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DIVISION 26 & 28

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SECTION 26 05 02

ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. This Section supplements Division 1, General Requirements.
- B. Where contradictions occur between this Section and Division 1, the most stringent of the two shall apply. Architect shall decide which is most stringent.
- C. Provisions of Divisions 21, 22, 23, and 28 shall also apply to the work of this section as if fully repeated here.
- D. Provision indicate Section 23 05 01/26 05 01 "Mechanical and Electrical Coordination" shall also apply to the work of this section as if fully repeated here.

1.2 DEFINITIONS

- A. The definitions of Division 1 and the General Conditions of this specification also apply to Divisions 26, 27 and 28 Contract.
- B. "Contract Documents" constitute the drawings, specifications, general conditions, project manuals, etc., prepared by Engineer (or other design professional in association with Engineer) for contractor's bid or contractor's negotiations with the Owner. Divisions 26, and 28 drawings and specifications prepared by the Engineer are not construction documents.
- C. "Construction Documents", "construction drawings", and similar terms for Divisions 26, and 28 Work refer to installation diagrams, shop drawings and coordination drawings prepared by the contractor using the design intent indicated on the Engineer's contract documents. These specifications detail the contractor's responsibility for "Engineering by Contractor" and for preparation of construction documents.
- D. "(N)" indicates "new" equipment to be provided under this contract.
- E. "(E)" indicates "existing" equipment on site which may or may not need to be relocated as a part of this work.
- F. "(R)" indicates existing equipment to be relocated as part of this work.
- G. "Furnish" means to "supply" and usually refers to an item of equipment.
- H. "Install" means to "set in place, connect and place in full operational order".

- I. "Provide" means to "furnish and install".
- J. "Equal" or "Equivalent" means "meets the specifications of the reference product or item in all significant aspects." Significant aspects shall be as determined by the Architect/Engineer.
- K. "Work by other(s) divisions"; "re: _____ Division", and similar expressions means work to be performed under the contract documents, but not necessarily under the division or section of the work on which the note appears. It is the contractor's sole responsibility to coordinate the work of the contract between his/her suppliers, subcontractors and employees. If clarification is required, consult Architect/Engineer before submitting bid.
- L. By inference, any reference to a "contractor" or "sub-contractor" means the entity, which has contracted with the Owner for the work of the Contract Documents.
- M. "Engineer" means the design professional firm, which has prepared these contract documents. All questions, submittals, etc. of this division shall be routed to the Engineer (through proper contractual channels).
- N. "Conduit" includes, in addition to pipe, all fittings, hangers and other accessories related to such conduit.
- O. "Concealed" means hidden from sight as in chases, furred spaces shafts, hung ceilings, or embedded in construction.
- P. "Exposed" means, "not concealed" as defined above. Work in trenches, crawl spaces, and tunnels shall be considered "concealed" unless otherwise specifically noted.
- Q. "Governmental" means all municipal, state and federal governmental agencies.
- R. Where any device or part of equipment is herein referred to in the singular number (such as "the conduit"), such reference shall be deemed to apply to as many such devices as are required to complete the installation as shown on the Drawings.
- S. "Electrical Contractor" means the Contractor doing Electrical work.
- T. "Security Contractor" means the Contractor doing Security work.
- U. "Fire Alarm Contractor" means the Contractor doing Fire Alarm work.

1.3 DESCRIPTION OF WORK

- A. The Specifications and the accompanying drawings are intended to secure the provisions of all material, labor, equipment, and services necessary to install complete, tested, and ready for operation the Electrical Systems in accordance with the Specifications and Drawings. The use of the term "provide" shall mean "furnish and install" throughout these specifications and drawings. All systems shall be complete with necessary appurtenances and minor auxiliaries, including pull boxes, offsets to

clear interferences, and supports which are not shown but are needed to make each system complete in every respect. All work described in the Specifications and not shown on the Drawings, or vice versa, shall be furnished in complete working order. If mention has been omitted of any item of work or material, necessary for completion of the system, then such items must be and are hereby included. The scope of this project includes, but is not limited to the following work:

1. Raceways and installation components.
2. Wire and Cable.
3. Panelboards.
4. Fuses.
5. Safety and disconnect switches.
6. Distribution equipment.
7. Motor controllers.
8. Transformers
9. Grounding
10. Light fixtures and lighting control
11. Control equipment.
12. Seismic bracing.
13. Power, control and alarm wiring systems.
14. Electrical provisions for fire and life safety.
15. Modification of existing Fire alarm system.
16. Alternate prices.
17. Modification to existing electrical distribution.
18. Demolition.
19. Furnishing of access doors (see Special Conditions - Article 33).
20. Furnishing and setting of all sleeves through the floors, roof and wall, where required including waterproofing and fireproof sealing and cap flashing.
21. Excavation and backfill (excavation in rock shall be included). All concrete work for pads (including housekeeping pads and conduit envelopment shall be included.
22. Hardware, such as inserts, bolts, etc., associated with concrete pads.
23. Cutting associated with electrical work.
24. Prime painting, where required for electrical equipment and installation.
25. Removal of existing electrical work in accordance with Architectural Demolition Scheme or as directed and required. Restoration of electrical service in affected adjoining areas which are to continue to function.
26. Provision for temporary light and power.
27. Installation and wiring of starters and controllers.
28. As-built drawings.

1.4 REGULATORY REQUIREMENTS

- A. All materials shall conform with the current applicable industry standards. Workmanship and neat appearance shall be as important as electrical and mechanical operation. Defective or damaged materials shall be replaced or repaired prior to final acceptance in a manner meeting approval of the Architect and at no additional cost to the Owner.

- B. The latest editions of the following standards are minimum requirements.
1. Underwriters' Laboratories, Inc. (UL)
 2. National Electrical Manufacturer's Assoc. (NEMA)
 3. American National Standards Institute (ANSI)
 4. Institute of Electrical and Electronic Engineers (IEEE)
 5. International Electrical Testing Association (NETA)
 6. Insulated Cable Engineer's Association (ICEA)
- C. All work and materials shall comply with latest rules, codes and regulations including, but not limited to the following:
1. OSHA.
 2. National Fire Codes of National Fire Protection Assoc. (NFPA).
 3. National Electrical Safety Code (NESC, ANSI C2).
 4. National Electrical Code (2014 Edition) with Hartford city, county and state Amendments.
 5. International Building Code (2015 Edition with city, county and state Amendments).
 6. Americans With Disabilities Act (ADA).
 7. All applicable Federal, state and local laws, code amendments and regulations.
- D. Code compliance is mandatory. Nothing in these drawings and specifications permits work not conforming to these codes.
- E. No work shall be concealed until after inspection and approval by proper authorities. If work is concealed without inspection and approval, Contractor shall be responsible for all work required to open and restore the concealed area including all required modifications.
- F. Contradictions: Where Codes are contradictory, follow the most stringent. Architect/Engineer shall determine which is most stringent.

1.5 CONTRACT DOCUMENTS

- A. Drawings indicate general arrangement of circuits and locations of outlets, conduit, and other work. Information shown on drawings is as accurate as planning can determine, but not guaranteed and field verification of all dimensions, locations, levels, etc., to suit field conditions is directed. Review all architectural, structural and mechanical drawings, and adjust all work to conform to all conditions shown therein. Architectural drawings shall take precedence over all other drawings. Discrepancies between different drawings or between drawings and specifications or regulations and codes governing installation shall be brought to attention of the Architect.
- B. Power system riser diagrams and schematic diagrams generally indicate equipment connections to be used for various systems. System conduit and wiring shall be as required for actual systems installed on this project. Provide all work shown on diagrams whether or not it is duplicated on the plans.

- C. Where the Drawings and Specifications do not comply with the minimum requirements of the Codes, either notify the Architect/Engineer in writing during the Bidding Period of the revisions required to meet Code requirements, or provide an installation which complies with the Code requirements. After entering into contract, Contractor will be held to complete all work necessary to meet these requirements without additional expense to the Owner.
- D. Follow Drawings and Specifications where they are superior to Code requirements. The more stringent of plans and drawing shall apply.

1.6 COORDINATION DRAWINGS

- A. Prepare coordination drawings in accordance with Division 1 "Submittals" to a scale of $\frac{1}{4}" = 1'-0"$ or larger; detailing major elements, components, and systems of electrical equipment (i.e., switchgear rooms and electrical rooms) and materials in relationship with other systems, installations, and building components. Where equipment is located outdoors, prepare shop drawings indicating electrical equipment locations and exterior elements in the equipment areas. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are important to the efficient flow of the work, including (but not necessarily limited to) the following:
 - 1. Indicate the proposed locations of major raceway systems, and materials. Include the following:
 - a. Exterior wall and foundation penetrations.
 - b. Fire-rated wall and floor penetrations.
 - c. Support details.
 - d. Sizes and location of required concrete pads and bases.
 - 2. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
 - 3. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installation.
 - 4. Electrical indicating conduit stub-up locations.

1.7 RECORD DRAWINGS

- A. Refer to Division 1 for additional requirements.
- B. Maintain a blue-line set of Electrical Contract Drawings in clean, undamaged condition, for mark-up of installations which vary from the Contract Drawings. These drawings shall be a separate set of drawings, not used for construction purposes, and shall be kept up to date as the job progresses. This set shall be made available for inspection by the Engineer or Architect at all times.
- C. Upon completion of the contract and before final payment is authorized, the contractor shall deliver the Owner a set of computerized "as built" capable of interfacing with AutoCAD software. Drawings shall have to show to scale, where applicable, all work including equipment, controls, etc., as actually installed.

- D. Prepare record documents in accordance with the requirements in Division 1 Section "Project Closeout." In addition to the requirements specified in Division 1, indicate installed conditions for:
 - 1. Major raceway systems, size and location, for both exterior and interior and conduit stub-up locations.
 - 2. Panelboard circuit directories reflecting all field changes.
 - 3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.
 - 4. Results of all testing performed as specified in the specification.
 - 5. Certification of inspection from authorities having jurisdiction.
 - E. Record the locations and invert elevations of underground installations.
- 1.8 OPERATING AND MAINTENANCE MANUALS
- A. Refer to Division 1 for additional requirements.
 - B. Submission:
 - 1. O&M manuals submitted for review shall be submitted as PDF documents, one document per manual.
 - 2. For final submission to owner, O&M Manuals shall be submitted as hard copies and digital PDF copies.
 - 3. Bind each hard copy Maintenance Manual in one or more vinyl covered, 3-ring binders, with pockets for folded drawings. Mark the back spine of each binder with system identification and volume number.
 - C. Requirement Contents:
 - 1. Manuals shall have index with tab dividers for each submittal section identifying all equipment and materials installed on the project including a local supplier for replacing a specific piece of equipment.
 - 2. Introduction - Explanation of manual and its use.
 - 3. Description of system or equipment.
 - a. Complete schematic drawings of all systems.
 - b. Functional and sequential description of all systems.
 - 4. Systems operations:
 - a. Operation procedures.
 - b. All posted instruction charts.
 - 5. Maintenance
 - a. Systems trouble-shooting charts
 - b. Procedures for checking out functions.
 - c. Recommended list of spare parts.
 - 6. Listing of Manufacturers
 - 7. Manufacturer's Data (where multiple model, type and size listings are included, clearly and conspicuously indicate those that are pertinent to this installati

Description - literature, drawings, illustrations, certified performance charts, technical data, etc.

- a. Operation
 - b. Maintenance - including complete trouble-shooting charts
 - c. Parts list
 - d. Names, addresses and telephone numbers of recommended repair and service companies.
 - e. Guarantee data.
8. Provide certificates for such items of equipment which have warranties in excess of one year.
 9. Provide test results for each specification section identified herein.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.
- B. Protection of Equipment:
 1. All electrical equipment to be used in the construction shall be properly stored and protected against the elements. All equipment shall be stored under cover, and shall not be stored at the construction site on the ground, in mud, water, rain, sleet, or dust. Large diameter cables may be stored on reels outside; however, all cable ends shall be waterproofed and the reels covered with weatherproof materials. Such weatherproof materials shall be heavy-duty, securely fastened, and made impervious to the elements.
 2. Conventional electrical construction materials such as building wire, outlet and junction boxes, wiring devices, conduit, lighting fixtures, fittings, etc., shall be stored in construction buildings, covered trailers, or portable covered warehouses. Any equipment subject to damage or corrosion from excessive moisture shall be stored in dry, heated areas. Any equipment containing plastic or material subject to damage caused by excessive heat or sunlight shall be stored to prevent such damage. This includes plastic ducts and lenses.
 3. Equipment damaged as a result of the above conditions shall be properly repaired at the contractor's expense or shall be replaced at the contractor's expense, if in the opinion of the Engineer, the equipment has been damaged to such an extent that it cannot operate properly after repairs are made.
 4. All electrical enclosures exposed to construction damage such as paint spots, spackling or plaster spatter, grout splashes, waterproofing compound, tar spots or runs, and pipe covering compound splashes, shall be completely covered and protected against damage.
 5. In the event leakage into the building of any foreign material or fluid occurs or may occur, the contractor shall take all steps as described above to protect any and all equipment.
 6. After connections to electrical equipment are complete and the equipment is ready for operation, all construction debris shall be removed from all enclosures. Such debris includes dust, dirt, wire clippings, tape, and insulation removed in order to make the connection.

- C. Where items cannot be immediately placed in their final position, this Contractor shall store and protect all Owner-furnished items until the time of their final installation. He shall be responsible for the care and protection of the items until acceptance by the Owner. Delivery of Utility Company furnished equipment shall be coordinated with the delivery policy of that company.

1.10 SAFETY AND INDEMNITY

- A. The Contractor shall be solely and completely responsible for conditions of the job site, including safety of all persons and property during performance of the work. This requirement will apply continuously and not be limited to normal working hours. See also General Conditions.
- B. No act, service, drawings review or construction review by the Architect or Engineer, is intended to include review of the adequacy of the Contractor's safety measures in, on, or near the construction site.

1.11 WARRANTIES

- A. The warranty period is generally one year after Date of Acceptance.
 - 1. During this period, provide labor and materials as required to repair or replace defects in the electrical systems at no cost to the Owner. Provide certificate with O & M manual submittal which guarantees same day service response to the Owner's call for such warranty service.
 - a. Provide certificates for such items of equipment which have warranties in excess of one year. Insert copies of O & M manual.
 - b. Major electrical switchboard
 - c. Light fixtures
 - d. Fire alarm system
 - 2. Provide extended manufacturers warranties to cover one full year from Date of Acceptance if standard manufacturers' warranty ends any time prior to that date.

1.12 LIABILITY

- A. The Contractor shall assume full responsibility for laying out his work and for any damage caused to the Owner or other sub-contractors by improper location or carrying out of his work.
- B. The Contractor shall provide proper guards for prevention of accidents, and provide and maintain any other necessary construction required to secure safety of life or property to secure such protection.

1.13 BYPASS CONNECTIONS

- A. The Contractor shall include all costs for removals and relocations in the Contract. These costs shall include work described in the Specifications and shown on the Drawings with allowances for normal unforeseen difficulties when concealed work has

been opened. A minimum of 7 bypass connections shall be included. Each bypass connection shall consist of 50 feet of 4 inch EMT conduit with 4 #500 AWG and 1#3 AWG ground conductors, (5) junction boxes, (4) 90 degrees bends, and all appurtenances as required for connections; bypass connections would be Installed 15 feet high in congested area, and be supported from structure above. Include cost of cutting and removal of feeder to be bypassed. Bypass connection installation shall be priced on an overtime schedule basis.

1.14 SHUTDOWNS

- A. When installation of a new system or reconnection of an existing system requires the temporary shutdown of an existing operating system, the connection into the existing system shall be performed at such time as designated by the Owner.
- B. The Owner shall be notified of the estimated duration of the shutdown period (3) weeks in advance of the date the work is desired to be performed.
- C. Work shall be arranged for continuous performance, including overtime, at no extra cost to the Owner to assure that existing operating services will be shut down only during the time actually required to make necessary connections.

1.15 COORDINATION WITH EXISTING OCCUPIED AREAS

- A. Minimize disruptions to operation of building systems in occupied areas.
- B. Provide temporary connections to prevent long disruptions.
- C. Provide multiple crews, premium time labor and/or shift labor to reduce duration of work and impact on the facility.
- D. When installation of a new system requires the temporary shutdown of an existing operating system, the connection of the new system shall be performed at such regular time or at overtime when designated by the Owner. Assume all connections to existing operational systems will be on premium time, provide a credit for all work allowed to occur on normal time.

1.16 ENGINEERING BY CONTRACTOR

- A. The construction of this work requires the Contractor to perform certain design activities with regard to several of the Contract systems or subsystems that can only be fully ascertained with regard to the prevailing site field conditions during construction activities. All such designs and related activities shall be the complete responsibility of the Contractor. Where these design activities require engineering, it is the responsibility of the Contractor to engage the service of a licensed New York State Professional Engineer experienced in the areas related to the design activities performed by the Contractor.

- B. Systems or subsystems which require engineering responsibility by the contractor include, but are not limited to:
1. Any system not fully detailed on the drawings.
 2. Fire alarm.
 3. Equipment supports, not fully detailed in the drawings.
 4. Conduit hangers and anchors not specified in these documents, or cataloged by the manufacturer.
 5. Vibration isolators and seismic restraints.
 6. Miscellaneous steel as required.
 7. Equipment supports, hangers.
 8. Pull box and splice box quantities and sizes.
- C. Contractor's design responsibility shall include system design, any required calculations to support system design, any compliance documents or certifications by any governing body up to and including replacement of design engineer with a different engineer of record, retained and paid by the contractor, as determined by authorities or original design engineer.
- D. Contractor shall complete all controlled or special inspections and file all required paperwork in a timely manner. Professional engineer retained by contractor to serve as "special inspector" shall meet all requirements for special inspector as determined by the authority having jurisdiction.

1.17 ACCESSIBILITY AND MEASUREMENT

- A. All work shall be installed so as to be readily accessible for operation, maintenance and repair. Minor deviations from the plans may be made to accomplish this, subject to the approval of the Engineer/Architect.
- B. Before ordering any material or doing any work, the Contractor shall verify all measurements at the Building, and shall be responsible for the correctness of same as related to the work under this Contract.

1.18 NAMES AND TRADE NAMES

- A. Where trade and manufacturers' names are specified or indicated on the Drawings, they are intended to indicate the standard of material or articles required. This shall not remove the responsibility of the Contractor from verifying the equipment's compliance with all rules and regulations governing the use of such equipment. No purchase of any equipment shall be done without written authorization, if such equipment will not abide with all rules and regulations, covering its intended use.

1.19 MISCELLANEOUS

- A. For watchman, staging, scaffolding, insurance, bond, pumping, rubbish removal, access to work areas, storage on site, and the like, refer to Division 1, General Requirements of these specifications.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIALS

- A. All equipment and materials installed shall be new, unless otherwise specified.
- B. All major equipment components shall have manufacturers' name, address, model number and serial number permanently attached in a conspicuous location.
- C. All equipment shall be UL listed and bear the UL label.

2.2 GENERAL SUBMITTAL REQUIREMENTS

A. Coordination and Sequencing:

- 1. After receipt of notice to proceed, the Contractor shall submit to the Architect a typed list of submittals and the scheduled date of submission. List shall include submittal number, section number and scheduled date of submission. Submittals shall be grouped and submitted in no more than ten complete packages.
- 2. The contractor shall not submit any shop drawings or product data that does not comply with the contract documents. Prior to submitting shop drawings, review submittal for compliance with Contract Documents and place a stamp or other confirmation thereon which states that submittals have been reviewed. Submittals without such verification will be returned disapproved without review.
- 3. Submittal is for information and record, unless otherwise indicated, and is not a change order request.
- 4. The Contractor shall submit shop drawings with such promptness as to cause no delay in his own work or that of another contractor.

B. Preparation of Submittals:

- 1. Refer to Division 1 requirements.
- 2. The Contractor shall submit for approval by the Architect data of materials and equipment to be incorporated in the work. Submittals shall be supported by descriptive material, catalogs, cuts, diagrams, performance curves, and charts published by the manufacturer to show conformance to specification and drawing requirements; model numbers alone will not be acceptable. Provide complete electrical characteristics for all equipment. Submit product submittals on items as outlined in sections hereinafter.
- 3. Product submittals shall be made by specification section. All items of a section, requiring submission, shall be submitted together at one time in a single PDF document. If two or more sections require inter-coordination (e.g., emergency generator and transfer switch; short circuit study, electrical room layouts and electrical switchboards), they shall be submitted at the same time.
- 4. Each individual submittal items within a PDF document shall be marked to show section number which pertains to the item.

5. Provide the following information in each PDF document: project name, Contractor, Subcontractor, submittal name, date of submission, specification section, and information to distinguish it from other submittals.
6. Submittals not presented in a neat and legible fashion will be returned “Without Action.”
7. Submittals shall show Contractor’s executed review and approval marking. Submittals which are received from sources other than through Contractor’s office will be returned “Without Action.”
8. Provide space for Architect’s “Action” marking.

C. Substitutions

1. Refer to the General Conditions, which governs “Substitution” of specified equipment or materials.
2. Indicate any portions of work which deviate from the Contract Documents.
 - a. Explain the reasons for the deviations.
 - b. Show how such deviations coordinate with interfacing portions of other work.
3. Where substitution of materials alters space requirements indicated on the drawings, submit shop drawings indicating proposed layout of space, all equipment to be installed therein and clearances between equipment (i.e., electrical rooms). All clearances required by the National Electrical Code and applicable state and local regulations must be maintained.

D. Review Process

1. The Architect reserves the right to require a sample of any equipment to be submitted for approval and to retain its possession.
2. Refer to the individual sections for identified equipment and material for which submittals are required. In addition, provide shop drawings and product data on the following equipment:

Division 26

Wires and Cables
 Grounding
 Supporting Devices
 Raceways
 Electrical Boxes and Fittings
 Vibration Isolation Systems
 Electrical Identification
 Panelboards
 Lighting control devices
 Wiring Devices
 Motor Disconnect and Fuses
 Lighting Fixtures

Division 28

Fire Alarm System

Do not submit on equipment or materials not requested in the specifications.

3. Review of shop drawings and product data by the Architect/Engineer, including any review annotations or stamp notations, does not relieve the contractor from the required compliance with the contract documents.
4. The shop drawing and product data review stamp notation requirements are defined as follows:
 - a. "REVIEWED:" The reviewer did not observe any items which were not in compliance with the contract documents. All dimensions, details, and coordination with other trades is the responsibility of the contractor.
 - b. "FURNISH AS PER COMMENTS:" The reviewer indicated items observed that were not in compliance with the contract documents. The contractor shall not resubmit, but shall make corrections and provide corrected documents with the "Record Drawings."
 - c. "REVISE AND RESUBMIT:" The reviewer indicated items observed which were not in compliance with the contract documents. The contractor shall resubmit showing corrections of all noted items. Delays for resubmittal does not relieve the contractor from meeting project schedules.
 - d. "REJECTED:" The submission does not comply with the contract requirements. The entire submittal must be corrected and submitted for review. Delays for resubmittal does not relieve the contractor from meeting project schedules.
5. If shop drawings are submitted and returned as "REVIEWED" or "FURNISH AS PER COMMENTS" and meet contract requirements, the contractor shall not resubmit any other shop drawings for these items.
6. If resubmittals are necessary, they shall be made as specified above for submittals. Resubmittals shall highlight all revisions made and cover shall include the phrase "RESUBMITTAL NO. _____."

Resubmittal requirements do not entitle the Contractor to additional time and are not a cause for delay of the project.

2.3 PROTECTION, MAINTENANCE AND PRODUCT HANDLING OF ELECTRICAL EQUIPMENT

- A. Electrical equipment shall be delivered and stored at the site, properly packed and crated until finally installed. Store materials in spaces as designated by the General Contractor. Investigate each space through which equipment must be moved. If necessary, equipment shall be shipped from manufacturer in crated sections of size suitable for moving through restricted spaces.
- B. Uninstalled and installed equipment and materials shall be adequately protected against loss or stealing, damage caused by water, paint, fire, plaster, moisture, acids, fumes, dust or other environmental conditions, or physical damage, during delivery, storage,

installation and shutdown conditions. This Contractor shall replace any damage or stolen material without extra cost to the Owner.

- C. Provide effective protection for all material and equipment against damage that may be caused by environmental conditions. Do no work when conditions of temperature in area of moisture on materials or substrates are not in accordance with material manufacturer's recommended conditions for installation.
- D. This Contractor shall be responsible for the maintenance of all equipment and systems installed, until final acceptance by the Architect and the Owner. The Operation of the equipment by the Owner does not constitute an acceptance of the work. Work will be accepted only after the Contractor has adjusted his equipment, demonstrated that it fulfills the requirements of the Drawings and Specifications, and has furnished all required certificates.
- E. This Contractor shall guarantee in writing to the Owner that all work installed by him shall be free of defects in workmanship and materials and that all apparatus will develop the capacities and characteristics as indicated, and that, if during a period of one year from date of final approval of work by the Architect, any defects in workmanship, materials or performance appear, he will remedy them without any cost to the Owner. Guarantee requirements shall consist of the aforesaid and other requirements, as established under applicable contract documents.
- F. Provide effective protection against damage for all material and equipment during shipment, and storage at the Project Site. Cover all stored equipment to exclude dust and moisture. Place stored conduit on dunnage with appropriate weather cover and caps on exposed ends.
- G. After cabinets and boxes are installed, cover openings to prevent entrance of water and foreign materials. Close conduit openings with temporary metal or plastic caps, including those terminated in cabinets.
- H. Protect all rough and finished floors and other finished surfaces from damage which may be caused by construction materials and methods. Protect floors with tarpaulins, chip pans and oil-proof floor covering. Protect finished surfaces from welding and cutting splatters with baffles and asbestos splatter blankets. Protect finished surfaces from paint droppings, adhesive and other marring agents with drop cloths. Protect other surfaces with appropriate protective measures.
- I. Have materials delivered to site. Unload and store materials in designated location, and protect from damage. Deliver materials to their point of installation.
- J. Deliver materials to Project site in manufacturer's original unopened containers with manufacturer's name and product identification clearly marked thereon.

2.4 NAMEPLATES

- A. Furnish a nameplate for each separately installed feeder, switch and circuit breaker, each individual panel, transformer, disconnect switch, push-button station and equipment enclosure.
- B. Unless otherwise noted, nameplates shall be black laminate with white letters of uniform size consisting of reasonably large caps, easily visible.
- C. Inscriptions shall consist of name and number of equipment as shown on the Drawings and as approved by the Architect.

PART 3 – EXECUTION

3.1 CONDITIONS AT SITE

- A. Visit to site is required of all bidders prior to submission of bid. All bidders will be held to have familiarized themselves with all discernible conditions, and no extra payment will be allowed for work required because of these conditions, whether specifically mentioned or not. Verify all grades, elevations, dimensions, and clearances at the site.
- B. Lines of other services and/or equipment that are damaged as a result of this work shall promptly be repaired at no expense to the Owner.
- C. Examine all work prepared by others to receive the work of this Section and report any defects affecting installation to the General Contractor for correction. Commencement of work will be construed as complete acceptance of preparatory work by others.
- D. Existing conditions, equipment, material, and sizes are shown for reference only. Verify existing conditions and bring any discrepancies to Architect's attention in writing prior to submission.

3.2 LICENSES, FEES AND PERMITS

- A. Arrange for required inspections and pay all license, permit and inspection fees. Furnish a certificate of final inspections and approvals from local authority having jurisdiction over electrical installation and deliver to Architect.
- B. This work shall include the procurement of and payment for all permits, certificates and fees for the performance of the electrical work in compliance with codes, applicable laws and municipal regulations including those from local utilities for services.

