is U.L listed and labeled for use on up to 3 hour fire rated openings. Available with or without keyed high security cylinder override.
1. Completely intelligent and integrated locking unit with Ethernet power and communication connection capability directly from the locking unit back to the central

- system host server without additional access control interfaces or components (excluding PoE switches and Mid-Span devices) via an existing or newly installed TCP/IP network.
2. Open architecture design supports wired integration with third party access control systems applications via software development kit (SDK). Real-time software accessible alarms for forced door, unknown card and door held open, with inside lever handle (request-to-exit), auxiliary latchbolt, deadbolt, and door position (open/closed status) monitoring.
 3. 2,400 users and 10,000 event transaction history (audit trail). Distributed intelligence allows stand alone operation in absence of network communication allowing for system operational redundancy.
 4. Energy Efficient Design: Provide lock bodies which have a holding current draw of 15mA maximum, and can operate on either 12 or 24 volts. Locks are to be field configurable for fail safe or fail secure operation.
 5. Supports HID 125 kHz proximity formats up to 39 bits, including Corporate 1000. Dual credentialing available with keypad option.
 6. Power and communication from one Ethernet (CAT5e or higher) cable. Compliant with 802.3af specifications requiring 12.95 watts for Power over Ethernet.
 7. Supports real-time system lockdown capabilities. Inside lever retracts latch bolt and deadbolt simultaneously.
 8. High security mechanical key provides emergency override retraction of latchbolt without need for electronic activation.
 9. Ethernet system framework, network cabling and mounting boxes, and PoE switches (by others) are required for complete system functionality.
 - a. Network Drop Cable Specifications: Cat5e or higher (Belden 153P D15A1000) or equivalent). TIA/EIB-568-B shielded with drain wire. 24 AWG Plenum rated.
 - b. Network Surface Mount Box: Cat5e or higher (RJ45); TIA/EIB-568-B
 10. Acceptable Manufacturers:
 - a. Sargent Manufacturing (SA) - Profile – S1 8200 Series.
 - b. No Substitution.
- B. IP Enabled Wireless Integrated Card Reader Mortise Lock: IP enabled WiFi™ ANSI/BHMA A156.13 Grade 1 mortise lockset with integrated proximity card reader, request-to-exit, latchbolt and deadbolt monitoring, and door position signaling in one complete unit. Motor driven locking/unlocking control of the lever handle trim, 3/4" deadlocking anti-friction latch, and 1" case-hardened steel deadbolt (optional). Lock is U.L listed and labeled for use on up to 3 hour fire rated openings. Available with or without keyed high security cylinder override.
1. Completely intelligent and integrated locking unit with network communication connection capability directly from the locking unit back to the central system host server without additional access control interfaces or components (excluding wireless access points) via an existing or newly installed 802.11b/g wireless network.

2. Open architecture design supports wireless integration with third party access control systems applications via software development kit (SDK). Real-time software accessible alarms for forced door, unknown card and door held open, with inside lever handle (request-to-exit), auxiliary latch, deadbolt, and door position (open/closed status) monitoring.
3. Advanced data security techniques including AES 128-bit encryption changing with every exchange. Supportive of open standard WiFi™ network security including: WEP, WPA, and LEAP.
4. 2,000 users and 10,000 event transaction history (audit trail). Distributed intelligence allows stand alone operation in absence of network communication allowing for system operational redundancy.
5. Supports HID 125 kHz proximity formats up to 39 bits, including Corporate 1000. Dual credentialing available with keypad option.
6. 9VDC power provided by (6) AA batteries for completely wireless applications.
7. Energy Efficient Design: Provide lock bodies which have a holding current draw of 15mA maximum, and can operate on either 12 or 24 volts. Locks are to be field configurable for fail safe or fail secure operation.
8. Real-time lockdown capabilities with separate external 9VDC power supply, hard wiring option. Inside lever retracts latch bolt and deadbolt simultaneously.
9. High security mechanical key provides emergency override retraction of latchbolt without need for electronic activation.
10. Ethernet system framework and 802.11 b/g wireless access points (by others) required for complete system functionality.
 - a. Comply with IEEE 802.11b/g WiFi standard for Wireless LAN communications.
 - b. Frequency Range: Worldwide product covering 2.4 to 2.5 GHz, programmable for different country regulations.
 - c. Maximum Output Power: 100 mW.
 - d. Power Management: Continuous aware power saving polling mode.
11. Acceptable Manufacturers:
 - a. Sargent Manufacturing (SA) - Profile - S2 8200 Series.
 - b. No Substitution.

2.2 CABLES AND WIRING

- A. Comply with Division 27 Section "Conductors and Cables for Electronic Safety and Security."
- B. Data Line Supervision: System to include alarm initiation capability in response to opening, closing, shorting, or grounding of data transmission lines.
- C. Install appropriate number of conductor pairs, in the wire gage (AWG) recommended by manufacturer, corresponding to the electronic locking functions specified, amperage

drawn and distances covered between the power supplies, power transfer devices, electrified hardware and access control equipment.

2.3 ACCESS CONTROL HARDWARE FINISHES

- A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.
- B. Protect mechanical finishes on exposed surfaces from damage by applying temporary protective coverings before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance of the installed access control system.
- B. Examine roughing-in for electrical source power to verify actual locations of wiring connections before electrified and integrated access control door hardware installation.
- C. Examine roughing-in for LAN and control cable conduit systems to PCs, controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.
- D. Notify architect of any discrepancies or conflicts between the specifications, drawings and scheduled access controlled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

3.2 PREPARATION

- A. Doors and frames at scheduled access controlled openings to be properly prepared to receive specified electrified and access control hardware and connections without additional in-field modifications.

3.3 INSTALLATION

- A. Install each item of integrated access control door hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.

- B. Mounting Heights: Mount integrated access control door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:
1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
 2. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
 3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
- C. Boxed Power Supplies: Verify locations.
1. Configuration: Provide the least number of power supplies required to adequately serve doors with access control hardware and equipment.
- D. Integrated Wiegand access control products, campus locks, and IP enabled products are required to be installed through current members of the ASSA ABLOY "Certified Integrator" (CI) program.
- E. Final connect the system control switches (integrated access control door hardware, remote readers, keypads, display terminals, biometrics), and monitoring, and signaling equipment to the related Controller devices at each opening to properly operate the electrified door and access control hardware according to system operational narratives.
- F. Retrofitting: Install each door hardware and access control item to comply with manufacturer's published templates and written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.
- G. Networked System Application Software: Install, and test application(s) software and databases for the complete and proper operation of systems involved. Assign software license(s) to Owner.

3.4 FIELD QUALITY CONTROL

- A. Field Inspection: Perform a final inspection of the installed integrated access control door hardware and access control system and state in report whether installed work complies with or deviates from requirements, including whether each component representing the opening assembly is properly installed, adjusted, operating and performing to system operational narratives.

- B. Commissioning and Testing Schedule: Prior to final acceptance of the access control system installation, the following testing and documentation to be performed and provided to the Owner.
1. Inspection: Verify that units and controls are properly installed, connected, and labeled and that interconnecting wires and terminals are identified.
 2. Pre-testing: Program and adjust the system and pretest all components, wiring, and functions to verify they conform to specified requirements. Provide testing reports indicating devices tested, pass/fail status, and actions taken to resolve problem(s) on failed tests.
 3. Acceptance Test Schedule: Correct deficiencies identified by tests and observations and retest until specified requirements are met.
 4. Provide "as designed" drawings showing each device and wiring connection and electronic enclosure legends indicating cabling in and out.
 5. Provide a complete set of operating instructions for access control hardware devices and a complete software user manual. The documentation includes module reference guides for each electronic enclosure.

3.5 ADJUSTING

- A. Adjust and check each operating item of integrated access control door hardware, and each door opening to ensure proper secured operation and function of every unit. Replace units that cannot be adjusted to operate as intended.

3.6 CLEANING AND PROTECTION

- A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all integrated access control door hardware at the latest possible time frame.
- B. Clean adjacent surfaces soiled by access control system installation.
- C. Clean operating items as necessary to restore proper finish and provide final protection and maintain conditions that ensure access control door hardware is without damage or deterioration at time of owner occupancy.

3.7 DEMONSTRATION

- A. Instruct Owner's maintenance personnel to adjust, operate, and maintain electronic integrated door hardware and the access control system.

3.8 ACCESS CONTROL HARDWARE SETS

- A. The hardware sets listed represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.
- B. Refer to Section 080671 "Door Hardware Schedule" for hardware sets.

END OF SECTION 281301

SECTION 28 23 23
NETWORK VIDEO RECORDER

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 provides specifications for the installation of a Network Video Recorder and related components.
- B. Related Sections
 - 1. Section 26 00 00 Electrical (including related sub-sections)
 - 2. Section 28 00 00 Electronic Safety and Security
 - 3. **Section 28 05 13 Wire and Cable**
 - 4. **Section 28 23 23 Network Video Server**
 - 5. Section 28 23 29 IP Fixed Video Surveillance Cameras

1.3 REFERENCES

- A. Follow provisions of Section 28 00 00 Electronic Safety and Security.

1.4 SYSTEM DESCRIPTION

- A. The Security Contractor shall furnish and install the Network Video Recorder (NVR).
 - 1. All active surveillance equipment shall be on emergency/UPS power.
- B. Coordinate all work that must be performed in security head end spaces with the General Contractor, the Electrical Contractor, and the Telecommunications contractor (if applicable).
- C. The CCTV cameras shall be connected to the local area network with signals routed to a new network video recorder for recording, storage and video retrieval.
- D. The Security Contractor shall coordinate space allocation and network IP addresses with the IT department.
- E. The NVR shall not be loaded to exceed 50% of the camera and/or storage capacity to allow room for expansion.

1.5 SUBMITTALS

- A. Follow provisions of Section 28 00 00 Electronic Safety and Security.
- B. Product Data:
 - 1. Manufacturer's technical data sheets and specifications.
 - 2. Provide a description of system operation indicating the purpose and capability of each device/component of the system with a functional diagram indicating all interfaces to other systems.

- C. Shop drawings shall reflect all requirements associated with Owner provided or existing equipment and materials that will be used as part of this system.
 - D. Video Storage calculations to show the system capacity can accommodate the specified video retention.
 - E. Battery calculations to show the expected loads and backup duration for all active surveillance equipment.
 - F. Closeout Submittals
 - 1. User Manuals
 - 2. Parts list.
 - 3. System device locations on architectural floor plans.
 - 4. Wiring and connection diagrams.
 - 5. Maintenance requirements.
- 1.6 QUALITY ASSURANCE
- A. Follow provisions of Section 28 00 00 Electronic Safety and Security.
 - B. All installation, configuration, setup, programming and related work shall be performed by technicians thoroughly trained by the manufacturer in the installation and service of the equipment provided.
- 1.7 DELIVERY, STORAGE AND HANDLING
- A. Follow provisions of Section 28 00 00 Electronic Safety and Security.
 - B. Deliver materials in manufacture's original, unopened, undamaged containers with original identification labels.
 - C. Protect stored materials from environmental and temperature conditions following the manufacturer's instructions.
 - D. Handle and operate products and systems according to manufacturer's instructions.
- 1.8 PROJECT/SITE CONDITIONS
- A. Follow provisions of Section 28 00 00 Electronic Safety and Security.
- 1.9 WARRANTY
- A. Follow provisions of Section 28 00 00 Electronic Safety and Security.
- 1.10 MAINTENANCE
- A. Make ordering of new equipment for expansions, replacements and spare parts available.
 - B. Provide factory direct technical support to the installing firm.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. NVR Server: Compatible with Minimum VMS Requirements
 - 1. American Dynamics:

- a. VideoEdge NVR 4.3 R720 with 4 camera license and 30TB of usable RAID 5 configured video storage.
2. Substitutions:
 - a. All proposed substitutions must be approved by the Consultant.
 - b. Proposed substitutions must provide a line-by-line specification compliance document.

2.2 NETWORK VIDEO RECORDER

- A. The NVR shall be integrated into a server-class computing platform ('PC'). The PC shall be available in a rack-mount chassis and shall fit in an EIA-standard 19" equipment rack.
- B. The system shall use commercial-off-the shelf hardware a 100% open standards based API for interoperability with other applications.
- C. Native support of H.264 compression that does not require the use of additional software or equipment.
- D. The NVR shall be compatible with the existing video management system, if applicable, along with the following minimal requirements:
 1. Provide hot swappable storage drives in a RAID 5 array
 2. Support dual stream cameras
 3. Include a dual Network Interface Card (NIC) that supports:
 4. Full duplex
 5. Fault tolerance
 6. Link aggregation
 7. Load Balancing
 8. Traffic prioritization
 9. Hot swap
- E. System Components:
 1. The server shall meet or exceed the manufacturer recommendations including:
 - a. All hard disk components used by the system shall be designed specifically for enterprise storage applications in disk dense environments.
 - b. Server shall have two Gigabit network controller ports.
 - c. Server shall have RS-232C serial port, for communications with pan-tilt-zoom cameras and other auxiliary devices.
 - d. Server shall have High-Speed USB 2.0 serial ports, for the attachment of external storage, digital I/O and archive devices.
 2. The server shall provide the following optional components:
 - a. The server shall optionally provide support for between sixteen (16) and one-hundred (100) digital input and output points for wired integration with access control, building automation

equipment, sensors, monitors, or other application requirements that may be determined at a later time. The server shall support any combination of the following digital input and output devices that are physically connected to the server via the PC's USB bus:

- i. 8 in + 8 out – 8 optically isolated digital inputs and 8 reed-relay outputs.
 - ii. 16 in – 16 optically isolated digital inputs.
 - iii. 16 out – 16 reed-relay outputs.
 - iv. 48 TTL – 48 TTL points defined as inputs or outputs in blocks of 8.
 - v. 96 TTL – 96 TTL points defined as inputs or outputs in blocks of 8.
- b. The server shall support capture of video from cameras:
- i. Server shall support IP cameras from leading camera manufacturers, with these video feeds connected through the server network controller without the need for encoders or other devices.
- F. Video Storage
1. The NVR shall provide 60 days of video storage.
 2. The integrator shall properly quantify of number of required NVR's as stated herein. The quantity of NVR's are a basic requirement of this project so as to properly distribute the load of cameras specific to this project.
 3. The NVR equipment will be distributed throughout the facility, located in an equipment rack provided by the Security Contractor, in locations as specified on the Contract Drawings.
 4. Provide video storage capacity using the following minimum criteria:
 - a. All cameras using H.264 compression.
 - b. Interior cameras: Use native camera resolution.
 - c. Exterior cameras: Use native camera resolution.
 - d. Wide angle lens cameras: Use native camera resolution.
 - e. Motion triggered recording
 - i. Assume that motion will be detected 50% of the day.
 - ii. Motion detection will be configurable by camera and schedule to mitigate nuisance triggers.
 - iii. Record video as specified herein when motion is detected.
 - iv. Record video as specified herein when no motion is detected.
- G. Coordinate with owner on the number of user licenses required.
- H. Provide UPS for backup power to the NVR(s) and peripheral equipment.

1. Follow provisions of Section 28 00 00 for UPS power requirements.
2. Coordinate with Division 26 to provide a dedicated Emergency Power circuit.

2.3 UNINTERRUPTABLE POWER SUPPLY

- A. Rack mounted components, including all active network communication hardware, shall be on an Uninterruptible Power Supply (UPS) system.
- B. Provide UPS for backup power to the NVR(s) and peripheral equipment.
 1. Follow provisions of Section 28 00 00 for UPS power requirements.
 2. Coordinate with Division 26 to provide a dedicated Emergency Power circuit.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine area to receive devices and notify any adverse conditions affecting installation or subsequent operation.
- B. Do not begin installation until unacceptable conditions are corrected.

3.2 PREPARATION

- A. Protect devices from damage during construction.

3.3 INSTALLATION

- A. Install devices in accordance with manufacturer's instruction at locations indicated on the floor drawing plans.
- B. Perform installation with qualified service personnel.
- C. Install devices in accordance with the National Electrical Code or applicable local codes.
- D. Ensure selected location is secure and offers protection from accidental damage.

3.4 INSTALLATION

- A. Follow provisions of Section 28 00 00 Electronic Safety and Security.
- B. All surveillance system devices and components shall be compatible.
- C. Provide labeling suitable to Owner for all major equipment components. Coordinate with Owner on numbering scheme to match existing, if applicable.
- D. Coordinate with Telecommunication subcontractor for network and patch panel provisions for security connections in the IT room. (If applicable)
- E. Coordinate with Owner for all system programming and database requirements.
 1. Provide all programming, setup, camera and device titling and data entry
 2. Camera and device title and descriptions shall be consistent for all components
- F. Install all Point-to-Point wiring with appropriate terminal connections for every wire and component termination so that all connections are mechanically and electrically secure.
- G. Install field wiring in continuous lengths, without splices.

- H. Verify upon job completion that all wiring and terminations are clearly labeled to identify the wire and terminal.

3.5 FIELD QUALITY CONTROL

- A. Test snugness of mounting screws of all installed equipment. B. Test proper operation of all VMS devices.
- B. Determine and report all problems to the manufacturer's customer service department.

3.6 ADJUSTING

- A. Make proper adjustment to video system devices for correct operation in accordance with manufacturer's instructions.

END OF SECTION

SECTION 28 23 29
IP FIXED VIDEO SURVEILLANCE CAMERAS

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 provides specifications for the installation of a fixed IP based Video Surveillance System (VS) and related components.
- B. Furnish labor, materials, inspections, supervision, etc., necessary for a turnkey installation and operation the equipment specified herein. Work includes furnishing all items and accessories required or necessary for the correct operation of the equipment as shown on plans and/or specified herein exception of those items noted within this specification as being provided by others.
- C. Related Sections include:
 - 1. Section 28 00 00 Electronic Safety and Security
 - 2. Section 28 05 13 Wire and Cable
 - 3. Section 28 23 23 Network Video Recorder

1.3 REFERENCES

- A. See Section 280000 Electronic Safety and Security.

1.4 SYSTEM DESCRIPTION

- A. The camera shall be of manufacturer's official product line, designed for commercial/industrial 24/7/365 use.
- B. The camera shall be based upon standard components and proven technology using open and published protocols.
- C. The Security Contractor shall furnish and install the surveillance system, consisting of camera assemblies, Network Switches, wiring & cabling, and low voltage camera power supplies.
 - 1. All active surveillance equipment and devices shall be on emergency/UPS power.
- D. Camera assemblies include camera, lens, housing, and mount. Provide and install wiring and low voltage power from the security wall field/rack to the camera locations.
 - 1. Scope of work shall be complete from point of origin (camera) to point of termination (security rack).
- E. Coordinate all work that must be performed in security head end spaces with the General Contractor, the Electrical Contractor, and the Telecommunications contractor (if applicable).
- F. The CCTV cameras shall be connected to the local area network with signals routed to a new network video recorder for recording, storage and video retrieval.
- G. The Security Contractor shall coordinate space allocation and network IP addresses with the IT department.
- H. Camera lenses for fixed cameras shall be varifocal and sized to provide the owner approved field of view. The lens shall be IR corrected and have megapixel resolution.

