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SPECIFICATIONS

Atlantic City Convention Center
Parking Garage Ventilation Control System Replacement
RVE Proj. #: 3938X003
FINAL REVIEW – 2-21-2020

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SECTION 01000 – GENERAL REQUIREMENTS

PART 1 - GENERAL

- A. Only major items of work are given in the Bid Form, but it is the intent of the specifications to secure a completely interconnected and functional system, and if any workmanship or materials be required which are obviously necessary to carry out the full intent and meaning of the plans and specifications or to be reasonably inferred therefrom, the cost of such workmanship or materials shall be included in the unit price bid for the major items of work.
- B. The contractor, in the construction of any project, shall not stockpile materials or his equipment on any private property; except areas designated by the plans as directed by the Engineer. If so required, the Engineer may direct the contractor to have his equipment removed from any project during weekend hours.
- C. During the construction of the project, travel lanes shall remain open at all times.
- D. The contractor shall apply and pay for all permits that may be required for any of the work involved with this project.
- E. All notes on plans shall be made a part of the specifications.
- F. Contractor shall notify Engineer at least forty-eight (48) hours in advance of any work on Saturdays. There will be no work permitted on Sundays or holidays. This project will receive inspection and the normal working hours for the Inspector are from 8:00 AM to 4:30 PM, Monday through Friday. Any overtime inspection costs which are avoidable will be reimbursed by the Contractor.
- G. The Contractor is hereby advised that Public Law 1975, Chapter 251 as amended by P.L. 1979, Chapter 459 is applicable to this project.

1.02 GOVERNING STANDARDS

- A. All activities shall conform to applicable OSHA Rules and Regulations.
- B. Permits shall be obtained by the contractor at the time of construction for all such activities.

END OF SECTION 01000

SECTION 01010 – SCOPE OF WORK

PART 1 - GENERAL

1.1 WORK COVERED BY CONTRACT DOCUMENTS

- A. Owner Identification: Spectra Venue Management
2301 Boardwalk
Atlantic City, NJ 08401
Phone: 609-348-7026
- B. Engineer Identification: Remington & Vernick Engineers
845 North Main Street
Pleasantville, NJ 08232
- C. Contract Documents:
 - 1. These Specifications and associated drawings indicate the extent of the Contract. Contract Documents were prepared for the Project by Remington & Vernick Engineers, 845 North main Street, Pleasantville, NJ 08232.
- D. General:
 - 1. **Scope Summary:** The project consists of the replacement of the existing carbon monoxide detection system in the parking garage of the Atlantic City Convention Center. The existing system consists of approximately 35 CO detectors located throughout ground floor parking garage. The existing detectors are manufactured by Tox Alert International, Inc. The existing Tox Alert system is connected to 21 roof mounted exhaust fans and 21 roof mounted supply fans. The scope of work for this project will be to replace the existing carbon monoxide detection and fan control system. This includes replacement of all carbon monoxide detectors and associated system controllers to operate the exhaust and supply fans. The new control system will operate with a sequence similar to the existing system. The basis of design for the new system shall be Honeywell E3Point. The new gas detection and fan control system shall be seamlessly integrated with the existing Honeywell Building Automation System for remote monitoring and control. The scope of work also includes the replacement of the existing motor control panels located on the exterior of some of the rooftop supply and exhaust fans. These panels shall be replaced in kind as indicated on the contract drawings. The contractor shall provide all labor and materials, including all wiring, conduit, control devices, programming, etc.
 - 2. **Controls:** All new equipment shall be fully integrated into the existing Honeywell Building Management System. Provide all new control devices, wiring, controllers, programming, and all other equipment and work necessary for a complete installation of the proposed control system and the seamless integration into the existing Honeywell BMS. The contractor shall provide all necessary programming and other work required to allow control and monitoring of the new CO detection system and existing supply and exhaust fans by the existing Honeywell BMS.

- a. Contact for Honeywell BMS & Honeywell E3Point Gas Detection System: **Brad Strauss**, Sr. Account Manager, Honeywell Building Solutions, 609-969-1568 (mobile), 856-437-1837 (office), Brad.Strauss@Honeywell.com
3. **Work Phasing:** The gas detection and exhaust system shall remain operational during all scheduled events at the facility and whenever the parking garage is scheduled to be utilized by the general public. The contractor may leave the existing gas detection system operational in place while the new gas detection system is being installed. When the system or individual fans/sensors are to be removed from service, the contractor shall coordinate this work in advance with the Owner.
4. The facility will be occupied during construction. Proper care must be taken by the Contractor and any of their subcontractors as not to disrupt or interfere with the normal operation of the facility during the entire length of this construction contract. Phasing of the work may be required, and the contractor shall include all associated costs in his bid.
5. The facility shall not be without electrical power throughout the contract. The contractor shall provide temporary power if necessary. The contractor shall provide temporary heating and cooling as needed throughout the duration of the contract.
6. At no point shall the facility be without adequate heating between October 15 and May 15. Provide temporary heating and cooling as needed throughout the duration of the contract.
7. The contractor shall temporarily remove ceiling and temporarily support ceiling devices (lighting, detectors, etc.) as necessary to complete the proposed work. The contractor shall restore the existing ceiling to a condition equal to or better than the existing condition upon completion of the proposed work. The contractor shall replace all damaged ceiling tiles, lighting, devices, etc. with new. All new materials shall match existing.
8. The Contractor is responsible and obligated to successfully complete the entire project and to complete each and every necessary detail of every item specified and/or is required to complete the specified work regardless of whether or not a particular detail is specifically mentioned in these specifications.
9. The contractor shall provide all temporary utilities required to complete the demolition and new work. Temporary utilities shall include water, electric, heating, and air conditioning as necessary.
10. The contractor shall provide equipment that is compatible with the existing control system at each facility. The contractor shall include in his bid all costs necessary to install controls for new equipment and integrate with the existing Building Automation System.
11. The contractor shall obtain an State of New Jersey licensed electrical contractor, registered and qualified with the State of New Jersey Department of Community Affairs for the installation of all electrical work necessary to complete this project.
12. The Contractor will be required to submit with their bid a proposed work schedule that shall be finalized to reflect actual project milestones after contract award. The project schedule shall follow the requirements of these specifications. Strict adherence to the agreed upon final work schedule will be required for this project. The schedule shall be generated by the Contractor in a Microsoft Project format and shall be updated weekly.