3.3 MATERIAL, WORKMANSHIP, AND CONTRACTOR'S QUALIFICATIONS

- A. Only professional quality workmanship will be accepted. Haphazard or poor installation practice will be cause for rejection of work.
- B. Provide foreman in charge of this work at all times. Foremen for this work shall have had experience in installing not less than 5 such electrical systems of equal or greater complexity.
- C. Where specifications call for an installation to be made in accordance with manufacturers' recommendations, a copy of such recommendations shall at all times be kept in job superintendent's office.
- D. All material shall be new and of the best quality and shall have the Underwriters Laboratories label attached. The Label shall be of the type for the intended application. The work throughout shall be executed in the best and most thorough manner under the direction of, and to the satisfaction of the Architect who will interpret the meaning of the Drawings and Specifications. The Architect shall have the power to reject any work and materials which, in his opinion, is not in full accordance therewith.
- E. If, after installation, operation of the equipment proves to be unsatisfactory to the Owner by reason of defects, errors or omissions, the Owner reserves the right to operate equipment until it can be removed from service for correction by Contractor. Contractor shall pay for damages to work of other trades caused by this defective equipment and its replacement.

3.4 SUPERVISION AND COORDINATION

- A. Contractor shall coordinate work of this Division with other trades to avoid conflict and to provide rough-ins and other connections for equipment furnished under other divisions that require electrical connections. Inform other trades of required clearances of accesses for or around electrical equipment to maintain serviceability and code compliance.
- B. The work of this Section shall be so arranged that there will be no delay in the proper installation and completion of any part or parts of each respective work wherein it may be interrelated with that of this Contract so that generally all construction work can proceed in its natural sequence without unnecessary delay. All communications of a coordinating nature to the Architect shall be via the General Contractor.
- C. Examine all Architectural, Structural, Heating, Ventilating and Air Conditioning, Sprinkler and Plumbing Drawings relating to this Project, and verify all governing conditions at the site and become fully informed as to the extent and character of the work required and its relation to other work in the building. No consideration will be granted for any alleged misunderstanding of the materials to be furnished or work to be done.

- D. Scaled and figured dimensions with respect to the items are approximate only; sizes of equipment have been taken from typical equipment items of the class indicated. Before proceeding with work, the Contractor shall carefully check all dimensions and sizes and shall assume full responsibility for the fitting-in of equipment and materials to the building and to meet architectural and structural conditions. Discrepancies shall be reported to the Architect in ample time to prevent delays or unwarranted changes to work.
- E. Coordinate work with other disciplines. Confer with other contractors whose work might affect this installation, and arrange all parts of this work and equipment in proper relation to the work and equipment of others, with the building construction and with architectural finish so that this work will harmonize in service, appearance, and function.
- F. Exposed piping shall be installed to provide the maximum amount of headroom but in no case shall piping be installed less than seven feet (7'-0") above the finished floor. Piping installed in areas where hung ceilings or other furred spaces are indicated shall be installed concealed.
- G. The Contractor is referred to the Architectural drawings for locations and types of hung ceilings and furred spaces.
- H. The Contractor shall have competent supervision on the site at all times to layout, check, coordinate and supervise the installation of all electrical work and be responsible for the accuracy thereof. He shall plan the installation of all electrical work, giving consideration to the work of other trades to prevent interference.
- I. The Contractor shall take all field measurements necessary for this work and shall assume responsibility for their accuracy.

3.5 RELATED WORK SPECIFIED ELSEWHERE

- A. The following items of materials and labor will be provided by other contractors under other Sections of the Specifications and shall be excluded from the work to be furnished by this Contractor:
 - 1. Furnishing of Power (Service) Transformers, and other service equipment as noted in Electrical Service System.
 - 2. Furnishing and setting of motors, adjusting thermal elements and replacing thermal overloads if necessary. Supplying of individual starters and control devices, unless specifically indicated otherwise.
 - 3. Installation of electric valves, float switches and pressure and pneumatic-electric switches, stats and related control devices, sprinkler devices.
 - 4. Furnishing and installing HVAC Temperature Control Boards, Supervisory Temperature Control and Energy Management Systems.
 - 5. Installation of duct type smoke detectors.
 - 6. Base flashing for conduits passing through roof.
 - 7. Setting of access doors in walls and ceilings.

8. Furnishing of alarm and supervisory devices for Sprinkler Alarm System.
9. Rough and finish patching.
10. Finish painting of exposed conduits, boxes, hangers, apparatus, etc.
11. Openings for sleeves in foundation walls below grade and floor slabs when noted on foundation Drawings or in foundation Specifications.

3.6 TESTING

- A. Provide all labor, materials, and equipment necessary to make required tests. Tests shall be complete and results approved before final inspection is begun.

3.7 PROGRESS OF WORK

- A. Order progress of electrical work so as to conform to progress of work of other trades, and complete entire installation as soon as condition of building will permit. Assume any cost resulting from defective or ill-timed work performed under this Division.

3.8 CUTTING AND PATCHING

- A. General: Perform cutting and patching in accordance with Division 1 Section "Cutting and Patching." In addition to the requirement specified in Division 1, the following requirements apply:
 1. Perform cutting, fitting, and patching of electrical equipment and materials required to:
 - a. Uncover work to provide for installation of ill-timed work.
 - b. Remove and replace defective work.
 - c. Remove and replace work not conforming to requirements of the Contract documents.
 - d. Remove samples of installed work as specified for testing.
 - e. Install equipment and materials in newly installed structures.
 - f. Upon written instructions from the architect, uncover and restore work to provide for Architect observation of concealed work.

3.9 SLEEVES

- A. Place sleeve in forms of walls, floor slabs and partitions for passage of all conduits, pipes, and ducts installed under Divisions 26, 27 and 28. Sleeves shall be set in place a sufficient time ahead of concrete work so as not to delay that work. Install sleeves and raceways through exterior walls so as to provide a waterproof installation. All floor penetrations shall be made watertight. Conduits passing through walls shall be installed to preserve integrity of the wall rating (i.e., fire rating, sound rating, air, etc.). All penetration made through existing concrete slabs or walls shall be x-rayed and approved by Structural Engineer prior to cutting.

3.10 LOAD BALANCE

- A. Connect branch circuits to panelboards, and panelboards to feeders so that loads are balanced among the phases within practical limits on the basis of connected load.
- B. Branch circuit numbers shown on the drawings are for identification only and do not necessarily indicate the final position of the branch circuits in the panelboards

3.11 MOISTURE-DAMP PROTECTION

- A. Wherever any electrical components such as: panels, raceways, etc will be in contact with surfaces which may become damp or wet, spacers to hold electrical work 1/4" (.006m) away from such surfaces shall be provided.

3.12 CLEANUP

- A. Remove all materials, scrap, etc., relative to electrical installations and leave premises in a clean, orderly condition. Any costs to the Owner for cleanup of site will be charged to the Contractor. At completion, all equipment, raceways, etc., shall be thoroughly cleaned and all residue removed from the inside and outside surfaces. Defaced finish shall be refinished.

3.13 TEMPORARY LIGHTING AND POWER

- A. Provide temporary power as requested by the general contractor and in accordance with OSHA and local code requirements. Lighting and power outlets shall be provided throughout the project. Check with general contractor prior to bid for special lighting and power outlets and provide as needed. All temporary power and lighting feeders and branch shall have over-current protection.
- B. Electrical services for temporary light and power shall be obtained from the nearest existing normal switchboard or panelboard and extended as required. Consult the Owner prior to making any connections to existing services. Exact size of temporary power required shall be field coordinated by the contractor.
- C. The Electrical Contractor shall furnish, install and maintain the temporary lighting and power system for all Contractors. The use of electricity shall be kept to a minimum.
- D. The Owner or Owner's Representative will pay for all energy required by the temporary lighting and power system.
- E. Provide all wiring, supports, lamp sockets, receptacle sockets and any other materials, supplies or equipment necessary for temporary light and power system.
- F. Ground fault protection required by OSHA for temporary receptacle circuits shall be accomplished by providing branch circuit panels containing ground fault protection branch circuit breakers.

- G. Provide a grounding conductor connection to each receptacle grounding terminal. Minimum size branch circuit and ground conductors shall be No. 12 AWG.
- H. Install separate stringer circuits for lighting and receptacles. Provide one lamp socket and one duplex receptacle (or two single receptacles) for every 400 square feet of new general construction area. (Approximately 20 feet on centers). Furthermore, provide one lamp socket and one duplex receptacle every 20 feet along the peripheral walls of the construction areas for temporary conditions. Each lamp socket shall be provided with a 100 watt lamp. Replace burned out lamps as required for as long as the temporary lighting system is maintained in operation.
- I. Provide sufficient supplementary temporary lighting to permit proper execution of the work. This supplementary lighting shall consist of but not be limited to the following:
1. Construction hoist landings.
 2. Stairways and stairway landings where existing illumination is inadequate due to alterations or construction.
 3. Interior rooms not covered with general construction area lighting.
 4. Provide temporary lighting on construction barriers if barriers block lighting in existing spaces. Provide temporary emergency lighting per code required distances if emergency lighting is obstructed by construction barriers.
- J. Provide power wiring to operate construction hoist. Provide fused disconnect switch at hoist location. Fuse size, wiring size and disconnect shall be as required.
- K. Provide 50 trailer extension cords, each 25 feet long. Cords shall be 16-3, Type SJ. 25 of the trailer cord sets shall be receptacle type ITT No. 6112 and 25 of the trailer cord sets shall be trouble light type with receptacle ITT No. J-3270.
- L. Keep the temporary lighting and power system operational commencing fifteen (15) minutes before the established starting time of that trade which starts work earliest in the morning and ending fifteen (15) minutes after the established quitting time of that trade which stops work latest in the evening. This applies to all weekdays, Monday through Friday inclusive, which are established as regular working days for any trade engaged in the work, and shall continue until Final Acceptance of the work or until these services are ordered terminated by the Owner or the Owner Representative.
- M. Any or all of the temporary services herein specified shall be disconnected, removed, or relocated when its or their use is no longer required, or if it or they should impede the progress of the work, and as requested by the Construction Manager and/or General Contractor. Should a change in location of any temporary equipment herein specified be necessary to progress the work, the contractor shall remove and relocate such equipment as directed by the Construction Manager and/or General Contractor at no additional cost to contract. The temporary equipment herein specified shall be removed and disposed of when directed by the Construction Manager and/or General Contractor.

- N. Any Contractor requiring overtime use shall reimburse the Electrical Contractor by private agreement between Contractors.
- O. Provide construction site lighting as required or directed. This lighting shall be mounted on shanties and shall be wired on separate circuits to permit illumination from dusk to dawn.
- P. Immediately upon activation of permanent service, the contractor shall distribute temporary power from the permanent service.
- Q. It is the intent of these specifications to generally indicate to the contractor the scope and requirements of temporary light and power. It is understood that these requirements shall vary during construction as required by field conditions, etc and as directed by the Construction Manager and/or General Contractor. It shall be the responsibility of the Contractor to adjust and modify the temporary wiring requirements accordingly.

3.14 MINOR CHANGES

- A. The Owner reserves the right to make minor changes in the locations of outlets and equipment up to the time of electrical rough-in without any cost to the Owner.

3.15 ELECTRICAL SYSTEMS OPERATIONAL TESTS, CERTIFICATION, AND DESIGN AUTHORITY ASSISTANCE

A. Testing

1. Refer to the individual specification sections for test requirements.
2. Prior to the final inspection, the systems or equipment shall be tested and reported as herein specified. Six (6) typewritten copies of the tests shall be submitted to the Architect/Engineer for approval.
3. All electrical systems shall be tested for compliance with the specifications.

B. Manufacturers' Certifications

1. The electrical systems specified herein shall be reviewed for compliance with these specifications, installation in accordance with the manufacturers' recommendations and system operation by a representative of the manufacturer. The manufacturer shall submit certification that the system has been installed in accordance with the manufacturers' recommendations and is operating as specified in the contract documents.

C. Design Authority Assistance

1. The Contractor shall provide personnel to assist the Architect/Engineer or his representative during all construction review visits. The Contractor shall provide all necessary tools and equipment to demonstrate the system operation and

- provide access to equipment, including screwdrivers, wrenches, ladders, flashlights, circuit testing devices, meters, keys, etc.
2. Remove equipment covers (i.e., panelboard trims, switchboards, panelboards, motor controls, device plates, and junction box covers) as directed for inspection of internal wiring. Accessible ceiling shall be removed as directed for inspection of equipment installed above ceilings. Reinstall all covers or ceilings after inspection.
 3. Energize and de-energize circuits and equipment as directed. Demonstrate operation of equipment as directed by Architect/Engineer.
 4. The Contractor shall provide authorized representatives of the manufacturers to demonstrate to the Architect/Engineer compliance with the specifications of their respective system during or prior to the final inspection at a time designated by the Architect. Refer to the appropriate specification section for additional testing requirements. Representatives of the fire alarm systems are required for demonstrations.

END OF SECTION

SECTION 26 05 03

TESTING

PART 1 - GENERAL

1.1 RELATED WORK SPECIFIED ELSEWHERE

- A. Acceptance and startup testing requirements for electrical power distribution equipment and systems. Contractor shall retain and pay for the services of a recognized independent testing firm for purpose of performing inspections and tests as herein specified.
1. The testing firm shall provide all material, equipment, labor, and technical supervision to perform such tests and inspections.
 2. It is the purpose of these tests to assure that all tested electrical equipment is operational and within industry and manufacturer's tolerances and is installed in accordance with design specifications.
 3. The tests and inspections shall determine suitability for startup and energization.
 4. The following equipment shall be tested and or calibrated:

Low Voltage Power Wires and Cables - Section 26 05 19

Medium Voltage Circuit Breaker Switchgear - Section 26 13 13

Panelboards – Section 26 24 13

1.2 SUBMITTAL

- A. Provide submittal per Contract General Conditions, Division 1, and Section 26 05 02.
- B. Qualification of testing firm.
- C. Submit PDF copies of certified test reports to Engineer for approval.
- D. PDF copies of blank forms for checklists, test reports, and other related forms for Engineer's review and approval.

1.3 GENERAL REQUIREMENTS

- A. The Contractor shall perform routine insulation resistance, continuity, and rotation tests for all distribution and utilization equipment prior to and in addition to any acceptance testing.
- B. The Contractor shall test all lighting, low voltage relays and circuits to ensure proper operating conditions prior to acceptance testing.
- C. The Contractor shall perform visual and mechanical inspections, verifying that the equipment nameplate information meets the intent of the drawings and specifications.

- D. The Contractor shall be responsible for all final settings and adjustments on protective devices and tap changes, submitting settings to the Architect/Engineer for review.
- E. Provide a complete short-circuit study, equipment interrupting/withstand evaluation, and a protective device coordination study for the electrical distribution system described herein. This study shall be submitted with electrical equipment submission and electrical room layouts.
- F. The Contractor shall engage the services of a recognized corporate and financially independent testing firm for the purpose of performing inspections and tests as herein specified.
- G. The firm shall provide all material, equipment, labor, and technical supervision to perform such tests and inspections.
- H. It is the purpose of these tests to assure that all tested electrical equipment is operational and within industry and manufacturer's tolerances and is installed in accordance with design specifications.
- I. The tests and inspections shall determine suitability for energization. Equipment shall not be energized until accepted by the testing firm.
- J. Prior to performing tests, the contractor shall notify the Architect a minimum of one week in advance, so that the Architect may schedule a representative to be present while tests are being conducted.
- K. Any defects shall be corrected at once, and the tests reconducted.
- L. It is the purpose of these tests to assure that all tested electrical equipment is operational and within industry and manufacturer's tolerances and is installed in accordance with design specifications.
- M. The tests shall be performed by competent personnel and shall demonstrate the following:
 - 1. That all lighting, power and control circuits are continuous and free from short circuits.
 - 2. That all circuits are free from unspecified grounds.
 - 3. That all connections within panelboards are tight and do not produce excess heating.
 - 4. That the resistance to ground of all non-grounded circuits is not less than one megohm.
 - 5. That all circuits are properly connected in accordance with the applicable wiring diagrams.
 - 6. That all circuits are operable by which a demonstration shall include functioning of each control not less than three times and continuous operation of each lighting and power circuit for not less than 1/2 hour.
 - 7. That all alarm and signal systems and all emergency and exit lights are properly functioning.

- N. When wiring systems are "megger" tested, the insulation resistance between conductors and between conductors and grounds, based on maximum load, shall not be less than that required by Electrical Code and local authorities having jurisdiction.
- O. A digital copy of record of all test data shall be supplied to the Architect (three copies). The tests shall cover but not be limited to the following:
 - 1. Secondary service and distribution system.
 - 2. Fire alarm, sprinkler and smoke detection systems.
 - 3. All communications, signaling and alarm systems.
 - 4. Power installations and motor controls.
 - 5. Light installations and circuit switching.
 - 6. Any part of the work called for in the Specification, or Drawings and as designated by the Architect or Engineers.
- P. If in the opinion of the Architect, the results of such tests show that the work has not complied with the requirements of the Specifications or Drawings, the Contractor shall make all additions or changes necessary to put the system in proper working condition and shall pay for all the expenses and for all subsequent tests which are necessary to determine whether the work is satisfactory. Any additional work or subsequent tests shall be carried out at the convenience of the Owner, prior to final payment.

1.4 QUALIFICATIONS OF TESTING FIRM

- A. The testing firm shall be a recognized corporate and financially 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 OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907, or be a Full Member company of the InterNational Electrical Testing Association (NETA).
- D. The lead, on-site, technical person shall be currently certified by the InterNational Electrical Testing Association (NETA) or National Institute for Certification in Engineering Technologies (NICET) in electrical power distribution system testing.
- E. The testing firm shall utilize engineers and technicians who are regularly employed by the firm for testing and engineering services. All studies, tests, and reports shall be sealed by a registered electrical professional engineer with a current Connecticut stamp.
- F. The testing firm shall submit proof of the above qualifications with bid documents, when requested.

- G. The terms used herewith, such as test agency, test contractor, testing laboratory, or contractor test company, shall be construed to mean the testing firm.

1.5 APPLICABLE CODES, STANDARDS, AND REFERENCES

- A. All inspections and tests shall be in accordance with the following codes and standards except as provided otherwise herein:

1. National Electrical Manufacturer's Association - NEMA
2. American Society for Testing and Materials - ASTM
3. Institute of Electrical and Electronic Engineers - IEEE
4. InterNational Electrical Testing Association - NETA Acceptance Testing Specifications - ATS-1991
5. American National Standards Institute - ANSI C2: National Electrical Safety Code
6. State and City of HARTFORD CONNECTICUT Codes and Ordinances
7. Insulated Cable Engineers Association - ICEA
8. Association of Edison Illuminating Companies - AEIC
9. Occupational Safety and Health Administration - OSHA
10. National Fire Protection Association - NFPA
 - a. ANSI/NFPA 70: National Electrical Code
 - b. ANSI/NFPA 70B: Electrical Equipment Maintenance
 - c. NFPA 70E: Electrical Safety Requirements for Employee Workplaces
 - d. ANSI/NFPA 78: Lightning Protection Standard
 - e. ANSI/NFPA 101: Life Safety Code

- B. All inspections and tests shall utilize the following references:

1. Project design specifications.
2. Project design drawings.
3. Short-circuit and coordination study.
4. Manufacturer's instruction manuals applicable to each particular apparatus.
5. Project list of equipment to be inspected and tested as stated above.

PART 2 – PRODUCTS

2.1 PROTECTIVE DEVICE COORDINATION STUDY

The electrical equipment manufacturer shall perform a protective device time-current coordination analysis of the specified electrical power distribution system. This analysis shall include:

- A. A determination of settings or ratings for the over-current protective devices supplied. Where necessary, an appropriate compromise shall be made between system protection and service continuity with system protection and service continuity considered to be of equal importance. The time-current coordination analysis shall be performed with the aid of a digital computer.

- B. An evaluation to the degree of system protection and service continuity possible with overcurrent devices supplied.
- C. Provide five copies of the protective device time-current coordination analysis for the Engineer's approval.
- D. Log-Log plots of time-current characteristic curves.
- E. A tabulation of the suggested settings of the adjustable overcurrent protective devices supplied.
- F. The key or limiting overcurrent device characteristics, load characteristics, and protection requirements affecting the setting or ratings of the overcurrent protective devices supplied.
- G. The degree of service continuity and system protection achieved with the overcurrent protective devices supplied.
- H. An analysis of the results in which any inadequacies shall be called to the attention of the Engineer and recommendations made for improvements. These recommendations shall be incorporated by the electrical equipment manufacturer to the electrical equipment at no cost to the Owner, where approved by the Engineer.

2.2 ARC FLASH HAZARD ANALYSIS

- A. Provide with the coordination and short circuit studies an Arc Flash study and device by device listing of PPE requirements and ratings as required by the NEC and NFPA 70E. All equipment shall have appropriate labeling installed in the field by the electrical contractor as determined by the study.
- B. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchgear, switchboards, panelboards, busway, etc.) where work could be performed on energized parts.

PART 3 - INSPECTION AND TEST PROCEDURES

3.1 PROCEDURE

- A. Testing firm to provide and comply with the following:
 - 1. Acceptance test procedures for each individual equipment listed in Part 1 of this section for Engineer review and approval prior to any test and after thorough evaluation of the system. Testing shall conform to the latest version of InterNational Electrical Testing Association (NETA) specifications and standards for electrical power distribution equipment and systems and manufacturer's instructions.

2. Refer to each individual specification section for testing requirements and comply.
3. Inspect installed equipment, record results and report any discrepancy and deficiency with contract documents and governing codes prior to testing. All results shall be submitted to the Engineer for approval.

3.2 SYSTEM FUNCTION TESTS

A. General:

1. Perform system function tests upon completion of equipment component tests as define in this specification. It is the purpose of system function tests to prove the proper interaction of all sensing, processing, and action devices.
2. Implementation:
 - a. Develop test parameters for the purpose of evaluating performance of all integral components and their functioning as a complete unit within design requirements.
 - b. Test all interlock devices, and trip settings on breakers.
 - c. Record the operation of alarms and indicating devices.

3.3 DEFICIENCIES

- #### A. All deficiencies reported by testing firm to be corrected by Contractor and Acceptance Test to be re-done accordingly.

END OF SECTION

SECTION 26 05 05

MANUFACTURERS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The following lists of manufacturers are for the specifications as identified.
- B. All submittals and documentation shall be in accordance with the project General Requirements, Division 1.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturing firms regularly engaged in manufacture of this material with characteristics and capacities required, whose products have been in satisfactory use in similar service for not less than 10 years.
- B. Provide product produced by the manufacturers, which are listed in Section "Approved Manufacturer's List".
- C. Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work are listed herein. All manufacturers not listed shall be pre-approved prior to bid in order to be considered. Refer to Division 1 for pre-approval format.

TITLE	SPECIFICATION SECTION	MANUFACTURER
Electrical Identification	26 05 53	Ideal Industries, Inc. National Band and Tag Co. Panduit Corp. Seton Name Plate Co. W.H. Brady, Co.

TITLE	SPECIFICATION SECTION	MANUFACTURER
Raceways		
Conduit & Tubing	26 05 33	Alflex Div.; Southwire Co. Allied Div.; Atkore Carlson, Inc. Liquatite Div.; Electri-Flex Wheatland Tube Co.
Conduit Bodies	26 05 33	Appleton Div.; Emerson Electric Crouse-Hinds Div.; Eaton Killark Div.; Hubbell Inc. OZ/Gedney Div.; Emerson Electric Steel City Div.; Thomas & Betts
Wireway & Enclosures	26 05 33	B-Line Div.; Eaton Hammond Mfg. Hoffman Div.; Pentair Square D Div.; Schneider Electric
Surface Raceways	26 05 33	Hubbell Inc. Isoduct Div.; Legrand Square D Div.; Schneider Electric Wiremold Div.; Legrand
Wire and Cables	26 05 19	General Cable Okonite Co. Prysmian Southwire Co.
Electrical Boxes & Fittings		
Raintight outlet boxes	26 05 34	Appleton Div.; Emerson Electric OZ/Gedney Div.; Emerson Electric RACO Div.; Hubbell, Inc. Steel City Div.; Thomas & Betts
Bushings, knockout closures and locknuts	26 05 34	Appleton Div.; Emerson Electric Midwest Electric OZ/Gedney Div.; Emerson Electric RACO Div.; Hubbell, Inc. Thomas & Betts
Wiring Devices		
Receptacles & Switches	26 27 26	Hubbell, Inc. Arrow Hart Div.; Eaton Leviton Lightolier Wattstopper

TITLE	SPECIFICATION SECTION	MANUFACTURER
Supporting Devices		
Slotted metal Angle & U-channel Systems	26 05 29	American Electric B-Line Div.; Eaton Unistrut Div.; Atkore
Conduit Sealing Bushings	26 05 29	OZ/Gedney Div.; Emerson Electric RACO Div.; Hubbell, Inc. Thomas & Betts
Switchboards & Panelboards	26 24 13 and 26 24 16	Cutler-Hammer Div.; Eaton General Electric Company Siemens (I-T-E-) Square D Div.; Schneider Electric
Transformers	26 22 00	Cutler-Hammer Div.; Eaton General Electric Company Hammond Power Solutions Siemens (I-T-E-) Square D Div.; Schneider Electric
Motor, Disconnects and Fuses		
Circuit and Motor Disconnects	26 28 16	Cutler-Hammer Div.; Eaton General Electric Company Siemens (I-T-E-) Square D Div.; Schneider Electric
Fuses (See Note)	26 28 16	Bussmann Div.; Eaton (Basis of Design) Mersen
Connections	26 28 16	Appleton Div.; Emerson Electric Burndy Corp. Ideal Industries, Inc. Thomas & Betts
NOTE: Contractor shall submit fuse coordination for the entire electrical distribution if alternate manufacturer is used.		
Motor Controllers	26 29 13	Allen-Bradley Div.; Rockwell Automation Cutler-Hammer Div.; Eaton Siemens Square D Div.; Schneider Electric
Grounding	26 05 26	Burndy Electrical Cadweld Div.; Erico Ideal Industries Okonite
Lighting Fixtures	26 51 00	Refer to Drawings

TITLE	SPECIFICATION SECTION	MANUFACTURER
Occupant Sensors	26 51 01	Honeywell Hubbell Inc. Leviton Lightolier Lutron Watt Stopper

PART 3 - EXECUTION

(Not applicable)

END OF SECTION

SECTION 26 05 06

BASIC MATERIAL AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. This Section supplements Division 1, General Requirements.

1.2 DESCRIPTION OF WORK

- A. Work included in this section consists of conduits, wires and other miscellaneous materials not specifically mentioned in other sections of Division 26, but necessary or required for equipment or system operation or function, and the labor to install them.

1.3 SUBMITTALS

- A. Materials list with manufacturer, style, series or model identified.
- B. Manufacturer's descriptive literature and/or sample if requested by the Architect/Engineer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS: Refer to Section 26 05 05.

2.2 CONDUIT RACEWAYS: Refer to Section 26 05 33.

2.3 WIRES AND CABLES: Refer to Section 26 05 19.

2.4 WIRING DEVICES: Refer to Section 26 27 26.

2.5 OUTLET BOXES, JUNCTION AND PULL BOXES

- A. Outlet Boxes: Hot-dipped galvanized or sherardized of required size, 4" square minimum, for flush mounted devices and lighting fixtures. Cast-type FD with gasketed covers for surface-mounted devices.
- B. Junction and Pull Boxes: Use outlet boxes as junction boxes wherever possible. Larger junction and pull boxes shall be fabricated from sheet steel, sized according to code, with screw-on covers, galvanized where required for outdoor exposure.
- C. All exterior boxes shall be cast, gasketed, weatherproof type with cast covers.
- D. Refer to Section 26 05 34 for additional requirements.

2.6 WIRE CONNECTORS

- A. For wires that are #8 AWG and smaller: Insulated pressure type with live spring, rated 105°C, 600 volt, for building wiring and 1000 volt in signs or fixtures.
- B. For wires that are #6 AWG and larger: Compression type with 3M #33 or equal tape insulation.

2.7 CONDUIT HANGERS

- A. Galvanized steel with special accessories for purpose and adequate to support load imposed. Support individual conduit 1-1/2-inch and larger and all multiple conduit runs with hangers. Clamp conduits individually to each support.
- B. Refer to Section 26 05 29 for additional requirements.