- I. All pole mounted exterior cameras shall have video and data signals transmitted over multi-mode fiber. The fiber and conduit, including the termination of the fiber in a fiber receiver and transmitter, as well as, the media converter required to convert the transmission from fiber to category cable for connection at the camera and NVR, respectively is required in this scope of work.
- J. Surveillance camera audio functions shall not be installed and/or disabled unless specifically requested by Owner.
- K. PoE network switches provided by the Security Contractor shall:
 - 1. Be racked mounted and located in the closets specified on the Contract Documents.
 - 2. Switches shall be appropriately sized to power all associated IP fixed cameras over a Cat-5 cable as stated in the Contract Documents.
 - 3. The switch shall automatically determine PoE requirements for speed, duplex and cable type, and discontinue power when PoE devices are disconnected.
 - 4. Each port shall have independent overload and short circuit protection as well as LED indicators to show power status.
 - 5. The switch shall be IEEE 802.3af Compliant and UL Listed.
 - 6. All switches shall be Layer 3 type.

1.5 SUBMITTALS

- A. Follow provisions of Section 28 00 00 Electronic Safety and Security.
- B. Video Quality test reports shall be provided for all cameras to confirm an optimum high definition video signal.
- C. Battery calculations to show the expected loads and backup duration for camera power supplies and UPS devices for all active surveillance equipment.
- D. Provide system programming, camera titles, descriptions, camera images and database.
 - 1. Provide camera titles and descriptions prior to system programming.
 - 2. Provide programming/database prior to performance testing.
 - 3. Provide a cross reference between specified camera numbers and programmed camera numbers.
 - 4. Provide final programming, camera images and system documentation on electronic media to Owner.

1.6 ENVIRONMENTAL SUSTAINABILITY

- A. The specified unit shall be manufactured in accordance with ISO 14000.
- B. The specified unit shall be compliant with 2002/95/EG RoHS and 2002/96/EG WEEE.

1.7 CERTIFICATIONS AND STANDARDS

- A. The camera shall carry the following EMC approvals:
 - 1. EN55022, EN55024
 - 2. FCC Part 15 - Subpart B
 - 3. VCCI
 - 4. C-tick AS/NZS CISPR22
 - 5. ICES-003

- B. The camera shall meet the following product safety standards
 - 1. UL / EN 60950 -1
 - C. The camera shall meet relevant parts of the following video standards:
 - 1. SMPTE 296M (HDTV 720p)
 - D. The camera shall meet the following standards
 - 1. MPEG-4:
 - 2. ISO/IEC 14496-10 AVC (H.264)
 - E. Networking:
 - 1. IEEE 802.3af (Power over Ethernet)
 - 2. IEEE 802.1X (Authentication)
 - 3. IPv4 (RFC 791)
 - 4. IPv6 (RFC 2460)
 - 5. QoS – DiffServ (RFC 2475)
 - F. Network video:
 - 1. ONVIF Profile S or ONVIF Version 1.01 or higher as defined by the ONVIF organization.
 - G. Mechanical Environment:
 - 1. IEC 62262 Class IK10 (Impact resistance)
 - 2. EN 62471 (Photobiological Safety)
- 1.8 QUALITY ASSURANCE
- A. Follow provisions of Section 28 00 00 Electronic Safety and Security.
- 1.9 DELIVERY, STORAGE AND HANDLING
- A. Follow provisions of Section 28 00 00 Electronic Safety and Security.
- 1.10 PROJECT/SITE CONDITIONS
- A. Follow provisions of Section 28 00 00 Electronic Safety and Security.
- 1.11 WARRANTY
- A. Follow provisions of Section 28 00 00 Electronic Safety and Security.
- 1.12 MAINTENANCE
- A. Follow provisions of Section 28 00 00 Electronic Safety and Security.
- PART 2 - PRODUCTS
- 2.1 MANUFACTURERS
- A. Interior IP Fixed Dome Camera
 - 1. illustra 610 Indoor HD LT 1080p minidome, auto focus, 3-9mm varifocal, PoE only, white, clear bubble, model ADCI610LT-D111
 - 2. Or Approved Equal
 - B. Exterior IP Fixed Dome Camera

1. illustra 610 Outdoor HD 1080p minidome, TDN, WDR, 3-9mm varifocal, IR Illuminator, vandal resistant, PoE+ heater, white, clear bubble, model ADCi610-D021
 - a. illustra 600/610 Dome pendant cap Outdoor,white, model ADCi6DPCAPOW
 - b. Discover, Mount, wall arm, for NV LookOut, no plate, model ADLOMARM
1. Or Approved Equal
- B. Lightning Protection
 1. Ditek
 2. Or Approved Equal
- C. PoE NETWORK SWITCH
 1. Cisco
 2. 2. D-LINK
 3. 3. Netgear
 4. 4. or Approved Equal

2.2 GENERAL

- A. The camera shall:
 1. Be designed to provide at least two video streams in HDTV 1080p (1920x1080) at up to 30 frames per second (60Hz mode) or 25 frames per second (50Hz mode) using H.264 or Motion JPEG.
 2. Be equipped with Day/Night functionality.
 3. Be equipped with remote zoom and focus capabilities.
 4. Operate on an open source; Linux-based platform, and including a built-in web server.
 5. Be manufactured with an all-metal vandal resistant body. The SMS's integrated CCTV System shall provide video surveillance, assessment, and visual alarm monitoring of selected interior and exterior access doors as well as other critical areas of the building as specified on the Contract Drawings.
 6. Be provided with wall, ceiling, building (corner/wall), pendant and pole mounts as indicated on the Contract Drawings and Schedules.
 - a. Surface mounted fixed and PTZ cameras shall not be mounted on walls without the use of a wall mount pendant adapter.
 - b. Pole mounted PTZ cameras shall be mounted with the use of the wall mount and a pole mount adapter.
 - c. Where installed under building overhangs, exterior cameras shall be flush mounted or appropriately pendant mounted at the correct height to accommodate a finished overhang ceiling.
 7. Be recorded on the Network Video Server (NVS) and provide full video at all times.
 8. Be protected from lightening if mounted on the exterior.
 9. Shall include a channel license per camera, if required.

10. Shall be compatible with the VMS.
11. Shall provide multi-stream so that recording and viewing can be at different frame rate and compression.

B. The Security Contractor shall coordinate space allocation and network IP addresses with the IT department as required.

2.3 HARDWARE

A. The camera shall:

1. Use a high quality IR-sensitive progressive scan sensor.
2. Be equipped with a high quality varifocal lens.
3. Be equipped with a removable IR-cut filter, providing so-called day/night functionality.
4. Provide automated iris functionality with P-Iris control.
5. Provide remote zoom and focus functionality.
6. Provide pictures down to 0.15 lux in color and down to 0.04 lux in B/W.

2.4 VIDEO

A. Resolution

1. The camera shall be able to deliver at least two individually configurable full resolution full frame rate video streams over IP networks.
2. Supported video resolutions shall include:
 - a. 640x360 (16:9)
 - b. 640x480
 - c. 1280x720 (16:9)
 - d. 1280x960
 - e. 1400x1050 (scaled)
3. The camera shall be able to provide both landscape format (4:3 and 16:9 aspect ratio) as well as corridor format (3:4 and 9:16 aspect ratio).

B. Encoding

1. The camera shall:
 - a. Support Motion JPEG encoding in a selectable range up to 30 frames per second in all resolutions.
 - b. Support Baseline Profile H.264 encoding with motion estimation in up to 30 frames per second in all resolutions.
 - c. Support Main Profile H.264 encoding with motion estimation and context-adaptive binary arithmetic coding (CABAC) in up to 30 frames per second in all resolutions.
 - d. Be able to provide independently configured simultaneous H.264 and Motion JPEG streams.
 - e. Support both Constant Bit Rate (CBR) and Variable Bit Rate (VBR) in H.264.
 - f. Provide configurable compression levels.

C. Transmission

1. The camera shall allow for video to be transported over:
 - a. HTTP (Unicast)
 - b. HTTPS (Unicast)
 - c. RTP (Unicast & Multicast)
 - d. RTP over RTSP (Unicast)
 - e. RTP over RTSP over HTTP (Unicast)
 2. The camera shall support Quality of Service (QoS) to be able to prioritize traffic.
- D. Image control
1. The camera shall incorporate Automatic and Manual White Balance
 2. The camera shall be equipped with an electronic shutter.
 3. The camera shall incorporate automatic and manually defined exposure zones.
 4. The camera shall be equipped with Wide Dynamic Range functionality - dynamic contrast.
 5. The camera shall support a configurable maximum shutter in the range from 2 seconds to 1/24500 seconds in 50Hz mode
 6. The camera shall support a configurable maximum shutter in the range from 2 to 1/29500 seconds in 60Hz mode.
 7. The camera shall incorporate Back Light Compensation.
 8. The camera shall allow for rotation of the image in steps of 90°.
 9. The camera shall support manually defined values for:
 - a. Color level
 - b. Brightness
 - c. Sharpness
 - d. Contrast

2.5 AUDIO

- A. The camera shall support two-way full duplex audio:
1. Input sources
 - a. Built-in microphone
 - b. External microphone
 - c. External line device
 2. Output sources
 - a. External line device
- B. Encoding
1. The camera shall support:
 - a. AAC LC at 8/16 kHz
 - b. G.711 PCM at 8 kHz
 - c. G.726 ADPCM at 8 kHz

2.6 FUNCTIONALITY

- A. Web server
 - 1. The camera shall contain a built-in web server making video and configuration available to multiple clients in a standard operating system and browser environment using HTTP, without the need for additional software.
 - 2. Optional components downloaded from the camera for specific tasks, e.g. Active X, shall be signed by an organization providing digital trust services, such as Verisign, Inc.
- B. IP addresses
 - 1. The camera shall support both fixed IP addresses and dynamically assigned IP addresses provided by a Dynamic Host Control Protocol (DHCP) server.
 - 2. The camera shall allow for automatic detection of the Camera based on UPnP and Bonjour when using a PC with an operating system supporting this feature.
 - 3. The camera shall provide support for both IPv4 and IPv6.
- C. PTZ functionality
 - 1. The camera shall provide non mechanical PTZ functionality (no moving parts).
 - a. The camera shall provide at least 100 preset positions.
 - b. The camera shall reach selected position within 0.1 second.
 - c. The camera shall provide a guard tour functionality which allow the camera to automatically move between selected presets using an individual speed and viewing time for each preset.
- D. Event functionality
 - 1. The camera shall be equipped with an integrated event functionality, which can be triggered by:
 - a. Video Motion Detection
 - b. Schedule
 - c. Camera tampering
 - d. Embedded third party applications
 - e. External input
 - f. Audio Detection
 - g. Edge storage disruption detection
 - 2. Response to triggers shall include:
 - a. Notification, using TCP, SMTP or HTTP
 - b. Image upload, using FTP, SMTP or HTTP
 - c. Activating external output
 - d. Recording to local storage and/or network attached storage
 - 3. The camera shall provide memory for pre & post alarm recordings.
 - 4. Event functions shall be configurable via the web interface.
- E. Edge storage
 - 1. The camera shall support continuous and event controlled recording to:
 - a. Local memory added to the cameras SD-card slot

- b. Network attached storage, located on the local network
 2. The camera shall be able to detect and notify Edge storage disruptions
- F. Protocol support
 1. The camera shall incorporate support for at least IP, HTTP, HTTPS, SSL/TLS, TCP, ICMP, SNMPv1/v2c/v3 (MIB-II), RTSP, RTP, UDP, IGMP, RTCP, SMTP, FTP, DHCP, UPnP, ARP, DNS, DynDNS, SOCKS, NTP, CIFS/SMB and Bonjour.
 2. The SMTP implementation shall include support for SMTP authentication.
- G. Text overlay
 1. The Camera shall:
 - a. Provide embedded on-screen text with support for date & time, and a customer-specific text, camera name, of at least 45 ASCII characters.
 - b. To ensure accuracy, the camera shall accept external time synchronization from an NTP (Network Time Protocol) server.
 - c. Provide the ability to apply a privacy mask to the image.
 - d. Allow for the overlay of a graphical image, such as a logotype, into the image.
- H. Security
 1. The camera shall:
 - a. Support the use of HTTPS and SSL/TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both administration data and video streams.
 - b. Support IEEE 802.1X authentication.
 - c. Provide support for restricting access to pre-defined IP addresses only, so-called IP address filtering.
 - d. Restrict access to the built-in web server by usernames and passwords at three different levels.
- I. API support
 1. The camera shall be fully supported by an open and published API (Application Programmers Interface), which shall provide necessary information for integration of functionality into third party applications.
 2. The camera shall conform to ONVIF Profile S or ONVIF Version 1.01 or higher as defined by the ONVIF organization, and shall be upgradable at any time.
- J. Embedded applications
 1. The camera shall provide a platform allowing the upload of third party applications into the camera.
 2. The camera vendor shall provide a compatibility tool for the application vendor to verify the stability and performance impact of their uploaded application.
- K. Installation and Maintenance
 1. The camera shall:
 - a. Be supplied with Windows-based management software which allows the assignment of IP addresses, upgrade of firmware and backup of the Cameras' configuration.

- b. Support the use of SNMP-based management tools according to SNMP v1, 2c & 3 / MIB-II.
 - c. Allow updates of the software (firmware) over the network, using FTP or HTTP.
 - d. Provide the ability to apply a rectangle of customer-defined number of pixels to the image, which can be used as a pixel counter identifying the size of objects in number of pixels.
 2. All customer-specific settings shall be stored in a non-volatile memory and shall not be lost during power cuts or soft reset.
 - L. User logs
 1. The camera shall:
 - a. Provide a log file, containing information about the 250 latest connections and access attempts since the unit's latest restart. The file shall include information about the connecting IP addresses and the time of connecting.
 - b. Provide a connection list of all currently connected viewers. The file shall include information about connecting IP address, time of connecting and the type of stream accessed.

2.7 CAMERA DIAGNOSTICS

- A. The camera shall:
 1. Be equipped with LEDs, capable of providing visible status information. LEDs shall indicate the camera's operational status and provide information about power, communication with receiver, the network status and the camera status.
 2. Be monitored by a Watchdog functionality, which shall automatically re-initiate processes or restart the unit if a malfunction is detected.

2.8 INTERFACES

- A. Network interface
 1. The camera shall be equipped with one 100BASE-TX Fast Ethernet-port, using a standard RJ-45 socket and shall support auto negotiation of network speed (100 MBit/s and 10 MBit/s) and transfer mode (full and half duplex).
- B. Audio
 1. The camera shall be equipped with one 3.5 mm jack for line/mic input and one 3.5 mm jack for line output.
- C. Inputs/Outputs
 1. The camera shall be equipped with one digital (alarm) input and one digital output, accessible via a removable terminal block. This input shall be configurable to respond to normally open (NO) or normally closed (NC) dry contacts.

2.9 ENCLOSURE

- A. The camera enclosure shall include the following:
 1. Manufactured with an all-metal vandal resistant body providing encapsulated electronics
 2. Vandal resistant casing with clear transparent cover
 3. Impact resistance according to IK10

- B. The camera enclosure shall provide the ability to adjust the camera modules angle with 360° (pan), 170° (tilt) and 340° (rotation) while maintaining an image that is not interfered by the camera housing.

2.10 POWER REQUIREMENTS

- A. Power over Ethernet according to IEEE 802.3af - Class 3.

2.11 ENVIRONMENTAL

- A. The camera shall:
 - 1. Operate in a temperature range of 0°C to +50°C (32°F to +122°F).
 - 2. Operate in a humidity range of 10–85% RH (non-condensing).

2.12 180/ 360 DEGREE CAMERA

- A. Shall provided Double Panorama, Panorama, Quad PTZ, Single PTZ image modes.
- B. Shall provide built-in image and distortion correction.
- C. Shall provide super dynamic function and face detection.
- D. Shall be IP, PoE IEEE 802.3af.
- E. Shall have a clear lower dome, unless otherwise specified.
- F. Shall include remote focus and zoom over the network.
- G. Shall have a minimum sensitivity of 0.05 Lux at:

2.13 MIDSPAN PoE POWER INJECTORS (as required)

- A. Provide rack mounted power injectors whenever PoE camera power exceeds 15 watts.
- B. Provide rack mounted power injectors when PoE camera power exceeds capacity of owner provided Network Switch port power.

PART 2 - EXECUTION

3.1 CONFIGURATION

- A. Cameras
 - 1. Lenses shall be field tested with Owner present to verify clear, crisp images and desired field of view a) Substitute camera lenses as necessary to obtain required field of view at no additional cost b) Provide spot filters for exterior lenses as required to reduce picture washout caused by sunlight
 - 2. The security integrator shall coordinate network and IP address requirements with Owner to identify the Media Access Control (MAC) address (Layer 2) of each provided camera, the location to be installed, and the port configuration needed for communication.
 - 3. Make all necessary adjustments to camera lenses to obtain clear, crisp images and desired field of view to the Owners satisfaction.
 - a. Substitute camera lenses as necessary to obtain required field of view at no additional cost.
- B. Adjust all cameras to produce high-definition images with no blooming, streaking or noticeable lag.
- C. Provide and install in-line PoE injectors, as required, when non-PoE network switches are used or when manufacturer specified power is not available to the camera.
- D. All camera power shall comply with the specified power requirements.

3.2 POWER REQUIREMENTS

- A. Refer to Section 28 00 00 for UPS and power requirements
- B. Rack mounted components, including all active network communication hardware, shall be on an Uninterruptible Power Supply (UPS) system.
- C. Camera power supplies shall be on an Auxiliary Power Supply (APS), system as required, with a battery backup.
 - 1. The Auxiliary power supply shall be furnished with a power distribution panel with each camera individually fused or protected with an over-current protector.
- D. Power supplies shall provide:
 - 1. 120 VAC input and output voltage as required
 - 2. UL Listed
 - 3. Power fail contacts to monitor the status of the input power
 - a. Connect each power supply power fail alarm as a separate alarm input into AC/ID system
 - 4. Key lockable wall mount metal enclosure with tamper switch
 - 5. Independently fused outputs

3.3 INSTALLATION

- A. Refer to Section 28 00 00 Electronic Safety and Security.
- B. The Contractor shall carefully follow instructions in documentation provided by the manufacturer to ensure all steps have been taken to provide a reliable, easy-to-operate system.
- C. All equipment shall be tested and configured in accordance with instructions provided by the manufacturer prior to installation.
- D. All firmware found in products shall be the latest and most up-to-date provided by the manufacturer, or of a version as specified by the provider of the Video Management System (VMS) or Network Video Recorder (NVR).
- E. All equipment requiring users to log on using a password shall be configured with user/site-specific password/passwords. No system/product default passwords shall be allowed.
- F. A proper installation shall meet NEC (National Electrical Code – US only) per the guidelines of that year's revision. When properly installed equipment meets Low Voltage, Class 2 classification of the NEC.
- G. All surveillance system devices and components shall be compatible.
- H. Camera Housings and Mounts
 - 1. Cameras shall include housings and mounts as indicated in the Drawings.
 - 2. Wiring to cameras shall pass from the back-box through the mount and into the housing. Exposed wiring or conduit shall not be acceptable.
 - 3. Provide sun shields for camera housings in outdoor locations exposed directly to sunlight.
 - 4. Provide surge protection for power and copper video cables for exterior cameras at the camera and at the point of termination (security rack).
 - 5. Field verify the exact camera location, position, and mounting prior to installation.

6. Roof mounted cameras shall use roof deck brackets.
7. Provide the smallest available housing for each camera application.
 - a. Integrated miniature dome cameras are preferred
- I. Provide labeling suitable to Owner for all major equipment components. Coordinate with Owner on numbering scheme to match existing. Major equipment components:
 1. Video monitors, IP camera Patch Panels (if required).
- J. Coordinate with Telecommunication subcontractor for network and patch panel provisions for security connections in the IT room. (If applicable)
- K. Coordinate with Owner for all system programming and database requirements.
 1. Provide all programming, setup, camera and device titling and data entry
 2. Camera and device title and descriptions shall be consistent for all components
- L. Install all Point-to-Point wiring with appropriate terminal connections for every wire and component termination so that all connections are mechanically and electrically secure.
- M. Install field wiring in continuous lengths, without splices.
- N. Verify upon job completion that all wiring and terminations are clearly labeled to identify the wire and terminal.
- O. Testing of the surveillance system includes checkout of installed cameras back to the Security head end equipment to confirm proper operation of camera assemblies. Security integrator shall provide all necessary test equipment to fully demonstrate proper performance of field devices. Copies of test results shall be included in the project completion submittals given to the Owner.

END OF SECTION

SECTION 283110

FIRE ALARM – EXISTING SYSTEM EXTENSION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. All of the Contract Documents, as listed on the Table of Contents and including General and Supplementary Conditions and Division 01, General Requirements, shall be included in, and made part of, this Section.

1.02 DESCRIPTION OF WORK

- A. Provide extension and modification to the existing fire alarm, detection and emergency communications system that currently serves the campus, according to the specifications and as shown on the drawings.
- B. The work shall include the necessary modification and expansion of the existing Simplex 4100 Series Fire Alarm Control Network System to include the required hardware modules, devices, with wiring, temporary reprogramming, final programming and system re-acceptance testing in accordance with NFPA standards and applicable code.
- C. The system operation, including event annunciation, occupant notification, fire safety functions, campus reporting and operator’s workstation functions shall match existing.
- D. All devices and their respective wiring including types, methods and color-coding shall match existing.
- E. The system shall include all necessary hardware, software and peripheral devices to perform the following functions:
 - 1. Fire/smoke detection and alarm
 - 2. One and two way emergency voice communications
 - 3. System supervision and Supervising Station service including point-level annunciation and control from the UCHC public safety “TSW” operator’s workstation.
 - 4. All related fire safety functions

- F. Temporary protection during construction, alteration and demolition.

- G. System programming and re-programming of all changes as necessary to accommodate the phased construction, alteration and demolition activities.

1.03 RELATED WORK

- A. For work to be included as part of this Section to be furnished and installed by the Electrical Subcontractor, refer to the Related Work section of Specification Section 260510.
- B. Carefully examine all of the Contract Documents, criteria sheets and all other Sections of the specifications for requirements which affect work under this Section, whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

- A. The following Reference Standards shall be used in system design, installation, operation and maintenance. Reference Standards used shall be the latest applicable edition of said document unless otherwise approved:
1. 2005 Connecticut Building Code with 2013 Amendment
 2. International Building Code (IBC - 2009)
 3. Connecticut Fire Prevention Regulations and Connecticut Electrical Code
 4. NFPA 70 – National Electrical Code (2014 Edition)
 5. NFPA 72 - National Fire Alarm Code (2010 Edition)
 6. NFPA 101 – Life Safety Code (2012 Edition)
 7. Underwriters Laboratories (UL) Listings, including ANSI/UL 864 (9th Edition)
 8. Americans with Disabilities Act (ADA), the Architectural Barriers Act (ABA), and applicable state and local Accessibility Regulations.
 9. All applicable State and Local ordinances.
 10. UCHC Design Standard 16725
 11. FM Global Data Sheet 5-40 *Fire Alarm Systems*

1.05 QUALITY ASSURANCE

- A. Each system component shall be UL Listed for its' intended purpose and match existing product to ensure compatibility. All components including control equipment, initiating devices, notification appliances and accessories shall be the products of the Simplex Grinnell.
- B. The Electrical Subcontractor shall retain the services of the existing service company of record and an Original Equipment Manufacturer's qualified representative (Simplex Grinnell) to coordinate the system operation and installation. Any agent conducting work under this project shall survey existing conditions, generate the shop drawings and assume responsibility for the complete, modified system.

1.06 WARRANTY

- A. Attention is directed to provisions of the General Requirements, Supplementary General Requirements and Section 260510 regarding guarantees and warranties for the work under this Contract.

1.07 SUBMITTALS

- A. Prepare and submit shop drawings in accordance with the requirements hereinbefore specified, and with the Shop Drawings, Product Data and Samples Section 013300 in the manner described therein, modified as noted hereinafter.
- B. All shop drawings shall have clearly marked the appropriate specification number of drawing designation, for identification of the submittal.
- C. Disposition of shop drawings shall not relieve the Electrical Subcontractor from the responsibility for deviations from drawings and specifications, unless the deviations are specifically noted in writing at the time of submission and written approval from the Engineer has been received. The disposition of shop drawings shall not relieve the Electrical Subcontractor from responsibility for errors in shop drawings or schedules.

- D. Fire alarm system shop drawings shall be prepared by a qualified, factory-trained, NICET-Certified system designer (level III minimum). Complete documentation shall be provided in accordance with NFPA 72 and contain the following information:
1. Any exceptions or deviations from the specified features and functions shall be noted and justified in writing. Failure to note deviations will result in disapproval.
 2. Revised point-to-point riser diagrams showing all new and existing equipment including the size, type, number and reference designations for all circuits and devices effected under this project. Each device shall be shown with address numbers or any other required field device settings, including speaker tap settings and candela rating. Riser diagrams shall consist of:
 - a. A complete one-line Network Riser Diagram showing any network modifications as applicable.
 - b. Detailed point-to-point riser diagram(s) showing all new and existing equipment, devices and circuits connected to a given fire alarm control panel.
 3. Scaled drawings showing all required modifications to existing panels showing module placement, field terminations and spare capacity allowances.
 4. A complete, itemized bill of materials being added with quantities, descriptions, and cross-reference information for each item.
 5. A complete list of all new and existing addressable devices with corresponding address number, device type, and alphanumeric message nomenclature for review and coordination.
 6. Sequence of Operation: Provide a complete sequence of operation in the form of an NFPA Input/Output programming matrix for the entire system as shown in NFPA 72.
 7. Original catalog data sheets for each item with submitted components noted, demonstrating compliance with these specifications. All equipment shall be subject to approval, and no equipment shall be ordered without prior approval.
 8. Floor plans showing all existing and new devices affected by the scope of this project. Devices shall be shown with field settings, and circuit and device designations noted. Field settings shall include the device address, candela rating and/or speaker-tap setting as applicable. Circuit identifier and device numbers are required to enable cross-reference with related documents.
 9. Provide battery calculations to support the size of standby power requirements specified herein reflecting all new and existing devices being supported.
 10. Provide system calculations for all notification circuits, amplifiers and power supplies submitted showing all new and existing devices being supported. Notification Appliance Circuit calculations shall be presented using the end-loading method described in NFPA recommended practices and as follows:
 - a. Demonstrate wire size, estimated circuit length, and maximum allowable wiring distance as designed.
 - b. Visual circuit calculations shall be based upon 20.4vDC battery terminal starting voltage and utilize UL maximum current draw rating for each appliance.
 - c. Visual circuits shall be designed for a maximum 4.4 volt drop unless otherwise permitted by the equipment manufacturer.
 - d. Speaker circuits shall be designed for a maximum 3dBA loss.
 11. Provide confirmation that the current service company of record or other qualified agent will provide on-site supervision during system installation and perform system reacceptance testing and instruction.

12. Provide a complete phasing and impairment plan to include a schedule of project milestones and related work, and an anticipated schedule for installation, impairments, programming and all phases of final testing. The Contractor shall provide firewatch personnel or temporary protection as directed by the Owner and AHJ when any system impairments exceed eight hours during normal business hours.

1.08 CLOSEOUT SUBMITTALS AND O & M MANUALS

- A. The following information shall be submitted for record purposes, in a binder, prior to final payment:
 1. Final as-built drawings with all information included in the shop drawings modified to show the entire system as constructed.
 2. Any amendments to the existing operation and maintenance manuals with the following information:
 3. A printout and electronic copy of the revised site specific system program.
 4. Certified test reports and Record of Completion.

1.09 CIRCUITING CRITERIA

- A. Network Communications and vertical trunk wiring:
 1. All network wiring, audio risers and vertical runs shall be Class A, Style 7 circuits to match existing. Coordinate network cabling requirements with UCHC and Simplex Grinnell.
 2. Network communications and all other circuits that serve occupant notification shall be subject to the Survivability requirements of NFPA 72 and these Specifications in accordance with the manufacturer's requirements.
- B. Addressable Signaling Line Circuit (SLC)
 1. SLC circuits shall be wired as Class A, circuits to match existing.
 2. SLC wiring shall utilize fault isolation modules so that a single open or ground fault on the conductors serving one evacuation zone/floor will not affect the operation of any other area. The system shall be designed to not exceed 90% of the number of devices each SLC is capable of supporting.
- C. Speaker Circuits
 1. Speaker Notification Appliance Circuits (NAC) shall be configured as Class A circuits.
 2. The system shall be provided with the minimum listed speaker circuits as follows:
 - a. Two (2) speaker circuits for each floor level or evacuation signaling zone.
 - b. Groups of speaker circuits shall be individually selective by evacuation signaling zones.
- D. Visual Strobes
 1. Visual Notification Appliance Circuit (NAC) wiring shall be configured as Class A circuits.
 2. The system shall be provided with a minimum of two (2) visual strobe circuits for each evacuation zone/floor level.

3. Visual notification appliance circuits shall emanate from panel mounted outputs; field-located addressable modules shall not be used to supervise or control visual appliance circuits.

1.10 AUTOMATIC SYSTEM OPERATION

A. Normal Operation

1. Under normal operation the system displays shall present a "SYSTEM IS NORMAL" message and the current time and date.
2. The system shall continually monitor all wiring and devices for changes in status and respond according to the sequences listed herein.
3. Modify the system to match existing occupant notification sequencing to include automatic and selective manual communications from the existing designated locations to match UCHC emergency response plans and procedures.

B. Alarm Condition

1. Any manual pull station and other designated initiating device (automatic initiating device, water flow switch, etc.) shall initiate an alarm condition to match existing sequences.
2. Alarm Condition Operation - Activation of an alarm initiating device shall immediately cause the following:
 - a. Sound an audible alarm signal and flash and alarm LED at the system control unit(s), fire command center and system annunciators.
 - b. Display the assigned English language message text including device address, type, location and status with time and date at the local control unit, fire command center and network annunciators.
 - c. Transmit the event via the current means to the existing Campus Network, Remote Supervising Station and Public Fire Alarm Reporting System.
 - d. Initiate the audible and visual occupant notification sequences throughout the building to match the existing sequence.
 - e. Release all magnetically-held doors on the floor of incidence.
 - f. Activate the exterior beacon.
 - g. Initiate shutdown or control of all dampers or smoke shutters serving the area of origin.
 - h. Activation of designated recall devices shall initiate Elevator recall functions in accordance with ANSI/ASME A17.1 and applicable code.
3. Air Handling System Interface
 - a. The activation of duct-mounted smoke detector that is associated directly with an Air Handling Unit or Fan shall cause the unit to shut down immediately.
 - b. Shutdown shall be initiated by supervised control signal to the associated equipment.
 - c. Provide parallel signals to the Building Automation System (BAS).
4. Fire/Smoke Damper Interface
 - a. Provide supervised output signals to initiate closure of each Fire/Smoke or Smoke Damper shown on the Contract Documents. Signals shall utilize a programmable output module and dedicated multi-voltage power relay, listed and rated for the application.

- b. Provide addressable monitor modules and status feedback from each Fire/Smoke or Smoke damper to track damper positions and report off-normal conditions to the system Annunciators.

C. Trouble Condition

1. Any events designated to activate a Trouble condition shall cause the specific event to display at the main Fire Alarm Control Unit(s), fire command center, network annunciators and the approved Supervising Station.

D. Supervisory Condition

1. Events to Activate a Supervisory Condition shall include activation of any sprinkler supervisory (tamper) switch, and any other designated pre-alarm or Supervisory event.
2. Supervisory Condition Operation: Any events designated to activate a Supervisory condition shall cause the specific event to display at the main Fire Alarm Control Unit(s), fire command center, network annunciators and the approved Supervising Station.

1.11 STATUS MONITORING OF NON-SYSTEM EQUIPMENT

- A. Provide the necessary hardware, wiring and programming to show status indication of the following new equipment as applicable.

1. Valve tamper at fire pump
2. Fire pump "running", "power loss", "phase reversal" - each pump
3. Emergency generator "ON", "start failure", "low fuel", "low oil pressure"
4. Sprinkler and standpipe valve tampers by device
5. Each stairwell or elevator pressurization fan (on/off/fault)
6. Each smoke removal fan that is running
7. Fire/Smoke dampers (open/closed)
8. Radio Repeater / Bi-directional amplifier fault.
9. Monitor fan/AHU run status and close associated fire/smoke dampers whenever the fan is off.

1.12 SYSTEM PROGRAMMING

- A. The system supplier shall provide all required temporary reprogramming and final programming within the scope of this project.
- B. An electronic copy of the site-specific system program file shall be retained on-site and turned over to the Building Owner with the project closeout documents.
- C. Provide all required re-programming of the existing operator's workstation located at the Public Safety Office, to include new graphic floor plans, custom navigation screens and custom control functions.

PART 2 PRODUCTS

2.01 FIRE ALARM CONTROL PANELS

- A. Provide modification or expansion of the existing Fire Alarm Control equipment to serve the scope of this project.

- B. The Contractor shall coordinate with the supplier of record to confirm the existing site conditions and system capacities to accommodate the required addressable loop, power supply, audio amplifier and standby battery capacity to support the required system operation.
- C. Provide new distributed Simplex 4100 ES Fire Alarm Control Units to support the renovated area, which will include the following:
 - 1. Central Processing Unit (CPU) with operator's display, network interface card and Audio Controller to provide the ability to generate the pre-recorded system messages and tones described herein.
 - 2. Addressable Loop - Signaling Line Circuit (SLC) addressable loop interface module to support a minimum of 250 addressable points.
 - 3. One hundred (100) watts of primary audio amplification with backup amplifiers. Power from each amplifier shall be distributed over a minimum of six (6) individually programmable on-board speaker circuits.
 - 4. Eighteen (18) amps of 24vdc System Power to support auxiliary power, SLC circuits and visual (strobe) Notification Appliance Circuits.
 - 5. A minimum of six (6) individually programmable strobe circuits, with a total number of circuits as specified and required.
- D. Modify the network panels located at the main Fire Command Center and Network Operator's Workstation as needed to include Operator's Control, annunciation and paging microphone with audio functions and common control switches.

2.02 POWER SUPPLIES

- A. Fire Alarm System Power Supplies
 - 1. Provide additional power supply modules integrated into the local Fire Alarm Control Unit serving the designated area to provide adequate power to all equipment and devices being installed.
 - 2. External standalone power supplies shall not be used, unless specifically shown on the Drawings.

2.03 AUDIO CONTROL AND AUDIO AMPLIFIERS

- A. Expand the existing audio controller, paging microphone and audio control select switches to serve the new areas shown.
- B. Pre-recorded messages and tones shall match existing to include the following:
 - 1. Pre-signal tone.
 - 2. Pre-recorded voice instructional message
 - 3. Evacuation tone (temporal code 3).
 - 4. Provide 25 VRMS or 70 VRMS audio amplifiers to match existing and operate all system speakers simultaneously, plus a total of 25% spare capacity. Amplifiers shall be sized to accommodate each speaker set at one (1) watt tap and each high output speaker at 8 watts. Each system panel shall be provided with redundant amplifiers or a floating back-up amplifier to serve audio circuits in the event of an amplifier failure.
 - 5. Provide area paging selector switches with LED indicators at the fire command center for each new evacuation zone.

- C. Speaker circuits serving each building area or evacuation signaling zone shall be programmed as separate signaling groups capable of broadcasting a separate audio channel.

2.04 BATTERIES/BATTERY CHARGER

A. Batteries

1. Rechargeable, sealed lead-acid batteries shall be provided with reliable and repeatable discharge and recharge characteristics for use in fire alarm systems.
2. Batteries shall be of identical voltage, model number, appearance and date of manufacture to allow connections in series to produce a system voltage of 24 volts DC.

B. Battery Charger

1. The battery charger shall automatically charge and monitor the condition of the batteries. The charger shall be dual-rate type with a combination high rate/float maintenance rate which is listed to recharge the batteries being provided and capable of recharging fully discharged batteries to 70% charge within 12 hours.
2. The control panel shall include a voltmeter and ammeter to indicate battery voltage and charging current.
3. The charger shall include a green "Charger On" LED, a yellow "Charger Trouble" LED and a red "High Rate" LED. The charger shall also include battery voltage test points and a fuse for overcurrent protection.

- C. Provided new standby batteries to support the system operation upon loss of normal power for a period of sixty (60) hours of supervisory operation, followed by fifteen (15) minutes of alarm.