2.8 FUSES: Refer to Section 26 28 16.

2.9 ACCESS PANELS

- A. Electrical Contractor to provide access panels for electrical equipment which are required for accessibility by code.

2.10 CONDUIT SLEEVES

- A. Sleeves for Conduit Penetration: Pipe Shields, Inc., model WFB at walls and QDFB at floors. Refer to Division 7 "Firestopping" for additional requirements.

2.11 EQUIPMENT MOUNTING AND SUPPORT HARDWARE

- A. Steel channels, bolts and washers, used for mounting or support of electrical equipment shall be galvanized typed. Where installed in corrosive atmosphere, stainless steel type hardware shall be used.
- B. Refer to Section 26 05 29 for additional requirements.

2.12 PREFABRICATED CURBS

- A. General: Except where curbs are provided with equipment, provide prefabricated curbs for all roof mounted equipment and conduit.
- B. Manufacturers:
 - 1. Design Basis: Pace
 - 2. Other Acceptable Manufacturers:
 - a. Thycurb

- C. Coordinate with roofing Contractor. Exterior insulation, cants, flashing and counter flashing shall be furnished and installed under roofing work, Division 7.

2.13 EQUIPMENT SUPPORTS

- A. Provide housekeeping pads for all floor mounted equipment.
 - 1. Housekeeping pads shall have a minimum height of 4" or as specified on the drawings, whichever is greater.
 - 2. Provide pins to tie new pad to existing floor.
 - 3. Provide rebar within new pad to support equipment load and prevent cracking of pad.

PART 3 - EXECUTION

3.1 GENERAL

- A. Provide complete raceway systems for all conductors including control wiring and low voltage wiring unless otherwise noted.
- B. Electrical system layouts indicated on drawings are generally diagrammatic, but shall be followed as closely as actual construction and work of other trades will permit. Govern exact routing of raceways and locations of outlets by structure and equipment served. Take all dimensions from architectural drawings.
- C. All home runs to panelboards are indicated as starting from the outlet nearest to the panel and continuing in the general direction of that panel. Continue such circuits to panel as though routes were completely indicated.
- D. Avoid cutting and boring holes through structure or structural members wherever possible. Obtain prior approval of the Architect, and conform to all structural requirements when cutting or boring structure.
- E. Furnish and install all necessary hardware, hangers, blocking, brackets, bracing, runners, etc., required for equipment specified under this Section.

3.2 RACEWAY: Refer to Section 26 05 33.

3.3 OUTLETS

- A. Exact location of outlets and equipment shall be governed by structural conditions and obstructions or other equipment items. When necessary, relocate outlets so that when fixtures or equipment are installed, they will be symmetrically located according to room layout and will not interfere with other work or equipment. Verify final location of all outlets, panels, equipment, etc., with the Architect/Engineer.

- B. Provide zinc-coated or cadmium-plated sheet steel outlet boxes not less than 4" octagonal or square, unless otherwise noted. Equip fixture outlet boxes with 3/8" no-bolt fixture studs. Where fixtures are mounted on or in an accessible type ceiling, provide a junction box and extend flexible conduit to each fixture. Outlet boxes in finished ceilings or walls shall be fitted with appropriate covers, set to come flush with the finished surface. Where more than one switch or device is located on one point, use gang boxes and covers unless otherwise indicated. Sectional switch boxes or utility boxes will not be permitted. Provide tile box or a 4" square box with tile ring in masonry walls which will not be plastered or furred, or where "dry-wall" type materials are applied. Through the wall type boxes are not permitted. Install minimum 12" lateral separation for back to back boxes.
- C. Surface-mounted devices are to be mounted in cast type boxes with gasketed covers: (Crouse-Hinds condulets or equal).
- D. Dimensions, unless shown on drawings, are given below and are from finished floor to center line of outlets unless noted otherwise. Adjust heights of outlets in masonry walls to correspond with consistent brick or block course. Outlets in block walls shall be installed in core of block.

Wall Switches	4' - 0" (to top of switch)
Convenience outlets	1' - 6" (to bottom of outlet)
Receptacle outlets in mechanical spaces	3' - 0" (to bottom of outlet)
Hallways	1' - 6" (to bottom of outlet)
Workroom wall outlet	4' - 4" (field verify height of backsplash)
Fire alarm horns, speakers	ceiling or wall
Fire alarm pull stations	4' - 0" (to top of device)
Fire alarm strobes	6' - 8" or 6" below ceiling (whichever is lower)
Motor controllers	5' - 0"
Safety and disconnect switches	5' - 0"

Confirm final location and heights of all outlets, wall switches, and television outlets with architectural drawings and furniture plans prior to installation.

- E. Outlets except over counters, benches, special equipment, baseboards, fin tube radiators, etc., or at wainscotting, shall be at a height to prevent interference to service equipment, or as noted on drawings.
- F. Refer to Section 26 05 34 for additional requirements.

3.4 JUNCTION PULL BOXES

- A. Construct junction or pull boxes not over 150 cubic inches in size shall be standard outlet boxes, and those over 150 cubic inches shall be constructed the same as "Cabinets," with screw covers of same gauge metal. Removal covers must be accessible at all times.

- B. Provide a standard access panel having a hinged metal door neatly fitted into a flush metal trim, where a junction box or equipment is located above non-accessible ceilings or behind finished walls. Coordinate location and type with the Architect.

END OF SECTION

SECTION 26 05 09

ELECTRICAL DEMOLITION AND RELOCATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. This Section supplements Division 1, General Requirements. Where contradictions occur between this Section and Division 1, the more stringent of the two shall apply. The Architect shall decide which is most stringent.
- B. Requirements of the following Divisions and Sections apply to this Section:
 - 1. Division 26 Section 26 05 02 "Electrical Requirements."
 - 2. Division 9 Section "Painting" for related requirements.
- C. Refer to other Division 26 Sections for additional specific electrical demolition or relocation associated with specific items.

1.2 SUMMARY

- A. This Section includes basic requirements for demolition and relocation of electrical materials, equipment, and installations. The Contractor shall be responsible for visiting the site prior to bid to determine the actual conditions, which might affect the bid or contract price. No allowance will be made subsequently resulting from the neglect to visit the site and make such determinations.
- B. Generally, electrical items that are to be replaced with other equipment in the same location is work covered by this section. Also covered by this section are electrical items that are to be removed in their entirety or that are to be relocated to another place.

1.3 PROTECTIVE MEASURES

- A. Provide the following protective measures:
 - 1. Wherever existing roofing surfaces are penetrated by electrical conduit, they shall be protected against water infiltration. Water leaks shall be repaired immediately upon discovery when they occur.
 - 2. Temporary protection against damage for all portions of existing structures and grounds where work is to be done, materials handled, and equipment moved or relocated.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIALS

- A. The Contractor shall provide all equipment and materials necessary for the removal or relocation of electrical equipment.
- B. Materials used in restoration or repairing work related to demolition and relocation shall conform in type, quality, and function to that of the original existing construction or as otherwise indicated.

2.2 DISPOSAL AND RETENTION

- A. Materials and equipment resulting from work and removed from the building or structures, or parts thereof, shall become the property of the Contractor and shall be removed from the site by the Contractor except as follow:
 - 1. Light fixtures, lamps, and ballasts.
 - 2. Fire, heat, and smoke detection devices.
 - 3. Telephones and telephone equipment other than outlet devices.
 - 4. Fire alarm notification devices and pull stations.
- B. Items removed or noted to be retained by the Owner but which are declined to be retained by the Owner shall be removed from the site by the Contractor.
- C. Combustible waste material and rubbish shall not be stored or allowed to accumulate within a building or its vicinity, but shall be kept in a suitable trash container for subsequent removal or shall be removed from the premises as rapidly as practical.

PART 3 - EXECUTION

3.1 GENERAL

- A. Disconnect, remove and/or relocate electrical material, equipment, devices, components, and other work noted and required by demolition or alterations in existing construction.
- B. Where the drawings indicate that equipment is to be replaced or where other equipment requires the relocation of existing equipment, the existing equipment shall be removed or relocated as though it was specifically noted to be removed or relocated.

- C. Provide new material and equipment required for relocated equipment.
- D. Wherever electrical materials have been removed from surfaces of the building or structure, those surfaces shall be patched and repaired.
- E. Remove, cut, alter, replace, patch, and repair existing work as necessary to install new work. Unless otherwise indicated or specified, do not cut, alter, or remove any structural members, ducts, piping, or service lines without approval of the Owner's representative.
- F. Existing work or equipment to be altered or extended and found to be defective shall be reported to the Owner's representative before it is disturbed or any further work is performed on it.
- G. Where electrical equipment is indicated to be removed or relocated, the work shall include the complete disconnection from its source, dismantling as necessary, and removal or installation of all conduit, wires, cables, etc. Unless noted otherwise, wires shall be removed from conduits back to the last utilization device or to the panelboard. No wiring shall be removed that prevents operation of other equipment not scheduled or indicated to be removed.
- H. Perform and schedule all demolition work with other trades and work of the contract as necessary for the efficient progress and flow of the work.
- I. Remove conductors from existing raceways to be rewired. Clean raceways as required prior to rewiring.
- J. Cut and cap abandoned floor raceways flush with concrete floor or behind walls and ceilings.
- K. Dispose of removed raceways and wiring.
- L. Where any fixture or wiring device is removed, provide adequate size and type of blank plates over each outlet.
- N. Dispose of removed electrical equipment as directed.
- M. All electrical work in adjoining areas which is indicated on the Drawings to continue to function but is affected by demolition work shall be reconnected and restored to present function as part of the electrical system of the Buildings.

- N. Connect new work to existing work in a neat and acceptable manner, with minimum interference to existing facilities.
- O. Maintain continuous operation of existing facilities affected by the work.
- P. Alarm and emergency systems are to be interrupted only with the written consent of the Owner.
- Q. Temporary shutdowns when required, to be made only with written consent of Owner at times not to interfere with normal operations.
- R. Where indicated on the Drawings or required by the alteration scheme, the Contractor shall remove all electrical outlets, switches, and other devices, complete with associated wiring, conduit, etc., from partitions, walls, and floors that are to be removed. When the removal of these makes dead electrical wiring that is to remain, Contractor shall install junction boxes or other devices necessary to make the circuits affected continuous and ready for operation. Otherwise, wiring shall be removed back to the nearest electrical outlet box that is to remain, or to the panelboard.
- S. All raceways which become exposed beyond finished surfaces because of the alteration work shall be removed and rerouted behind finished surfaces.
- T. Wiring that is to be removed as a result of demolition work, but is required to continue to function, shall be interrupted at convenient locations, rerouted (new wiring and conduits) and reconnected for continuation of their original function. New wiring extensions shall match existing ones in all respects, conductor ampacity, conduit size, etc.

END OF SECTION

SECTION 26 05 10

PROJECT CLOSEOUT

PART 1 – GENERAL

1.1 WORK INCLUDED

- A. The contractor shall summarize and document adherence with the requirements of the specifications for project closeout including:
1. Copies of all warranties
 2. Operation & Maintenance Manuals
 3. Required tests
 4. Certifications
 5. Record drawings
 6. Permit requirements
- B. The contractor shall compile a closeout manual which shall include:
1. A list of all required tests and a place for signoff of date completed.
 2. A list of all submittals with dates of acceptance by the engineer.
 3. A schedule indicating dates for beginning testing and startup of equipment and dates of tests to be witnessed by the engineer, or designated representative, as required by the specifications.
 4. Project close out check list.
- C. The final closeout manual shall include the following:
1. Test reports as required by the specifications with signoff by the appropriate individual (engineer, architect, building official, etc.).
 2. Documentation indicating all equipment is operating properly and is fully accessible for maintenance.
 3. Copies of all warranties..
- D. This section only includes the requirements for documentation of the contract documents, by the contractor, for project completion. This section does not in any way decrease the scope of any of the drawings or specifications.

1.2 SUBMITTALS

- A. Within 90 days after notice to proceed submit a preliminary closeout manual with the following:
1. A list of all required tests.

2. Preliminary schedule showing major milestones for completion of the electrical and technology systems.
- B. Within 30 days of the first major milestone submit the completed closeout manual as described in Part 1.
 - C. Within 2 weeks of substantial completion submit a completed “Project Closeout Check List”, and the Final Closeout Manual.
 - D. Listed below is a checklist for use by the contractor. This list is not all inclusive for this project.

Project Close-Out Summary - Electrical

- The following tests have been completed. Submit test report for record.
 - Feeder Testing and Reporting (Megger Result)
 - Transformers Testing and Reporting
- All main components of the electrical system cleaned and vacuumed. This includes unit switch boards, distribution boards, panel boards, etc. Provide M-E Engineers with schedule when this is going to occur and a letter stating it has been completed.
- The contractor shall schedule a walk through with the engineer to inspect all main feeder sizes. Covers for panel boards and distribution boards should be removed by the contractor for visual inspection of feeder sizes.
- The fire alarm system manufacturer shall provide the Owner/Architect with a “Letter of Certification” indicating the system is fully functional and meets all manufacturers requirements as well as code and design requirements. Fire department must sign off the system.
- Provide spare fuses in switch gear room per specifications.
- Panelboard directories updated and completed.
- Record drawings submitted.
- All lighting control systems complete with controls fully operational for visual inspections.

PART 2 – PRODUCTS

(Not Applicable)

PART 3 – EXECUTION

3.1 EQUIPMENT STARTUP AND TESTING

- A. Prior to completion and punchlist by the engineer, the contractor shall startup and test each piece of equipment as required by the specifications. The contractor shall provide documentation of all required tests with signoff of by the appropriate individual (engineer, architect, and building official).

3.2 LIFE SAFETY SYSTEMS

- A. All life safety systems shall be fully and successfully tested by the contractor before being witnessed by the engineer or building official.
- B. The contractor shall provide a detailed test procedure, with instrumentation to be used, for approval by the engineer and building official prior to any testing.
- C. Once tested by the contractor and fully operation the systems shall be demonstrated to the engineer. Once accepted by the engineer the system shall be demonstrated to the building and fire officials.

3.3 COORDINATION WITH OTHERS

- A. The Division 26 contractor shall coordinate his requirements with the general contractor to ensure the other building systems are completed to the point that they will not adversely affect the operation of the Division 26, 27 and 28 systems.

3.4 PUNCH LISTS

- A. The contractor shall submit in writing that the project is ready for final review by the engineer.
- B. Once the project is ready for final review the engineer will create a punch list of any corrections or deficiencies.
- C. The contractor shall complete all punch list items and provide a letter to the architect after completion stating all items have been completed or reasons why they were not completed.
- D. Upon receipt of this letter the engineer will verify that the punch list has been satisfactorily completed.

END OF SECTION

SECTION 26 05 19

WIRES AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Requirement of the following Division 26 Sections apply to this section:
 - 1. Electrical Requirements

1.2 SUMMARY

- A. This Section includes wires, cables, and connectors for power, lighting, signal, control and related systems rated 600 volts and less.
- B. Related Sections: The following Sections contain requirements that relate to this section:
 - 1. Division 26 Section "Electrical Boxes and Fittings" for connectors for terminating cables in boxes and other electrical enclosures.
- C. The work includes providing wire and cable complete with all accessories in accordance with Drawings and Specifications and as required for a complete system. Wiring size referenced in this Section shall be AWG, except as noted. For special wiring for individual systems refer to respective Section of these Specifications.

1.3 SUBMITTALS

- A. Product Data for electrical wires, cables and connectors.
- B. Shop drawings shall include detail drawings and data sheets for all wire and cable, compression wire connectors, large aluminum wire connectors, and large copper wire connectors.
- C. Cable Pulling Submittals:
 - 1. The following requirements pertain to all 600 volt or less feeders, sized 4/0 AWG or larger that are either in excess of 200 feet or requiring more than 180° of bend:
 - 2. The Contractor shall utilize a pulling calculation software package, such as Polywater Cable Management Software or SKM Cable Pulling Analysis Software, to model and determine the expected pulling tensions and sidewall pressures that the conductor(s) will be exposed to. If the calculations determine

that the expected pulling tensions and sidewall pressures will exceed the manufacturer's recommended values, the contractor is responsible making modifications necessary to correct the problem and re-run the analysis.

Contractor shall submit the results of the analysis for the intended conduit routing prior to commencement of cable pulling for engineer's approval. If the intended conduit routing is modified due to engineers comments or coordination with the other trades the contractor must re-run the analysis and resubmit for approval.

3. Contractor to submit detail conduit routing drawings showing pulling set ups and direction of cable pulls. These drawings shall clearly detail the intent of the cable pulls with reference to cable pull models. Indicate all splice locations for approval by engineer and owner.
4. Submit wire manufacture's maximum pulling tension and sidewall pressure recommendation.
5. Submit cable pulling machine for approval.
6. Submit UL listed pulling lubricants for approval.
7. Utilize Tensiometer similar or equal to, Condux Running Line Tensiometer, CableGlider HD.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with provisions of the following code:
- B. NFPA 70 "National Electrical Code."
 1. Conform to applicable codes and regulations regarding toxicity of combustion products of insulating materials.
 2. Comply with most restrictive code.
- C. UL Compliance: Provide components, which are listed and labeled by UL under the following standards.

1. UL Std. 44	Rubber Insulated Wires and Cables
2. UL Std. 83	Thermoplastic-Insulated Wires and Cables
3. UL Std. 486A	Wire Connectors and Soldering Lugs for Use with Copper Conductors
4. UL Std. 854	Service Entrance Cable
- D. NEMA/ICEA Compliance: Provide components which comply with ANSI/NEMA WC 70-2009 / ICEA S-95-658-2009.
- E. IEEE Compliance: Provide components, which comply with the following standard.
 1. Std. 82: Test procedures for Impulse Voltage Tests on Insulated Conductors.

F. QUALITY ASSURANCE

1. "Manufacturers" - Firms regularly engaged in manufacture of wire and cable of types and ratings whose products have been in satisfactory use in similar service for not less than 5 years.
2. Provide wire and cable which has been listed and labeled by Underwriters' Laboratories, and comply with applicable portions of National Electrical Manufacturers Association Standards.
3. Provide wire and cable produced by a manufacturer listed as an Approved Manufacturer in this section.
4. Provide equipment whose performance under specified conditions, is certified by the Manufacturer.

PART 2 - PRODUCTS

2.1 WIRES AND CABLES (600 VOLT COPPER CONDUCTORS – BASE DESIGN)

- A. General: Provide suitable wire and cable for the temperature, conditions and location where installed. All wires and cables shall be new and delivered to the site in unbroken packages and reels.
- B. All wires and cables shall be of the same manufacturer throughout the entire project.
- C. Conductors:
 1. Provide solid conductors for power and lighting circuits #10 AWG and smaller. Provide stranded conductors for #8 AWG and larger.
 2. Minimum conductor size shall be No. 12 for lighting and power and No. 14 for control and alarm. Increase wire as noted hereinafter for long runs.
 3. Communications and signal wiring shall conform to the recommendations of the manufacturer's communication and signal systems and shall be as specified in respective Sections of these Specifications.
- D. Conductor Material: All wires and cables shall be copper, single conductor rated at 600 volts, which conform to or exceed ICEA specifications. Use XHHW-2 or THWN-2/THHN, UNO.
 1. Emergency system feeders shall either be a listed 2-hour cable paired with listed conduit, MI cable, or encased in minimum of 2 inches of concrete.
- E. Grounding conductors: Shall be of the same type as its associated phase conductors.
- F. All conductors shall be label with wire size, insulation rating, etc using an engraved process. Computer scan or labels are not permitted.

- G. Color Coding for phase identification in accordance with Table 1 in Part 3 herein.
1. Where color-coded cable is not available, certify in writing and request permission for overlap color taping conductors (minimum length 6 in.) in accessible locations.
 2. Conductors for control circuits and signal systems shall also be consistently color coded to avoid confusion and permit easy identification of conductors. The IPCEA color code shall be used wherever possible. No two wires in the same raceway shall be the same color, unless provided with flameproof linen identification tags on each end.
- H. Connectors for Conductors:
1. Provide UL-listed factory-fabricated, solderless metal connectors of sizes, ampacity ratings, materials, types and classes for applications and for services indicated. Use connectors with temperature ratings equal to or greater than those of the wires upon which used.
 2. For wires that are #8 AWG and smaller: Insulated pressure type with live spring, rated 105°C, 600 volt, for building wiring and 1000 volt in signs or fixtures.
 3. For wires that are #6 AWG and larger: Compression type with 3M #33 or equal tape insulation.
- I. Splices and Taps:
1. No. 10 AWG and smaller - Connectors for solid conductors shall be solderless, screw-on, spring pressure cable type, 600 volt, 105°C with integral insulation and UL approved for aluminum and copper conductors. Connectors for stranded conductors shall be crimp-on type with integral insulating cover.
 2. No. 8 AWG and larger - Hydraulically applied crimping sleeve or tap connector sized for the conductors. Insulate the hydraulically applied connector with 90-degree, 600-volt insulating cover provided by the connector manufacturer. Insulator materials and installation shall be approved for the specific application, location, voltage, and temperature and shall not have an insulation value less than the conductors being joined.
- J. Wire Sizes
1. For General Use:
 - a. No. 12 minimum copper wire shall be used for lighting and power.
 - b. No. 10 minimum copper wire shall be used at 120 volts and over 90 ft. for 15 amp circuit and 60 ft. for 20 amp circuit length.
 - c. No. 10 minimum copper wire shall be used at 265 volts and over 175 ft. circuit length.
 2. For Control and Alarm (unless otherwise noted):
 - a. No. 14 minimum copper wire shall be used.
 - b. No. 12 minimum copper wire shall be used at 120 volts and over 60 ft. circuit length.

3. For Other Voltages and Phases and for Longer Circuit Lengths:
Size wire as required to maintain equivalent voltage drop.
4. Raceways: Increase raceway sizes for larger wire as required.

K. Insulation:

1. Rubber and thermoplastic insulation shall comply with ASTM and IPCEA standards. Paper and lead insulation shall comply with AEIC standards

PART 3 - EXECUTION

3.1 WIRING METHOD

- A. Use the following wiring methods as indicated:
 1. Install all wire in raceway. Power and control wiring shall be installed in separate raceways.

3.2 INSTALLATION OF WIRES AND CABLES

- A. General: Install electrical cables, wires, and connectors in compliance with NEC.
- B. Coordinate cable and wire installation with other Work.
- C. Wire and cable shall not be drawn into conduit and raceways until all conduit work is complete - joints made up tightly and the entire run secured in place.
- D. Do not install more conductors in a raceway than indicated on the drawings. A maximum of six branch circuits are to be installed in any one conduit on a 3-phase, 4-wire system, unless specifically noted otherwise on the drawings. When more than three branch circuits are installed in a raceway, the conductor size shall be increase per code for derating.
- E. Minimum wire size shall be a No.12 AWG except for control or signal circuits, which may be No. 14 AWG.
- F. Unless otherwise indicated on drawings, all wiring for branch circuits shall be a minimum No. 12 AWG in 3/4" conduit, protected by 20 amperes circuit breakers.
- G. Size of current carrying conductors, unless noted otherwise on drawings, shall be determined from Table 310-16 of the latest National Electric Code for the load served.
- H. Pull conductors simultaneously where more than one is being installed in same raceway. Use UL listed pulling compound or lubricant, where necessary.

- I. Care shall be exercised in pulling to avoid damage to the wire or cable. Lubricants shall be used for pulling wire or cable if the character of the pull would otherwise damage the conductors, insulation or jacket. Pull no thermoplastic wires at temperatures lower than 0°C.
- J. Use pulling means including: fish tape, cable, rope, and basket weave wire/cable grips which will not damage cables or raceways. Do not use rope hitches for pulling attachment to wire or cable.
- K. Keep conductor splice to minimum. All splices shall be made within junction boxes, wiring troughs and other enclosures as permitted by the National Electrical Code. Do not splice conductors in panelboards, safety switches, switchboard motor control centers or motor control enclosures. Splices in conductors installed below grade will not be permitted, unless approved in writing by the Architect.
- L. Install splice and tap connectors, which possess equivalent or better mechanical strength and insulation than conductors being spliced.
- M. Use splice and tap connectors which are compatible with conductor material.
- N. Provide adequate length of conductors within electrical enclosures and train the conductors to terminal points with no excess. Bundle multiple conductors, with conductors larger than No. 10 AWG cabled in individual circuits. Make terminations so there is no bare conductor at the terminal.
- O. Tighten electrical connectors and terminals, including screws and bolts, in accordance with manufacturers' published torque tightening values. Where manufacturers' torque requirements are not indicated, tighten connectors and terminals to comply with tightening torque values specified in UL 486A and UL 486B.
- P. 600 Volt Wire and Cable:
 - 1. The inside of conduits and raceways shall be dry and clean before wires are pulled.
 - 2. Cables shall be supported at the upper end of all risers and at intermediate points as required by the NEC. Supports shall be O.Z. Type "R" or approved equal, insulation wedges or Kellems grips.
 - 3. Wire and cable shall be installed in accordance with manufacturer's instructions.
 - 4. Seal, between the wire and conduit with a non hardening compound approved for the purpose, all cable and wire entering a building from underground where cable exits the conduit.
 - 5. Cable spacers shall be installed where required. Spacers shall be conduit fittings for spacing of cables at terminations and shall consist of galvanized or cadmium plates, steel or malleable iron threaded conduit and fittings and inserts of non-metallic insulating material with openings adequate to accommodate cables being spaced. Cable spacers shall be adequate to accommodate cables being spaced. Cable spacers shall be O.Z. Mfg. Co., Inc. Type E or Type EL with grounding lug or approved equal.

6. Provide separate raceways for conductors of 120/208 and 277/480 volt systems.
7. Install cable limiters at each end of each conductor of more than three (3) paralleled conductors per phase, over 100 ft. in length. Limiters shall be rated 600 volts, 200,000 amps RMS interrupting capacity and shall have waterproof sleeves.
8. Provide individual raceways for two pole ungrounded circuits.
9. In certain systems, equipment furnished by an approved manufacturer may require a different number and arrangement of conductors from that indicated on the Drawings. In such cases, the Contractor for the work under this Division shall comply with such requirements at no additional cost to the Owner.
10. In the event the Contractor for the work under this Division or Section chooses to furnish and install a system or item of equipment of different arrangement from that shown or specified, he shall furnish and install any additional wiring and conduit required by the system at no additional cost to the Owner.
11. In wireways and large pull boxes, lace and tie off conductors in groups of 3 phases and neutral (if used) to limit conductor unbalanced loading. Conductor group shall be as installed in conduits.
12. Tag all feeders and risers in all pull boxes and in all gutter spaces through which they pass. Tags shall be engraved white core nameplates identifying feeders as shown on the Drawings or the circuit protective device from which they originate.
13. Leave all wires with sufficient slack at terminals ends for convenient connections and fixtures and for convenient servicing. Stow loose ends neatly in outlet box.
14. Splices and taps shall be made in accessible boxes, panelboards fittings, gutters, terminal panels, etc. only. Materials shall be compatible with the conductors, insulations and protective jackets on the cables and wires.
15. All copper conductors No. 8 & larger shall be spliced, and tapped with color-keyed compression connectors, as manufactured by Thomas & Betts Co., Series 54000, Ideal Industries Series 87000, or approved equal. The manufacturers recommended tooling shall be used. Mechanical type connectors shall not be used. All copper conductors No. 8 and larger shall be terminated with self crimping, self adjusting, spring action type cable terminators, as manufactured by CYTOLOK or approved.
16. All copper conductors No. 10 AWG & smaller shall be terminated and spliced with Ideal Industries wing-nut wire connectors, or approved equal compression connectors. The nylon self-insulated type shall be used to isolate the terminal from other metal parts and equipment.
17. Splices and joints shall be insulated with materials approved for the particular use, location, voltage, and temperature. Insulation shall be not less than that of the conductors being joined.
18. Plastic electrical insulating tape shall be flame retardant, cold and weather resistant.
19. All circuit and control wiring in cabinets, panels, pullboxes, and junction boxes shall be tied and held with nylon Ty-Rap cable ties as manufactured by Thomas & Betts Co. or approved equal.
20. Wire identification ties fastened to conductors at the point of attachment to terminal blocks and equipment components shall be nylon, self-locking Ty-Raps as manufactured by Thomas & Betts Co., Series Ty-51M, 53M, or approved

- equal.
- 21. Cables shall be tagged in all pull boxes, wireways and wiring gutters of panels. Where two or more circuits run to or through a control device, outlet box or junction box, each circuit shall be tagged as a guide in making connections.
- 22. Tags for feeders shall indicate feeder number, size, phase, voltage, origin and termination. Feeder tags shall identify all phases individually.
- 23. Tags for control and alarm wiring shall indicate type of control or alarm, size of wire and origin and termination.
- 24. Tags shall be Thomas Betts Co., Ideal Industries wire-marker dispenser type, self-laminated wire markers.
- 25. Wire lubricating compound shall be suitable for the wire insulation and conduit with which it is used, and shall not harden or become adhesive. Lubricating compound shall be Ideal Industries, Type Yellow 77, or approved equal. Lubricating compound shall not be used on wire for isolated type electrical power systems.
- 26. Contractor shall examine the areas and conditions under which wire and cable are to be installed, and notify Architect in wiring of conditions detrimental to proper and timely completion of the work.
- 27. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.3 FIELD QUALITY CONTROL

- A. Prior to energizing, check installed wires and cables with megohm meter to determine insulation resistance levels to assure requirements are fulfilled.
- B. Prior to energizing, test wires and cables for electrical continuity and for short circuits.
- C. Subsequent to wire and cable hook-ups, energize circuits and demonstrate proper functioning. Correct malfunctioning units, and retest to demonstrate compliance.
- D. Prior to completion of project, an infrared scan of switchgear and panelboard feeder equipment connection shall be performed when all loads are energized.
- E. TABLE 1: Color Coding for Phase Identification:
 - 1. Color code secondary service, feeder, and branch circuit conductors with factory applied color as follows:

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

3.4 FEEDER TESTING

A. Products

1. Material: Contractor shall provide all necessary testing equipment and devices required to perform the test described in this section.