- D. Power cable size from the batteries to the control panels served shall be determined and considered by the system supplier based on power demand and acceptable voltage drop calculations.

2.05 HVAC/BAS INTERFACE

- A. Provide all required new fire alarm control and monitor points wired to terminal blocks, which will serve as an interface with the BuildingAutomation System (BAS).

- B. Interface shall be accomplished by field-located programmable Input/Output modules to initiate unit shut down and control sequences.

C. Control Signals

1. Provide output signals from the fire alarm system to the BAS for the following:
 - a. Smoke detector activation – by individual (new) smoke zone.
 - b. General trouble – by (new) smoke zone.
 - c. Each (new) duct-mounted smoke detector in alarm.
2. Signals from the H-O-A switch panels shall be provided to allow for the following operation:
 - a. When the H-O-A is in the automatic position, the controlled equipment shall operate as directed by the BAS.

- b. When the H-O-A switch is in the "Hand" or "ON" position, a signal shall be sent to the BAS to bypass all other control of the selected equipment and turn the controlled equipment on. The controlled equipment shall continue to operate until the H-O-A switch is restored to the "AUTOMATIC" or "OFF" position.
 - c. When the H-O-A switch is in the "OFF" position, a signal shall be sent to the BAS to bypass all other control of the selected equipment and turn the controlled equipment off. The controlled equipment shall remain in the off condition until the H-O-A switch is restored to the "AUTOMATIC" or "ON" position.
3. HVAC air handling units (such as supply air handling units or exhaust air handling units) consisting of multiple fans operating in parallel in a common unit, may have one H-O-A switch for the unit to control both fans simultaneously.
 4. All required sequencing, command signals and status feedback signals shall be closely coordinated with Division 25 and the work of related trades. Where manual override (HOA) control is provided, the Fire Alarm System shall be programmed to bypass associated smoke detectors and restore smoke dampers to their open position, and transmit the command signal(s) to the Building Automation System (BAS) to initiate the appropriate sequencing.
- D. Monitor Signals
1. Wiring from the BAS shall be provided for the following monitor signals:
 - a. For each piece of equipment controlled by an H-O-A switch, the BAS system shall determine the actual status, ON or OFF (Open or Closed) of the equipment and provide status feedback to the Fire Alarm System.
 - b. These status signals shall be used to control associated dampers depending upon fan run status, and illuminate the proper indicators at each H-O-A switch.
 - c. Each component operating in a Fault condition.
- E. It shall be the Electrical Subcontractor's responsibility to coordinate with the ATC Subcontractor and fire alarm supplier the proper rating (amperage and voltage) and contact types between the fire alarm system and the BAS system to accomplish the above.
- F. All wiring between the fire alarm system and the BAS interface panel shall be by the Electrical Subcontractor. All wiring between the BAS and the BAS interface panel shall be by the BAS Subcontractor.
- G. All external circuits requiring system operating power shall be individually fused at the control panel.

2.06 SYSTEM INTERFACE MODULES

A. General

1. Provide integration to or expansion of the existing addressable loop Signaling Line Circuit (SLC) interface module to support the new addressable devices being installed.
2. The system shall support separate, individually-isolated loops for each floor or evacuation zone. Each SLC shall originate from the local FACU serving the given area and be wired so that a single wiring fault in one area will not affect the operation of the SLC serving any other evacuation signaling zone. Provide additional fault isolation modules to augment the existing as needed.

3. The number of addressable devices connected to an existing communicating device module shall not exceed 95% of its capacity.
4. Each addressable device must be uniquely identified by a distinct address code with corresponding device labels consistent with the reviewed shop drawings and final signage plans.

B. Monitor Module

1. Monitor modules shall supervise and monitor the status of non-addressable, normally open, direct contact devices such as sprinkler water flow switches and valve tamper (supervisory) switches and related systems. These monitor modules shall communicate the equipment status (normal, alarm, trouble) to the control panel.

C. Control Module

1. Control modules shall provide programmable outputs to supervise the initiation and control of auxiliary devices and related fire safety functions. Functions shall include the control of building fans and dampers, elevator recall functions, door release and any other system control functions shown or specified.
2. Control modules shall provide a supervised form C output rated for 2 amps @ 30VDC (resistive) or .5 amps at 120VAC (resistive) or .25 amps @120VAC (inductive), which will serve as a pilot-duty relay intended to operate external power relays to perform auxiliary control functions.

D. Control Relays

1. Provide multi-voltage Power Relays as needed to support Fire Safety control functions and the proper isolation of control circuit wiring from addressable Modules. Each power relay shall be polarized and operate from a 24VDC nominal input voltage and provide an output contact rating of 10 or 20 amps at 120VAC as needed. Relays with an output rated for 20amps shall have individually fused outputs.

2.07 INITIATING DEVICES

- A. Photoelectric Smoke Detector: Provide new analog/addressable photoelectric smoke sensors with device base and remote alarm indicator as needed to match existing. Device alarm verification and sensitivity parameters shall be programmed to match existing.

B. Duct Smoke Detectors

1. Provide duct mounted analog photoelectric smoke detectors to match existing and in accordance with NFPA 90A.
2. Upon alarm actuation of the smoke detector a supervised output shall send signals to an auxiliary power relay to initiate shutdown the respective fan and send signals to the BAS.
3. Each duct smoke detector shall include a remote alarm indicator (LED) mounted within proximity of the duct detector and labeled to clearly show which detector it is associated with.

C. Heat Detectors

1. Provide analog/addressable heat detectors for either fixed temperature or rate-of-rise operation to match existing.

2. Where otherwise required, provide conventional fixed temperature, weatherproof or explosion-proof heat detectors in lieu of analog detectors. Conventional devices shall be individually addressable via a dedicated addressable monitor module which shall be installed in an appropriately heated, ventilated location.
3. Temporary protection during construction, alteration and demolition.
4. System programming and re-programming of all changes as necessary to accommodate the phased construction, alteration and demolition activities.

D. Manual Pull Stations

1. Manual pull stations shall be addressable devices to match existing.
2. Where ambient conditions preclude the use of addressable devices, conventional pull stations shall be used and a dedicated addressable module shall be installed in an appropriately heat and ventilated location.

2.08 ALARM NOTIFICATION APPLIANCES

- A. Provide flush mounted audible and visual notification appliances where shown and required to match existing to the maximum extent practical. The contractor shall provide surface mount backboxes and alternate outdoor-rated appliances where site conditions dictate. Specific audible and visual characteristics shall be as follows:

1. Visual Signals: Furnish and install multi-candela, synchronized xenon strobes in compliance with NFPA 72 and rated per ANSI/UL 1971. As a minimum, strobes shall have an effective intensity rating of 15 candela in corridors and areas up to 20' x 20', 75 candela in areas up to 45' x 45' and 110 candela in areas up to 54' x 54' or larger.
2. Visual appliances in sleeping areas that are mounted 24" or less from the ceiling shall be rated as a 177cd appliance.
3. Wall-mount Speakers: Provide multi-tapped cone speakers with square or rectangular grille with red finish where shown or required. Each speaker shall have selective ¼, ½, 1, or 2 watt taps. Each speaker shall produce a sound output level of 84dbA at 10' (1 watt setting).
4. High Output Speakers: Provide high output speakers with a multiple tap setting up to 15 watts in high ambient noise areas.

- B. Provide re-entrant-type devices with the appropriate weatherproof listings in outdoor or wash-down areas.

2.09 SYSTEM ACCESSORIES

- A. Door Hold Open Devices: Door hold open devices shall be furnished and installed by the door hardware supplier to match existing. The Electrical Subcontractor shall provide 24 VDC power to these devices and coordinate with the door hardware supplier and provide all required wiring and additional hardware to properly control doors.
- B. Remote Annunciator Panel (Fire Command Station): Provide a full-function Remote Annunciator Panel where shown and required. The annunciator shall integrate with the building Fire Alarm Network, and include a multi-line system status display with common control switches, audio controller and paging microphone to provide selective audio control capabilities.

2.10 WIRING AND RACEWAYS

A. Wiring

1. Size and type of all system wiring shall be as recommended by the system manufacturer and documented on the shop drawings. Provide a minimum of #18 AWG wiring to match existing.
2. Survivability: Provide two (2) hour fire rated conductors for all circuits that are designated to have Level 2 Survivability or higher, and are not protected in their entirety by 2-hour construction.
 - a. All network data and audio wiring between fire alarm control units and terminal cabinets.
 - b. Wiring between any new fire alarm control units and the Fire Command Center.
 - c. Fire alarm circuits traveling between zones.
 - d. All notification appliance circuits shall be protected from their point of origin until they enter the evacuation signaling zone they serve.
 - e. Device wiring to notification appliances from fire alarm control unit to the first device on the circuit (including the last device back to panel).
 - f. Control wiring to all stair pressurization systems and associated equipment.
 - g. Engine start circuits for each automatic transfer switch to the generator.
3. Provide physically separated outgoing and return loops for all Class A wiring in accordance with NFPA 72 recommendation and NEC guidelines. For network and audio risers, provide a minimum of twelve inches of separation when the conduit is run vertically, and a four foot separation when the conduit is run horizontally.

B. Raceways

1. Raceways for all fire alarm wiring and peripheral equipment shall be Rigid Galvanized Steel, Intermediate Metal Conduit or Electrical Metallic Tubing (EMT), (minimum 3/4") subject to the restrictions of the National Electrical Code. Refer to Specification Section 260530 for additional information.

C. 2-Hour Fire Rated Mineral Insulated (MI) Conductors

1. General

- a. This section includes 2 hour fire rated type MI mineral-insulated metal-sheathed cable with multiple, twisted copper conductors within a seamless copper sheath, cable connectors and connections.

2. References

- a. NFPA 72 – National Fire Alarm and Signaling Code
- b. International Building Code (IBC) Section 909 - 2009
- c. ANSI/NFPA 70 - National Electrical Code
- d. FM 3D0Q9.AM 8/1997
- e. UL Category FHIT – Classified Electrical Circuit Integrity System with a 2 hour fire rating, 12/2012.

3. Qualifications
 - a. Manufacturer shall be a company specializing in manufacturing products specified in this Section with minimum ten years documented experience.
 - b. Cable shall not off gas or propagate smoke.
4. Regulatory Requirements
 - a. Cable shall conform to requirements of ANSI/NFPA 70.
 - b. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.
5. Project Conditions
 - a. Verify that field measurements and conditions are as shown on Drawings.
 - b. Cable routing shown on Drawings is approximate. Route cable as required to meet project conditions.
 - c. Where cable routing is not shown, and destination only is indicated, determine exact routing and lengths required.
6. Coordination
 - a. Coordinate work specified in this section with work provided under other electrical work and the work of other trades.
 - b. Determine required separation between cable and other work.
 - c. Determine cable routing to avoid interference with other work.
7. Manufacturer
 - a. Pentair Thermal Management/Pyrotenax System 1850 2-hour fire rated.
8. Mineral-Insulated Metal-Sheathed Cable
 - a. Description: ANSI/NFPA 70, Type MI
 - b. Conductor: Copper
 - c. Insulation Voltage Rating: 300 volts.
 - d. Insulation Material: Magnesium oxide refractory mineral.
 - e. Metal-sheath Material: Seamless soft-drawn copper.
 - f. Fire Rating: Cable assembly, including factory splices and supports shall have a 2 hour fire rating as listed and classified by Underwriters Laboratories, Inc.
 - g. Overjacket:
 - 1) If installed interior to the building: none required
 - 2) If installed direct buried, PVC or manufactured extruded jacket.
 - h. Cable sheath shall be marked with conductor size, voltage and UL fire resistant classification number.
 - i. Each components of the cable assembly shall contain less than 300 ppm of lead, and shall meet the requirements of LEED for Healthcare MR Credit 4.2.

9. Wiring Connectors And Terminations

a. Cable Termination:

- 1) Pentair Thermal Management/Pyrotenax Model PyroPack – Multi-conductor (Installation PTM document #545E) and fire alarm twisted pair cables (PTM document #578E).

b. Cable Splice:

- 1) All cable splices of MI cable required due to length of conductor shall be factory installed and have 2 hour fire rating equivalent to the conductor itself. Field splices shall not be allowed unless installed within 2 hour fire rated rooms. Field splices within 2 hour fire rated rooms shall be Tyco Thermal Controls/Pyrotenax Model Installation Sheet 550.

10. Examination

- a. Verify that cable end factory temporary seals have remained intact, that the insulation has not been exposed to air, and that no moisture has entered cable insulation.
- b. Verify that work of other trades likely to damage cable has been completed.

11. Storage

- a. Cables shall be shipped from the manufacturer with ends temporarily sealed against moisture ingress.
- b. When cables are cut in the field, the end shall be sealed using standard sealing compound and PVC tape.
- c. Cable shall be stored in a clean dry location.

12. Handling

- a. Cable shall be uncoiled by rolling or rotating supply reel. Do not pull from coil periphery or center.
- b. Take precautions necessary to prevent damage to cable from contact with sharp objects, including pulling over foreign material or sheaves.

13. Wiring Methods

- a. Fire Rated Locations: Use only fire rated cable.
- b. Use wiring methods indicated on Drawings and as specified herein.

2.11 SPARE PARTS

- A. The fire alarm system shall be furnished with spare parts stored in an area approved by the Fire Department.
- B. The following list of spare parts shall be supplied:
 1. Two (2) spare control modules (each type).
 2. Two (2) spare monitor modules (each type).
 3. Six (6) initiating devices – including device base and sensors as applicable (each type).

4. Six (6) notification appliances (each type).

PART 3 EXECUTION

3.01 COOPERATION AND WORK PROGRESS

- A. The Electrical work shall be carried on under the usual construction conditions, in conjunction with all other work at the site. The Electrical Subcontractor shall cooperate with the Architect, Construction Manager, all other Subcontractors and equipment suppliers working at the site. The Electrical Subcontractor shall coordinate the work and proceed in a manner so as not to delay the progress of the project.
- B. The Electrical Subcontractor shall coordinate his work with the progress of the building and other Trades so that he will complete his work as soon as conditions permit and such that interruptions of the building functions will be at a minimum. Any overtime hours worked or additional costs incurred due to lack of or improper coordination with other Trades or the Owner by the Electrical Subcontractor shall be assumed by him without any additional cost to the Owner.
- C. The Electrical Subcontractor shall furnish information on all equipment provided under this Section but installed under another Section to the installing Subcontractor as specified herein.
- D. The Electrical Subcontractor shall provide all materials, equipment and workmanship to ensure adequate protection of all electrical equipment during the course of construction of the project. This shall also include protection from moisture and all foreign matter. The Electrical Subcontractor shall also be responsible for damage which he causes to the work of other Trades, and he shall remedy such injury at his own expense.
- E. Waste materials shall be removed promptly from the premises. All material and equipment stored on the premises shall be kept in a neat and orderly fashion. Material or equipment shall not be stored where exposed to the weather. The Electrical Subcontractor shall be responsible for the security, safekeeping and damages, including acts of vandalism, of all material and equipment stored at the job site.
- F. The Electrical Subcontractor shall be responsible for unloading all electrical equipment and materials delivered to the site. This shall also include all large and heavy items or equipment which require hoisting. Consult with the Construction Manager for hoisting/crane requirements. During construction of the building, the Electrical Subcontractor shall provide additional protection against moisture, dust accumulation and physical damage of the main service and distribution equipment. This shall include furnishing and installing temporary heaters within these units, as approved, to evaporate excessive moisture and ventilate it from the room, as may be required.
- G. It shall be the responsibility of the Electrical Subcontractor to coordinate the delivery of the electrical equipment to the project prior to the time installation of equipment will be required; but he shall also make sure such equipment is not delivered too far in advance of such required installation, to ensure that possible damage and deterioration of such equipment will not occur. Such equipment stored for an excessively long period of time (as determined in the opinion of the Architect) on the project site prior to installation may be subject to rejection by the Architect.
- H. The Electrical Subcontractor shall erect and maintain, at all times, necessary safeguards for the protection of life and property of the Owner, Workmen, Staff and the Public.

- I. Prior to installation, the Electrical Subcontractor has the responsibility to coordinate the exact mounting arrangement and location of electrical equipment to allow proper space requirements as indicated in the NEC. Particular attention shall be given in the field to group installations. If it is questionable that sufficient space, conflict with the work of other Subcontractors, architectural or structural obstructions will result in an arrangement which will prevent proper access, operation or maintenance of the indicated equipment, the Electrical Subcontractor shall immediately notify the Construction Manager and not proceed with this part of the Contract work until definite instructions have been given to him by the Architect.

3.02 INSTALLATION

A. General

1. Furnish and install the complete fire alarm system according to the drawings, specifications and all applicable Codes and Ordinances. In addition, the installation shall be consistent with the manufacturer's recommendations and the reviewed shop drawings.
2. The Electrical Subcontractor shall furnish and install, in accordance with manufacturer's instructions, all wiring, conduit and outlet boxes required for the erection of a complete system as described herein and as indicated on the drawings.
3. Final connections between the control equipment and wiring system shall be made under direct supervision of a representative of the manufacturer.
4. The Electrical Subcontractor shall be responsible for the proper placement of all devices to ensure proper location and spacing in accordance with the Contract Documents and applicable code.
5. Installation of equipment and devices that pertain to other work in the Contract shall be closely coordinated with the appropriate Contractors. The Electrical Subcontractor shall clean all dirt and debris from the inside and the outside of the fire alarm equipment after completion of the installation.
6. Unless specifically permitted by the Local Authority Having Jurisdiction, smoke detectors shall not be installed until after the construction cleanup of all trades is complete and final. If smoke detectors are installed for any reason during the construction period, it shall be the responsibility of the Electrical Subcontractor, at his cost, to clean and recalibrate, or replace each device in accordance with NFPA 72 - prior to final testing and the request for acceptance.
7. All miscellaneous hardware and support accessories, including support rods, nuts, bolts, screws and other such items, shall be furnished as required for proper installation of the system and shall be of a galvanized or cadmium plated finish, or of other approved rust-inhibiting coating.
8. The Electrical Subcontractor shall ensure that all concealed equipment that may require maintenance or access for any reason, are made easily accessible.

B. Raceways

1. All fire alarm system wiring shall be run in conduit as specified in section 260530 and shall meet the requirements of NEC Article 760 and all National, State and Local Electrical Codes. Conduit sizes shall be determined by the fire alarm equipment manufacturer to support the quantities and types of wiring to be installed. Minimum 3/4" conduit.

2. All pull and junction boxes shall be sprayed red and labeled "Fire Alarm". A red stripe, 4" wide, shall be painted on all conduit for fire alarm system wiring and/or all junction boxes and conduit fittings shall be painted red. Wiring color code shall be maintained throughout the installation. Fire alarm cable in raceways shall be tagged every 20'-0" and shall have the legend "Fire Alarm".

C. Wiring

1. Wiring types and sizes shall be as recommended by the equipment manufacturer. Minimum #18 AWG.
2. All wiring shall be UL listed for fire protective signaling systems and meet the requirements of NEC Article 760.
3. Color code shall be used throughout. All wires shall be tagged at all junction points and shall test free from grounds or crosses between the conductors.
4. Wiring shall be routed to maintain sufficient distance between the feed and return loop as required by the Authority Having Jurisdiction and as specified herein.
5. Maximum wiring distances shall be within manufacturer's specifications and as directed on the approved shop drawings.
6. T-tapping of notification appliance circuit conductors shall NOT be accepted.

D. Mineral Insulated (MI) Metal-Sheathed Cable

1. Install products in accordance with manufacturer's instructions.
2. Bending:
 - a. Not less than five (5) times the cable diameter for cable not more than ¾ inch.
3. Pulling:
 - a. For all cables up to and including ½" diameter, use ten inch (250mm) or larger sheaves.
4. Splicing:
 - a. All fire rated splices shall be made in the factory.
 - b. In the event a field splice is necessary, it must be made within a 2 hour fire rated room, approved by the engineer and:
 - 1) Made in the field by manufacturer's field technician, or
 - 2) Made in the field by personnel trained by the cable manufacturer using manufacturer's components.
5. Terminations:
 - a. Field made terminations shall be made with cable manufacturer's termination kits only. Stripping tools, crimping and compression tools available from the manufacturer shall be used for proper cable termination.
 - b. Terminations must be completed immediately once started to avoid moisture ingress from surrounding air. Prior to completing each termination, test insulation resistance and follow manufacturer's drying procedures until insulation resistance reaches an acceptable level.

6. Exposed or Surface installations:
 - a. Cable may be secured directly to fire rated building structure using an approved method such as one, or any combination, of the following:
 - 1) Straps: ½ inch (13mm) wide x 3 1/2 inch (38mm) long by 0.030 (0.75mm) thick stainless steel or copper straps. Each strap shall contain two ¼ inch (6mm) holes for securing with 3/16 inch (5mm) by minimum 1 3/4 inch (44mm) long steel anchors.
 - 2) Steel struts and cable tray: Use only the steel strut framing system and support recommended by Pyrotenax. Aluminum or other materials are not acceptable.
 - b. Supports shall not exceed three (3) feet on center horizontally, or six (6) feet vertically.
 - c. Cables shall be installed perpendicular and parallel to building lines.
7. Embedded Installations:
 - a. Protect against damage during pulling, and during concrete pouring or backfill and tamping.
 - b. Where cables emerge from grade, provide PVC conduit, metal plate or angle iron. This protection shall minimally extend from 18 inches (460mm) below grade to 8 ft. (2.5m) above grade.
 - c. Provide overall extruded polymer jacket over exposed copper cable sheath when embedded in corrosive environments.
8. Wall or floor penetrations:
 - a. Provide sleeve to protect cable and penetration opening during pulling.
 - b. Provide approved fire stopping of all penetrations.
9. Neatly train and lace cable inside boxes, equipment, and panelboards.
10. Field Quality Control
 - a. Inspect cable for physical damage and proper connection.
 - b. Measure tightness of bolted connections and compare torque measurements with manufacturer's recommended values.
 - c. Verify continuity of each conductor.
 - d. Prior to energizing cables, measure insulation resistance of each cable. Tabulate and submit for approval.
 - e. Provide certification from cable manufacturer that installation is in accordance with their requirements.

3.03 IMPAIRMENTS AND SAFEGUARDS

- A. Safeguarding of the building during demolition, alteration and construction shall be a joint cooperative effort involving the entire project team, including the fire protection contractor, the fire alarm contractor, the general contractor/construction manager, owner and all authorities having jurisdiction. The fire protection contractor shall coordinate with any and all parties as appropriate in order to achieve proper safeguarding as described in the project documents.

- B. The Contractor shall ensure proper building protection and safeguarding at all times during demolition, alteration, and construction in complete compliance with all applicable codes, regulations, standards, including but not limited to applicable Building and Fire Codes, and NFPA 241 - 2013 edition.
- C. During times when the existing, modified and/or new building fire protection systems are impaired, the contractors shall provide appropriate safeguarding of the renovation work area, and temporary heat detection or adequate alternate protection throughout the space, as coordinated with, and approved by, the tenant's and owner's fire prevention program manager, building manager, construction manager, insurance underwriters, and all authorities having jurisdiction. Safeguarding shall also apply to all related phasing, shut-downs, swing spaces, temporary facilities and relocations, etc. Detection shall be located and installed in accordance with the products' listing and manufacturer's instructions, and shall be tested and maintained until such time that the permanent building protection is restored. Alternative safeguarding such as, but not limited to, fire watch personnel, or temporary fire protection systems, may be considered if acceptable to the tenant/owner and authorities having jurisdiction. Refer to, and coordinate with, fire alarm systems documents, and safeguarding and impairments notes and specifications. Coordinate with fire alarm system contractor and all other trades.
- D. Provide, and include as shop drawings submittals, a complete demolition, alteration, construction, phasing and impairment plan to include the information above, a schedule of project milestones and related work, and an anticipated schedule for installation, impairments, programming and all phases of final testing and completion of the work. This plan shall be coordinated with all authorities having jurisdiction, the tenant's/owner's fire prevention program manager, construction manager, and shall include any and all information, drawings, and graphics to meet the approval of the authorities having jurisdiction. The contractors shall provide firewatch personnel or temporary protection as required by any authorities having jurisdiction, the tenant/owner, or the tenant's/owner's insurance underwriters.
- E. The above impairment plan shall be approved by all authorities, tenant/owner fire prevention program manager, tenant/owner insurance underwriters, etc., prior to any shutdowns or impairments.
- F. All costs associated with the above safeguarding during demolition, alteration, construction, phasing, shutdowns, etc. with regard to fire protection systems shall be included in the fire protection contractor's base bid.
- G. Temporary Protection
1. The Contractor shall provide temporary protection while portions of the existing fire protection sprinkler system or existing fire protective signaling system are impaired or out of service during construction, alteration and demolition activities.
 2. Temporary protection shall be installed throughout the affected areas in accordance with the Contractor's impairment plan and Farmington Fire Department requirements. Protection shall include, but not be limited, to the following:
 - a. Automatic fire detection equipment including smoke detectors and/or temporary heat detectors.
 - b. Notification equipment including, but not limited to, ADA compliant combination audible/visual notification appliances.
 - c. Manual fire alarm pull stations.

3. Temporary fire protective devices shall be installed in accordance with the product's labeling, manufacture's listing requirements and applicable codes.
4. Installation of temporary fire protective devices shall be coordinated with the construction, alteration and demolition conditions, and shall account for structural members, ductwork, piping and conduit racks as they occur or are encountered during construction.
5. Temporary fire protective devices shall be connected to the building fire alarm system and shall function as permanent until replaced with final fire protection and fire protective systems.
6. Temporary fire device layout shall be changed as necessary during construction in order to maintain proper coverage including spacing and locations of devices as work progresses and building areas are impacted.
7. Bagging or the temporary covering of smoke detectors shall not be allowed during construction, unless specifically permitted by Farmington Fire Department. Where detectors are permitted to remain during construction, they shall be cleaned and recalibrated or replaced in accordance with NFPA 72 requirements.

3.04 ADDITIONAL DEVICE INSTALLATION REQUIREMENTS

- A. The Electrical Subcontractor shall carry within his bid the cost of materials and labor required for installing additional devices which may be required by the Fire Department during final inspection. This shall be carried as a separate line item and unit cost associated for each item as indicated in Equipment Allowances section of this specification.
- B. The cost shall include the following additional devices:
 1. Two (2) spare control modules (each type), including conduit and wire with an average length of 20'-0".
 2. Two (2) spare monitor modules (each type), including conduit and wire with an average length of 20'-0".
 3. Six (6) initiating devices – including device base and sensors as applicable (each type), including conduit and wire with an average length of 20'-0".
 4. Six (6) notification appliances (each type), including conduit and wire with an average length of 20'-0".

3.05 MATERIALS AND WORKMANSHIP

- A. All materials and equipment shall be new and unused and shall meet requirements of the latest Standards of NFPA, UL, NEMA, IPCEA, ANSI and IEEE. Equipment shall have components required or recommended by OSHA, applicable NFPA documents and shall be UL listed and labeled.
- B. Despite references in the specifications or on the drawings to materials or pieces of equipment by name, make or catalog number, such references shall be interpreted as establishing standards of quality for materials and performance.
- C. Finish of materials, components and equipment shall not be less than Industry good practice. When material or equipment is visible or subject to corrosive or atmospheric conditions, the finish shall be as approved by the Architect.
- D. Provide proper access to material or equipment that requires inspection, replacement, repair or service. If proper access cannot be provided, confer with the Architect as to the best method of approach to minimize effects of reduced access.

- E. All work shall be installed in a neat and workmanlike manner and shall be done in accordance with all Local and State Codes and in accordance with the manufacturer's instructions.
- F. The Owner will not be responsible for material, equipment or the installation of same before testing and acceptance.

3.06 COORDINATION OF MAINTENANCE AND MONITORING

- A. It shall be the Contractor's responsibility to arrange for meetings between the Owner's representatives and representatives of the testing company responsible for the maintenance, testing and supervision of the completed fire alarm system.
- B. Require the system supplier to provide complete shop drawings as stated herein. The foregoing materials shall be submitted to the Engineer for approval with shop drawings, prior to the ordering of equipment or starting the installation.
- C. Provide the services of an authorized technical representative of the Original Equipment Manufacturer to supervise the installation, provide adjustment and all testing of the system required to assure a complete and fully operative facility in accordance with this specification and all Fire Department Regulations. Signed test reports and Record of Completion substantiating this shall be submitted by the system supplier.
- D. It shall be the responsibility of the Electrical Subcontractor, where equipment or systems added under this Contract are found to be defective or not in accordance with the manufacturer's published data, the specification and/or Contract Drawings, to correct all discrepancies. It shall further be the responsibility of the Electrical Subcontractor to perform all retests and indicate to the Owner, the Fire Department and the Engineer that all systems perform as required by the Contract Drawings and specifications. Retests shall be performed in accordance with the Owner's requirements and at a time which is acceptable to the Owner and all costs for retesting and operational retesting shall be borne by the Electrical Subcontractor. The Electrical Subcontractor shall notify the Owner and Engineer (7) days in advance of the date when the system will be ready for retesting.

3.07 MANUFACTURER'S CERTIFICATION

- A. The qualified, factory trained OEM representative shall provide on-site supervision of the fire alarm system installation. The representative shall certify, in writing, that the system and equipment has been installed, adjusted, and tested in accordance with the manufacturer's recommendations.
- B. The Electrical Subcontractor shall provide three (3) copies of the manufacturer's representative's certification before final payment is made.

3.08 FIELD ACCEPTANCE TESTS

- A. The Owner shall not be responsible for fire alarm system material or equipment prior to testing and acceptance.

- B. Before final approval and acceptance by Building Owner, fire protection and life safety systems shall be subjected to complete integrated reacceptance testing in accordance with all applicable NFPA Codes and Standards. Tests shall be conducted by the current testing company of record, and witnessed by the representative of the Fire Department, the Owner's Building Construction Department, Risk Management Division and Security Department. Piping, wiring and accessory devices in any new portion of the system shall not be covered up or concealed permanently until they have been tested and approved. At least 48 hours' notice shall be given to aforementioned representatives before test.
- C. Test shall comprise activating and verifying the operations of each and every device (input and output) and corresponding auxiliary functions directly affected by the system alteration. In addition, ten percent of the initiating devices that are not directly affected by the system changes (up to a maximum of 50 devices) shall be tested and verified in accordance with the Reacceptance testing requirements of NFPA 72.
- D. A written test log of this complete test shall be submitted prior to acceptance of the system by the Owner.
- E. Test shall include all supervising station reporting, (i.e. the public fire alarm reporting system and/or remote supervising station) as applicable.
- F. Test shall meet requirements of the following as applicable:
1. NFPA 72 including, but not limited to the requirements for local protected premises systems and Supervisory Service.
 2. NFPA 72 Chapter 26 – Supervising Station and Public Fire Alarm Reporting Systems.
 3. NFPA 72 Chapter 10 and 14 – Inspection, Testing and Maintenance.
 4. Coordinate testing between related systems in accordance with NFPA standards including, but not limited to NFPA 13, 20, 25, 70, 90A, 92, and NFPA 110.
 5. FM Global Data Sheet 5-40 requirements.
- G. To assure that wire size, power supply, number of devices on a circuit, etc., are suitable to support 100 percent of devices being in alarm or operated simultaneously, this test shall include the following:
1. Place all sensors and monitor modules in alarm. Each shall display its address and alarm condition. At least the first ten (10) devices on each circuit shall also have their alarm LED's lighted.
 2. Operate all control modules for the alarm or operated condition. Each module shall display its address and condition.
 3. Measure the actual voltage drop at the end of each visual Notification Appliance circuit.
 4. Reset all alarmed and operated devices. The panel shall display the address of any off-normal devices.
- H. Test each sensor for alarm verification by momentarily testing for alarm. The sensor shall not initiate an alarm. Then, test by placing the sensor in alarm such that it remains in alarm for the verification period and initiates the alarm sequence.
- I. Test each sensor for trouble by removing the sensor from its base. The address and trouble condition for each shall be displayed. Insert a different type of sensor into the base. The address and trouble condition shall be displayed. The sensor will return to normal only when the proper sensor type is reinserted in the base.

- J. Print out the English language descriptor and status of each module in the system. The printout shall also include the date and time.
- K. Upon installation, each speaker shall be set at the power setting recommended by the system supplier shown in the shop drawings.
- L. During system commissioning, audible sound levels shall be measured and recorded in all occupied spaces with the evacuation signal sounding. Following the initial measurement, the Contractor shall adjust each speaker setting to optimize system performance and produce 75dbA or 15dbA above ambient (whichever is greater), in accordance with NFPA 72 requirements.
- M. Measurements shall be recorded for each space to certify that the sound level requirements comply with these requirements in the following format:

"Room/Area"	"Ambient Sound Level db"	"Ambient And Evacuation Sound Level dB"
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- N. Provide a final test report and Record of Completion indicating proper functioning of the system and conformance to the specifications. The test and Certificate of Completion shall be performed by factory-trained qualified technicians. Each and every device shall be tested, and standalone operation of remote panels shall be verified.
- O. The final testing, certification and documentation shall be performed by the same company that shall hold and execute the Test and Inspection contract.
- P. The Contractor shall provide the final test reports and Record of Completion with the request for final Fire Department Acceptance Testing.

3.09 FIRE ALARM INSPECTION AND TESTING CONTRACT - (BY OWNER)

- A. Before making final connections to the Public Fire Alarm Reporting System, a Service Contract must be in evidence to support the entire modified system. The Contract shall be in effect between the Owner and a UL-certified testing company, and shall provide for periodic testing and emergency service response on a 24 hour on call basis with a 4 hour response time.

END OF SECTION

SECTION 310000

EARTHWORK

PART 1 GENERAL

1.00 SCOPE OF WORK

- A. Cutting, proofrolling, filling and grading to required lines, dimensions, contours and elevations for proposed improvements.
- B. Scarifying, compaction, moisture content control and, where deemed necessary, removal of unsuitable material to ensure proper preparation of areas for the proposed improvements.
- C. Protection, modification, and/or installation of utilities as sitework progresses, paying particular attention to grade changes and any necessary staging of work.

1.02 RELATED SECTIONS AND DOCUMENTS

- A. Section 320000 - General Requirements
- B. Section 020100 - Protection of Existing Utilities
- C. Section 312500 - Soil Erosion and Sediment Control
- D. Section 312333 - Trench Excavation and Backfill for Utilities
- E. Section 312313 - Excavation, Backfill and Subgrade Preparation for Buildings
- F. Section 312316 - Excavation, Backfill and Subgrade Preparation for Pavement
- G. Section 321216 - Asphaltic Concrete Paving
- H. Section 321313 - Portland Cement Concrete Paving
- I. Section 321613 - Curbs and Sidewalks
- J. Contract Drawings and Documents

1.03 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM) - latest edition
 - 1. D 422 Method for Particle Size Analysis of Soils
 - 2. D 1557 Test for Moisture-Density Relations of Soils Using 10-lb (4.5 Kg) Hammer and 18-inch (457 mm) Drop (Modified Proctor)
 - 3. D 2216 Laboratory Determination of Moisture content of Soil
 - 4. D 2487 Classification of Soils for Engineering Purposes
 - 5. D 2922 Tests for Density of Soil and Soil- Aggregate in Place by Nuclear Methods (Shallow Depth)
 - 6. D 3017 Test for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
 - 7. D 4318 Test for Plastic Limit, Liquid Limit, and Plasticity Index of Soils
- B. American Association of State Highway and Transportation Officials (AASHTO) - latest edition

1. T-88 Mechanical Analysis of Soils

C. All applicable OSHA Regulations

1.04 QUALITY ASSURANCE

- A. The Contractor shall provide at least one supervisory person who shall be present at all times during execution of the work and who is thoroughly familiar with the type of work being performed and its best methods for completion. This person shall have the authority to act on behalf of the Contractor.
- B. The Contractor shall comply with any provisions of all applicable codes, regulations and standards.
- C. An Engineer familiar with the requirements of the Geotechnical Report, selected and paid by the Owner (herein referenced to as "Owner's Engineer"), will be retained to perform construction inspection on site based on density testing, visual observation, and judgement. This inspection will not relieve the Contractor from his responsibility to complete the work in accordance with the Contract Documents.
- D. Visual field confirmation and density testing of subgrade preparation and fill placement procedures shall be performed by the Owner's Engineer (if hired by Owner) as part of the construction testing requirements.
- E. The Owner's Engineer shall prepare field reports that indicate compaction test location, elevation data, testing results and acceptability (if hired by owner). The Owner, Architect, and Contractor shall be provided with copies of reports within one week of the time the test was performed.
- F. All costs related to reinspection due to failures shall be paid for by the Contractor at no additional expense to the Owner. The Owner reserves the right to direct any inspection that is deemed necessary. The Contractor shall provide free access to site and coordinate his construction activities to accommodate inspection activities.