B. Execution

1. Visual and Mechanical Inspection
 - a. Inspect cables for physical damage and proper connection in accordance with one-line diagrams.
 - b. Test cable mechanical connections to manufacturer's recommended values using a calibrated torque wrench.
 - c. Check cable color coding with Table I in this section and National Electrical Code standards.
2. Electrical Tests
 - a. Perform insulation-resistance test on each conductor with respect to ground and adjacent conductors. Applied potential shall be 1000 volts dc for 1 minute.
 - b. Perform continuity test to insure proper cable connection.
 - c. Megger conductors phase-to-phase and phase-to-ground for continuity and insulation tests before connection to utilization devices for the following:
 1. 100 percent of feeders.
 2. 10 percent of branch circuits.
 3. 100 percent of 3-phase motor branch circuits.
 - d. Verify phase rotation for all three-phase motor circuits.
3. Test Values
 - a. Evaluate results by comparison with cables of same length and type. Investigate any values less than 50 megohms.
 - b. Submit results to Engineer for approval in accordance with Section 26 05 02 and 26 05 03.

END OF SECTION

SECTION 26 05 26

GROUNDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. Division-26 Basic Materials and Methods sections apply to work of this section.
- C. Requirements of this section apply to electrical grounding and bonding work specified elsewhere in these specifications.

1.2 SUMMARY

- A. Extent of electrical grounding and bonding work is indicated by drawings and schedules and as specified herein. Grounding and bonding work is defined to encompass systems, circuits, and equipment.
- B. Type of electrical grounding and bonding work specified in this section includes the following:
 - 1. Solidly grounded.
- C. Applications of electrical grounding and bonding work in this section includes the following:
 - 1. Building frames - structural steel.
 - 2. Electrical power systems.
 - 3. Grounding electrodes.
 - 4. Separately derived systems.
 - 5. Raceways.
 - 6. Service equipment.
 - 7. Enclosures.
 - 8. Equipment.
 - 9. Lighting Standards.
- D. Refer to other Division-26 sections for wires/cables, electrical raceways, boxes and fittings, and wiring devices which are required in conjunction with electrical grounding and bonding work; not work of this section.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's data on grounding and bonding products and associated accessories.
- B. Wiring Diagrams: Submit wiring diagrams for electrical grounding and bonding work which indicates layout of ground rods, location of system grounding electrode connections, routing of grounding electrode conductors, also include diagrams for circuits and equipment grounding connections.
- C. Submit ground riser diagram for entire project. Show bus bars with transformer ground electrode conductors, etc.
- D. Shop drawings shall include splice kits, ground rods, and ground wire.

1.4 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of grounding and bonding products, of types, and ratings required, and ancillary grounding materials, including stranded cable, copper braid and bus, grounding electrodes and plate electrodes, and bonding jumpers whose products have been in satisfactory use in similar service for not less than 10 years.
- B. Installer's Qualifications: Firms with at least 5 years of successful installation experience on projects with electrical grounding work similar to that required for project.
- C. Codes and Standards:
 - 1. Electrical Code Compliance: Comply with applicable local electrical code requirements of the authority having jurisdiction, and NEC as applicable to electrical grounding and bonding, pertaining to systems, circuits and equipment.
 - 2. UL Compliance: Comply with applicable requirements of UL Standards No.'s 467, "Electrical Grounding and Bonding Equipment", and 869 "Electrical Service Equipment", pertaining to grounding and bonding of systems, circuits and equipment. In addition, comply with UL Std 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors." Provide grounding and bonding products which are UL-listed and labeled for their intended usage.
 - 3. IEEE Compliance: Comply with applicable requirements and recommended installation practices of IEEE Standards 80, 81, 141 and 142 pertaining to grounding and bonding of systems, circuits and equipment.
 - 4. For patient care area electrical power systems, grounding shall conform to Article 517 of the NEC.

PART 2 - PRODUCTS

2.1 GENERAL

A. Materials and Components:

1. Provide electrical grounding and bonding system; with assembly of materials, including, but not limited to, cables/wires, connectors, solderless lug terminals, grounding electrodes and plate electrodes, bonding jumper braid, surge arresters, and additional accessories needed for a complete installation. Where more than one type component product meets indicated requirements, selection is installer's option. Where materials or components are not indicated provide products which comply with NEC, UL, and IEEE requirements and with established industry standards for those applications indicated.

2.2 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B3.
2. Stranded Conductors: ASTM B8.
3. Tinned Conductors: ASTM B33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductors, 1/3 inch (6 mm) in diameter.
5. Bonding Conductor: No. 4 or No. 5 AWG, stranded conductors.
6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

C. Bare Grounding Conductor and Conductor Protector for Wood Poles:

1. No. 4 AWG minimum, soft-drawn copper.
2. Conductor Protector: Half-round PVC or wood molding. If wood, use pressure-treated fir or cypress or cedar.

- D. Grounding Bus: Rectangular bars of annealed copper (1/4 by 2 inches (6 by 50 mm) in cross section, unless otherwise indicated; with insulators.

2.3 CONNECTORS

- A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
 - 1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by Cadweld (or approved equal) manufacturer for materials being joined and installation conditions.

2.4 GROUNDING ELECTRODES

- A. Ground Rods: Copper clad steel; not less than 3/4 inch by 10 feet (19 mm by 3 m) in diameter.
- B. Chemical-Enhanced Grounding Electrodes: Copper tube, straight or L-shaped, charged with nonhazardous electrolytic chemical salts.
 - 1. Termination: Factory-attached No. 4/0 AWG bare conductor at least 48 inches (1200 mm) long.
 - 2. Backfill Material: Electrode manufacturer's recommended material.
- C. Ground clamps shall be bronze, solderless type with bronze screws suitable for receiving required or noted conductors.
- D. Grounding wires shall be UL and NEC approved types, copper, with insulation color identified green, except where otherwise shown on the Drawings, or specified.

PART 3 – EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No.10 AWG and smaller, and stranded conductors for No.8 AWG and larger, unless otherwise indicated.
- B. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- C. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Install bus on insulated spacers 1 inch (25 mm), minimum, from wall 6 inches (150 mm) above finished floor, unless otherwise indicated.
 - 2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, down to specified height above floor, and connect to horizontal bus.

D. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.2 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits. The conduit shall not be acceptable as an equipment ground.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 1. Feeders and branch circuits.
 2. Lighting circuits.
 3. Receptacle circuits.
 4. Single-phase motor and appliance branch circuits.
 5. Three-phase motor and appliance branch circuits.
 6. Flexible raceway runs.
- C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- D. Heat-Tracing Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- E. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal in addition to the equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated..

3.3 EXAMINATION

- A. Examine areas and conditions under which electrical grounding and bonding connections are to be made and notify Engineer in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected.

3.4 INSTALLATION OF ELECTRICAL GROUNDING AND BONDING SYSTEMS

- A. General: Install electrical grounding and bonding systems in accordance with manufacturer's instructions and applicable portions of NEC, NECA's "Standard of

Installation”, and in accordance with recognized industry practices to ensure that products comply with requirements.

- B. Coordinate with other electrical work as necessary to interface installation of electrical grounding and bonding system work with other work.
- C. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
 - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment
 - 3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.
- E. Grounding and Bonding for Piping:

Bond the water piping to the building ground with approved grounding clamps. All ground connections shall be executed with the same thorough workmanship as the connections for normal current carrying parts. The work must be neatly installed, as careless grounding either in appearance or workmanship will be rejected.
- F. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.
- G. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet (18 m) apart.
- H. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer’s published torque tightening values for connectors and bolts. Where manufacturer’s torquing requirements are not indicated, tighten connections to comply with tightening torque values specified in UL 486A to assure permanent and effective grounding.
- I. Apply corrosion-resistant finish to field-connections, buried metallic grounding and bonding products, and places where factory applied protective coatings have been destroyed, which are subjected to corrosive action.
- J. Install all connectors on clean metal contact surfaces, to ensure electrical conductivity and circuit integrity.

- K. The complete electrical installation shall be permanently and effectively grounded before the water meter and grounded in accordance with all code requirements, whether or not such connections are specifically shown or specified. Measured resistance to ground shall be 5 ohms. maximum.
- L. Parts of the electrical installation to be grounded shall include, but not be limited to, the following: outdoor equipment, conduit system for light and power, cabinets, housings and neutrals of transformers, motor frames, housings of alarm and control panels and associated devices, lighting fixtures,
- M. All copper bars for grounding shall be medium hard drawn. After installation, the copper bar shall be painted with one coat of an approved lacquer.
- N. Ground conductors shall be of sizes and material in accordance with the requirements of the National Electrical Code. Cable for grounding connections shall be bare in accordance with the latest revisions of ASTM Designations B3 and B8. All open bare grounding cable shall be secured in place with cast and honed malleable clamps and clamp backs, and 1/4 inch bolts.
- O. Ground wires shall be continuous without splices. There shall be no soldered joints in any ground connection. Connectors, clamps, etc. shall be solderless type.
- P. Ground outdoor electrical equipment to driven ground rods, as required by code.
- Q. Ground interrupted metallic raceways with ground conductors connected to metallic raceway at each end.
- R. Separately ground center taps of wye connected transformers in accordance with National Electrical Code (NFPA 70).

3.5 FIELD QUALITY CONTROL

- A. Upon completion of installation of electrical grounding and bonding systems, test ground resistance with ground resistance tester. Where tests show resistance to ground is over 5 ohms, take appropriate action to reduce resistance to 5 ohms, or less, by driving additional ground rods; then retest to demonstrate compliance.
- B. Inspect all connections prior to concealing same.

PART 4 – APPROVED MANUFACTURERS

- A. For ground rods.
 - 1. Carolina Galvanizing.
 - 2. Weaver Electric

END OF SECTION

SECTION 26 05 29

SUPPORTING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Requirements of the following Division 26 Sections apply to this section:
 - 1. "Electrical Requirements."

1.2 SUMMARY

- A. This Section includes secure support from the building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.
- B. Related Sections: The following Sections contain requirements that related to this Section:
 - 1. Division 5 Section "Metal Fabrications" for requirements for miscellaneous metal items involved in supports and fastenings.
 - 2. Division 7 Section "Firestopping" for requirements for firestopping at sleeves through walls and floors that are fire barriers.
 - 3. Refer to Division 26 Sections for additional specific support requirements that may be applicable to specific items.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product data for each type of product specified.
 - 1. Hanger and support schedule showing manufacturer's figure number, size, spacing, features, and application for each required type of hanger, support, sleeve, seal, and fastener to be used.
- C. Shop drawings indicating details of fabricated products and materials.
- D. Engineered Design consisting of details and engineering analysis for supports for the following items:
 - 1. Conduit (racked)

2. Ceiling mounted boxes, transformers.
3. Conduit - Ceiling mounted.

1.4 QUALITY ASSURANCE

- A. Electrical Component Standard: Components and installation shall comply with local codes as well as NFPA 70 “National Electrical Code.”
- B. Electrical components shall be listed and labeled by UL, ETL, CSA, or other approved, nationally recognized testing and listing agency that provides third-party certification follow-up services.
- C. Installation shall comply with local authorities seismic requirements.

PART 2 - PRODUCTS

2.1 COATINGS

- A. Coating: Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic. Products for use outdoors shall be hot-dip galvanized.

2.2 MANUFACTURED SUPPORTING DEVICES

- A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.
- B. Fasteners: Types, materials, and construction features as follows:
 1. Expansion Anchors: Carbon steel wedge or sleeve type.
 2. Toggle Bolts: All steel springhead type.
- C. Conduit Sealing Bushings: Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit, or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.
- D. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers. Construct body of malleable-iron casting with hot-dip galvanized finish.

- E. U-Channel Systems: 16-gauge steel channels, with 9/16-inch-diameter holes, at a minimum of 8 inches on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacture.

2.3 FABRICATED SUPPORTING DEVICES

- A. General: Shop- or field-fabricated supports or manufactured supports assembled from U-channel components.
- B. Steel Brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install supporting devices to fasten electrical components securely and permanently in accordance with local codes and NEC requirements.
- B. Coordinate with the building structural system and with other electrical installation.
- C. Raceway Supports: Comply with local codes, the NEC and the following requirements:
 - 1. Conform to manufacturer's recommendations for selection and installation of supports.
 - 2. Strength of each support shall be adequate to carry present and future load multiplied by a safety factor of at least four. Where this determination results in a safety allowance of less than 200 lbs., provide additional strength until there is a minimum of 200 lbs safety allowance in the strength of each support.
 - 3. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.
 - 4. Support parallel runs of horizontal raceways together on trapeze-type hangers.
 - 5. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1-1/2-inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings only. For hanger rods with spring steel fasteners, use 1/4-inch diameter or larger threaded steel. Use spring fasteners that are specifically designed for supporting single conduits or tubing.
 - 6. Space supports for raceway in accordance with NEC.
 - 7. Support exposed and concealed raceway within 1 foot of an unsupported box and access fittings. In horizontal runs, supports at the box and access fittings may be omitted where box or access fittings are independently supported and raceway terminals are not made with chase nipples of threadless box connectors.

8. In vertical runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on raceway terminals.
- D. Vertical Conductor Supports: Install simultaneously with installation of conductors (i.e., strain reliefs).
- E. Miscellaneous Supports: Support miscellaneous electrical components as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.
- F. In open overhead spaces, cast boxes threaded to raceways need not be supported separately except where used for fixture support; support sheet metal boxes directly from the building structure or by bar hangers. Where bar hangers are used, attach the bar to the raceways on opposite sides of the box and support the raceway with an approved type of fastener not more than 24 inches from the box.
- G. Sleeves: Install in concrete slabs and walls and all other fire-rated floors and wall for raceways and cable installations. For sleeves through fire-rated wall or floor construction, apply UL-listed firestopping sealant in gaps between sleeves and enclosed conduits and cables in accordance with “Fire Stopping” requirement of Division 7.
- H. Conduit Seals: Install seals for conduit penetrations of slabs on grade and exterior walls below grade and where indicated. Tighten sleeve seal screws until sealing grommets have expanded to form watertight seal.
- I. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, cable trays, cabinets, panelboards, transformers, boxes, disconnect switches, and control components in accordance with the following:
 1. Fasten by means of wood screws or screw-type nails on wood, toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or masonry, and machine screws, welded threaded studs, or spring-tension clamps on steel. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions or light steel construction, use sheet metal screws.
 2. Holes cut to depth of more than 1-1/2 inches in reinforced concrete beams or to depth of more than 3/4 inch in concrete shall not cut the main reinforcing bars. Fill holes that are not used.
 3. Ensure that the load applied to any fastener does not exceed 25 percent of the proof test load. Use vibration- and shock-resistant fasteners for attachments to concrete slabs.

- J. TESTS: Test pull-out resistance of one of each type, size, and anchorage material for the following fastener types:
1. Expansion anchors.
 2. Toggle bolts.

Provide all jacks, jigs, fixtures, and calibrated indicating scales required for reliable testing. Obtain the structural Engineer's approval before transmitting loads to the structure. Test to 90 percent of rated proof load for fastener. If fastening fails test, revise all similar fastener installations and retest until satisfactory results are achieved.

NOTES:

1. Maximum spacing of supports (feet).
2. Maximum spacing for IMC applies to straight runs only. Otherwise the maximum of EMT applies.
3. Support for cable tray shall be as directed in their respective sections.

END OF SECTION

SECTION 26 05 33

RACEWAYS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.
- B. Requirements of the following Division 26 Sections apply to this Section:
 - 1. "Electrical Requirements."

1.2 SUMMARY

- A. This Section includes raceways for electrical wiring. Types of raceways in this section include the following:
 - 1. Rigid metallic conduit (RMC).
 - 2. Intermediate metal conduit (IMC).
 - 3. Electrical metallic tubing (EMT).
 - 4. Flexible metal conduit (FMC).
 - 5. Liquid-tight flexible conduit (LFMC).
 - 6. Metal clad cable (MC).
 - 7. Rigid non-metallic conduit (PVC).
 - 8. Wireway (WW).
 - 9. Surface metal raceways (SMR).
- B. Related Sections: The following section contains requirements that relate to this section:
 - 1. Division 26 Section "Electrical Boxes and Fittings" for conduit connectors, fittings, and couplings.
 - 2. Division 7 Section "Firestopping" for conduit penetrations through rated walls and slabs.
 - 3. Division 28 Section "Fire Alarm".

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of contract and Division 1 Specification Section.

- B. Product Data for the following products:
 - 1. Raceways and fittings.
 - 2. Wireways and fittings.
 - 3. Boxes and fittings.
 - 4. Color selection chart for wallplates.
- C. Installation Instructions: Manufacturer's written installation instructions for wireway, surface raceway, and nonmetallic raceway products.

1.4 QUALITY ASSURANCE

- A. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."
- B. NEMA Compliance: Comply with applicable requirements of NEMA standards pertaining to raceways.
- C. UL Compliance and Labeling: Comply with applicable requirements of UL standards pertaining to electrical raceway systems. Provide raceway products and components listed and labeled by UL.
- D. Manufacturers - Firm regularly engaged in manufacture of raceways of types and capacities required and whose products have been in satisfactory use in similar service for not less than 5 years.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

- A. Rigid Steel Conduit: ANSI C80.1
 - 1. Shall be full weight steel pipe, hot dip galvanized inside and outside, threaded, minimum 3/4 inch.
 - 2. Shall be painted with two protective coats of asphaltum compound where located underground or below slab.
- B. Intermediate Steel Conduit: UL 1242.
 - 1. Shall be intermediate weight steel pipe, hot dip galvanized, threaded, minimum 3/4 inch.
 - 2. Shall be painted with two protective coats of asphaltum compound where located underground or below slab.
- C. Electrical Metallic Tubing and Fittings: ANSI C80.3.

1. Shall be thin wall steel pipe, galvanized, thread-less, minimum 3/4 inch. EMT shall not be used for cable rated above 600 volts.

- D. Flexible Metal Conduit: UL 1, zinc-coated steel.
 - 1. Shall be continuous single strip, galvanized, minimum 3/4 inch.
- E. Liquid-tight Flexible Metal Conduit and Fittings: UL 360.
 - 1. Liquid-tight, flexible steel, conduits shall be zinc coated flexible galvanized steel tubing over which is extruded a liquid-tight jacket of polyvinyl chloride (PVC). Conduit shall be provided with a continuous copper bonding conductor wound spirally between the convolutions.

2.2 METAL CLAD CABLE, TYPE MC

- A. The multi-conductor metal clad cable shall comply with UL 1569 "Metal Clad, Type MC," UL 83 "Thermoplastic Insulated Wires and Cables" Federal Specification J-C-30B "Wire and Cable," Local and National Electrical Codes.
- B. The metal clad cable shall be THHN insulation, copper conductors in sizes #12 through #8 AWG only for continuous operation at a maximum conductor temperature of 90 degree C dry.
- C. These cables shall bear appropriate Underwriters Laboratories labels for metal clad cable and be suitable for use as branch circuits in both concealed, and very limited exposed work, in accordance with applicable sections of the National Electrical Code.
- D. An insulated grounding conductor sized in accordance with Table 5.3 Underwriter's Standard UL 1569 shall be cabled with the circuit conductors and shall be identified in compliance with Section 29 of UL 1569. The grounding conductor shall not be smaller than size indicated in NEC Article Table 250.122.
- E. A galvanized steel or aluminum armor shall be applied over the inner cable assembly with a positive interlock in compliance with Section 10 of UL 1569. A PVC jacket shall completely cover the steel or aluminum armor where liquid tight flexible metal conduit is required.

2.3 CONDUIT BODIES AND FITTINGS

- A. General: Types, shapes, and sizes as required to suit individual applications and NEC requirements. Provide matching gasketed covers secured with corrosion-resistant screws.
- B. Metallic Conduit and Tubing: Use metallic conduit bodies. Use bodies with threaded hubs for threaded raceways.
 - 1. Metallic conduit fittings shall be corrosion resistant.

- C. EMT Conduit Bodies: Use bodies with steel set screw connectors and couplings for interior applications and steel compression gland connectors and couplings for exterior applications.
1. Material shall be steel or malleable iron only.
 2. Couplings and connectors shall be "concrete tight" or "raintight", couplings and connectors for conduit sizes 2-inch and smaller shall be of the gland and ring compression type. Connectors shall have insulated throats.
 3. Set screw or indent type connectors are not permitted. Compression waterproof connection type fittings only shall be utilized.
- D. Nonmetallic Conduit: Use nonmetallic conduit bodies conforming to UL514B.
- E. Liquid-Tight Flexible Conduit Fittings: With threaded grounding cone, a steel, nylon or equal plastic compression ring, and a gland for tightening. Either steel or malleable iron only with insulated throats and male thread and locknut or male bushing with or without O-ring seal. Each connector shall provide a low resistance ground connection between the flexible conduit and the outlet box, conduit or other equipment to which it is connected.
- F. Bushings: Insulated type, designed to prevent abrasion of wires without impairing the continuity of the conduit grounding system, for rigid steel conduit and IMC – and EMT, larger than $\frac{3}{4}$ " size.
1. Bushings shall be of the metallic insulated type.
- G. Expansion Fittings: Each conduit that is buried in or secured to the buildings construction on opposite sides of a building expansion joint and each long run of exposed conduit that may be subject to excessive stresses shall be provided with an expansion fitting. Expansion fittings for rigid steel conduit shall be hot-dipped galvanized malleable iron with factory installed packing and a grounding ring. Expansion fittings for rigid non-metallic conduit shall be of the short type in runs 25' or less, and the long type in runs 26' to 80'. The long type shall be a two piece barrel and piston joint, providing 6" of the total movement range in $\frac{3}{4}$ " through 6" conduit sizes. The short type shall be a one piece, coupling with O-ring, providing 2" of total movement range in $\frac{3}{4}$ " to 2" conduit sizes.
1. Shall comply with UL 467 and UL 514 and shall accommodate, 0.75 inch deflection, expansion, or contraction in any direction, and shall allow 30 degree angular deflections.
 2. Shall include internal flexible metal braid sized to guarantee conduit ground continuity and fault currents in accordance with UL 467, and the NEC tables for ground conductors.
 3. Shall be watertight, seismically qualified, corrosion- resistant, threaded for and compatible with rigid or intermediate metal conduit.
 4. Jacket shall be flexible, corrosion-resistant, watertight, moisture and heat resistant molded rubber material with stainless steel jacket clamps.

- H. Seal Off Fittings: Threaded, zinc or cadmium coated, cast or malleable iron type for steel conduits. Fittings used to prevent passage of water vapor shall be of the continuous drain type.
- I. For weatherproof and dust-tight installations provide liquid-tight fittings with sealing ring and insulated throat.
- J. Rigid steel and IMC conduit fittings:
 - 1. Fittings shall be standard threaded couplings, locknuts, bushings, and elbows. Material shall be steel or malleable iron only.
 - 2. Locknuts shall be of the bonding type with sharp edges for digging into the metal wall of an enclosure.
 - 3. Bushings shall be of the metallic insulating type, and shall consist of an insulating insert molded or locked into the metallic body of the fitting. Bushings made entirely of metal or nonmetallic material are not permitted.
 - 4. Sealing fittings shall be of the threaded cast iron type. Sealing fittings used to prevent passage of water vapor shall be of the continuous drain type. In concealed work, each fitting shall be installed in a flush steel box with blank coverplate having the same finish as that of other electrical plates in the room.
- K. Flexible steel conduit (Greenfield) fittings:
 - 1. Material shall be steel or malleable iron only.
 - 2. Shall be multiple point type, threading into the wall of the conduit convolutions, and shall have insulated throat.

2.4 WIREWAYS

- A. General: Electrical wireways shall be of types, sizes, and number of channels as indicated. Fittings and accessories including but not limited to couplings, offsets, elbows, expansion joints, adapters, hold-down straps, and end caps shall match and mate with wireway as required for complete system. Where features are not indicated, select to fulfill wiring requirements and comply with applicable provisions of NEC. Wireways shall be steel and of sizes noted and shall have a minimum of No. 16 gauge thickness.
- B. Wireway covers shall be hinged type.

2.5 CONDUIT SUPPORTS:

- A. All parts and hardware shall be zinc-coated or have equivalent corrosion protection.
- B. Individual conduit hangers shall be designed for the purpose, with pre-assembled closure bolt and nut, and provisions for receiving hanger rod.

- C. Multiple conduit (trapeze) hangers shall be of not less than 1-1/2 by 1-1/2 inch, 12 gage steel, cold formed, lipped channels. Hanger rods shall be not less than 3/8-inch diameter steel.
- D. Solid masonry and concrete anchors shall be a type approved for the purpose.

2.6 SLEEVES

- A. Provide and assume responsibility for locating and maintaining in proper position all sleeves required for the work.
- B. For raceways in sleeves, provide seals of oakum packing and lead or O.Z. Type WSK series compound on both sides.
- C. For cables through sleeves, provide seals similar to O.Z. Type WSCS compound.
- D. Through floors, exterior masonry walls, roof, and underground, sleeves shall be schedule 40 galvanized steel pipe. For area not requiring schedule 40 pipe, sleeves shall be 18 gauge galvanized steel pipe.

2.7 FIRE SEALANTS

- A. Openings through floors and walls in which cables, conduits, or pipe pass shall be sealed by U.L. classified smoke and fire stop fittings, and have an hourly rating equal to the fire rating of the floor or wall. Fittings shall be similar to O-Z Gedney Type "CES" or "CAFS".
- B. Penetrations through fire-rated floors in which wiring for floor service outlets are routed shall be sealed by U.L. classified smoke and fire-stop fittings, and shall have an hourly rating equal to the floor rating. Fittings shall be similar to O-Z Gedney Type "PTFS".

PART 3 - EXECUTION

3.1 WIRING METHOD

- A. Use the following wiring methods:

USES	TYPE	TYPE	TYPE	TYPE	TYPE	TYPE	TYPE	TYPE
	Rigid Metallic Conduit (RMC)	Interm. Metal Conduit (IMC)	Elec Metal Tubing (EMT)	Flex metal Conduit (FMC)	Liquid Tight Flex Metal Conduit (LFMC)	Metal Clad Cable (MC)	Rigid Non Metal (PVC)	Wire-Way (WW)
Outdoor underground concrete encased, below	X						X	

USES	TYPE	TYPE	TYPE	TYPE	TYPE	TYPE	TYPE	TYPE
	Rigid Metallic Conduit (RMC)	Interm. Metal Conduit (IMC)	Elec Metal Tubing (EMT)	Flex metal Conduit (FMC)	Liquid Tight Flex Metal Conduit (LFMC)	Metal Clad Cable (MC)	Rigid Non Metal (PVC)	Wire-Way (WW)
building or away from building								
Outdoor above ground exposed or concealed	X	X						
Outdoor above ground final connection to vibrating equip: xfrms, solenoids, motors, etc.					X			
Indoor 600 volts and above concrete encased.	X							
Indoor exposed 10 feet to floor in "back of house" spaces such as mechanical, electrical, basements, attics, etc.	X	X						
Indoor exposed above 10 feet to floor.			X					
Indoor concealed homerun to panelboards, and for branch circuits			X					
Indoor concealed final branch wiring to receptacles and light						X		

USES	TYPE	TYPE	TYPE	TYPE	TYPE	TYPE	TYPE	TYPE
	Rigid Metallic Conduit (RMC)	Interm. Metal Conduit (IMC)	Elec Metal Tubing (EMT)	Flex metal Conduit (FMC)	Liquid Tight Flex Metal Conduit (LFMC)	Metal Clad Cable (MC)	Rigid Non Metal (PVC)	Wire-Way (WW)
fixture. Max 50' length from homerun j-box to outlet. MC not allowed for isolated ground circuits, or homeruns to panels, or connections to mechanical equipment. Max conductor is #8 AWG MC Cable.								
Indoor final connection to vibrating equipment: xfrms, solenoids, motors, etc. in dry areas				X				
Indoor final connection to vibrating equipment: xfrms, solenoids, motors, etc., in moist, humid, wet, or corrosive areas.					X			
Within concrete slabs, or connections to cast-in-place floor boxes. LFMC not allowed for homerun. Maximum	X	X			X			

USES	TYPE	TYPE	TYPE	TYPE	TYPE	TYPE	TYPE	TYPE
	Rigid Metallic Conduit (RMC)	Interm. Metal Conduit (IMC)	Elec Metal Tubing (EMT)	Flex metal Conduit (FMC)	Liquid Tight Flex Metal Conduit (LFMC)	Metal Clad Cable (MC)	Rigid Non Metal (PVC)	Wire-Way (WW)
sizes and locations of conduit subject to approval by structural engineer and Architect								
Hazardous Areas	X							
Terrazzo floor with conduit routed underneath, not within terrazzo.	X							
Fire Alarm initiating circuits and signaling circuits.			X					
Fire alarm system auto dialer telephone circuit	X							

3.2 INSTALLATION

- A. General: Install electrical raceways in accordance with manufacturers’ written installation instructions, applicable requirements of NEC, and as follows.
- B. Conceal conduit and EMT, unless indicated otherwise, within finished wall, ceilings, and floors. Keep raceways at least 12 inches away from parallel runs of flues and steam or hot water pipes. Install raceways level and square and at proper elevations.
- C. Elevation of Raceway: Where possible, install horizontal raceway runs above water and steam piping.
- D. Complete installation of electrical raceways before starting installation of conductors within raceways.

- E. Provide supports for raceways as specified elsewhere in Division 26 and in accordance with NEC and local authorities' seismic requirements.
- F. Prevent foreign matter from entering raceways by using temporary closure protection.
- G. Protect stub-ups from damage where conduits rise from floor slabs. Arrange so curved portion of bends is not visible above the finished slab. All elbow penetration through the slab shall be PVC coated rigid metallic conduit Ells.
- H. Make bends and offsets so the inside diameter is not effectively reduced. Unless otherwise indicated, keep the legs of a bend in the same plane and the straight legs of offsets parallel.
- I. Use raceway fittings that are of types compatible with the associated raceway and suitable for the use and location. For intermediate steel conduit, use threaded rigid steel conduit fittings except as otherwise indicated.
- J. Run concealed raceways with a minimum of bends in the shortest practical distance considering the type of building construction and obstructions except as otherwise indicated.
- K. Install exposed raceways parallel and perpendicular to nearby surfaces or structural members and follow the surface contours as much as practical. All exposed conduit runs shall be approved by the Architect prior to installing.
- L. All exposed conduits in public areas shall first be approved to be routed in public areas, then be painted to match surrounding walls. Verify exact color with the Architect.
- M. Run exposed, parallel, or banked raceways together. Make bends in parallel or banked runs from the same center line so that the bends are parallel. Factory elbows may be used in banked runs only where they can be installed parallel. This requires that there be a change in the plane of the run such as from wall to ceiling and that the raceways be of the same size. In other cases, provide field bends for parallel raceways. All exposed conduit routing shall be approved by the Architect prior to installing.
- N. Join raceways with fittings designed and approved for the purpose and make joints tight. Where joints cannot be made tight, use bonding jumpers to provide electrical continuity of the raceway system. Make raceway terminations tight. Where terminations are subject to vibration, use bonding bushings or wedges to assure electrical continuity. Where subject to vibration or dampness, use insulating bushings to protect conductors. Use expansion fittings at building expansion joints.
- O. Tighten set screws of threadless fittings with suitable tool.
- P. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely and install the locknuts with concave side against the box. Where terminations cannot be made secure with one locknut, use two locknuts, one inside and one outside of the box. All conduit connections to junction boxes shall have

insulated bushings.

- Q. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.
- R. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line having not less than 200-lb tensile strength. Leave no less than 12 inches of slack at each end of the pull wire.
- S. Install raceway sealing fittings in accordance with the manufacturer's written instructions. Locate fittings at suitable, approved, accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points and elsewhere as indicated:
 - 1. Where conduits pass from warm locations to cold locations, such as the boundaries of refrigerated spaces, air-conditioned spaces and walk-in coolers.
 - 2. Where required by the NEC.
- T. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment with an adjustable top or coupling threaded inside for plugs and set flush with the finished floor. Extend conductors to equipment with rigid steel conduit; flexible metal conduit may be used 6 inches above the floor. Where equipment connections are not made under this contract, install screwdriver-operated threaded flush plugs flush with floor.
- U. Flexible connection: Use length (maximum of 6 ft.) of flexible conduit for recessed and semi-recessed lighting fixtures, for equipment subject to vibration, noise transmission, or movement. Install separate equipment grounding conductor across flexible connections.
- V. Grounding: Install a separate green equipment grounding conductor in all raceways from the panelboard/junction box supplying the raceway to the receptacle or equipment ground terminals. Conduits will not be permitted as a ground conductor.

3.3 RACEWAYS

- A. Install conduit and tubing products as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and National Electrical Contractors Association's "Standard of Installation", and in accordance with the recognized industry practices to ensure that products serve intended function.
- B. Run raceways concealed, except as noted. Exposed raceways shall be run parallel with or at right angles to walls.

- C. Raceways supports shall be provided by means of ceiling trapeze, strap hangers, or wall brackets, structural steel angles or channels. Provide U-bolts at each floor level or riser raceways and connected to acceptable supports. Secure raceways to supports with pipe straps or U-bolts. Spacing of support shall be as per NEC and per manufacturer's recommendations.
- D. Mount supports to structure with toggle bolts on hollow masonry, expansion shields or inserts on concrete and brick, machine screws on metal, wood screws on wood. Nails, rawl plugs or wood plugs are not permitted.
- E. Provide a 12 in. minimum separation between raceways and steam and hot water pipes. Provide approved thermal insulation for electric lines where this separation cannot be maintained.
- F. Keep raceways clear of motor foundations and from underside of boilers. Also, install raceway so that they will not obstruct headroom, doorways, or walkways.
- G. In walls, run raceways vertically only.
- H. Mechanically join all metal raceways, enclosures and junction boxes to form a continuous electrical conductor. Connect all electrical boxes, fittings and cabinets so as to provide effective electrical continuity and firm mechanical assembly. Maintain grounding continuity of interrupted metallic raceways with ground conductor.
- I. Install complete conduit runs before pulling in wire or cable. Install raceways so that required conductors may be drawn in without injury or excessive strain to raceway or cable. Where raceway size is not indicated, follow applicable code.
- J. Do not cross pipe shafts or ventilation duct openings with raceway. Route raceway to avoid present or future openings in floor, wall or ceiling construction, when so indicated on the drawings.
- K. Keep end of raceways plugged or capped during construction.
- L. For empty raceways over 10 ft. long, provide fish or pull wire. Pull wire shall consist of steel core nylon rope and terminal ball.
- M. Damaged or deformed raceway is not permitted and shall be removed.
- N. Branch circuit conduits shall not be supported by the suspended ceiling or its supporting members, lighting fixtures, mechanical piping, or air-conditioning ducts.
- O. Work with extreme care near existing ducts, conduits, cables and other utilities to avoid damaging them.
- P. Galvanized Rigid steel conduit:
 - 1. Paint male threads of field threaded conduit with graphite base pipe compound.

- Q. Intermediate metal conduit:
1. Paint male threads of field threaded conduit with graphite base pipe compounds.
- R. Electric metallic tubing (EMT):
1. EMT is permitted to be used with the following limitations: for branch circuits only, and in dry locations (hung ceilings, hollow block walls and furred spaces).
- S. Flexible steel conduit:
1. Flexible steel conduit "Greenfield", shall be used for the following applications: for short connections where rigid conduit or tubing is impracticable, from outlet box to recessed lighting fixture with minimum length of 4 ft. and a maximum length of 6 ft.
 2. Connect the ground conductor to the enclosure or raceway at each end.
- T. Surface metal raceways shall be used only where shown on the drawings or as directed by the Architect.
- U. Provide expansion-deflection fittings at expansion joints and on length of runs in accordance with manufacturer's recommendations. Expansion-deflection fittings shall be of size as required complete with bonding jumper.
- V. For Hazardous Locations:
1. UL approved sealing fittings shall be installed, to prevent passage of explosive vapors as required by the NEC.
- W. For Wet, Damp, or Moist Locations:
1. Provide sealing fittings, to prevent passage of water vapor, where conduits pass from warm to cold locations, such as refrigerated spaces, air conditioned spaces, or similar spaces.

3.4 SLEEVES

- A. Sleeves shall be provided in accordance with the following guidelines:
1. Set required sleeves and inserts in place during progress of construction to avoid cutting of completed work.
 2. Provide sleeves for raceway passing through floors and foundations. Determine exact location of sleeves in field to avoid interference with structural members or equipment of all trades.
 3. Install sleeves rigidly so that proper position and alignment will be maintained during construction and pouring of concrete.

3.5 FIRE STOPS

- A. Where wiring, conduits, wireways, and other electrical raceways pass through fire partitions, fire walls, or floors, install an approved fire-stop that provides an effective barrier against the spread of fire, smoke and gases. Fire-stop material shall be packed tight and shall completely fill clearances between raceways and openings.
- B. Floor, exterior wall, and roof seals shall also be made watertight.

3.6 ADJUSTING AND CLEANING

- A. Upon completion of installation of raceways, inspect interiors of raceways; clear all blockages and remove burrs, dirt, and construction debris.

3.7 FIELD QUALITY CONTROL

- A. Contractor shall perform continuity tests by testing the resistance of all feeder conduits from the service to the point of their final distribution using 1 conductor return. The maximum resistance shall be 25 ohms.

END OF SECTION

SECTION 26 05 34

ELECTRICAL BOXES AND FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this section.
- B. This section is a Division 26 Basic Electrical Material and Methods section, and is a part of each Division 26 section making reference to electrical wiring boxes and fittings specified herein.

1.2 DESCRIPTION OF WORK

- A. Drawings are diagrammatic. All bends, boxes, fittings, couplings are not necessarily shown. Supply as necessary to comply with the National Electric Code.
- B. Types of electrical boxes and fittings specified in this section include the following:
 - 1. Outlet boxes.
 - 2. Junction boxes.
 - 3. Pull boxes.
 - 4. Bushings.
 - 5. Locknuts.
 - 6. Knockout closures.

1.3 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of electrical boxes and fittings, of types, sizes, and capacities required, whose products have been in satisfactory use in similar service for not less than five years.
- B. Installer's Qualifications: Firms with at least five years of successful installation experience on projects utilizing electrical boxes and fittings similar to those required for this project.
- C. Local Code and NEC Compliance: Comply with local code and NEC as applicable to construction and installation of electrical wiring boxes and fittings.
- D. UL Compliance: Comply with applicable requirements of UL 50, UL 514-Series, and UL 886 pertaining to electrical boxes and fittings. Provide electrical boxes and fittings which are UL-listed and labeled.

- E. NEMA Compliance: Comply with applicable requirements of NEMA Stds/Pub No.'s OS1, OS2 and PUB 250 pertaining to outlet and device boxes, covers and box supports.
- F. Federal Specification Compliance: Comply with applicable requirements of FS W-C 586, "Electrical Cast Metal Conduit Outlet Boxes, Bodies, and Entrance Caps."

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's data on electrical boxes and fittings.
- B. Shop Drawings: Submit layout drawings of electrical floor, junction and pull boxes showing accurately scaled box layouts and their spatial relationship to associated equipment.

PART 2 - PRODUCTS

2.1 OUTLET BOXES

- A. Outlet boxes for concealed work shall be galvanized steel, 4 in. square or octagon (except as otherwise required by construction, devices or wiring) and as follows:
 - 1. Above ceiling: 1-1/2 in. deep.
 - 2. In ceiling or slab: 3 in. deep.
 - 3. In wall for fixtures: 2-3/4 in. deep.
 - 4. In wall for receptacles and switches: 1-1/2 in. deep.
 - 5. With raised covers and fixtures studs where required.
 - 6. Through-the-wall type are not permitted.
- B. Outlet boxes for exposed work shall be galvanized cast iron or aluminum with threaded hubs. Except as otherwise required by construction, devices or wiring the outlet boxes shall be in 4 in. round x 2 in. deep for mounting on ceilings and 4 in. square x 2 in. deep for mounting on walls.
- C. Outlet boxes without fixture or device, shall have blank cover.
- D. Extension rings shall be provided as required to suit various conditions.
- E. Grounding screw and cable wiring connector shall be provided as required by wiring method.
- F. Construct outlet boxes with mounting holes, and with cable and conduit-size knockout openings in bottom and sides.
- G. Provide boxes with threaded screw holes, with corrosion-resistant cover and grounding screws for fastening surface and device type box covers, and for equipment type grounding.

- H. Provide outlet box accessories as required for each installation, including box supports, mounting ears and brackets, wallboard hangers, box extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, which are compatible with outlet boxes being used to fulfill installation requirements for individual wiring situations. Choice of accessories is Installer's code-compliance option.
- I. Outlet boxes located outdoors and damp locations shall be weatherproof corrosion-resistant cast-metal raintight outlet wiring boxes, of types, shapes and sizes, including depth of boxes, with threaded conduit holes for fastening electrical conduit, cast-metal face plates with spring-hinged watertight caps suitably configured for each application, including face plate gaskets and corrosion-resistant plugs and fasteners.

2.2 JUNCTION AND PULL BOXES

- A. Junction and pull boxes shall be made of galvanized code-gauge sheet steel junction and pull boxes, with screw-on covers; of types, shapes and sizes, to suit each respective location and installation; with welded seams and equipped with stainless steel nuts, bolts, screws, and washers. Pull boxes installed in finished spaces must be flush mounted cabinets provided with trim, hinged door and flush latch and lock to match flush mounted panelboard trim.
- B. Provide junction and/or pull boxes as noted or as required. All junction and pull boxes shall be accessible.
- C. Junction and pull boxes located outdoors and in damp locations shall be galvanized cast iron with threaded hubs and gaskets.
- D. Junction or pull box to be mounted flush with grade shall be polymer composite rain tight with screw cover lids. Box dimensions shall be 30"W x 48"L x 36"D. Covers shall be polymer composite suitable for pedestrian traffic secured to box with stainless steel screws. Box to be furnished with continuous neoprene gasket to seal cover. Conduit entry shall be on side of box with bell ends.
- E. Provide barriers in junction boxes or pull boxes between:
 - 1. 277/480 volt wiring energized from separate services.
 - 2. 120/208 volt and 277/480 volt wiring.
 - 3. Emergency and normal wiring.

2.3 BUSHINGS, KNOCKOUT CLOSURES AND LOCKNUTS

- A. Provide corrosion-resistant box knockout closures, conduit locknuts and malleable iron conduit bushings, offset connectors, of types and sizes, to suit respective installation requirements and applications.

PART 3 - EXECUTION

3.1 INSTALLATION OF ELECTRICAL BOXES AND FITTINGS

- A. General: Install electrical boxes and fittings in accordance with manufacturer's written instructions, applicable requirements of local codes, NEC and NECA's "Standard of Installation," and in accordance with recognized industry practices to fulfill project requirements.
- B. Coordinate installation of electrical boxes and fittings with wire/cable, wiring devices, and raceway installation work.
- C. Provide rain tight "in use" outlets for interior and exterior locations exposed to weather or moisture.
- D. Install electrical boxes in those locations which ensure ready accessibility to enclosed electrical wiring.
- E. Boxes separated by less than 24 inches shall be provided with firestop putty pads on the backside of all boxes exceeding 16 sq. inches in area. Provide Firestop putty pads on the back side for all outlet boxes within 24 inches of each other, in opposite sides, and at same elevation, in the same wall. Provide Firestop putty pads on the back side for all boxes in a wall or ceiling where the aggregate surface area of the outlet boxes exceeds 100 sq. inches per 100 sf of surface of wall or ceiling area. Firestop putty pads shall be Hilti CP617XI (9" x 9") for each box 16 sq inches or less.
- F. Position recessed outlet boxes accurately to allow for surface finish thickness.
- G. Avoid using round boxes where conduit must enter box through side of box, which would result in difficult and insecure connections when fastened with locknut or bushing on rounded surfaces.
- H. Fasten electrical boxes firmly and rigidly to substrates, or structural surfaces to which attached, or solidly embedded electrical boxes in concrete or masonry.
- I. Provide electrical connections for installed boxes.
- J. Exterior junction or pull boxes shall be mounted flush with grade, unless noted otherwise or indicated to be above ground on the drawings. Boxes shall be surrounded on all sides with 6 inches minimum of concrete. Top of concrete shall flush with grade. Seal all conduit entries into box with duct seal to prevent entrance of moisture, after conductors are installed.
- K. Tap and splices, where permitted by these specifications within exterior junction boxes, shall be performed with an encapsulating watertight splice or tap kit which insulates and moisture seals the connection. Kit shall consist of the appropriate size and type mold, encapsulating resin and end sealing tape.
- L. Subsequent to installation of boxes, protect boxes from construction debris and damage.

- M. Set boxes square and true with the building finish. Boxes shall be secured to the building structure by adjustable strap irons.
- N. Verify outlet locations in finished spaces with Architectural Drawings of interior details and finishes. Take caution in locating outlet to allow for overhead pipes, ducts, and variations in arrangement, thickness in finish, window trim and other Architectural Construction Details.
- O. Correct any inaccuracy in locating outlets without additional expense to the Owner. Refer to Architect any condition that would place an outlet box in an unsuitable location, such as a molding, break glass in wall finish, or behind radiator.
- P. Mount outlet boxes for similar equipment at uniform height within same or similar areas. Where mounting height or location of outlets is not shown or specified, mount outlet as best suited for equipment connected thereto, or as directed.
- Q. Close all unused openings in outlet boxes with knockout closers manufactured for this purpose. Provide blank plates on outlet boxes in which no device is installed or device installed does not provide a suitable cover.
- R. Provide barriers between switches connected to different phases for voltages exceeding 150 volts to ground.
- S. Outlet boxes for fixtures recessed in hung ceilings, shall be accessible through the opening created by the removal of the fixture.
- T. Securely fasten exposed outlet boxes by attaching to permanent inserts or lead anchors with machine screws. Adequately support all boxes during construction to prevent movement.
- U. Boxes for concealed work shall be pressed steel galvanized and shall conform to UL's "Standard for Outlet Boxes and Fittings." Outlet boxes shall be provided with a galvanized steel cover or extension ring depth as required.
- V. All ceiling fixture outlet boxes, except as noted, shall be 4" octagonal and 1-5/8" deep and with 3/8" fixture stud. Where cast in slab, boxes shall be open back concrete type.
- W. Wall bracket outlets shall be 4" square and 1-5/8" deep with cover having 2-7/8" round openings and except for lampholders shall be furnished with fixture stud.
- X. Junction outlets shall be the same as bracket outlets but without stud, furnished with covers to suit each condition and as directed. Where number of conductors exceed capacity of standard box, provide special size box.
- Y. All outlet boxes for concealed convenience receptacles or local switches shall be 4" square and 1-5/8" deep with regular deep switch extension cover, except where installed on columns they shall be of sufficient depth so that conduits may be installed into these

boxes in back of fireproofing. Outlet boxes for gang receptacles and switches shall suit space conditions.

- Z. Boxes for use with surface mounted raceways shall be of the same construction and manufacture as the raceway.
- AA. Boxes shall be of the cast type for switches and receptacles when installed on the exterior of the project. Such boxes shall be aluminum or malleable iron of the threaded hub type, with covers without projecting edges or corners and with openings suitable for the devices to be contained therein. Outlet boxes and covers shall be galvanized or anodized and shall be gasketed.
- BB. Except where special outlets are required, wall outlets for signaling systems shall be 4" square with single gang raised cover and bushed plate.
- CC. Panel, junction and pull boxes:
 - 1. Panel, junction and pull boxes shall be located clear of other trades equipment, accessible, supported from the building structure, and independent of the conduits.
 - 2. Conceal junction and pull boxes in finished spaces.
 - 3. Coordinate size of motor terminal boxes with motor branch circuit conduit and wiring.

3.2 GROUNDING

- A. Upon completion of installation work, properly ground electrical boxes and demonstrate compliance with requirements.

END OF SECTION

SECTION 26 05 48

VIBRATION ISOLATION SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Furnish and install vibration control devices, materials, and related items. Perform all work as shown on the drawings and as specified herein to provide complete vibration isolation systems in proper working order.

1.2 MATERIAL AND EQUIPMENT

- A. All vibration isolation mounts shall be supplied by one of the approved manufacturers stated in the PRODUCTS Section of this specification. Substitutions of equal equipment beyond the alternatives listed will be permitted only with the written permission of the Architect. Accompany each request for acceptance of substitute equipment with manufacturer's certified data proving the equivalence of the proposed substitute in quality and performance. The Architect shall be the final judge of the validity of the data submitted.
- B. Unless otherwise specified, supply only new equipment, parts, and materials.

1.3 SUBMITTALS

- A. Refer to related sections elsewhere for procedural instructions for submittals.
- B. The shop drawing submittal for isolated electrical equipment shall include submittal information for the isolation mounts. Information supplied shall be as follows:
 - 1. A complete description of products to be supplied including product data, dimensions, specifications, and installation instructions.
 - 2. Detailed selection data for each vibration isolator supporting equipment, including:
 - a. The equipment identification mark.
 - b. The isolator type.
 - c. The actual load.
- C. Submission of samples may be requested for each type of vibration isolation device. After approval, samples will be returned for installation at the job. All costs associated with submission of samples shall be borne by the Contractor.

1.4 QUALITY ASSURANCE

- A. Coordinate the size, location, and special requirements of vibration isolation equipment and systems with other trades. Coordinate plan dimensions with size of housekeeping pads.
- B. Provide vibration isolators of the appropriate sizes and proper loading to meet the specified requirements.
- C. Supply and install any incidental materials needed to meet the requirements stated herein, even if not expressly specified or shown on the drawings, without claim for additional payment.
- D. Verify correctness of equipment model numbers and conformance of each component with manufacturer's specifications.
- E. Should any electrical equipment cause excessive noise or vibration, the Contractor shall be responsible for remedial work required to reduce noise and vibration levels. Excessive is defined as exceeding the manufacturer's specifications for the unit in question.
- F. Upon completion of the work, the Architect or Architect's representative shall inspect the installation and shall inform the installing contractor of any further work that must be completed. Make all adjustments as directed by the Architect that result from the final inspection. This work shall be done before vibration isolation systems are accepted.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATION MOUNT TYPES

- A. Type DNP (Double Neoprene Pad):
 - 1. Neoprene pad isolators shall be formed by two layers of 1/4" to 5/16" thick ribbed or waffled neoprene, separated by a stainless steel or aluminum plate. These layers shall be permanently adhered together. The pads shall be sized so that they will be loaded within the manufacturer's recommended range.
 - 2. Type DNP isolators shall be formed from one of the following products or approved equal:

Type NR	Amber/Booth
Type Korpad	Korfund Dynamics
Type WSW	Mason Industries
Type NPS	Kinetics Noise Control
Series Shear Flex	Vibration Mountings & Control

B. Type HN (Hanger Neoprene):

1. Vibration isolation hangers shall consist of a neoprene-in-shear or glass fiber element contained in a steel housing. A neoprene neck bushing (or other element) shall be provided where the hanger rod passes through the hanger housing to prevent the rod from contacting the hanger housing. The diameter of the hole in the housing shall be sufficient to permit the hanger rod to swing through a 30° arc before contacting the hanger housing.
2. Type HN isolators shall be one of the following products or approved equal:

Type BRDA	Amber/Booth
Type H	Korfund Dynamics
Type HD	Mason Industries
Type RH or FH	Kinetics Noise Control
Type RHD or RFD	Vibration Mountings & Control

2.2 FLEXIBLE ELECTRICAL CONNECTIONS

A. Type A:

1. Flexible Electrical Connection Type A shall be a prefabricated unit incorporating a flexible and watertight outer jacket, grounding strap, plastic inner sleeve to maintain smooth wireway, and end hubs with tapered electrical threads to fit standard threaded rigid metal conduit.
2. Flexible Electrical Connection Type A shall be Crouse-Hinds (Syracuse, NY) “XD Expansion/Deflection Coupling,” Spring City Electrical Mfg. Co. (Spring City, PA) “Type DF Expansion and Deflection Fitting,,” or approved equal.

B. Type B:

1. Flexible Electrical Connection Type B shall be field fabricated using a minimum 2 (two) foot length of flexible conduit or cable.

C. Type C:

1. Flexible Electrical Connection Type C shall be field fabricated using a minimum 4 (four) foot length of flexible conduit or cable.

PART 3 - EXECUTION

3.1 APPLICATION

A. Transformers, Unit Substations, and Uninterruptible Power Supplies (UPS):

1. Transformers, Unit Substations, and UPS devices within the building construction shall be mounted on Type DNP isolators. If the transformers are suspended, use Type HN isolators selected to achieve not less than 0.1” static deflection.

2. Electrical connections to isolated transformers and UPS devices shall be made using flexible electrical connections Type A or Type B.

B. Dimmers:

1. Dimmer cabinets shall be mounted on Type DNP isolators.
2. Electrical connections to dimmers shall be made using flexible electrical connections Type A or Type B.

C. Mechanical Equipment:

1. Electrical connections to vibration isolated mechanical equipment shall be made using flexible electrical connections Type A or Type C.

3.2 INSTALLATION

A. General:

1. In all cases, isolated electrical equipment shall be positioned so that it is free standing and does not come in rigid contact with the building structure or other systems.

B. Isolation Mounts:

1. All mounts shall be aligned squarely above or below mounting points for the supported equipment.
2. If a housekeeping pad is provided, the isolators shall bear on the housekeeping pad and the isolator base plate shall rest entirely on the pad.
3. Hanger rods for vibration isolated supports shall be connected to structural beams or joists, not to the floor slab between beams and joists. Provide suitable intermediate support members as necessary.
4. Vibration isolation hanger elements shall be positioned as high as possible in the hanger rod assembly, but not in contact with the building structure, and so that the hanger housing may rotate a full 360° about the rod axis without contacting any object.