1.05 SUBMITTALS

- A. Within ten days after award of the contract, the Contractor shall submit to the Owner and Owner's Engineer a schedule detailing the sequence, and time of completion of all phases of work under this section.
- B. At least two weeks in advance of imported fill use, the Contractor shall submit either the following laboratory test data or a 50-pound soil sample to the Owner's Engineer for each type of imported soil/gravel material to be used as compacted fill.
 - 1. Moisture and Density Relationship: ASTM D1557.
 - 2. Mechanical Analysis: AASHTO T-88
 - 3. Plasticity Index: ASTM D 4318
- C. Together with the above test data, the Contractor shall submit a 50 pound sample of each type of off-site fill material in an air tight container for the review of the Owner's Engineer.
- D. Submit the name of each material supplier and specific type and source of each material. Any change in source or soil type throughout the job requires review of the Owner and the Owner's Engineer.

1.06 ENVIRONMENTAL CONSIDERATIONS

- A. Construct erosion control systems as shown on the Contract Documents or as directed by the Owner's Engineer to protect adjacent properties and water resources from erosion and sediment damage.
- B. Imported fill shall be free of all hazardous substances as established by the State of Connecticut Department of Environmental Protection. Certification of compliance shall be furnished to the Owner and the Consultant by the Contractor no less than two weeks prior to its intended use. Under no circumstance shall fill material be brought on-site prior to the Engineer's review of the certification of environmental compliance.

PART 2 PRODUCTS

2.00 MATERIALS

- A. 3/4-inch clean stone or imported fill material approved by Owner's Engineer and specified herein.
- B. Topsoil fill as specified in Landscape Specification.
- C. Soil Materials:
 - 1. Fill soils shall consist of approved sandy/silty sand soils reused from on-site. The soils for reuse shall be free of rock or gravel larger than four (4) inches in any dimension; free of debris, waste, frozen materials, vegetation, and other deleterious matter.
 - 2. Imported fill shall consist of well-graded inorganic soil containing less than 15% fines (passing the No. 200 sieve) and shall be free of wood, metal and the other deleterious materials. The material shall be free of all hazardous substances as established by the State of Connecticut Department of Environmental Protection. Certification of compliance shall be furnished to the Owner and the Consultant by the Contractor no less than two weeks prior to its intended use. The Contractor shall notify the Consultant of the proposed borrow source and shall deliver a 50 lb sample to the Consultant at least one week prior to the use of the material to permit inspection and laboratory testing of the material to establish field density criteria. The borrow material shall have a water content during blending or placement such that adequate compaction as specified below can be obtained.
 - 3. Unsuitable and deleterious materials and debris shall be disposed of off-site in accordance with all applicable regulations, at no cost to the Owner.

2.01 EQUIPMENT

- A. Excavation is to be performed using capable, well maintained equipment and methods acceptable to the Owner and the Contract Document requirements and schedule.
- B. Compaction shall be performed using a minimum 5-ton static drum weight, vibratory smooth drum roller or approved equivalent.
- C. A smaller vibratory roller may be required for compaction of fill in areas that are inaccessible to the roller specified in Paragraph 2.02.B above. In such a case, 1-ton walk behind roller shall be used.

PART 3 EXECUTION

3.00 PREPARATION

- A. Prior to all work of this section, the Contractor shall become thoroughly familiar with the site, site conditions, and all portions of the work falling within this section.
- B. The Contractor shall refer to the Contract Documents for staging of earthwork operations and for erosion control measures to be implemented prior to commencement of earthwork.
- C. Locate and identify existing utilities that are to remain and protect them from damage.
- D. Notify utility companies to allow removal and/or relocation of any utilities that are in conflict with the proposed improvements.
- E. Protect adjacent properties from equipment and vehicular traffic.
- F. Protect fences, structures, sidewalks, paving, curbs, etc. to remain from equipment and vehicular traffic.
- G. Protect benchmarks, property corners and all other survey monuments from damage or displacement. If a marker needs to be removed/relocated it shall be referred by a licensed land surveyor and replaced, as necessary, by the same at no additional cost to the Owner.
- H. Remove from the site, material encountered in grading operations that, in the opinion of the Owner's Engineer, is unsuitable or undesirable for backfilling in subgrade or foundation areas as per these specifications. Dispose of unsuitable material off-site in an appropriate manner, satisfactory to Owner and in compliance with all governing agencies.
- I. Contractor shall notify the Owner and Owner's Engineer 72 hours prior to the start of any on-site earthwork.

3.01 GENERAL

- A. Identify required lines, levels, contours and datum to bring site grades to the proposed subgrade conditions inferred from the drawings.
- B. Do not allow or cause any of the work performed or installed to be covered by work of this section prior to all inspections, tests and approvals.
- C. By submitting his bid, the Contractor represents that he has reviewed the information provided and investigated the site to determine type, quantity, quality, and character of excavation work to be performed.
- D. Perform excavation using capable, well maintained equipment and methods acceptable to the Owner and governing agencies.
- E. When performing grading operations during periods of prolonged wet or dry weather, provide adequate measures for surface drainage and ground water control, and moisture control of soils (i.e., wetting or drying by discing) so as to place and compact the soil within the moisture content range a few percentage points of its optimum water content. Any disturbed areas shall be proofrolled at the end of each day.
- F. Shoring, bracing, and fencing shall be installed in accordance with Federal OSHA requirements as well as the requirements of all state and local authorities having jurisdiction. Shoring and bracing design, if required, shall be done by a Professional

Engineer licensed in the State of Connecticut, and shall be the sole responsibility of the Contractor. Such designs shall be submitted to the Owner not less than one week prior to its intended use.

3.02 COMPACTION OF SUBGRADE SURFACES

- A. Thoroughly compact the exposed ground surface following clearing and grubbing and any required excavation with a minimum of 6 passes of the above compactor and obtain at least 95% of the maximum density as determined by ASTM D1557, Modified Proctor Test. Areas of former test pits shall be staked out by the Contractor. After the locations are verified by the Owner's Engineer, the Contractor shall compact these areas with a minimum of 10 passes.
- B. Any soft areas exhibiting excessive weaving or unsatisfactory material identified during excavation, fill placement, compaction and proof-roll shall be removed, and compacted as specified in Section 3.03.A above. Backfilling of these areas shall be done in accordance with Section 3.04.
- C. Prior to preparing the subgrade in low lying areas, perform the following procedures:
 - 1. Drain standing water by gravity or with a pump. Water should not be discharged directly to a storm drain system.
 - 2. After drainage of low area is complete, remove mulch, mud, debris, and other unsuitable material using equipment and methods that will minimize disturbance to the underlying soils.
 - 3. Thoroughly compact subgrade as specified herein.
 - 4. If proposed for fill, all mud and other materials removed from above low areas shall be dried on-site by spreading in thin layers for observation by Owner or Owner's Engineer. Material shall be inspected and, if found to be suitable for use as fill material, shall be incorporated into lowest elevation of site filling operation, but not under the building area, within 25 feet of the perimeter of the building pad, or within 3 feet of the paving subgrade elevation. If, after observation by Owner or Owner's Engineer, material is found to be unsuitable, it shall be removed from the site at no cost to the Owner.

3.03 BACKFILLING AND COMPACTION

- A. No fill materials shall be placed during unfavorable weather conditions. When work is interrupted by heavy rains, fill operations shall not be resumed until all saturated surficial soils are returned to a satisfactory moisture content as determined by the Owner's Engineer.
- B. Place and compact approved fill materials in 12-inch maximum loose lifts using a minimum of 6 passes with the above 5-ton static drum weight compactor and obtain at least 95% of the maximum density as determined by ASTM D-1557. Smaller compaction equipment, together with 6-inch maximum lifts will be necessary for backfill behind walls and areas of limited maneuverability.
- C. Visual confirmation of fill quality, lift thickness and compaction procedures, together with density testing, shall determine the acceptability of fill. Any unsatisfactory material or soft areas exhibiting excessive weaving shall be immediately removed, replaced and recompacted as stated above to the satisfaction of the Owner's Engineer.
- D. No fill material shall be placed in areas of standing water, in areas of frozen or thawing ground, or over surfaces or lifts that have not been approved by the Owner's Engineer.

3.04 MAINTENANCE OF SUBGRADE AND FILLS

- A. Finished subgrades shall be verified by the Contractor to ensure proper elevation and conditions for construction above subgrade.
- B. During earthwork operations, exposed areas shall be constructed or excavated in a manner that provides for surface drainage and prohibits ponding water. All fill areas shall be sealed at the end of each day using a smooth drum roller.
- C. Protect subgrade from excessive construction traffic and wheel loading including concrete and dump trucks.
- D. Remove areas of finished subgrade judged to be unsatisfactory to the depth necessary and replace in a manner that will comply with compaction requirements by use of material approved by the Owner's Engineer. Surface of subgrade after compaction shall be hard, uniform, smooth, stable and true to grade and cross-section.
- E. It is the Contractor's responsibility to provide adequate dewatering of the site by means and methods approved by the Owner's Engineer, if groundwater is encountered during the earthwork activities. The Contractor shall review the Geotechnical Report to obtain information regarding the depth of groundwater on-site.

3.05 FINISH ELEVATIONS AND LINES

- A. For setting and establishing finish elevations and lines, secure the services of a licensed land surveyor acceptable to the Owner and Owner's Engineer.
- B. Provide elevation grade stakes and any other surveying necessary for the layout of the work. The Contractor shall conduct his work in such a manner that survey stakes will be protected as long as their need exists. Grade stakes which are damaged or stolen shall be replaced by the Contractor's Surveyor at the Contractor's expense.
- C. Graded areas shall be uniform, hard and smooth, free from rock, debris, or irregular surface changes. Finished subgrade surface shall not be more than 0.10 feet above or below the design finished subgrade elevation; any deviation shall not result in changes in drainage areas or ponding. All ground surfaces shall vary uniformly between indicated elevations. Finish drainage ditches shall be graded to allow for proper drainage without ponding and in a manner that will minimize the potential for erosion.
- D. Areas having drainage slopes of one-quarter inch per foot or more shall have grade stakes, set with an instrument, at grid intervals of 50-ft.
- E. Areas having drainage slopes of one-quarter inch per foot or less shall have grade stakes, set with an instrument, at grid intervals of 25-ft.
- F. Correct all settlement and eroded areas for one year after date of project completion at no additional expense to Owner. Bring paved and landscaped areas to proper elevation. Replant or replace any grass, shrubs, bushes, or other vegetation disturbed by construction using corrective measures.

END OF SECTION

SECTION 312316

EXCAVATION, BACKFILL & SUBGRADE PREPARATION FOR PAVEMENT

PART 1 GENERAL

1.00 SCOPE OF WORK

- A. Excavation and backfilling to line, grade and configuration as shown in the Contract Documents and as described in these specifications for proposed asphaltic concrete and Portland cement concrete pavement
- B. Removal of unsuitable material beneath proposed paved areas.
- C. Compacting fill materials in acceptable manner as specified herein.

1.01 RELATED SECTIONS AND DOCUMENTS

- A. Section 320000 – General Requirements
- B. Section 312500 - Soil Erosion and Sediment Control
- C. Section 310000 – Earthwork
- D. Section 321313 – Portland Cement Concrete Paving
- E. Section 321613 – Curbs and Sidewalks
- F. Contract Drawings and Documents

1.02 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM) - latest edition
 - 1. D 422 Method for Particle Size Analysis of Soils
 - 2. D 1557 Test for Moisture-Density Relations of Soils Using 10-lb (4.5 Kg) Hammer and 18-inch (457 mm) Drop (Modified Proctor)
 - 3. D 2216 Laboratory Determination of Moisture content of Soil
 - 4. D 2487 Classification of Soils for Engineering Purposes
 - 5. D 2922 Tests for Density of Soil and Soil- Aggregate in Place by Nuclear Methods (Shallow Depth)
 - 6. D 3017 Test for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
 - 7. D 4318 Test for Plastic Limit, Liquid Limit, and Plasticity Index of Soils
- B. American Association of State Highway and Transportation Officials (AASHTO) - latest edition
 - 1. T 88 Mechanical Analysis of Soils
- C. All applicable OSHA Regulations

1.04 QUALITY ASSURANCE

- A. An Engineer, familiar with the requirements of the Contract Documents, selected and paid by the Owner (herein referenced to as “Owner’s Engineer”), may be retained to perform construction testing on filling operations and subgrade preparation as specified in section

31 00 00 and described herein. This inspection will not relieve the Contractor from his responsibility to complete the work in accordance with the plans and specifications.

1.05 SUBMITTALS

- A. Shop drawings or details pertaining to excavating and filling for structures are not required unless otherwise shown on Contract Document or if procedures contrary to the Contract Documents are proposed.
- B. Submit 50-lb sample of each type of off-site fill material that is to be used in backfilling in air-tight containers to the Owner's Engineer or submit gradation and certification of aggregate material that is to be used to the Owner's Engineer for review at least one week prior to use on-site.

PART 2 PRODUCTS

2.00 MATERIALS

- A. Fill material from on-site as specified in Section 31 00 00 of these Specifications and approved by the Owner's Engineer.
- B. Fill material from off-site as specified in Section 31 00 00 of these specifications and approved by the Owner's Engineer.
- C. Products containing materials with recycled content will be documented in accordance with the procedure outlined in the Project Documents.
- D. Products containing materials manufactured and extracted, harvested or recovered within 500 miles will be documented in accordance with the procedure outlined in the Project Documents.

2.01 EQUIPMENT

- A. Off-site materials shall be transported to project using well maintained and operating vehicles. Once on-site, transporting vehicles shall at no time endanger improvements by rutting, overloading, or pumping.
- B. Excavation is to be performed using capable, well maintained equipment and methods acceptable to the Owner and the Contract Document requirements and schedule.
- C. Compaction shall be performed using a 5-ton static drum weight, vibratory, smooth drum roller or as specified in the Geotechnical Report.
- D. Smaller compaction equipment, together with thinner lifts may be required at areas of limited access or maneuverability. In such a case, the compaction equipment shall be a double drum walk-behind roller and shall be subject to the Owner's Engineer approval.

PART 3 EXECUTION

3.01 PREPARATION

- A. Identify lines, elevations, and grades necessary to construct pavements, curb, sidewalk, and roadways as shown on Contract Documents.
- B. Protect benchmarks, property corners, and other survey monuments from damage or displacement. If marker needs to be removed it shall be referenced by licensed land surveyor and replaced, as necessary, by same.

- C. Locate and identify site utilities that have previously been installed and protect from damage.
- D. Locate and identify existing utilities that are to remain and protect from damage.
- E. Overexcavate and properly prepare areas of subgrade that are not capable of supporting proposed systems. These areas shall be stabilized by using aggregate material placed and compacted as specified.

3.02 EXCAVATION

- A. Excavate pavement areas to line and grade as shown on the Contract Documents.
- B. Areas of existing curb islands, sidewalks and existing pavement failure shall be excavated to competent soil to the satisfaction of the Owner's Engineer. Excavation of soft soils will be required in both fill and overlay areas to the satisfaction of the Owner's Engineer.
- C. Perform excavation using capable, well maintained equipment and methods acceptable to Owner and local governing agencies.
- D. Where existing grades are above proposed subgrade elevation, excavate materials in the pavement areas to the subgrade elevations necessary based on the finished pavement lines and grades as shown in the Contract Documents being careful not to overexcavate beyond the elevations needed. Replacement of fill in areas overexcavated by the Contractor without approval of the Owner's Engineer shall be replaced as compacted fill in accordance with these Specifications at no additional cost to the Owner.
- E. Excavated on-site soils that meet the requirements of Section 31 00 00 of these Specifications and approved by the Owner's Engineer may be used as fill on-site.
- F. Excavated on-site soils that are unsuitable for fill may be used in landscaped areas if approved by the Owner's Engineer. Otherwise this material shall be legally disposed of off-site at no additional cost to the Owner.
- G. Unsuitable material, such as wood and any other deleterious materials determined to be unsuitable by the Owner's Engineer for use as on-site fill shall be legally disposed of off-site at no additional cost to the Owner.

3.03 SUBGRADE PREPARATION

- A. Existing grades below areas of proposed pavement shall be leveled prior to fill placement. The Contractor shall remove existing trees, roots, stumps, organic wetland soils, and top soil in these areas prior to placement of any fill and legally dispose of this material off-site at no additional cost to Owner.
- B. The Contractor shall drain any standing or puddled water in low lying areas.
- C. All existing grades below areas of proposed pavement shall be proofrolled and compacted with a minimum of 6 passes using the vibratory drum roller specified in part 2.02 of this Section prior to placement of pavement subbase. Existing areas which exhibit "pumping" or "rutting" under the action of the roller shall be removed and replaced with suitable fill material as specified in Section 31 00 00 of these Specifications, or as directed by the Owner's Engineer.
- D. Excavated on-site soils that are unsuitable for pavement subgrade below paved areas may be used in landscaped areas if approved by the Owner's Engineer. Otherwise this material shall be legally disposed of off-site at no additional cost to the Owner.

- E. Unsuitable material, such as wood and any other deleterious materials determined to be unsuitable by the Owner's Engineer for use as on-site fill shall be legally disposed of off-site at no additional cost to the Owner.

3.04 SUBGRADE FILL PLACEMENT AND COMPACTION

- A. Fill material shall not be placed in areas of standing water, in areas of frozen or thawing ground, or in areas that have not been approved by the Owner's Engineer.
- B. Fill materials shall not be placed during unfavorable weather conditions. When work is interrupted by heavy rains, fill operations shall not be resumed until all saturated surficial soils are returned to a satisfactory moisture content as determined by the Owner's Engineer.
- C. Maintain optimum moisture content of fill materials as specified herein to attain required compaction density.
- D. Materials shall be tested in accordance with Section 31 00 00.
- E. If compaction requirements are not complied with at any time during construction process, remove and recompact deficient areas until proper compaction is obtained at no additional expense to Owner.
- F. Fill lift surfaces shall be made smooth and free from ruts or indentations at the end of any work day when significant precipitation is forecast to prevent saturation of surficial fill material. Fill surfaces shall be graded to drain and sealed with a smooth drum roller at the completion of each work day.
- G. Subgrade fill in paved areas shall be placed in uniform loose lifts and compacted in accordance with the Specifications.
- H. Wet, saturated material shall be removed and replaced or scarified and air dried as necessary to achieve the field densities specified in this Section. Drying may be assisted by discing, harrowing, or pulverizing until moisture content is reduced.
- I. Prior to paving, the subgrade shall be proofrolled with a minimum of 6 overlapping coverages using a 5-ton static drum weight vibratory roller.
- J. Remove areas of finished subgrade found to have insufficient compaction density of depth necessary and replace with suitable compacted fill as approved by the Owner or Owner's Engineer. Surface of subgrade after compaction shall be hard, uniform, smooth, stable, and true to grade and cross-section.