C. Flexible Electrical Connections:

1. Type C connections shall be installed in a grossly slack “U” shape or a 360 loop.
2. Rigid conduit on the isolated-equipment side of the flexible connection, and the flexible connection itself, shall not be tied to the building construction or other rigid structures.

END OF SECTION

SECTION 26 05 49

SEISMIC DESIGN

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. Seismic restraints and/or bracing shall be provided for selected electrical equipment and wiring methods as described hereinafter. These seismic design requirements are complementary to the requirements specified elsewhere for the fastening and support of electrical work. Nothing on the drawings or elsewhere in these specifications shall be interpreted as a reason to waive any of the requirements of this Seismic Design section.
- B. This project is located in Seismic zone __, an area with an effective peak velocity-related acceleration coefficient (A) of __.**
- C. Provide seismic support for the following items:
 - Switchboards
 - All lighting fixtures and exit signs
 - Emergency battery packs and/or central systems
 - Raceways associated with emergency lighting/power, fire alarm/detection system
 - Dry type transformers
 - Raceways 2½” and larger suspended on individual hangers longer than 12 inches, and all raceways on trapezes.
 - All pendant or ceiling mounted lighting fixtures if located in public corridors or other
 - Emergency battery packs and/or central systems
 - Inverter systems
 - Fire alarm/detection systems
 - All raceways supplying emergency lighting/power, fire alarm/detection system
 - Raceways mounted in or above public corridors or paths of egress on individual hangers longer than 12 inches or suspended on trapezes or larger than 2 inches.
- D. All seismic restraint and isolation devices, braces, and supports shall be capable of accepting without failure forces produced by seismic acceleration (expressed in multiples of the acceleration of gravity “G”) based on the level grade of the attachment of the equipment support system. For design purposes, the following acceleration levels shall be used.

DESIGN LEVEL OF ACCELERATION AT EQUIPMENT CENTER OF GRAVITY			
ELEVATION ABOVE GRADE	RIGIDLY FLOOR OR WALL MOUNTED EQUIPMENT	RESILIENTLY MOUNTED AND/OR SUPPORTED FROM CEILING OR STRUCTURE ABOVE	LIFE SAFETY EQUIPMENT (FIRE ALARM, HOSPITAL COMMUNICATIONS, EMERGENCY
SEISMIC ZONE 1 $A_v = 0.05$ TO 0.09			
BELOW GRADE UP TO 20 FEET ABOVE GRADE	0.100 "G"	0.400 "G"	1.000 "G"
21 FEET – 300 FEET	0.200 "G"	0.450 "G"	
301 FEET – 600 FT.	0.350 "G"	0.500 "G"	
SEISMIC ZONE 2 $A_v = 0.10$ TO 0.19			
BELOW GRADE UP TO 20 FEET ABOVE GRADE	0.125 "G"	0.500 "G"	1.000 "G"
21 FEET – 300 FEET	0.500 "G"	0.750 "G"	
301 FEET – 600 FT.	0.750 "G"	1.000 "G"	
SEISMIC ZONE 3 $A_v = 0.2$ TO 2.3			
BELOW GRADE UP TO 20 FEET ABOVE GRADE	0.225 "G"	0.750 "G"	1.000 "G"
21 FEET – 300 FEET	0.500 "G"	0.830 "G"	1.100 "G"
301 FEET – 600 FT.	0.750 "G"	1.250 "G"	1.500 "G"
SEISMIC ZONE 4 $A_v = >0.3$			
BELOW GRADE UP TO 20 FEET ABOVE GRADE	0.300 "G"	1.000 "G"	1.000 "G"
21 FEET – 300 FEET	0.600 "G"	1.250 "G"	1.250 "G"
301 FEET – 01 FEET	0.850 "G"	1.350 "G"	1.500 "G"

- E. The following vertical accelerations shall be considered in the design of systems in Zones 3 and 4 ($A_v = 0.2$ to 0.3 , $A_v > 0.3$ respectively):
1. 1/3 of the applicable horizontal acceleration for elevations at or below ground level up to an elevation of 40 feet, except rooftops.
 2. 1/3 of the applicable horizontal acceleration for elevations above 40 feet in areas where the equipment center of gravity is within a five foot radius of all continuous columns, except rooftops. Use the 2/3 values on all identical equipment if any of the units on the same floor are in the 2/3 zone or if there is any doubt as to the equipment location.
 3. 2/3 of the applicable horizontal acceleration for elevations above 40 feet and within the bay areas of the structure where the equipment center of gravity is not within a five foot radius of all continuous vertical columns and all rooftops.

4. 2/3 of the applicable horizontal acceleration on all identical equipment if any of the units on the same floor are in the 2/3 zone of if there is any doubt as to the equipment location.

1.3 OEM EQUIPMENT ISOLATION PACKAGES

A. Internal and/or External Systems

1. Substitution of internally or externally isolated or restrained equipment instead of the isolation and restraints specified in this section is acceptable provided all requirements of this section are met. The equipment manufacturer shall provide a letter of guarantee from their Engineering Department stamped and certifying that the seismic restraints are in full compliance with these specifications. Letters from field offices and representatives are unacceptable.
2. All costs for converting to the specified vibration isolation and/or restraints shall be borne by the equipment manufacturer in the event of non-compliance with the preceding.
3. In the event that the equipment is internally isolated and restrained, the entire unit assembly must be seismically attached to the structure.

1.4 SUBMITTALS

A. Seismic Certification and Analysis

1. Provide seismic restraint calculations certifying that all seismic restraint devices are capable of accepting, without failure, the "G" forces shown in the table above. Calculations shall be provided for all connections of the equipment to the structure. All performance of products (such as strut, cable, anchors, clips, etc.) associated with restraints must be supported by the manufacturer's data sheets or certified calculations. For roof mounted equipment, both the seismic acceleration and wind loads shall be calculated. The highest load shall be used for the design of the restraints and isolators.
2. Calculations to support seismic restraint designs must be stamped by a registered professional engineer with at least five years of seismic design experience.
3. Analysis must indicate calculated dead loads, derived loads, and materials used for connections to equipment and structure. Analysis must detail anchoring methods, bolt diameter, embedment and/or weld length.

1.5 RELATED WORK

A. Housekeeping Steel

1. Where steel sills are called for under a piece of electrical equipment, attachment shall be designed and certified according to this section by the seismic/isolation supplier.
2. Steel sills shall be sized to accommodate a minimum of six inches of clearance all around the equipment and its mounting package. In addition, 3/4" clearance

shall be provided between the electrical equipment and the steel sills so that the space may be kept clear of debris that would inhibit the isolation.

B. Supplementary Support Steel

1. Structural support and connections for all electrical equipment, including roof mounted equipment, specified in other sections shall comply with the seismic requirements of this section.

C. Design Responsibilities

1. Include the following in the responsibility of the seismic equipment supplier:
 - a. Determine guidelines for vibration isolation and restraint size and location.
 - b. Provide equipment vibration isolation and seismic restraints as required.
 - c. Guarantee specified isolation system deflections.
 - d. Provide installation instructions, drawings, and field supervision to insure proper installation and performance of systems.
 - e. Certify correctness of installation upon completion.

1.6 QUALITY ASSURANCE

- A. Installation of electrical equipment shall, as a minimum, be installed in accordance with the latest applicable edition of the **BOCA National Building Code/Uniform Building Code/Southern Building Code Congress**
- B. Listing and Labeling: Provide products that are Underwriters Laboratories listed and labeled for their applications and installation conditions and for the environments in which installed.
 1. The Terms “Listed” and “Labeled”: As defined in the “National Electrical Code”, Article 100.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Available manufactures: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:
 1. AVNEC, Inc. of Floral Park, NY
 2. Mason Industries, Inc. of Hauppauge, NY
 3. Vibration Mounting and Control of Butler, NJ
 4. Consolidated Kinetics of Columbus, OH

B. Attachments

1. Hardware and devices such as beam clamps, anchor bolts, cables, and cast-in-place plates must be by this section's supplier to ensure seismic compliance and certification. Alternate anchor bolts may be provided so long as the sizing and dimensions on the seismic submittals are followed:

2.2 SEISMIC RESTRAINTS AND VIBRATION ISOLATORS

A. General

1. All isolation and seismic restraint devices shall be capable of accepting, without failure, the "G" forces as determined by the seismic certification and calculations described above.
2. Corrosion protection for both indoor and outdoor applications shall be as follows:
 - a. Springs – Cadmium plated, zinc electroplated, or powder coat.
 - b. Hardware – cadmium plated
 - c. All other metal parts – hot spray or hot dipped galvanized.
3. All seismic restraint devices:
 - a. Shall maintain the equipment in a captive position and not short circuit isolation devices during normal operating conditions.
 - b. Shall have provisions for bolting and/or welding to the structure.

B. Seismic Restraint Types

1. Restraints for suspended systems
 - a. Isolated systems and, where required elsewhere by this specification, lighting fixtures – braced with multiple steel cable with approved fastening devices to equipment and structure.
 - b. Non-isolated systems – braced with structural steel strut with approved fastening devices to equipment and structure.
2. Restraints for systems rigidly connected to walls or floor or ceiling slabs.
 - a. Rigid attachment to structure using wedge type expansion anchors for bolting and steel plates, either cast-in or anchored with wedge type expansion bolts, for welding. Power shots are not acceptable. Concrete anchor bolt spacing shall be in accordance with ICBO National Standards for seismic anchorage.

C. Vibration Isolator Types

For Emergency Generators within the Building Structure – Spring Isolator, Restrained

- a. Spring shall have minimum outer diameter to overall height ratio of 0.8:1 at rated deflection.
- b. Reserve deflection (from that at published rated load to solid height) equal to 50% of the rated deflection.

- c. Formed steel or ductile top cup with adjusting bolt and locking cap screw for securing to equipment.
 - d. Minimum ¼” thick neoprene acoustical base or cup on underside, unless designated otherwise.
 - e. Capable of increasing vertical height by a minimum of ¾”. The integrity of restraint hardware shall not be compromised by these leveling features.
 - f. Integral restraining bolts with elasrometric cushions preventing metal-to-metal contact.
 - g. Internal spring adjusting nut or bolt with leveling capability.
 - h. Capable of supporting equipment at fixed elevation during equipment installation.
 - i. Built-in all directional limit stops with minimum ¼” clearance under normal operation.
2. For Dry Type Transformers –
 - a. Double deflection neoprene isolators encased in ductile iron or steel casing.
 3. For Emergency Generators on Grade – Pad Type Elastomer Isolator
 - a. Neoprene pad shall have 0.75” minimum thickness and shall have opposed cylindrical supports spaced on one inch centers to provide uniform deflection of 0.1 inch under rated load. Supports shall be connected under in the center by an 1/8” tear strip to facilitate trimming to desired size in one inch increments. Supports will also have through holes to accept up to 3/8” bolts without special drilling or coring.
 - b. 1/16” galvanized steel plate between multiple pad layers.
 - c. Load distribution plate where attachment to equipment bearing surface is less than 75% of the pad area.
 - d. When bolting is required for seismic compliance, neoprene washers and bushings shall be provided to prevent short circuiting.
 4. For Conduit Risers – Resilient Conduit Anchors and Guides
 - a. One inch of six pound density Fiberglass packed around the conduit.

PART 3 – EXECUTION

3.1 APPLICATION

- A. Isolation and seismic restraint systems must be installed in strict accordance with the manufacturer’s written instructions and all submittal data.
- B. Vibration isolators shall not cause any change of position of equipment resulting in stress on equipment connections.

3.2 INSTALLATION

- A. Equipment shall be restrained as indicated in the table at the end of this specification.
- B. Additional Requirements
 - 1. All bases shall be placed in position and supported temporarily by blocks or shims prior to the installation of the equipment, isolators, and restraints.
 - 2. Spring isolators shall be installed after all equipment is installed without changing equipment elevations.
 - 3. After the entire installation is complete and under full operation load, the spring isolators shall be adjusted so that the load is transferred from the blocks to the isolators.
 - 4. Remove all debris from beneath the equipment and verify that there are no short circuits of the isolation. The equipment's movement shall be free in all directions.
 - 5. All electrical connections to isolated equipment such as transformers and generators shall be in flexible conduit.
 - 6. Use wedge type expansion bolts to bolt the base to the structure.

3.3 SEISMIC RESTRAINTS

- A. Installation
 - 1. All equipment specified to receive seismic support shall be restrained per the table at the end of this section.
 - 2. All floor mounted equipment whether isolated or not shall be snubbed, anchored, bolted, or welded to the structure to comply with the required acceleration. Calculations that determine that isolated equipment movement may be less than the operating clearance of snubbers (restraints) do not preclude the need for snubbers. All equipment must be positively attached to the structure.
 - 3. Lighting fixtures shall be seismically restrained in accordance with the following:
 - a. Lighting fixtures recessed into suspended ceilings shall be supported from the ceiling structure by not less than two earthquake clips, or other approved supports, each capable of supporting 50% of the fixture weight.
 - b. Lighting fixtures surface mounted on the underside of suspended ceilings shall be provided with at least two supports, each independently connected to the slab above with cable type restraints as described hereinbefore for suspended systems and each capable of supporting 100% of the fixture weight.
 - 4. All horizontally suspended **[cable trays,] [bus ducts], [and]** conduit systems shall use restraints for non-isolated suspended systems. Spacing of seismic bracing shall be according to table below. All bus ducts and cable trays passing through floors shall be bolted at each floor level or secured above and below each floor with riser clamps. This restraint shall be in addition to the spring type hangers specified.

SEISMIC BRACING TABLE			
EQUIPMENT	ON CENTER SPACING		WITHIN EACH CHANGE OF DIRECTION
	TRANS-	LONGITU-	
CONDUIT	40 FEET	80 FEET	
BUS DUCT	20 FEET	40 FEET	4 FEET
CABLE TRAY	40 FEET	80 FEET	10 FEET

5. For all seismically supported trapeze supported conduit, the individual conduits shall be transversely and vertically restrained to the trapeze support at the designated restraint locations. Restrain at least every third trapeze hanger transversely and every fifth one longitudinally as well as the trapeze on both sides of every change of direction.
6. For overhead supported equipment, overstress of the building structure must not occur. Bracing may occur from:
 - a. Flanges of structural steel beams.
 - b. Upper truss chords in bar joists.
 - c. Cast in place or drilled and shielded inserts in concrete structures.
7. For dry type transformers suspended from the slab above, use isolators with 0.20” deflection and seismic restraints for isolated, suspended equipment.
8. Where conduits pass through cored or sleeved holes, the holes shall be a maximum of 2” larger than the conduit O.D. Pack the space with fireproofing material. No additional horizontal seismic bracing is required at these locations.
9. All non-isolated floor or wall mounted equipment such as **[substations], [switchboards,] panelboards, etc.** which require restraint shall use restraint for rigid attachment. **[For floor mounted transformers up to and including 300 kva, use isolators with a 0.30” deflection and rigid attachment seismic restraints. For larger transformers, provide a calculation for the isolators and restraints required.]** Where base anchoring of equipment **[such as UPS’s or switchboards]** is insufficient to resist seismic forces, additional restraints for suspended, non-isolated equipment shall be located above the unit’s center of gravity to suitably resist “G” forces specified.

3.4 INSPECTION

- A. Upon completion of installation of all vibration isolation and seismic restraint devices, a certification report prepared by the manufacturer shall be submitted in writing to the architect/engineer indicating that all systems are installed properly and in compliance with the specifications. The report shall identify those areas that require corrective measures or certify that none exist. Any field coordination type changes to the originally submitted seismic restraint designs must be clearly defined and detailed in this report.

END OF SECTION

SECTION 26 05 53

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Requirements of the following Division 26 Sections apply to this Section:
 - 1. "Electrical Requirements."

1.2 SUMMARY

- A. This Section includes identification of electrical materials, equipment, and installations. It includes requirements for electrical identification components including but not limited to the following:
 - 1. Identification labeling for raceways, cables, and conductors.
 - 2. Operational instruction signs.
 - 3. Warning and caution signs.
 - 4. Equipment labels and signs.
- B. Related Sections: The following Sections contain requirements that relate to this Section;
 - 1. Division 9 Section "Painting" for related identification requirements.
 - 2. Division 26 Section "Wires and Cables" for requirements for color coding of conductors for phase identification.
- C. Refer to other Division 26 Sections for additional specific electrical identification associated with specific items.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product Data for each type of product specified.
- C. Schedule of identification nomenclature to be used for identification signs and labels.
- D. Samples of engraved, plastic laminate to be used on switchgear, switchboards, disconnect switches and panelboards.

1.4 QUALITY ASSURANCE

- A. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."
- B. ANSI Compliance: Comply with requirements of ANSI Standard A13.1, "Scheme for the identification of Piping Systems," with regard to type and size of lettering for raceway and cable labels.

PART 2 - PRODUCTS

2.1 ELECTRICAL IDENTIFICATION PRODUCTS

- A. Colored Adhesive Marking Tape for Raceways, Wires, and Cables: Self-adhesive vinyl tape not less than 3 mil thick by 1 inch to 2 inches in width.
- B. Wire/Cable Designation Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wrap around, cable/conductor markers with preprinted numbers and letters.
- C. Engraved, Plastic-Laminated Labels, Signs, and Instruction Plates: Engraving stock melamine plastic laminate, 1/16-inch minimum thick for sign up to 20 square inches, or 8 inches in length; 1/8-inch thick for larger sizes. Engraved legend in black letters on white face for normal power and red letters on white face for emergency power. Plastic laminate shall be punched for mechanical fasteners.
- D. Baked-Enamel Warning and Caution Signs for Interior Use: Preprinted aluminum signs, punched for fasteners, with colors, legend, and size appropriate to the location.
- E. Exterior Metal-Backed Butyrate Warning and Caution Signs: Weather-resistant, non-fading, preprinted cellulose acetate butyrate signs with 20-gage, galvanized steel backing, with colors, legend, and size appropriate to the location. Provide 1/4-inch grommets in corners for mounting.
- F. Fasteners for Plastic-Laminated and Metal Signs: Self-tapping stainless steel screws or number 10/32 stainless steel machine screws with nuts and flat and lock washers.
- G. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18-inch minimum width, 50-lb minimum tensile strength, and suitable for a temperature range from minus 50°F to 350°F. Provide ties in specified colors when used for color coding.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification work with corresponding designations specified or indicated. Install numbers, lettering, and colors as approved in submittals and as required by code.
- B. Install identification devices in accordance with manufacturer's written instructions and requirements of local codes and the NEC.
- C. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.

3.2 CONDUIT IDENTIFICATION

- A. Identify Junction, Pull, and Connection Boxes: Code-required caution sign for boxes shall be pressure-sensitive, self-adhesive label indicating system voltage in black, preprinted on orange background. Install on outside of box cover. Also label box covers with identity of contained circuits. Use pressure-sensitive plastic labels at exposed locations and similar labels at concealed boxes.
- B. Underground Electrical Line Identification: During trench backfilling, for underground power, signal, and communications lines, install continuous underground plastic line marker, located directly above line at 6 to 8 inches below finished grade. Where multiple lines, installed in a common trench or concrete envelope, do not exceed an overall width of 16 inches; install a single line marker.
- C. Install line marker for underground wiring, both direct-buried and in raceway.
- D. Identify Raceways of Certain Systems with Color Banding: Band exposed or accessible raceways of the following systems for identification. Bands shall be painted with colors indicated below. Make each color band 2 inches wide, completely encircling conduit, and place adjacent bands of two-color markings in contact, side by side. Install bands at changes in direction, at penetrations of walls and floors, and at 40-foot maximum intervals in straight runs. Apply the following colors:
 - 1. Fire Alarm Systems: Red.
 - 2. Fire Suppression Supervisory and Control System: Red and Yellow.
 - 3. Mechanical and Electrical Supervisory System: Green and Blue.
 - 4. Telephone System: Green and Yellow.
 - 5. Tag or label conductors as follows:
 - a. Future Connections: Conductors indicated to be for future connection or connection under another contract with identification indicating source and intent.

- b. Multiple Circuits: Where multiple branch circuits or control wiring or communications/signal conductors are present in the same box or enclosure label each conductor or cable. Provide label on each box indicating source, voltage, circuit number, and phase for branch circuit wiring. Phase and voltage of branch circuit wiring may be indicated by mean of coded color of conductor insulation. For control and communications/signal wiring, use color coding or wire/cable marking tape at terminations and at intermediate locations where conductors appear in wiring boxes, troughs, and control cabinets. Use consistent letter/number conductor designations throughout on wire/cable marking tapes.
 - c. Match identification markings with designations used in panelboards shop drawings, Contract Documents, and similar previously established identification schemes for the facilities' electrical installations.
- E. Install labels at locations indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.
- F. Conductor Color Coding: Provide color coding for secondary service, feeder, and branch circuit conductors throughout the project secondary electrical system as follows:

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

- G. Use conductors with color factory-applied the entire length of the conductors except as follows:
- 1. The following field-applied color-coding methods may be used in lieu of factory-coded wire for sizes larger than No. 10 AWG:
 - a. Apply colored, pressure-sensitive plastic tap in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply the last two laps of tape with no tension to prevent possible unwinding. Use 1-inch-wide tape in colors as specified. Do not obliterate cable identification markings by taping. Tape locations may be adjusted slightly to prevent such obliteration.
 - b. In lieu of pressure-sensitive tape, colored cable ties may be used for color identification. Apply three ties of specified color to each wire at each terminal or splice point starting 3 inches from the terminal and spaced 3 inches apart. Apply with a special tool or pliers, tighten for snug fit, and cut off excess length.

2. All grounded conductors No. 6 AWG and smaller shall be a factory applied color across the entire length of conductors.
- H. Power Circuit Identification:
1. Securely fasten wrap-around marker bands to cables, feeders, and power circuits in pull boxes, junction boxes, and switchgear rooms.
- I. Apply warning, caution, and instruction signs and stencils as follows:
1. Install warning, caution, or instruction signs where required by NEC where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install butyrate signs with metal backing for outdoor items.
 2. Emergency Operating Signs: Install engraved laminate signs with white legend on red background with minimum 3/8-inch high lettering for emergency instructions on power transfer, load shedding, or other emergency operations.
- J. Install equipment/system circuit/device identification as follows:
1. Apply equipment identification labels of engraved plastic-laminate on each major unit for electrical equipment including central or master unit of each electrical system. This includes communication/signal/alarm system, unless unit is specified with its own self-explanatory identification. Except as otherwise indicated, provide single line of text, with 3/8-inch-high lettering on 1-1/2-inch-high label (2-inch-high where two lines are required), black lettering in white field for normal power and red lettering on white field for emergency power. Text shall match terminology and numbering of the Contract Documents and shop drawings. Apply labels for each unit of the following categories of electrical equipment:
 - a. Panelboards, electrical cabinets, and enclosures.
 - b. Access doors and panels for concealed electrical items.
 - c. Transformers.
- K. Apply circuit/control/item designation labels of engraved plastic laminate for disconnect switches, breakers, pushbuttons, pilot lights, motor control centers, and similar items for power distribution and control components above, except panelboards and alarm/signal components, where labeling is specified elsewhere. For panelboards, provide framed, typed circuit schedules with explicit description and identification (including room numbers) of items controlled by each individual breaker.
- L. Arc Flash Warning Signs: Provide arc flash warning signs at all panelboards, switchboards, control panels, meter enclosures, starters, motor control centers,

etc., that may be subject to inspection or repair. Warning signs shall be white letters on a red background with informative text in black on a white background. Signs shall be permanently affixed directly to the equipment in a readily visible location or located adjacent to the equipment with a smaller warning label on the equipment that directs maintenance personnel to the more informative sign. Warning sign data shall be appropriate and specific to each piece of equipment or device and shall identify flash hazard category, incident energy, VAC shock hazard, flash protection boundary, limited approach boundary, restricted approach boundary, restricted approach boundary, and prohibited approach boundary. Warning sign shall also indicate all recommended protective equipment. Calculations supporting the data on each warning sign shall be completed by a licensed professional engineer hired by the Contractor and presented to the owner in book form for future reference. Arch flash warning signs shall be in accordance to the most stringent of NFPA 70E, NFPA 70, and OSHA.

END OF SECTION

SECTION 26 27 26

WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Receptacles
 - 2. Ground Fault Circuit Interrupter Receptacles
 - 3. Plugs
 - 4. Plug Connectors
 - 5. Snap Switches
 - 6. Dimmer-Switches
 - 7. Wall Plates
- B. Related Sections: The following sections contain requirements that relate to this section:
 - 1. Division 26 Section "Disconnects, Fuses and Enclosed Breakers" for devices other than snap switches and plug/receptacle sets used as disconnects for motors.

1.3 SUBMITTALS

- A. Product data for each type of product specified. Include a color selection chart showing available color for each device type.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with provisions of the following codes.
 - 1. NFPA 70 "National Electrical Code."
- B. UL and NEMA Compliance: Provide wiring devices which are listed and labeled by UL and comply with applicable UL and NEMA standards.

1.5 SEQUENCE AND SCHEDULING

- A. Schedule installation of finish plates after the surface upon which they are installed has received final finish.

PART 2 - PRODUCTS

2.1 WIRING DEVICES

- A. General: Provide wiring devices, in types, characteristics, grades, colors, and electrical ratings for applications indicated which are UL listed and which comply with NEMA WD 1 and other applicable UL and NEMA standards.
- B. Color of Devices: Color of all devices shall be coordinated with the Architect, except special purpose devices shall be black, emergency power system devices which shall be red, corrosion-resistant devices which shall be yellow, surge suppression devices shall be blue, or isolated ground devices which shall be orange.
- C. Receptacles: As scheduled in Table 1 in Part 3 indicated herein. Comply with UL 498 and NEMA WD 1 and WD 5.
- D. Receptacles, Industrial Heavy Duty: Provide pin and sleeve design receptacles conforming to UL 498. Comply with UL 1010 where installed in hazardous locations. Provide features indicated.
- E. Ground-Fault Interrupter (GFI) Receptacles: As scheduled in Tables 1 and 2 in Part 3 indicated herein: Provide "terminal" or feed-through type ground-fault circuit interrupter, as indicated on drawings, with integral heavy-duty NEMA 5-20R duplex receptacles. Provide unit designed for installation in a 2-3/4-inch deep outlet box without adapter, grounding type, Class A, Group 1 per UL Standard 943.
- F. Vacancy Sensors: See Section 26 51 01.
- G. Wireways:
 - 1. Wiring troughs shall be 4" x 4" or 6" x 6", brake-formed of code gauge steel, furnished in standard 10-foot sections with knock-outs, as required. Wiring troughs shall be of the screw cover type and shall have a high grade enamel finish baked on a chemically-cleaned and zinc-phosphatized surface providing maximum resistance to corrosion.
 - 2. Wiring troughs shall be furnished with all the required components, such as square junction boxes, 90-degree elbows, T-shaped pull boxes, crossover pull boxes, box-connecting couplings, fittings and screw-on cover plates. Lengths of individual sections shall be provided in accordance with installation requirements.

- H. All exterior weatherproof receptacles located on the roof, receptacles located in elevator pits and machine rooms shall be GFI type or GFI protected and have “in use” covers.
- I. All devices shall be premium specification grade.