3.05 MAINTENANCE OF APPROVE SUBGRADE SURFACES

- A. Finished subgrades shall be verified to ensure proper elevation and conditions for construction above subgrade.
- B. Protect subgrade from excessive wheel loading during construction including concrete trucks, dump trucks, and other construction equipment.
- C. Remove areas of finished subgrade found to have insufficient compaction density to depth necessary and replace in manner that will comply with compaction requirements by use of material that has been approved by the Owner's Engineer. Surface of subgrade after compaction shall be hard, uniform, smooth, stable, and true to grade and cross-section.

3.06 FINISH GRADING

- A. Finish grading shall be in accordance with Section 310000.

3.07 QUALITY CONTROL

- A. Compaction tests shall be performed by the Owner's Engineer as specified in Section 310000 together with the following for areas of proposed pavement:
 - 1. In cut areas, not less than one compaction test for every 15,000 square feet.
 - 2. In fill areas, one test for every 15,000 square feet for each lift.
- B. Prior to paving, the finished subgrades shall be verified by the Contractor to ensure proper elevation and conditions for construction above subgrade.
- C. Tolerances of 0.10 feet will be permitted. Any deviation from the design grades shall not result in changes in drainage areas or ponding. The Contractor shall provide engineering and field staking necessary for verification of lines, grades, and elevations.

END OF SECTION

SECTION 312500

SOIL EROSION AND SEDIMENT CONTROL

PART 1 GENERAL

1.00 SCOPE OF WORK

- A. Temporary and permanent soil erosion control systems.

1.02 RELATED SECTIONS

- A. Section 310000 - Earthwork
- B. Contract Drawings and Documents

1.03 REFERENCE STANDARDS

- A. The Connecticut Department of Environmental Protection's (CTDEP) Guidelines for Soil Erosion and Sediment Control, latest edition

1.04 QUALITY ASSURANCE

- A. The Contractor shall carefully adhere to the construction sequence that is shown on the Contract Drawings.
- B. The Contractor shall follow Soil Erosion and Sediment Control Notes that are shown on the Contract Drawings.
- C. The Contractor shall make frequent inspection of temporary soil erosion controls and maintain them in working order until permanent soil erosion controls are established.

1.05 ENVIRONMENTAL REQUIREMENTS

- A. The Contractor shall protect adjacent properties and water resources from soil erosion and sediment damage throughout construction.

PART 2 PRODUCTS

2.00 MATERIALS

- A. Quick-growing grasses such as wheat, rye or oats in accordance with Contract Drawings.
- B. Haybales
- C. Temporary mulches such as loose hay, straw, netting, wood, cellulose or agricultural silage.
- D. Fence stakes shall be metal stakes a minimum of 5 feet in length and be either metal stakes or 2 in x 2 in hardwood stakes driven 1' – 6" into the ground.
- E. Filter fabric as specified on the Contract Drawings, or approved Equal.

PART 3 EXECUTION

3.00 PREPARATION

- A. Review site conditions and sediment control plans.
- B. Review the soil erosion and sediment control plans as they apply to current conditions. Any proposed deviation from the plans must be submitted to the Owner's Engineer in writing 72 hours prior to commencing that work.

3.01 SOIL EROSION CONTROL AND SLOPE PROTECTION IMPLEMENTATION

- A. Place soil erosion control systems in accordance with the Contract Documents prior to any earthwork construction.
- B. Limit the surface area of erodible earth material exposed by clearing and grubbing, excavation, borrow and embankment operations by following the construction phasing on the Soil Erosion and Sediment Control Plan.
- C. The Contractor will be required to incorporate all permanent soil erosion control features into the project at the earliest practical time to minimize the need for temporary controls. Cut slopes shall be permanently seeded and mulched as the excavation proceeds to the extent considered desirable and practical. Equip catch basins with filter fabric inlet protection immediately upon construction.
- D. The temporary soil erosion control systems installed by the Contractor shall be maintained as directed by the Owner's Engineer to control siltation at all times during the life of the contract. The Contractor must respond to any maintenance or additional work ordered by the Owner's Engineer within a 48 hour period.
- E. Slopes that erode easily shall be temporarily seeded as the work progresses with quick growing grass grains of wheat, rye or oats unless otherwise specified in the Landscape Specifications. In areas where seeding is ineffective, as determined by the Owner's Engineer or other governing authorities, the Contractor shall provide fibrous netting as shown on Contract Drawings at no additional cost to the Owner.
- F. All soil erosion control measures shall be maintained until all permanent improvements to the site are complete unless otherwise directed by the Owner's Engineer.

END OF SECTION

SECTION 320000

GENERAL SITE REQUIREMENTS

PART 1 GENERAL

1.00 SCOPE OF WORK

- A. The work generally includes, but is not limited to, the following:
1. Soil Erosion and Sediment Control Measures
 2. Earthwork
 3. Placement of Compacted Fill
 4. Paving of Sidewalk
- B. Associated work items as described in the Contract Drawings and Documents and all construction methods and procedures necessary for the performance of the work.
- C. The Site Contractor shall provide adequate personnel, facilities, material, and equipment to complete the work shown on the Contract Drawings and Documents and as specified herein and in accordance with the requirements of the town within the agreed upon schedule. When these specifications are at variance, the more restrictive requirements shall apply. The Contractor shall employ a qualified supervisor to provide adequate and efficient coordination of the Work and to adhere to all requirements set forth in this specification and general construction practices within the State of Connecticut and those required by the town. The Supervisor shall be present on the site on a continuous full-time basis and have authority to act on behalf of the Contractor.
- D. The Contractor shall obtain and pay for the construction of all related site work. The Contractor shall pay for all other fees and services, give notice, file necessary drawings, and obtain permits and certificates of approval required in connection with the related work of their contracts, comply with laws, ordinances, rules and regulations of departments having jurisdiction over this work.
- E. Additional Owner and Engineer time for repeat inspections of punch list items after the initial inspections will be charged to the Contractor in the form of a deductive change order.

1.01 CONTRACTOR TO ACCEPT SITE CONDITIONS AND CONTRACT DOCUMENTS

- A. The Contractor shall accept the site as is. The Contractor shall make and shall be deemed to have made a thorough site inspection in order to field check existing site conditions, correlate conditions with the drawings and resolve any possible construction conflicts with the Owner and Owner's Engineer prior to commencement of work. This includes a topographic survey of any areas the Contractor requires additional topographic information, and subsurface utility investigations. Any conditions that differ from the existing conditions shown on the drawings that are not brought to the attention of the Owner and Owner's Engineer prior to the start of work shall not be considered grounds for a change order.
- B. The work to be performed is as shown on the Contract Drawings. Attempts have been made to note all specific items on the drawings. The contractor is responsible for means and methods of construction; as such, these plans may not completely represent all specific site details of installation required for sitework construction. Contractor is responsible to provide all improvements required to achieve construction depicted on these plans. Incidental items not included in the Contract Documents shall be constructed in accordance with standard engineering or architectural requirements. It shall be the

Contractor's responsibility to repair or replace any existing facilities (utilities, streets, sidewalks, etc.) damaged by him during the work. Such repairs or replacement shall be done at the Contractor's own expense to the satisfaction of the Owner.

- C. The Contractor shall provide written requests for information to the Owner and Owner's Engineer prior to the construction of any specific sitework item if any sitework item depicted on the plans warrants additional engineering information required for construction and is not related to means and methods of construction. The Contractor shall be responsible for sitework items installed differently than intended as depicted on the plans in the absence of submitting and receiving reviews and/or direction on written requests for information from the Owner or Owner's Engineer.
- D. It is specifically noted that information related to elevations and proposed utilities (such as roadway grades, invert elevations, rim elevations, grate elevations, building finished floor elevations, etc.) may be found in more than one location on the contract documents. Contractor shall specifically review all plans, profiles and any information/data tables for consistency prior to construction. Any inconsistencies or discrepancies that are found shall immediately be brought to the attention of the Owner's Engineer in writing requesting clarification prior to construction.
- E. Contractor is specifically noted that there are additional notes, specifications and requirements contained on sheets throughout the plan set and available references to specifications from applicable governing authorities and industry standards. It is the contractor's responsibility to obtain, review and adhere to all applicable requirements.
- F. Contractor's acceptance of the project contract specifically binds the contractor to the requirements noted above and contained in this entire document.

1.02 INDEMNIFICATION

- A. The Contractor shall indemnify and save harmless the Owner, and its respective agents, officers, employees and Owner's Engineer (herein collectively called the "indemnities") from and against any and all liability, loss, damages, interest, judgments and liens growing out of, and any and all costs and expenses (including, but not limited to, counsel fees and disbursements) arising out of, or incurred in connection with, any and all claims, demands, suits, actions, or proceedings which may be made or brought against any of the indemnities for or in relation to any violation of this Contract, the laws, statutes, ordinances, rules, regulations, executive orders and agreements herein provided or any injuries, including death at any time resulting therefrom, sustained by any person or persons, or on account of any damage to property, arising out of or in consequence of the performance of or the failure to perform the contract, whether or not such injuries to persons or damage to property are due or claimed to be due to any negligence of the Contractor or its employees, agents, subcontractors or materialmen, the indemnities or any other person.

1.03 WARRANTIES

- A. The Contractor shall correct defective work at the Contractor's expense which appears within one year's time from acceptance of work. Failure of Contractor to correct such defects within a reasonable time after being notified to do so shall permit the Owner to cause such defects to be corrected and charge the Contractor the cost of corrections.
- B. The Contractor shall submit to the Owner and Owner's Engineer all material warranties supplied by manufacturers.

1.04 GENERAL QUALITY ASSURANCE

- A. References and Standards: The Contractor shall comply with all rules, regulations, laws and ordinances of all Authorities having jurisdiction. All labor, materials, equipment, and services necessary to make the work comply with such requirements shall be provided without additional cost. All Standards shall be the latest edition and revisions.
- B. The Contractor shall deliver material to the site, in the approved Manufacturer's original and unopened containers and packaging, bearing labels as to type of material, brand name and manufacturer's name. Delivered materials shall be identical to approved samples. Certifications for materials shall be included with the shipment.
- C. The Contractor shall store material under cover (if appropriate) in a clean, dry, above-ground location, and remove materials which are damaged or otherwise not suitable for installation from the job site and replace with acceptable materials.

1.05 SECURITY

- A. Protect work, existing premises and Owner's operations from theft, vandalism, and unauthorized entry.
- B. Initiate and maintain security program as described herein throughout construction period until Owner acceptance precludes the need for Contractor security.
- C. Restrict entrance of persons and vehicles into project site. Allow entrance only to authorized persons with proper identification. Maintain log of workers and visitors, make available to Owner on request.
- D. Maintain a list of authorized persons; submit copy to Owner on request.

1.06 SAFETY PROVISIONS:

- A. Site safety is entirely the responsibility of the Contractor. The Contractor is hereby made aware that the Owner's Engineer does not have the authority to stop the work on the grounds of unsafe work practices.
- B. The Contractor shall give all notices and comply with all laws, ordinances, rules and regulations as required by all authorities having jurisdiction bearing on the conduct of the Work as specified.
- C. If any of the Contractor's work is performed contrary to such laws, ordinances, rules and regulations, and/or without the required notices, he shall bear all cost arising therefrom.
- D. The Contractor shall also give prior written notice to all concerned utility companies, agencies, authorities, owners, etc., at least forty-eight (48) hours in advance of commencing any work on this Contract.
- E. Maintenance materials, including extra materials, spare parts, tools, and software.

1.07 SUBMITTALS:

A. General:

1. The Contractor shall submit to the Owner's Engineer and to Town Officials and/or the Town Engineer, where required, sufficient documentation from the manufacturers that all material and products used by the Contractor meet the required specifications. Such documentation shall be submitted and reviewed prior to the delivery of the material.
2. This documentation shall include shop drawings, vendor drawings, manufacturer's specifications and catalog cuts. The shop drawings shall include plans, elevations, sections and details of the work showing in detail the methods of installation and all data and assumptions considered in the design.
3. The Owner's Engineer will review appropriate documentation for general compliance to the specifications prior to delivery. The Owner's Engineer's review will be made on a timely basis.
4. The review of the Owner's Engineer or failure to review shall not be construed as permitting any departure from Contract requirements, or as relieving the Contractor of responsibility for any errors, including details, dimensions or materials. If submittals show variations from Contract requirements, the Owner's Engineer may review such variations, subject to a proper adjustment in the Contract. If the Contractor fails to describe such variations, he shall not be relieved of the responsibility for executing work in accordance with the Contract Documents even though such submittals identifying other variations have been reviewed. It is specifically noted that variations from items depicted on the plan require the review and approval of the Town Engineer.
5. All submittals required by specifications shall be submitted, unless otherwise stated herein, as follows:
 1. Specifications – Three copies of material specifications shall be submitted to the Owner's Engineer unless agreed that less copies will be sufficient.
 2. Shop Drawings – A reproducible and two copies shall be submitted to the Owner's Engineer.
6. The work shall not begin until all required submittals for each segment of work have been reviewed.

1.10 PROJECT COORDINATION

- A. Cooperate with the Owner when necessary in allocation of mobilization areas of the site for field offices and sheds, for access, traffic and parking facilities.
- B. Comply with Owner procedures for intraproject communications; submittals, reports and records, schedules, coordination drawings, and recommendations and resolution of ambiguities and conflicts.
- C. Comply with instructions of the Town and the Owner for use of temporary utilities and construction facilities.
- D. Submit preliminary progress schedule and coordinate with project construction schedule. After review, revise and resubmit schedule to comply with revised project schedule. During progress of work revise and resubmit as directed.
- E. Provide information required by Owner and Owner's Engineer for preparation of coordination drawings.

- F. Notify Owner and Owner's Engineer when work is considered ready for substantial completion. Accompany Owner's Engineer on preliminary inspection to determine items to be listed for completion or correction in Contractor's Notice of Substantial Completion and punchlist.

1.11 PROGRESS SCHEDULE

- A. The Contractor shall submit a detailed schedule for approval by the Owner before beginning work and shall adhere to the approved schedule. The schedule, which shall list all major and minor construction tasks, shall be based on the requirements set forth by the Owner and Construction Manager and shall be in accordance with the construction phasing plans. All work shall be done in a continuous manner unless otherwise directed by the Owner and Construction Manager and shall be completed at a satisfactory rate of progress. If in the opinion of the Owner, or his/her representative, work is not being done at a satisfactory rate of progress, the Owner may order the Contractor to increase his work force to insure completion of the project on schedule.

1.12 PERMIT APPLICATIONS AND COMPLIANCE

- A. The Contractor shall carefully plan and coordinate his work so as to comply with all criteria, conditions and the intent of all project permits.

1.13 ENVIRONMENTAL PROTECTION

- A. It is the Contractor's responsibility to assure himself that all applicable Federal, State and local laws, concerning pollution and environmental protection are being complied with by his personnel and subcontractors.
- B. When Contractor is in, or it is anticipated that any part of the work may become in non-compliance with applicable Federal, State, and local laws or regulations, the Owner may issue an order stopping all or part of the work until satisfactory corrective actions have been taken, or may order supplemental actions to be taken to stay in, or come into, compliance. No part of the time lost due to any such stop order shall be made subject of a claim for extensions of time, or for extra compensation or damages by the Contractor.
- C. In particular, the Contractor shall not allow the discharge of concrete, mortar, grout, gasoline, diesel, or the washing from vessels containing these materials, or other construction materials, into public areas, onto adjacent properties or the sewage or stormwater conveyance systems.
- D. Contractor shall provide and maintain all facilities necessary for pollution control under this Contract as long as construction operations continue.

1.14 CONTRACTOR'S REPRESENTATIVES

- A. The Contractor shall provide and maintain a capable and experienced field person to oversee all contract operations. The Contractor shall submit references for his proposed representative to, and obtain approval from, the Owner and/or Owner's Engineer prior to the start of construction. The representative shall be on-site during all operating hours of the project.
- B. As appropriate, the Contractor or his subcontractors shall provide qualified supervisory personnel for specialist aspects of the work, such as concrete, landscaping, and site furnishings.

1.15 SITE ACCESS

A. General

1. The Contractor shall construct any construction access ways shown on the Drawings or as required prior to the execution of his work. The contractor shall be required to maintain all necessary access and parking areas, haul roads, ramps and any other temporary facilities required by the Owner to insure safe and satisfactory operation of the facility and completion of the work in accordance with the schedule. Cleanliness of off-site streets (both private and public) shall be maintained by the Contractor throughout construction. All public roadways shall be kept free of debris and sediment that result from the subject work. The contractor will provide daily sweeping if required by the Town.

The Contractor shall coordinate construction fencing with the Owner.

1.16 EXISTING CONDITIONS, UTILITIES AND STRUCTURES

- A. Prior to the beginning of any grading work, the Contractor shall make sufficient checks on the topographic conditions and subsurface utilities to satisfy himself that the existing information as shown on the topographic survey and contract documents are adequate for construction. Should any discrepancies be found, they shall be reported to the Owner's Engineer immediately. Claims for extras due to discrepancies in the existing conditions will not be reviewed if the Owner's Engineer and Owner are not notified immediately (within 24 hours of beginning of site work).
- B. Verify Locations: Locations of existing underground utilities and structures as shown on the Contract Documents are approximate and may not necessarily be complete. These locations must be verified by the Contractor prior to construction. It is specifically noted that the contractor may require the use of a utility location service in the event the Contractor deems it necessary to perform this verification.
- C. Prior to construction of the sanitary, water, gas, electric, telephone, cable and storm sewer systems, the Contractor shall conduct test pits at all proposed utility crossings with existing underground utilities and/or storm pipes. Elevations of existing utilities shall be accurately recorded and submitted to the Owner's Engineer for verification of the proposed design. Any necessary adjustments to the proposed design will be made by the Owner's Engineer in a timely manner.
- D. The Contractor is specifically made aware that the exact depth and location of the off-site water and gas mains are unknown. The Contractor shall perform test pits prior to installation of the new laterals where shown on the plans to verify the depth and location of existing connection points.
- E. Avoid Damage: The Contractor shall exercise care to avoid damage to all existing structures, poles, utilities, pipes, etc. which are scheduled to remain. In locations where the excavation is carried beneath or adjacent to such facilities, the Contractor shall adequately support such structures, utilities or pipes as necessary to remain in operation and maintain their original position. The Contractor shall be responsible for any damage caused to any utilities by this work, and shall repair any damage without charge to the Owner.
- F. The Contractor shall provide written requests for information to the Owner and Owner's Engineer prior to the construction of any specific item if any specific item depicted on the plans warrants additional information required for construction and is not related to means and method of construction. The Contractor shall be responsible for specific sitework items

installed differently than intended as depicted on the plans in the absence of submitting and addressing written requests for information.