2.2 WIRING DEVICE ACCESSORIES

- A. Wall Plates: Single and combination, of types, sizes, and with ganging and cutouts as indicated. Provide metal screws for securing plates to devices with screw heads colored to match finish of plates. Provide wall plates with engraved legend where indicated on drawings. Engraving shall be done by the device manufacturer. All lettering shall be 1/8-inch high and shall be black for normal power systems and red for emergency power systems. Provide plates possessing the following additional construction features:
 - 1. Material and Finish: 0.04 inch thick, type 302 satin finished stainless steel. Plate shall be Hubbell “S” Series or approved equal.
 - 2. Surface mounted wiring devices and blank outlet plates shall be cadmium plated. Interior outlet plates shall be pressed steel. Outlets exposed to weather or corrosive conditions shall be of the cast-metal type.
 - 3. Plates for weatherproof receptacles shall consist of cast- aluminum gasketed plate with spring-loaded lift covers providing access to the outlet. Lift cover to correspond to number of outlets to be gasketed. Plates for weatherproof switches shall consist of a cast plate with flexible bubble for activating a push type switch. Plates shall be for corrosion-resistant devices, as manufactured by Hubbell, Inc., or approved equal.
- B. For all devices installed which are exposed to the weather, moisture or where indicated on the drawings, device plates shall be weatherproof. Device plates shall be cast type with gasketing to prevent entrance of moisture when closed.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Contractor shall examine location where wiring devices and installation components are to be installed and determine space conditions and notify architect in writing of conditions detrimental to proper and timely completion of the work.
- B. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF WIRING DEVICES AND ACCESSORIES

- A. Install wiring devices and accessories as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and in accordance with recognized industry practices to fulfill project requirements.
- B. Coordinate with other work, including painting, electrical boxes and wiring installations, as necessary to interface installation of wiring devices with other work.
- C. The mounting height of devices is indicated in the legend on the drawings. Where finished walls are exposed concrete block, brick or tile, the height shall be adjusted to allow outlet box for device to be mounted at a joint.
- D. Receptacles above countertops shall be installed with major axis horizontal above the backsplash.
- E. Electrical outlets shall be installed vertically unless otherwise noted. Those located on interior columns shall be centered laterally.
- F. Mount all devices within outlet boxes to allow device plates to be in contact with wall on all sides. Align devices with major axis of device parallel to adjacent predominant building feature, i.e., door frames or countertops.
- G. Install wall switches on the strike side of doors.
- H. Mount switches with the long dimension vertical and the operating handle in the upward position when in the "On" position.
- I. Install wiring devices only in electrical boxes which are clean; free from building materials, dirt, and debris.
- J. Provide a current carrying conductor, neutral, equipment grounding conductor and an insulated grounding conductor to each isolated ground "IG" receptacle.
- K. Install galvanized steel wall plates in unfinished spaces.
- L. Install wiring devices after wiring work is completed.
- M. Install wall plates after painting work is completed.
- N. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for wiring devices. Where manufacturer's torque requirements are not indicated, tighten connectors and terminal to comply with tightening torque requirements specified in UL Standard 486A. Use properly scaled torque indicating hand tool.
- O. At time of completion, replace items which have been damaged including those burned and scored by faulty plugs.

- P. Where it is not possible to set the switch box flush with the wall, furnish raised edge plates.
- Q. Where more than one switch is being installed, provide multiple gang switch plates for number of switches as required.

3.3 PROTECTION

- A. Protect installed components from damage. Replace damaged items prior to final acceptance.

3.4 FIELD QUALITY CONTROL

- A. Testing: Prior to energizing circuits, test wiring for electrical continuity, and for short-circuits. Ensure proper polarity of connections is maintained. Subsequent to energizing test wiring devices and demonstrating compliance with requirements, operate each operable device at least six times.
- B. Test ground fault interrupter operation with both local and remote fault simulations in accordance with manufacturer recommendations.

C. TABLE 1

RECEPTACLES

Designation (1)	Current Rating Amps	Voltage Rating	Single/Duplex	NEMA Config.	Hubbell Catalog #(3)	Notes
-	20	125	Duplex	5-20R	HBL2162	-
-	20	125	Single	5-20R	HBL5361	-
IG	20	125	Duplex	5-20R	IG5362	Isolated Ground
WP	20	125	Duplex	5-20R	HBL5362WR	Weather-proof (4)
GFI	20	125	Duplex	5-20R	GF20LA	Integral GFI (2)
SS	20	125	Duplex	5-20R	5362S	Surge Suppression
TP	20	125	Duplex	5-20R	DR20TR	Tamperproof
CH	15	125	Simplex	5-15R	HBL5235	Clock Hanger

NOTES

1. Letter designations are used where symbols alone do not clearly designate on plans locations where specific receptacle types are used.
2. Protecting downstream receptacles on same circuit is not acceptable.

3. Refer to Section 26 05 05 for additional acceptable manufacturers. Color of device shall be verified with Architect (ivory, gray, white, etc.). All emergency receptacles shall be red.
4. Where required per NEC or local code provide 'WP26M' in-use water-proof cover.

D. TABLE 2

RECEPTACLES FOR HOSPITAL CARE FACILITIES

Designation (1)	Current Rating Amps	Voltage Rating	Single/Duplex	NEMA Config.	Hubbell Catalog #(3)	Notes
-	20	125	Duplex	5-20R	HBL8300	-
-	20	125	Simplex	5-20R	HBL8310	-
GFI	20	125	Duplex	5-20R	GFR8300HL	Integral GFI (2)
-	20	125	Duplex	5-20R	HBL8300SGA	Tamper-proof
-	20	125	Simplex	L5-20R	HBL2300HG	Locking
-	20	125	Simplex	-	HBL24310	Explosion Proof
-	50	250	Simplex	-	HBL25505	X-ray
-	60	250	Simplex	-	HBL25605	X-ray

NOTES

1. Letter designations are used where symbols alone do not clearly designate on plans locations where specific receptacle types are used.
2. Protecting downstream receptacles on same circuit is not acceptable.
3. Refer to Section 26 05 05 for additional acceptable manufacturers. Color of device shall be verified with Architect (ivory, gray, white, etc.). All emergency receptacles shall be red.
4. Where required per NEC or local code provide 'WP26M' in-use water-proof cover.

E. TABLE 3

SNAP SWITCHES/WALL DIMMERS

Designation (1)	Typical Application	Load Rating	Voltage Rating (AC)	Poles	Hubbell Catalog #(4)	Notes
S	Control Lights	20A	120/277	1	DS120	-
S3	Control Lights	20A	120/277	3-way	DS320	-
S4	Control Lights	20A	120/277	4-way	DS420	
Sp	Switch & Pilot Light	20A	120/277	1	DS1201	(2)
D	Dimmer Switch	1000W	120	1	Vareo Series w/preset	(3)
Sk	Key Switch	20A	120/277	1	HBL1221L	

NOTES

1. For snap switches, designation is the same as the symbol used on plans for the device. Type of switch is determined from plan context including type of device or circuit being controlled.
2. Pilot light “on” when switch is “on.”
3. Lutron dimmer (refer to 26 05 05 for additional manufacturers). Provide dimmer wattage size to handle load served. Derate dimmer switch per manufacturer’s recommendations where dimmers are ganged together.
4. Refer to Section 26 05 05 for additional acceptable manufacturers. Color of device shall be verified with Architect (ivory, gray, white, etc.).

END OF SECTION

SECTION 26 28 16

DISCONNECTS, FUSES AND ENCLOSED BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. Division 26 Basic Electrical Materials and Methods sections, apply to work of this section.

1.2 SUMMARY

- A. Provide all circuit and motor disconnect switch and circuit breaker work including fusing, electrical connections to motors, appliance and mechanical equipment as indicated on the drawings and schedules.
- B. All disconnects serving smoke fans/motors shall have auxiliary contact wired to control circuit of upstream starter/VFD to monitor the position of the disconnect.
- C. Types of circuit and motor disconnect switches in this section include the following:
 - 1. Equipment disconnects.
 - 2. Appliance disconnects.
 - 3. Motor-circuit disconnects
 - 4. Enclosed breakers.
- D. Applications of electrical power connections specified in this section include the following:
 - 1. To resistive heaters.
 - 2. From electrical source to motor starters.
 - 3. From motor starters to motors.
 - 4. To lighting fixtures.
 - 5. To transformers, inverters, rheostats, and similar current adjustment features of equipment.
 - 6. To grounds including earthing connections.
 - 7. To panelboards and similar equipment
- E. All panelboards, transformers, disconnect switches, starters, etc., shall be fabricated by same manufacturer throughout the entire project.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's data on circuit and motor disconnect switches, fuses, equipment connectors.
- B. Fuse Product Data: For each type of fuse indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
 - 1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings:
 - a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
 - b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
 - 2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
 - 3. Current-limitation curves for fuses with current-limiting characteristics.
 - 4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
 - 5. Fuse sizes for elevator feeders and elevator disconnect switches, and circuit breakers.

1.4 QUALITY ASSURANCE

- A. All equipment shall be in compliance with codes and standards referenced in Section 26 05 02 titled "Electrical Requirements".
- B. "Manufacturers" - Firms regularly engaged in manufacture of the type of equipment required for the application, whose products have been in satisfactory use in similar service for not less than 5 years.
- C. UL Compliance: Comply with requirements of UL 98, "Enclosed and Dead-Front Switches." Provide circuit and motor disconnect switches which have been UL listed and labeled.
- D. Comply with NEC (NFPA 70) for construction and installation of safety and disconnect switches.
- E. Comply with UL Std 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors," including, but not limited to, tightening of electrical connectors to torque values indicated.

- F. NEMA Compliance: Comply with applicable requirements for NEMA Stds Pub/No. KS 1, "Enclosed Switches," and No. 250, "Enclosures for Electrical Equipment (1000 Volts Maximum)."
- G. ANSI Compliance: Comply with applicable requirements of ANSI C97.1, "Low-Voltage Cartridge Fuses 600 Volts or Less."
- H. NEMA Compliance: Comply with NEMA FU1 for cartridge fuses.

1.5 PROJECT CONDITIONS

- A. Molded case circuit breakers and all components shall be designed, manufactured and tested in accordance with the latest applicable standards of the following:
 - 1. UL 489 – Molded Case Circuit Breakers
 - 2. NEMA AB1 – Molded Case Circuit Breakers
 - 3. NEMA 250 – Enclosures for Electrical Equipment

PART 2 - PRODUCTS

2.1 CIRCUIT AND MOTOR DISCONNECT SWITCHES

- A. Furnish and install safety switches as required for motor outlets or other equipment. Switches shall be of size, number of poles, and fused or non-fused, as required for job conditions and the National Electrical Code.
- B. Switches shall be equipped with fuse contacts and jaws which ensure positive fuse and jaw contact by means of reinforcing spring clips or other approved means. All current carrying parts shall be silver-plated. Hinges shall be non-current carrying. Switches shall be so designed that they can be locked in either open or closed position.
- C. All switches shall have switch blades which are fully visible in the OFF position when the door is open. Switches shall have removable arc suppressors, where necessary to permit easy access to line-side lugs. Lugs shall be UL listed for aluminum and/or copper cables and front removable. 30A thru 100A switches shall have provisions for field installed fuse pullers. Switches shall include solid neutral where required.
- D. All safety switches shall be NEMA 1 enclosed Type "HD" (heavy duty) quick-make, quick-break, and have interlocking cover with handle that may either be front or side operating with padlocking provisions. Provide NEMA 3R weather proof enclosures where indicated on the drawings or exposed to exterior or damp locations. Incorporate rejection clips where used with Class "R" fuses.
- E. Handle position shall indicate if switch is ON or OFF. Handle shall have provision for padlock.

- F. Switches shall be rated for voltage, poles, amperes, and horsepower, as required or shown on Drawings. All switches shall be rated for maximum available fault current as required or shown on Drawings.
- G. Fusible Switches: Heavy duty switches, with fuses of classes and current ratings indicated on drawings. See Section "2.3" for Fuse specifications. Where current limiting fuses are indicated, provide switches with non-interchangeable feature suitable only for current limiting type fuses.
- H. Non-fusible Disconnects: Heavy duty switches of classes and current ratings as indicated on drawings.
- I. Double-Throw Switches: Heavy duty switches of classes and current rating as indicated on drawings.
- J. Accessories:
 - 1. Electrical Interlocks: Provide number and arrangement of interlock contacts in switches as indicated on drawings or specified elsewhere in specifications.
 - 2. Special Enclosure Material: Provide special enclosure material as follows for switches indicated on drawings to be NEMA 4X:
 - a. Stainless Steel Type 316.
 - b. Heavy case aluminum.
 - 3. Captive Fuse Pullers: Provide built-in pullers arranged to facilitate fuse removal.

2.2 CONNECTIONS FOR EQUIPMENT

- A. General: For each electrical connection indicated provide complete assembly of materials, including but not necessarily limited to, pressure connectors, terminals (lugs), electrical insulating tape, electrical solder, electrical soldering flux, heat-shrinkable insulating tubing, cable ties, solderless wirenuts. All other items and accessories as needed to complete splices and terminations of types indicated.
- B. Metal Conduit, Tubing and Fittings:
 - 1. General: Provide metal conduit, tubing and fitting of types, grades, sizes and weights (wall thicknesses) indicated for each type service. Where types and grades are not indicated, provide proper selection as determined by Installer to fulfill wiring requirements and comply with NEC requirements for raceways. Provide products complying with Section 26 05 06 titled "Basic Materials and Methods" and Section 26 05 33 titled "Raceways and Boxes" and in accordance with the following listing of metal conduit, tubing and fittings:
 - a. Rigid steel conduit.
 - b. Rigid metal conduit fittings.
 - c. Electrical metallic tubing.
 - d. EMT fittings.

- e. Flexible metal conduit.
- f. Flexible metal conduit fittings.
- g. Liquid-tight flexible metal conduit.
- h. Liquid tight flexible metal conduit fittings.

C. Wires, Cables, and Connectors:

1. General: Provide wires, cables and connectors complying with Division 26 05 06 titled "Basic Materials and Methods" and "Section 26 05 19" titled "Wires and Cables."
2. Wires/Cables: Unless otherwise indicated, provide wires/cables (conductors) for electrical connections which match, including sizes and rating, of wires/cables which are supplying electrical power. Provide copper conductors with conductivity of not less than 98% at 20°C (68°F).
3. Connectors and Terminals: Provide electrical connectors and terminals which mate and match, including sizes and ratings, with equipment terminals and are recommended for use by equipment manufacturer for intended applications.
4. Electrical Connection Accessories: Provide electrical insulating tape, heat shrinkable insulating tubing and boots, electrical solder, electrical soldering flux, wirenuts and cable ties as recommended for use by accessories manufacturers for type services indicated.

2.3 FUSES

- A. General: Except as otherwise indicated, provide fuses of types, sizes, ratings, and average time-current and peak let-through current characteristics, which comply with manufacturer's standard design, materials, and constructed in accordance with published product information, and with industry standards and configurations.
- B. Class RK1 dual element time-delay fuses: Provide UL Class RK1 current limiting time-delay fuses rated 600-volts, (250 volts where specified), 60 Hz, with 200,000 RMS symmetrical interrupting current rating for protecting circuit breakers, motors and panelboards.
- C. Class RK5 dual element time-delay fuses: Provide UL Class RK5 current limiting time-delay fuses rated 600 volts, (250 volts where specified), 60 Hz, with 200,000 RMS symmetrical interrupting current rating for protecting circuit breakers, motors, and transformers.
- D. Class L time-delay fuses: Provide UL Class L time-delay fuses rated 600 volts, 60 Hz, with 200,000 RMS symmetrical interrupting current rating.

2.4 SPARE-FUSE CABINET

- A. Characteristics: Wall-mounted NEMA-1 steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.

1. Size: Adequate for storage of spare fuses specified in Section 3.3 with [5] percent spare capacity minimum.
 2. Finish: Gray, baked enamel.
 3. Provide engraved, plastic laminate label "Spare Fuses" for cabinet. Refer to Section 26 05 53 for more information.
 4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.
- B. A complete set of spare fuses shall be purchased at the same time the initial fuses are purchased. Spare fuses shall consist of a standard carton for 0 to 60 amperes rating, and for above 60 amperes rating provide 10% of each type and rating or a set of three, whichever is greater. Spare fuses shall be placed in one or more spare fuse cabinets as required. The spare fuse cabinet shall be 30" H x 24" W x 12" D with key lock door, center shelf and fuse index holder. Include one set of fuse bulletins in the fuse cabinet.
- C. Fuses shall be U.L. Class L, time-delay and shall employ "O" rings as positive gas seals between the end bells and the glass melamine fuse barrel. Mounting terminals shall be opened. Fuses shall be time-delay and must hold 500% of rated current for a minimum of 4 seconds and clear 20 times rated current within .01 seconds. Fuse links shall consist of pure copper.

2.5 MOLDED CASE PROTECTIVE DEVICES

- A. Protective devices shall be molded case circuit breakers with inverse time and instantaneous tripping characteristics.
- B. 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 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.
- C. Circuit breakers shall have a minimum symmetrical interrupting capacity as indicated on the drawings.
- D. The Contractor 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.

2.6 ENCLOSURES

- A. Provide enclosures suitable for locations as indicated on the drawings and as described below:
1. Nema 1 surface of flush-mounted general purpose enclosures intended for indoor use.

- B. All enclosed circuit breakers shall have nameplates that contain a permanent record of catalog number and maximum rating.
- C. Provide handle mechanisms that are pad-lockable in the "OFF" position.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Contractor shall examine location where fuses and safety and disconnect switches and circuit breakers are to be installed and notify Architect/Engineer in writing of conditions detrimental to proper and timely/completion of the work.
- B. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF CIRCUIT AND MOTOR DISCONNECT SWITCHES

- A. Install circuit and motor disconnect switches as indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NEMA, and NECA's "Standard of Installation," and in accordance with recognized industry practices.
- B. Coordinate circuit and motor disconnect switch installation work with electrical raceway and cable work, as necessary for proper interface.
- C. Install disconnect switches for use with motor-driven appliances, and motors and controllers within sight of controller position unless otherwise indicated. For all disconnecting means located remote from the motor controller (starter or variable frequency drive), contractor to provide disconnect with auxiliary contacts, contacts and control wiring back to motor controller.

Provide NEMA 3R disconnect switches for all exterior locations and any location subject to moisture.

- D. Provide box with spare set of each size fuse used on job.
- E. Provide nameplate on switch, indicating equipment served.
- F. Provide line voltage wiring from starter/VFD control circuit to Aux contact in disconnect. Provide 2# 10, 3/4" C or run with power wire if same voltage.

3.3 INSTALLATION OF EQUIPMENT CONNECTIONS

- A. Install electrical connections in accordance with equipment manufacturer's written instructions and with recognized industry practices, and complying with applicable requirements of UL, NEC and NECA's "Standard of installation" to ensure that products fulfill requirements.
- B. Coordinate with other work, including wires/cables, raceway and equipment installation, as necessary to properly interface installation of electrical connections for equipment with other work.
- C. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams. Mate and match conductors of electrical connections for proper interface between electrical power supplies and installed equipment.
- D. Cover splices with electrical insulating material equivalent to, or of greater insulation resistivity rating, than electrical insulation rating of those conductors being spliced.
- E. Prepare cables and wires, by cutting and stripping covering armor, jacket, and insulation properly to ensure uniform and neat appearance where cables and wires are terminated. Exercise care to avoid cutting through tapes which will remain on conductors. Also avoid "nicking" copper conductors while skinning wire.
- F. Trim cables and wires as short as practicable and arrange routing to facilitate inspection, testing and maintenance.
- G. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturers published torque tightening values for equipment connectors. Accomplish tightening by utilizing proper torque tools, including torque screwdriver, beam-type torque wrench, and ratchet wrench with adjustable torque settings. Where manufacturer's torque requirements are not available, tighten connectors and terminals to comply with torque values contained in UL 486A.
- H. Provide flexible conduit for motor connections, and other electrical equipment connections, where subject to movement and vibration.
- I. Provide liquid-tight flexible conduit for connection of motors and other electrical equipment where subject to movement and vibration, and also where connections are subjected to one or more of the following conditions:
 - 1. Exterior location.
 - 2. Moist or humid atmosphere where condensation can be expected to accumulate.
 - 3. Corrosive atmosphere.
 - 4. Water spray.
 - 5. Dripping oil, grease, or water.

- J. Fasten identification markers to each electrical power supply wire/cable conductor which indicates their voltage, phase and feeder number in accordance with Division 26 section titled "Electrical Identification." Affix markers on each terminal conductor, as close as possible to the point of connection.
- K. Provide flexible metal conduit or Type "S" rubber cords, pigtails, caps, etc., as required to constitute an operating system. All flexible cords shall have a grounding conductor. Ground all equipment. See Section 26 05 26 titled "Grounding" for additional requirements.
- L. Prior to roughing-in, refer to all equipment manufacturer's shop drawings for details of equipment connections. Provide receptacles as required to match the cord caps on the equipment furnished. Provide either direct wiring or receptacles for final connection to equipment as required for the particular equipment furnished regardless of the type of outlet shown on the plans.

3.4 INSTALLATION OF FUSES

- A. Install fuses as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to ensure that protective devices comply with requirements. Comply with NEC, and NEMA standards for installation of fuses.
- B. Coordinate work including electrical wiring, as necessary, to interface installation of fuses with other trades.
- C. Install fuses in fused switches.
- D. Provide spare fuse cabinet located in each main switchgear room. Provide spare fuse of size and type for every five (5) fuses installed. A minimum of three (3) spare fuses shall be provided for each size installed.
- E. Contractor shall install Class R fuse rejection kits on all heavy duty safety switches not already fitted for Class R fuses.

3.5 INSTALLATION OF ENCLOSED CIRCUIT BREAKERS

- A. Install enclosed circuit breakers as indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NEMA, and NECA's "Standard of Installation," and in accordance with recognized industry practices.
- B. Coordinate enclosed circuit breakers installation work with electrical raceway and cable work, as necessary for proper interface.

3.6 GROUNDING

- A. Provide equipment grounding connections, sufficiently tight to assure a permanent and effective ground for electrical disconnect switches.

3.7 FIELD QUALITY CONTROL

- A. Testing: Subsequent to completion of installation of electrical disconnect switches and circuit breakers, energize circuits and demonstrate capability and compliance with requirements. Except as otherwise indicated, do not test switches by operating them under load. However, demonstrate switch operation through six opening/closing cycles with circuit unloaded. Open each switch enclosure for inspection of interior, mechanical and electrical connections, fuse installation, and for verification of type and rating of fuses installed. Correct deficiencies then retest to demonstrate compliance. Remove and replace defective units with new units and retest.
- B. Upon completion of installation of fuses, test and inspect system to ensure compliance with requirements.
- C. Final tests and inspections of fuses shall be made prior to energization of the equipment. This shall include a thorough cleaning, tightening and review of all electrical connections and inspection of all grounding conductors.

END OF SECTION

SECTION 26 29 13

MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. Division 26 Basic Electrical Materials and Methods sections apply to work specified in this section.

1.2 SUMMARY

- A. Extent of motor controller work is indicated by drawings and schedules.
- B. Types of motor controllers specified in this section include the following:
 - 1. Combination.
 - 2. Fractional HP manual.
- C. Work of this section includes wires/cables, raceways, electrical boxes and fittings, as specified in Division 26 sections, and used in conjunction with motor controllers.
- D. Refer to applicable Division 26 sections for wires/cables, electrical raceways, and boxes and fittings required in connection with motor controllers.
- E. All motor controllers, switchboards, panelboards, transformers, disconnect switches, starters, etc., shall be fabricated by same manufacturer throughout the project.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's data and installation instructions or motor controllers.
- B. Shop Drawings: Submit shop drawings of motor controllers showing accurately scaled equipment locations and spatial relationships to associated motors and equipment.
- C. Wiring Diagrams: Submit power and control wiring diagrams for motor controllers showing connections to electrical power panels, feeders, and equipment. Differentiate between portions of wiring which are manufacturer-installed and portions which are field-installed.

1.4 QUALITY ASSURANCE

- A. Manufacturer's Qualification: Firms regularly engaged in manufacture of motor controllers of types and sizes required, whose products have been in satisfactory use in similar service for no less than 5 years.
- B. Installer's Qualifications: Firms with at least 5 years of successful installation experience with projects utilizing motor controller work similar to that required for this project.
- C. Codes and Standards:
 - 1. Electrical Code Compliance: Comply with applicable local electrical code requirements of the authority having jurisdiction and NEC Articles 220, 250, and 430, as applicable to installation, and construction of motor controllers.
 - 2. NFPA Compliance: Comply with applicable requirements of NFPA 70E, "Standard for Electrical Safety Requirements for Employee Workplaces."
 - 3. UL Compliance: Comply with applicable requirements of UL 486A and 486B, and components which are UL-listed and labeled.
 - 4. IEEE Compliance: Comply with recommended practices contained in IEEE Standard 241, "Recommended Practice for Electric Power Systems in Commercial Buildings," pertaining to motor controllers.
 - 5. NEMA Compliance: Comply with applicable requirements of NEMA Standard ICS 2, "Industrial Control Devices, Controllers and Assemblies," and Pub/No. 250, "Enclosures for Electrical Equipment (1000 Volts Maximum)," pertaining to motor controllers and enclosures.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver motor controllers and components properly packaged in factory-fabricated type containers.
- B. Store motor controllers and components in original packaging and in a clean dry space; protect from weather and construction traffic.
- C. Handle motor controllers and components carefully to avoid breakage's, impacts, denting and scoring finishes. Do not install damaged equipment; replace and return damaged units to equipment manufacturer.

1.6 SEQUENCING AND SCHEDULING

- A. Coordinate with other electrical work including wires/cables, electrical boxes and fittings, and raceway, to properly interface installation of motor controllers with other work.
- B. Sequence motor controller installation work with other work to minimize possibility of damage and soiling during remainder of construction period.

1.7 MAINTENANCE

- A. Maintenance Data: Submit maintenance data and parts list for each motor controller and component; including “troubleshooting” maintenance guide. Include that data, product data and shop drawings in a maintenance manual; in accordance with requirements of Division 1.
- B. Maintenance Stock, Fuses: For types and rating required, furnish additional fuses, amounting to one unit for every 10 installed units, but not less than 5 units each.

PART 2 - PRODUCTS

2.1 MOTOR CONTROLLERS

- A. General: Except as otherwise indicated, provide motor controllers and ancillary components which comply with manufacturer’s standard materials, design and construction in accordance with published product information, and as required for a complete installation.
- B. Combination Controllers: Provide full-voltage alternating-current combination nonreversing controllers. Controllers shall consist of variable frequency drivers or motor circuit protector and disconnect switch mounted in common enclosure, of types, sizes, rating, and NEMA sizes shown on drawings. Each starter shall have a 120-volt, 60 Hz, control power transformer, H-O-A selector switch, red run pilot light, single phase protection and (2) two sets of N.O. and N.C. contacts for the building automation system. Equip controllers with block type manual reset overload relays and with fusible disconnect switches. Provide operating handle for disconnect switch mechanism with indication and control of switch position, with enclosure door either opened or closed, and capable of being locked in OFF position with three padlocks. Construct and mount controllers and disconnect switches in single NEMA Type 1 enclosure; coat with manufacturer’s standard color finish. Provide NEMA 3R where installed in an exterior or damp location.
- C. Provide start time delay relay with range 0-300 seconds for all motors 10 HP and larger. Set each relay 4 seconds apart for sequenced start-up after loss and restoration of normal power.
- D. Fractional HP Manual Controllers: Provide single-phase fractional HP manual motor controllers, of sizes and ratings shown on drawings. Equip with manually operated quick-make, quick-break toggle mechanisms; and with one-piece melting alloy type thermal units. Controller to become inoperative when thermal unit is removed. Provide controllers with double break silver-alloy contacts, visible from both sides of controller; green pilot lights, and switch capable of being padlocked OFF. Enclose controller unit in NEMA Type 1 general purpose enclosure; coat with manufacturer’s standard color finish. Provide NEMA 3R where installed in an exterior or damp location.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions under which motor controllers are to be installed, and notify Engineer in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF MOTOR CONTROLLERS

- A. Install motor controllers in accordance with equipment manufacturer's written instructions and with recognized industry practices; complying with applicable requirements of NEC, UL and NEMA standards, to ensure that products fulfill requirements.
- B. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturers' published torque tightening values for equipment connectors. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals to comply with torque requirements specified in UL Standards 486A and 486B, and the National Electrical Code.

3.3 FIELD QUALITY CONTROL

- A. Prior to energization of motor controller equipment, check with ground resistance tester, phase-to-phase and phase-to-ground insulation resistance levels to ensure requirements are fulfilled.
- B. Prior to energization, check circuitry for electrical continuity, and for short circuits.
- C. Ensure that direction of rotation of each motor fulfills requirements.