PART 2 PRODUCTS

2.00 MATERIALS

- A. Use materials appropriate to the work, and meeting with the Owner's Engineer's approval.

PART 3 EXECUTION

3.00 GENERAL

- A. Execute general measures as appropriate, and meeting with the Owner's Engineer's approval.

END OF SECTION

SECTION 321313

PORTLAND CEMENT CONCRETE PAVING

PART 1 GENERAL

1.00 SECTION INCLUDES

- A. Preparation and placement of Portland cement in concrete areas identified on Contract Documents.

1.01 RELATED SECTIONS AND DOCUMENTS

- A. Section 310000 - Earthwork
- B. Section 312316 - Excavation, Backfill, and Subgrade Preparation for Pavement
- C. Connecticut Department of Transportation Standard Specifications, latest edition.
- D. Contract Drawings and Documents

1.02 REFERENCE STANDARDS

- A. American Concrete Institute (ACI) latest edition
 - 1. 301 Specifications for Structural Concrete for Buildings
 - 2. 304R Guide for Measuring Mixing, Transporting and Placing Concrete
 - 3. 308 Standard Practice for Curing Concrete
- B. American Society for Testing and Materials (ASTM) latest edition
 - 1. A 185 Steel Welded Wire Fabric, Plain for Concrete Reinforcement
 - 2. C497 Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement
 - 3. A615 Deformed and Plain Billet-Steel for Concrete Reinforcement
 - 4. C33 Concrete Aggregates
 - 5. C 94 Ready-Mixed Concrete
 - 6. C 150 Portland Cement
 - 7. C 260 Air-Entraining Admixtures for Concrete
 - 8. D 309 Liquid Membrane-Forming Compounds for Curing Concrete
 - 9. C494 Chemical Admixtures for Concrete
 - 10. C1751 Performed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
- C. FS TT-C-800 - Curing Compound, Concrete, for New and Existing Surfaces.
- D. Connecticut Department of Transportation Standard Specification, latest edition.

1.03 QUALITY ASSURANCE

- A. The Contractor shall pay for the services of a test laboratory, approved by the Engineer, for concrete inspection. The test laboratory shall have at least one Professional Engineer on staff and shall submit proof that any concrete inspectors used on the project shall have successfully completed the ACI course in Concrete Inspection within the past year.
- B. Establish and maintain required lines and elevations.

- C. Check surface areas at intervals necessary to eliminate ponding areas. Remove and replace unacceptable work as directed by Owner's Engineer.
- D. Sweep concrete pavement and wash free of stains, discolorations, dirt, and other foreign material just prior to final inspection.
- E. Protect concrete from damage until acceptance of work. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of material.

1.04 SUBMITTALS

- A. Submit materials certificate to the Owner's Engineer, which is signed by materials producer and Contractor, certifying that materials comply with, or exceed, requirements specified herein.
- B. The Contractor shall retain an independent testing agency to perform the required tests. The Contractor shall provide any necessary assistance to the testing agency and provide the testing agency with the intended construction schedule at least one week prior to the start of construction.
- C. Submit concrete mix design to the Owner's Engineer for review at least 14 days prior to use.
- D. Testing results of concrete, steel and paving tests performed by Contractor's testing laboratory shall be submitted to Owner's Engineer in a timely manner.

1.05 PROJECT CONDITIONS

- A. Maintain access for vehicular and pedestrian traffic as required for other construction activities. Utilize temporary striping, flagmen, barricades, warning signs, and warning lights as required.

PART 2 PRODUCTS

2.00 MATERIALS

- A. Forms: Steel, wood, or other suitable material of size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. Use straight forms, free of distortion and defects. Use flexible spring steel forms or laminated boards to form radius bends as required. Forms shall be of depth equal to depth of curbing or sidewalk, and so designed as to permit secure fastening together at tops. Coat forms with nonstaining type of coating that will not discolor or deface surface of concrete.
- B. Welded Wire Mesh: Welded plain cold-drawn steel wire fabric, ASTM A 185.
- C. Reinforcing Bars: Deformed steel bars, ASTM A 615, Grade 60.
- D. Concrete materials: Comply with applicable requirements for concrete materials, admixtures, bonding materials, curing materials and others as required. Concrete shall have a minimum 28-day compressive strength of 4000 psi.
- E. Joint Sealers: Resilient premolded bituminous impregnated fiberboard units complying with ASTM D 1751 FS HH-F-341, Type II, Class A.

- F. Welded wire fabric as indicated on Contract Documents.

2.01 MIX DESIGN AND TESTING

- A. Concrete mix design and testing shall comply with requirements of ACI.
- B. Design mix to produce normal weight concrete consisting of Portland cement, aggregate, water-reducing admixture, air-entraining admixture, and water to produce following properties:
 - 1. Compressive Strength: 4,500 psi, minimum at 28 days, unless otherwise indicated on Contract Documents.
 - 2. Slump Range: 4-inches +/- 1-inch at time of placement
 - 3. Air Entrainment: 4 to 7 percent

PART 3 EXECUTION

3.00 PREPARATION

- A. Proof-roll prepared base material surface to check for unstable areas. Paving work shall begin only after unsuitable areas have been corrected and are ready to receive paving. Compaction testing for the base material shall be completed prior to the placement of the paving.
- B. Remove loose material from compacted base material surface to produce firm, smooth surface immediately before placing concrete.

3.01 INSTALLATION

- A. Form Construction
 - 1. Set forms to require grades and lines, rigidly braced and secured.
 - 2. Install sufficient quantity of forms to allow continuance of work and so that forms remain in place minimum of 24 hours after concrete placement.
 - 3. Check completed formwork for grade and alignment to following tolerances:
 - a. Top of forms not more than 1/8-inch in 10-ft
 - b. Vertical face on longitudinal axis, not more than
 - c. 1/4-inch in 10-ft
 - 4. Clean forms after each use and coat with form release agent as often as required to ensure separation from concrete without damage.
 - 5. Install 4-inch x 4-inch welded wire fabric as indicated on Contract Documents. Support wire on metal wire chairs to ensure that wire stays mid-depth of sidewalk section during concrete pour.
- B. Reinforcement: Locate, place and support reinforcement in accordance with Contract Documents and ACI.
- C. Concrete Placement
 - 1. Place concrete in accordance with requirements of Connecticut Department of Transportation Standard Specifications and ACI requirements.
 - 2. Do not place concrete until base material and forms have been checked for line and grade. Moisten base material if required to provide uniform dampened condition at time concrete is placed. Concrete shall not be placed around manholes or other structures until they are at required finish elevation and alignment.

3. Deposit and spread concrete in continuous operation between transverse joints, as far as possible. If interrupted for more than 1/2 hour, place construction joint. Automatic machine may be used for curb and gutter placement at Contractor's option. Machine placement must produce curbs and gutters to required cross-section, lines, grades, finish and jointing as specified for formed concrete. If results are not acceptable, replace with formed concrete as specified.
 4. Concrete placement in poor weather conditions shall be subject to limitation of ACI.
- D. Joint Construction: Construct expansion, weakened-plane control or contraction, and construction joints straight with face perpendicular to concrete surface. Construct traverse joints perpendicular to centerline, unless otherwise detailed.
1. Weakened-Plane Control or Contraction Joints: Provide joints per the drawings. Construct control joints for depth equal to at least 1/4 concrete thickness, as follows:
 2. Form tooled joints in fresh concrete by grooving top with recommended tool and finishing edge with jointer.
 3. Form sawed joints using powered saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut joints into hardened concrete as soon as surface will not be torn, abraded, or otherwise damaged by cutting action.
 4. Construction Joints: Place concrete joints at end of placements and at locations where placement operations are stopped for period of more than 1/2 hour, except where such placements terminate at expansion joints. Construct joints using standard metal keyway-section forms.
 5. Expansion Joints: Locate expansion joints per the drawings. Provide premolded joint filler for expansion joints abutting concrete curbs, catch basins, manholes, inlets, structures, sidewalks, and other fixed objects.
- E. Joint Fillers: Extend joint fillers full-width and depth of joint, and not less than 1/2-inch or more than 1-inch below finished surface where joint sealer is indicated. Furnish joint fillers in one-piece lengths for full width being placed, wherever possible. Where more than one length is required, lace or clip joint filler sections together.

3.02 CONCRETE FINISHING

- A. After striking off and consolidating concrete, smooth surface by screening and floating. Adjust floating to compact surface and produce uniform texture. After floating, test surface for trueness with 10-ft straightedge. Distribute concrete as required to remove surface irregularities, and refloat repaired areas to provide continuous smooth finish.
- B. Work edges of sidewalks, gutters, back top edge of curb, and formed joints with edging tool, rounding edge to 1/2-inch radius. After completion of floating and trowelling, when excess moisture or surface sheen has disappeared, complete surface finishing, as follows:
 1. Paving: provide course, nonslip finish by scoring surface with stiff-bristled broom perpendicular to flow of traffic.
 2. Curbs, gutters and sidewalks: Broom finish by drawing fine haired broom across surface perpendicular to line of traffic. Repeat operation as necessary to produce a fine line texture.
- C. After form removal, clean ends of joints and point up minor honeycombed areas. Remove and replace areas or sections with major defects, as directed by Owner's Engineer.
- D. Protect and cure finished concrete paving using acceptable moist-curing methods, more particularly described in "water-curing" section of ACI 308.

3.03 BACKFILL

- A. After the concrete has set sufficiently, the spaces in front and back of the curb or sidewalk shall be refilled to the required elevation with suitable material in accordance with Section 310000, which shall be compacted until firm and solid and neatly graded.

3.04 CLEANING AND ADJUSTING

- A. Sweep concrete pavement and wash free of stains, discolorations, dirt, and other foreign material just prior to final inspection.
- B. Protect concrete from damage until acceptance of work. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials.

END OF SECTION

SECTION 321613
CURB AND SIDEWALKS

PART 1 GENERAL

1.00 SCOPE OF WORK

- A. Preparation and Placement of Concrete Sidewalk
- B. Preparation and Placement of Concrete Curb

1.01 RELATED SECTIONS AND DOCUMENTS

- A. Section 310000 - Earthwork.
- B. Section 312316 - Excavation, Backfill and Subgrade Preparation for Pavement.
- C. Section 321313 - Portland Cement Concrete Paving
- D. Connecticut Department of Transportation Standard Specifications Latest Edition.
- E. Contract Drawing and Documents

1.02 REFERENCE STANDARDS

- A. American Concrete Institute (ACI) latest edition
 - 1. 301 Specifications for Structural Concrete for Buildings
 - 2. 304R Guide for Measuring Mixing, Transporting and Placing Concrete
 - 3. 308 Standard Practice for Curing Concrete
- B. American Society for Testing and Materials (ASTM) latest edition
 - 1. A 185 Steel Welded Wire Fabric, Plain for Concrete Reinforcement
 - 2. C497 Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement
 - 3. A615 Deformed and Plain Billet-Steel for Concrete Reinforcement
 - 4. C33 Concrete Aggregates
 - 5. C 94 Ready-Mixed Concrete
 - 6. C 150 Portland Cement
 - 7. C 260 Air-Entraining Admixtures for Concrete
 - 8. D 309 Liquid Membrane-Forming Compounds for Curing Concrete
 - 9. C494 Chemical Admixtures for Concrete
 - 10. C1751 Performed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
- C. FS TT-C-800 - Curing Compound, Concrete, for New and Existing Surfaces.
- D. Connecticut Department of Transportation Standard Specifications, latest edition.

1.03 QUALITY ASSURANCE

- A. The Contractor shall warrant that concrete curb and base is 3,000 psi unless otherwise noted on the Construction Documents.

- B. Establish and maintain required lines and elevations.
- C. Check surface areas at intervals necessary to eliminate ponding areas. Remove and replace unacceptable work as directed by Owner.
- D. Sweep concrete pavement and wash free of stains, discolorations, dirt, and other foreign material just prior to final inspection.
- E. Protect concrete from damage until acceptance of work. Exclude traffic from pavement for at least 30 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of material.

1.04 SUBMITTALS

- A. Submit concrete mix design to the Owner's Engineer for review at least 14 days prior to use.

1.05 PROJECT CONDITIONS

- A. Contractor shall maintain access for vehicular and pedestrian traffic as required for other construction activities. Utilize temporary striping, flagmen, barricades, warning signs, and warning lights as required.

PART 2 PRODUCTS

2.00 MATERIALS

- A. Forms: Steel, wood, or other suitable material of size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. Use straight forms, free of distortion and defects. Use flexible spring steel forms or laminated boards to form radius bends as required. The forms shall be of a depth equal to the depth of curbing or sidewalk, and so designed as to permit secure fastening together at the tops. Coat forms with non-staining type coating that will not discolor or deface surface of concrete.
- B. Concrete Materials: Comply with requirements of Connecticut Department of Transportation Standard Specifications and applicable Section 321613 for concrete materials, admixtures, bonding materials, curing materials and others as required. Concrete shall have a minimum 28-day compressive strength of 3,000 psi.
- C. Joint Fillers: Resilient pre-molded bituminous impregnated fiberboard units complying with AASHTO M 213.
- D. Welded wire fabric as indicated on Contract Documents.
- E. Products containing materials with recycled content will be documented in accordance with the procedure outlined in the Project Documents.
- F. Products containing materials manufactured and extracted, harvested or recovered within 500 miles will be documented in accordance with the procedure outlined in the Project Documents.
- G. Adhesives or sealants used for work in this section shall meet the goals of the CT HPB requirements as indicated in the Project Documents, where applicable.

2.01 MIX DESIGN AND TESTING

- A. Concrete mix design and testing shall comply with requirements of ACI and Section 321613 of these Specifications as they relate to Cast-in-Place Concrete.
- B. Design mix to produce normal weight concrete consisting of Portland cement, aggregate, water-reducing admixture, air-entraining admixture, and water to produce the following properties:
 - 1. Compressive Strength: 3,000 psi, minimum at 28 days, unless otherwise indicated on the Contract Drawings.
 - 2. Slump Range: 3-inches +/- 1-inch at time of placement
 - 3. Air Entrainment: 4 to 7 percent

PART 3 EXECUTION

3.00 PREPARATION

- A. Proof-roll prepared base material surface to check for unstable areas. The paving work shall begin after any unsuitable areas have been corrected and are ready to receive paving. Compaction testing for the base material shall be completed prior to the placement of the paving.
- B. Surface Preparation: Remove loose material from compacted base material surface to produce a firm, smooth surface immediately before placing concrete.

3.01 INSTALLATION

A. Form Construction

- 1. Set forms to required grades and lines, rigidly braced and secured.
- 2. Install sufficient quantity of forms to allow continuance of work and so that forms remain in place a minimum of 24 hours after concrete placement.
- 3. Check completed formwork for grade and alignment to following tolerances:
- 4. Top of forms not more than 1/8-inch in 10-ft.
- 5. Vertical face on longitude axis, not more than 1/4-inch in 10-ft.
- 6. Clean forms after each use, and coat with form release agent as often as required to ensure separation from concrete without damage.
- 7. Install 6-inch x 6-inch welded wire fabric as indicated on Contract Documents. Support wire on metal wire chairs to ensure that wire stays mid-depth of sidewalk section during concrete pour.

B. Concrete Placement

- 1. Comply with applicable requirements of ACI and Architectural Specifications.
- 2. Do not place concrete until base material and forms have been checked for line and grade. Moisten base material if required to provide uniform dampened condition at time concrete is placed. Concrete shall not be placed around manholes or other structures until they are at the required finish elevation and alignment.
- 3. Place concrete using methods which prevent segregation of mix. Consolidate concrete along face of forms and adjacent to transverse joints with internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Consolidate with care to prevent dislocation of dowels, and joint devices.

4. Deposit and spread concrete in continuous operation between transverse joints, as far as possible. If interrupted for more than 2 hours, place construction joint. Automatic machine may be used for curb and gutter placement at Contractor's option. Machine placement must produce curbs and gutters to required cross section, lines, grades, finish, and jointing as specified for formed concrete. If results are not acceptable, replace with formed concrete as specified.
5. Concrete placement shall be conducted in accordance with related ACI recommended procedures.

C. Joint Construction

1. Transverse Expansion Joints: Transverse expansion joint in sidewalk shall have the filler cut to the exact cross section of the sidewalk. The joints shall be similar to the type of expansion joint used in the adjacent pavement. Joint spacing as specified on the plans.

- D. Joint Fillers: Extend joint fillers full-width and depth of joint, and not less than 2-inches or more than 1-inch below finished surface where joint sealer is indicated. Furnish joint fillers in one-piece lengths for full width being placed, wherever possible. Where more than one length is required, lace or clip joint filler sections together.

- E. Joint Sealants: All joints shall be sealed with approved exterior pavement joint sealants and shall be installed per manufacturer's recommendations.

3.02 CONCRETE FINISHING

- A. After striking off and consolidating concrete, smooth surface by screening and floating. Adjust floating to compact surface and produce uniform texture. After floating, test surface for trueness with 10-ft straightedge. Distribute concrete as required to remove surface irregularities, and refloat repaired areas to provide continuous smooth finish.

- B. Work edges of sidewalks, back top edge of integral curb, and formed joints with an edging tool, and round to 2-inch radius. Eliminate tool marks on concrete surface. After completion of floating and troweling when excess moisture or surface sheen has disappeared, complete surface finishing as follows:

1. Inclined Slab Surfaces: Provide coarse, non-slip finish by scoring surface with stiff-bristled broom perpendicular to line of traffic.
2. Curbs, gutters, and sidewalks: Broom Finish by drawing fine-hair broom across surface perpendicular to line of traffic. Repeat operation as necessary to produce a fine line texture.

- C. Do not remove forms for 24 hours after concrete has been placed. After form removal, clean ends of joints and point up any minor honeycombed areas. Remove and replace areas or sections with major defects, as directed.

- D. Protect and cure finished concrete paving using acceptable moist-curing methods, more particularly described in the "water-curing" section of ACI 308-81.

3.03 BACKFILL

- A. After the concrete has set sufficiently, the spaces in front and back of the curb and gutter or sidewalk shall be refilled to the required elevation with suitable material in accordance with Section 31 00 00, which shall be compacted until firm and solid and neatly graded.

3.04 CLEANING AND ADJUSTING

- A. Sweep concrete pavement and wash free of stains, discolorations, dirt, and other foreign material just prior to final inspection.
- B. Protect concrete from damage until acceptance of work. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials.

END OF SECTION