3.4 GROUNDING

- A. Provide equipment grounding connections for motor controller equipment. Tighten connections to comply with torque tightening requirements specified in UL Standard 486A to assure permanent and effective grounding.

3.5 ADJUSTING AND CLEANING

- A. Adjust operating mechanisms, where necessary, for free mechanical movement.
- B. Touch-up scratched or marred enclosure surfaces to match original finishes.

3.6 DEMONSTRATION

- A. Upon completion of installation of motor controller equipment and electrical circuitry, energize controller circuitry and demonstrate functioning of equipment in accordance with requirements. Where possible, correct malfunctioning units at site, then retest to

demonstrate compliance; otherwise, remove and replace with new units, and retest to demonstrate compliance.

END OF SECTION

SECTION 28 31 00

ADDRESSABLE FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of contract, including General and Supplementary conditions and Division-1 specification sections, apply to work of this section.
- B. Division 26, Basic Electrical Materials & Methods apply to work specified in this section.
- C. Division 26 "Electrical Identification" apply to work in this section for labeling of conduit and equipment.
- D. Related work specified in other divisions of these specifications.
 - 1. Installation of duct type smoke detectors.
 - 2. Control wiring from Fire Alarm Control equipment to mechanical fans, dampers, control equipment both low voltage and line voltage and all other control wiring associated with mechanical equipment.
- E. Secure permits and approvals prior to installation.
- F. Prior to commencement and after completion of work notify Authorities Having Jurisdiction.
- G. Submit letter of approval for installation before requesting acceptance of system.

1.2 SUMMARY

- A. Provide modifications to existing fire alarm system. Complete and coordinated wiring, fire management system in accordance with the contract documents.
- B. Any fire alarm devices, wiring etc., not indicated on the drawings, but required by the Authority Having Jurisdiction and Fire Department, shall be provided as part of this specification. As minimum, an additional 25 audio/visual alarms 25 smoke detectors and 25 addressable interface devices shall be included in price including labor, circuitry and programming. Devices shall be placed as directed in field.

1.3 RELATED WORK

- A. The Contractor shall coordinate work in this Section with all related trades. Work and/or equipment provided in other Sections and related to the alarm system shall include, but not be limited to:
1. Fire/Smoke Dampers wiring and connections shall be provided under this contract. Refer to mechanical drawings for quantities and locations.
 2. Sprinkler waterflow and supervisory switches shall be furnished and installed by the plumbing contractor, but wired and connected by the electrical contractor. Modification of existing sprinkler devices to accommodate monitoring by the new Sprinkler system shall be the responsibility of the alarm system installing contractor (if applicable).
 3. Duct smoke detectors shall be furnished, wired and connected by the electrical contractor. The HVAC contractor shall furnish necessary duct opening to install the duct smoke detectors.
 4. New air handling and smoke exhaust system fan control circuits and status contacts to be furnished by the HVAC control equipment.
 5. Dry pipe/deluge sprinkler system release valve control circuits and supervision contacts shall be provided by the dry pipe/deluge sprinkler system control equipment (if applicable).
 6. Conduit: Section 26 05 33.
 7. Wire and Cables: Section 26 05 13.

1.4 SUBMITTALS

- A. Procedure - prepare and make submittals listed in accordance with Division 1, "Submittals" as required by Local Department of Fire.
- B. Provide list of all types of equipment and components provided. This shall be incorporated as part of a Table of Contents, which will also indicate the manufacturer's part number, the description of the part, and the part number of the manufacturer's product datasheet on which the information can be found.
- C. Provide description of operation of the system (Sequence of Operation), similar to that provided in Part 2 of this Section of the Specifications, to include any and all exceptions, variances or substitutions listed at the time of bid. Any such exceptions, variances or substitutions that were not listed at the time of bid and are identified in the submittal, shall be grounds for immediate disapproval without comment. The sequence of operation shall be project specific, and shall provide individual sequences for every type of alarm, supervisory, or trouble condition that may occur as part of normal or off-normal system use.

- D. Product Data - submit manufacturer's specifications, recommendations, and installation instruction for use intended. The data shall include but is not limited to the following:
1. Visual alarms
 2. Audio/visual alarms
 3. Addressable interface devices
 4. Wiring conductors
 5. Wire connectors
 6. Include Underwriters Laboratories or Factory Mutual listing cards for equipment provided.
- E. Provide manufacturer's printed product data, catalog cuts and description of any special installation procedures. Poorly photocopied and/or illegible product data sheets shall not be acceptable and shall be rejected. All product datasheets shall be highlighted or stamped with arrows to indicate the specific components being submitted for approval.
- F. Provide copy of Connecticut state License to perform such work.
- G. Drawings
1. A legend sheet identifying device symbols, nomenclature, and conventions used in the package.
 2. Floor plans drawn to a scale not less than 1/8-inch equals 1 foot which clearly show locations of devices, equipment, risers, panels, electrical power connections, approximate location of conduit runs, and other details required to clearly describe the proposed system.
 3. Device riser diagram shall individually depict all control panels, annunciators, addressable devices, and notification appliances. Riser diagrams shall include a specific, proposed point descriptor above each addressable device. Riser diagrams shall include a specific, discrete point address that shall correspond to addresses depicted on the device layout floor plans. Drawing shall provide wire specifications, and wire tags shown on all conductors depicted on the riser diagram. All circuits shall have designations that shall correspond with those require on the control panel and floor plan drawings. End-of-line resistors (and values) shall be depicted.
 4. Device typical wiring diagram drawing(s) shall be provided which depict all system components, and their respective field wiring termination points. Wire type, gauge, and jacket shall also be indicated. When an addressable module is used in multiple configurations for monitoring or controlling various types of equipment, different device typical diagrams shall be provided. End-of-line resistors (and values) shall be depicted.
- H. Field Test Reports
1. Preliminary and acceptance tests.
 2. Include the control panel and initiating and indicating devices, a unique identifier for each device with an indication of test results, and signature of the factory-

trained technician of the control panel manufacturer and equipment installer.
With reports on preliminary tests, include printer information.

I. Records Drawings

1. Upon completion, and before final acceptance of the work, submit a complete set of CAD generated as-built drawings for the fire alarm system, including components and any other associated appurtenances. Include as-built circuit diagrams complete with conductor color codes and a listing of initiating device locations and fixing voltage for each. Submit a minimum ten of 11 x 17 inch reproducible as-built drawings with title block similar to contractor drawings, and provide CAD diskettes of entire project. Submit as-built drawings in addition to the record drawings required by Division 1, "Operation and Maintenance Data".
2. List of FACP alphanumeric address names
3. Request for formal inspection and tests
4. When tests have been completed and corrections made, submit a signed, dated certificate with a request for formal inspection and tests.

1.5 QUALITY ASSURANCE

- A. Codes and Standards: Except as modified by governing codes and where more stringent standards are specified by the contract documents, comply with the latest applicable provisions and the latest recommendations of the following:
1. All equipment shall be UL listed for its intended use.
 2. National Electric Code, Article 760.
 3. National Fire Protection Association Standards: NFPA72 and NFPA 101.
 4. Local and State Building Codes and the Local Authorities Having Jurisdiction.
 5. MEA / BSA
 6. Underwriters Laboratories Inc.: The system and all components shall be listed by Underwriters Laboratories Inc. for use in fire protective signaling system under the following standards as applicable:
 - UL 864/UOJZ, APOU Control Units for Fire Protective Signaling Systems.
 - UL 268 Smoke Detectors for Fire Protective Signaling Systems.
 - UL 268A Smoke Detectors for Duct Applications.
 - UL 217 Smoke Detectors Single Station.
 - UL 521 Heat Detectors for Fire Protective Signaling Systems.
 - UL 228 Door Holders for Fire Protective Signaling Systems.
 - UL 464 Audible Signaling Appliances.
 - UL 1638 Visual Signaling Appliances.
 - UL 38 Manually Activated Signaling Boxes.
 - UL 346 Waterflow Indicators for Fire Protective Signaling Systems.
 - UL 1971 Standard for Signaling Devices for the Hearing Impaired
 - UL 1481 Power Supplies for Fire Protective Signaling Systems.
 - UL 1711 Amplifiers for Fire Protective Signaling Systems.
 7. Americans with Disabilities Act (ADA)

8. International Standards Organization (ISO): ISO-9001
 9. Local and City Codes.
- B. Federal Specifications Compliance: Comply with FED-STD-595, "Colors used in Government Procurement".
- C. Guarantee - all components, parts and assemblies supplied by the manufacturer shall be guaranteed against defects in materials and workmanship for a period of 12 months upon acceptance. Warranty service shall be provided by a trained specialist of the equipment manufacturer. The specialist shall be based in a fully-staffed branch office located within 50 miles from the job site.
- D. Testing - conduct a total system test for Architect/Engineer and Local Fire Department. Tests shall include as a minimum.
1. Verify operation of all manual pull stations and detectors.
 2. Verify line supervision of each initiating and indicating circuit.
 3. Verify the Class A operation of each initiating circuit.
 4. Verify operation of all indicating devices.
 5. Verify operation of all alarm initiated function.
 6. Perform smoke test(s) as directed by the Local Fire Department. Provide electricians, and factory representatives to perform as many tests as required to approve system. The Engineer, Owner and Architect shall be advised a minimum of five working days before each test.
- E. All equipment provided as part of this section shall be fully compatible with existing fire alarm system.
- F. Regulatory Requirements
1. Devices and equipment for fire alarm service shall be listed by Underwriters Laboratories, Inc. and listed in UL FPKD or approved by Factory Mutual and listed in FM P7825. The omission of these terms under the description of any item of equipment described shall not be construed as waiving this requirement.
- G. Modification of References
1. In NFPA publications referred to herein, consider advisory provisions to be mandatory, as though the word "shall" had been substituted for "should" wherever it appears; interpret reference to "authority having jurisdiction".
- 1.6 DELIVERY, STORAGE AND HANDLING
- A. Protect equipment delivered and placed in storage from the weather, humidity and temperature variation, dirt and dust, and other contaminants.

PART 2 - PRODUCTS

2.1 SYSTEM DESIGN

A. Scope :

1. The work covered by this section of the specifications includes the furnishing of all labor, equipment, materials, and performing all operations in connection with modifications of existing fire alarm system
2. All locally required Sprinkler – Smoke Detection system peripherals, placards, pull station white stripe plate, riser diagram, etc. shall be included in the system price.

B. Operations

1. Display
 - a. Under normal condition, front panel shall display a “SYSTEM NORMAL” or equivalent message and the current time and date.
2. Sequence of Operation
 - a. The system shall identify any off normal condition and log each condition into the system database as an event.
 - (1) The system shall automatically display on the control panel Liquid Crystal Display the first event of the highest priority by type. The priorities and types shall be alarm, supervisory, trouble, and monitor.
 - (2) The system shall have a Queue operation, and shall not require event acknowledgment by the system operator. The system shall have a labeled color coded indicator for each type of event; alarm - red, supervisory - yellow, trouble - yellow, monitor - yellow. When an unseen event exists for a given type, the indicator shall be lit.
 - (3) New alarm, supervisory, or trouble events shall sound an audible signal at the control panel.
 - b. Operation of any alarm-initiating device shall automatically:
 - (1) Update the control/display as described above (a.(1)).
 - (2) Sound all audible appliances in a Temporal-3 Pattern. ALL AUDIBLE APPLIANCES SHALL BE SYNCHRONIZED WITH EACH OTHER WHEN TWO OR MORE HORNS CAN BE HEARD. Audible devices shall have the ability to be silenced.
 - (3) Activate all strobe appliances throughout the facility. ALL STROBE APPLIANCES SHALL BE SYNCHRONIZED WITH EACH OTHER, IN ANY LOCATION WITH TWO OR MORE DEVICES IN A COMMON FIELD OF VIEW. Visual devices shall be non-silenced unless the system is successfully reset.
 - (4) Operate control relay contacts to shutdown all HVAC units serving the floor of alarm initiation.

- (5) Operate control relay contacts to return all elevators that serve the floor of alarm initiation to the ground floor. If the alarm originates from the ground floor, operate control circuits contacts to return all elevators to the floor above or to a level as directed by the local fire department.
 - (6) Operate control relay contacts to release all magnetically held smoke doors throughout the building.
 - (7) Visually annunciate the individual point of alarm on all remote annunciator panels. The visual indication shall remain on until the alarm condition is reset to normal.
 - (8) Transmit an alarm condition, via the integral central station communicator, to central station/Local Fire Department (as required by the AHJ).
- c. Activation of a sprinkler supervisory initiating device shall:(if applicable)
- (1) Update the control/display as described above (a.(1)).
 - (2) Transmit a supervisory condition, via the integral central station communicator, to central station/Local Fire Department (as required by the AHJ).
 - (3) Visually annunciate the individual point of alarm on all remote annunciator panels. The visual indication shall remain on until the alarm condition is reset to normal.
- d. The entire fire alarm system wiring shall be electrically supervised to automatically detect and report trouble conditions to the fire alarm control panel. Any opens, grounds or disarrangement of system wiring and shorts across alarm signaling wiring shall automatically:
- (1) Update the control/display as described above (a.(1)).
 - (2) Transmit a trouble condition, via the integral central station communicator, to central station/Local Fire Department (as required by the AHJ).
 - (3) Visually and audibly annunciate a general trouble condition, on the remote annunciator panels. The visual indication shall remain on until the trouble condition is repaired.
- e. Purge / Smoke Control
- (1) Fans will not be affected upon system reset. Restarting the fans may be accomplished by turning them back on in an individual sequential fashion or through individual manual switches at the Purge controls to eliminate the possibility of all fans turning on simultaneously.
 - (2) Purge switches will remain inactive until the key switch is activated. When the switch is activated the associated Purge switches will be enabled.

C. Wiring

1. Where it is necessary to interface conventional initiating devices provide intelligent input modules to supervise Class A zone wiring.

2. Each of the following types of devices or equipment shall be provided with supervised circuits as shown on the drawings but shall be typically as follows:
 - a. Sprinkler Valve Supervisory Switches: Provide one (1) supervisory module circuit for each sprinkler valve supervisory switch (if applicable).
 - b. When waterflow and tamper switches exist at the same location, provide one (1) dual input addressable module. When odd numbers of devices exist at a single location, provide additional single input addressable modules (if applicable).
3. Each of the following types of alarm notification appliances shall be circuited as shown on the drawings but shall be typically as follows:
 - a. Audible Signals: Provide sufficient spare capacity to assure that the addition of five (5) audible devices can be supported without the need for addition control components (power supplies, signal circuit modules, batteries, etc.).
 - b. Visual Signals Provide sufficient spare capacity to assure that the addition of three (3) audible devices can be supported without the need for addition control components (power supplies, signal circuit modules, batteries, etc.).
4. Each of the following types of remote equipment associated with the alarm system shall be provided with a form 'C' control relay contact as shown on the drawings, but shall be typically as follows:
 - a. HVAC Fan Systems: Provide one (1) shutdown control relay contact for each HVAC fan system.
 - b. HVAC Supply Fans: Provide one (1) shutdown control relay contact for each HVAC supply fan.
 - c. HVAC Return Fans: Provide one (1) shutdown control relay contact for each HVAC return fan.
5. Provide a dedicated 24VDC circuit to feed all auxiliary relays required for inductive loads. Circuits shall be supervised via an end-of-line relay and addressable input module. Auxiliary relays shall not derive their power from the starter or load being controlled.
6. Each control or data gathering panel shall have a dedicated 20Amp-120VAC feed from the nearest available emergency panel. An appropriate fuse cut out or lockable C.B. shall be included.

2.3 SUPPORT FOR INSTALLER AND OWNER MAINTENANCE

- A. Provide a coded one-man walk test feature. Allow audible or silent testing. Signal alarms and troubles during test. Allow receipt of alarms and programmed operations for alarms from areas not under test.
- B. Provide internal system diagnostics and maintenance user interface controls to display/report the power, communication, and general status of specific panel components, detectors, and modules.
- C. Provide loop controller diagnostics to identify common alarm, trouble, ground fault, Class A fault, and map faults. Map faults include wire changes, device type changes by location, device additions/deletions and conventional open, short, and ground

conditions. Ground faults on the circuit wiring of remote module shall be identified by device address.

- D. Allow the user to display/report the condition of addressable analog detectors. Include device address, device type, percent obscuration, and maintenance indicator. The maintenance indicator shall provide the user with a measure of contamination of a device upon which cleaning decisions can confidently be made.
- E. Allow the user to report history for alarm, supervisory, monitor, trouble, smoke verification, watchdog, and restore activity. Include Facility Name, Licensee, Project Program Compilation date, Compiler Version, Project Revision Number, and the time and date of the History Report.
- F. Allow the user to disable/enable devices, zones, actions, timers and sequences. Protect the disable function with a password.
- G. Allow the user to activate/restore outputs, actions, sequences, and simulate detector smoke levels.
- H. Allow the service user to enter time and date, reconfigure an external port for download programming, initiate auto programming and change passwords. Protect these functions with a password.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The entire system shall be installed in a workmanlike manner, in accordance with approved manufacturer's wiring diagram. The contractor shall furnish all conduit, wiring, outlet boxes, junction boxes, cabinets and similar devices necessary for the complete installation. All wiring shall be of the type recommended by the manufacturer, approved by the local Fire Department and specified within.
- B. All penetration of floor slabs and firewalls shall be sleeved (1" conduit minimum) fire stopped in accordance with all local fire codes.
- C. End of Line Resistors shall be furnished as required for mounting as directed by the manufacturer. Devices containing end-of-line resistors shall be appropriately labeled. Devices should be labeled so removal of the device is not required to identify the EOL device.
- D. All manual pull stations shall be mounted 48 inches above the finished floor, as measured to the handle.
- E. All audio/visual devices shall be mounted 80 inches above the finished floor, as measured at the bottom of the lens such that the entire lens is above 80". Devices shall be mounted no less than 6 inches from the ceiling. All audiovisual devices shall have lexan covers in all areas.

- F. No area smoke detectors shall be mounted within 36 inches of any HVAC supply, return air register or lighting fixture.
- G. No area smoke or heat detector shall be mounted within 12 inches of any wall. All detectors shall be installed in strict accordance with NFPA 72.
- H. All mechanical rooms, boiler rooms, wiring closets, custodian rooms, attic spaces, etc. or areas with exposed or hard ceilings shall be piped with 3/4" conduit. Fire alarm cabling may be routed without conduit above hung ceilings. Support with J-hooks every 5 feet. All cabling shall be plenum rated.
- I. All areas in public view shall be in metal conduit. All boxes must be painted red and labeled.
- J. All addressable modules shall be mounted within 36 inches of the monitored or controlled point of termination. This shall include, but is not necessarily limited to, fan shutdown, elevator recall, shunt trip, sprinkler status points, or door release. Label all addressable modules as to their function.
- K. All low voltage wiring terminated to the fire alarm system shall be PLENUM RATED with no exceptions and no less than No. 12 AWG in size for NAC circuits and 16 AWG for Initiating Circuits, and solid copper.
- L. All line voltage (120VAC) wiring shall be no less than No. 12 AWG in size, and solid copper. This shall include all system grounding.
- M. All wiring shall be color-coded throughout, to National Electrical Code standards.
- N. Power-limited/Non-power-limited NEC wiring standards SHALL BE OBSERVED.
- O. All junction box covers shall be painted red and labeled INTERIOR FIRE ALARM SYSTEM.
- P. Alarm system wiring shall not co-mingle with any other system wiring in the facility. Conduits shall not be shared under any circumstance. Only when fire alarm wiring enters the enclosure of a monitored or controlled system will co-habitation be permitted (i.e. at fan starters or elevator controllers).
- Q. Auxiliary relays shall be appropriately labeled to indicate "FIRE ALARM SYSTEM" and their specific function (i.e. FAN S-1 SHUTDOWN).
- R. All fire alarm wiring shall be continuous and unspliced. Terminations shall only occur at fire alarm devices or control panel enclosures under terminal screws. All other splicing methods are specifically disallowed (i.e. plastic wirenuts).
- S. All alarm wiring shall be installed using a dedicated system of supports (i.e. bridle rings). Fire alarm wiring shall not be bundled or strapped to existing conduit, pipe or wire in the facility.
- T. All alarm wiring shall be sleeved when passing through any wall, using conduit sleeves (1" min.) with bushings, and fire stopped in accordance with Code.
- U. The system shall be arranged to receive power from one three wire 120 Vac, 20 A supply. All low voltage operation shall be provided from the fire alarm control panel.
- V. All alarm devices shall be accessible for periodic maintenance. Should a device location indicated on the Contract Drawings not meet this requirement, it shall be the

responsibility of the installing contractor to bring it, in writing, to the attention of the Project Engineer. Failure to bring such issues to the attention of the Project Engineer shall be the exclusive liability of the installing Electrical Contractor.

3.2 PAINTING

- A. Paint exposed electrical, fire alarm conduit and surface metal raceway to match adjacent finishes in exposed areas. Paint conduit and surface metal raceways red in unfinished areas and above finished ceilings.

3.3 FIELD QUALITY CONTROL

- A. The system shall be installed and fully tested under the supervision of a trained manufacturer's representative. The system shall be demonstrated to perform all of the function as specified.
- B. It shall be the responsibility of the installing contractor to assure that construction debris does not adversely affect any sensing devices installed as part of this project. Should it be deemed necessary by the Consulting Engineer, End-User or AHJ, the installing contractor shall be responsible for the cleaning of all smoke detectors prior to final acceptance.
- C. Preliminary Tests
 - 1. Conduct the following tests during installation of wiring and system components. Correct any deficiencies pertaining to these requirements prior to formal functional and operational tests of the system.
 - 2. Ground Resistance
 - a. Measure the resistance of each connection to ground. Ground resistance shall not exceed 10 ohms.
 - 3. Dielectric Strength and Insulation Resistance
 - a. Test dielectric strength and the insulation resistance of system interconnecting wiring by means of an instrument capable of generating 500 volts dc and equipped to indicate leakage current in 1000 mega-ohms. For the purpose of this test, instrument shall be connected between each conductor on the line and between each conductor and ground at control panel and of line, with the other extremity open circuited and series-connected devices shunted or in place. System shall withstand test without breakdown and indicate a resistance of not less than 500,000 ohms, the measurement being taken after an electrification of not more than 1.0 minute with a dc potential of not less than 100 volts nor more than 550 volts. Dielectric tests shall be witnessed by Engineer or his designee.
 - 4. Smoke and Thermal Sensor Tests
 - a. Prior to formal inspection and tests, clean and perform sensitivity tests on each smoke and thermal sensor. Clean the smoke and thermal sensors in accordance with the manufacturer's recommended procedures. Perform voltage activation sensitivity test on each sensor and record the results.

Remove sensors with a sensitivity level above or below the UL accepted sensitivity range for that sensor and replace with new sensors. Present recorded data at the formal inspection for verification. Approved copies shall become part of the operations and maintenance manual for the fire alarm system.

5. Field Inspection and Test
 - a. Before final acceptance of the work, test each system to demonstrate compliance with the contract requirement. Each system shall be subjected, at minimum, to complete functional and operational tests including tests in place of each smoke sensor and detector, each thermal sensor, each manual station and visual and audio/visual device, tests of wiring supervision and tests of control panel functions. Test the interface to the Public Address system and coordinate the P.A. alarm signal generation with the public address system subcontractor. Preliminary tests shall be performed in accordance with manufacturer's published testing instructions and in accordance with NFPA 72. Furnish one extra Operations and Maintenance Manual with the formal request for final acceptance testing. The system shall be operational, with no trouble or alarm conditions, a minimum of 14 consecutive days prior to formal tests. Printer shall be operational during the preliminary tests and break-in period. Provide printer records with the request for formal inspection as evidence of completion of required preliminary test.
6. Formal Inspection and Test
 - a. The Authority having Jurisdiction will witness formal tests after receipt of written certification that preliminary tests have been completed and that the system is ready for final inspection. The system manufacturer's technical representative shall be present for the inspection and test. At minimum, preliminary tests shall be repeated and functional and operation tests conducted, as requested by the Architect/Engineer. Correct defects and conduct additional tests to demonstrate that the system conforms to contract specifications. Contractor shall provide two-way radios, personnel and test equipment required for conducting tests. Smoke detectors shall be tested using the manufacturer's calibrated test method. In addition, formal testing will require real smoke to be used to test smoke detectors. Canned smoke will not be permitted. Test equipment shall be turned over to the Authority having Jurisdiction following test completion.
7. Manufacturer's Field Service
 - a. Manufacturer's Representative

Furnish the services of a factory-trained fire alarm system manufacturer's representative or technician, experienced in the installation and operation of the type of system being provided, to supervise the installation, testing, including formal testing, adjustment of the system, and instruction to the facility personnel. Furnish names and phone numbers of the factory-trained fire alarm system representatives or technicians.

D. Documentation And Training

1. The contractor shall compile and provide to the owners three (3) complete manual on the completed system to include SITE SPECIFIC operating and maintenance instruction, catalog cuts of all equipment and components, as-built wiring diagrams and a manufacturer's suggested spare parts list.
2. In addition to the above manuals, the Electrical Contractor shall provide the services of the manufacturer's trained representative for **two (2)** separate calendar days for a period of four **(4) hours** per day to instruct the owners' designated personnel on the operation and maintenance of the entire system.
3. As-built drawings shall consist of the following:
 - a. Complete revision of all previously submitted drawings
 - b. Point-to-point depiction of all device wiring on the device layout floor plans.
 - c. One (1) set of B-size, laminated as-built drawings.
 - d. Two (2) sets of 30"x42" inch 1/16"=1' scale drawing showing all points of alarm. One set shall be submitted with the close-out documents. Second set shall be mounted in frame with a lexan cover. These drawing must be submitted to project Engineer or approval.

E. Adjustments

1. Equipment manufacturer shall provide necessary subsequent custom reprogramming to modify and adjust operations and individual identification nomenclature to the owner satisfaction four months after final system acceptance and twelve months after system acceptance. Reprogramming is to be done at the job site and witnessed by the Authority having Jurisdiction representative. Revision of as-built and record drawings shall be by the installing Contractor.

3.4 FIRE ALARM

- A. Provide modifications to existing fire alarm system as indicated on plans and specified herein.
- B. All work shall be provided in accordance with the recommendations and under the supervision of the existing system supplier, who shall warranty all existing and new work at completion of the project. See fire alarm riser diagrams for vendor information.
- C. Activation of any device that activates existing speakers and strobes shall also activate new speakers and strobes.
- D. All new equipment shall be fully compatible with existing system.

- E. Contractor shall be responsible for any required relocations and/or reconnections of existing equipment to remain, including reprogramming at no additional cost.
- F. All fire alarm devices, wiring etc., not indicated on the drawings, but required by the authority having jurisdiction and fire department, shall be provided as part of this specification. As minimum, an additional **5** per floor audio/visual alarms **5** per floor smoke detectors and **5** per floor addressable interface devices shall be included in price including labor, circuitry and programming. These devices shall be located in field as directed by authority having jurisdiction.
- G. Raceways used to interconnect all system components shall be galvanized rigid steel conduit. Teflon coated open wiring shall be used in concealed areas where permitted by code.
- H. Wiring shall be type THWN of sizes conforming to the code and in quantities as recommended by the system supplier. All wiring shall be teflon coated.
- I. Wire and circuitry for audible and visual devices shall be connected with “A” and “B” circuit configuration.
- J. The contractor shall submit equipment cuts and wiring diagrams and sequence of operation for approval and shall conduct final testing of the system in the presence of the owner, architect, and engineer.
- K. All material and installation shall be guaranteed to be free of defects in material and workmanship for one (1) year. Four (4) sets of approved wiring diagrams and maintenance data shall be turned over to the owner.
- L. Synchronize all notification appliances in areas where there are more than two such devices in any field of view spaced less of 55 ft. from each other.
- M. Strobe and speaker/strobe devices shall be mounted 80 AFF to bottom of device.

END OF SECTION