Progress reports including the updated schedule (Gantt Chart) will be submitted to the Engineer on a weekly basis. The Building shall not be without electrical power any time except during an agreed upon shutdown as necessary and at no time during the hours of 6 AM to 10 PM, Monday through Friday. The entire building shall not be without adequate occupancy heating at any time after October 15. The Contractor will make provisions for this requirement in the proposal.

13. A Pre-Construction Meeting between the Spectra Venue Management (the Owner), the Engineer, and the Contractor will be required prior to start of construction at a site chosen by the Owner. All allowances/costs for the pre-construction meeting must be included in the Contractor's proposal pricing and submitted with the bid. No additional payments will be made by the Owner for the pre-construction meeting.

14. Contracts:

- a. The Project will be constructed under a single Prime Contracting arrangement.
 - b. The contract will be awarded to one Contractor for the work required.
 - c. The Contractor's completed bid form shall reflect the actual amount of work required. The amounts on the Contractor's bid form as submitted with their bid will be used to generate the project schedule of values for payment purposes.
 - d. The quantities described in the specifications are for the convenience of the contractor only. Items will be paid on a lump sum basis and no additional payment will be made if as-built quantities exceed plan quantities.
 - e. All means and methods to complete the scope of work shall be included in the Contractor's bid, even if such is not specifically described herein. Contractor is strongly recommended to visit the site prior to submitting their bid to include all necessary means and methods work to successfully complete the project in their bid.
 - f. Only major items of work are given in the Bid Form, but it is the intent of the specifications to secure a completely interconnected and functioning system, and if any workmanship or materials be required which are obviously necessary to carry out the full intent and meaning of the plans and specifications or to be reasonably inferred there from, the cost of such workmanship or materials shall be included in the unit price bid for the major items of work.
 - g. Local custom and trade-union jurisdictional settlements do not control the scope of work included in the Prime Contract. When a potential jurisdictional dispute or similar interruption of work is first identified or threatened, the affected Prime Contractor shall promptly negotiate a reasonable settlement to avoid interruption and delays at no additional cost to the Owner.
15. The furnishing of all restoration specified herein required for a complete installation. Any interior or exterior finishes (roofs, ceilings, floors, walkways and walls) and/or landscapes damaged during the installation of the equipment will be repaired /replaced with like materials to the satisfaction of the Owner at no extra cost.

16. The contract price includes a bid item "Allowance". The allowance is for any additional work that may be required due to unforeseen conditions experienced during the contract period as directed by the Owner/Engineer. Additional work shall only be performed at the direction of the Owner/Engineer.
17. The work shall be in accordance with accepted standards. All demolition materials and scrap shall be disposed of in a legal manner and in accordance with all local, State and Federal or other agencies having jurisdiction.
18. The Contractor shall field verify all existing condition, equipment, and dimensions prior to construction and/or preparation of shop drawings and notify Engineer immediately of major discrepancies.
19. This Scope of Work outlines the general items and distribution of work and shall not be construed as being all-inclusive.
20. The Contractor shall be responsible for applying for and obtaining any and all permits required to satisfactorily complete this construction project. Any costs related to obtaining permits shall be included in the proposal.
21. Codes and Standards: The work as specified and performed for this project shall classify as "renovation work" and as such will comply with all applicable Renovation Sections of the State of New Jersey, Building Code. Where existing equipment is being replaced with new equipment, or wherever additions are made to the existing electrical and mechanical systems said work will comply with the adopted revision of the NEC, NESC, LSC, UL, IBC, NSPC, IMC, IFGC, NFPA, ASME, ANSI or other applicable codes.
22. The Contractor shall be responsible for measuring and recording the existing supply, return, outdoor, and exhaust airflows prior to demolition/modification to equipment, and submit this information in a report to the Engineer. The Contractor shall be responsible for the rebalancing of the new or repaired equipment to their pre-demolition values.
23. The Contractor shall be responsible for any modifications to the existing equipment and equipment support (roof or ground mounted) as needed to accommodate the new or repaired equipment.
24. Provide all electrical work in compliance with the 2014 National Electrical Code and the most current International Building Code acknowledged by the State of New Jersey.

1.2 CONTRACT BOILER PLATE

- A. If a discrepancy exists between the Spectra Venue Management Boiler Plate and the General Conditions sections, the Global Spectrum Boiler Plate shall govern.

1.3 WORK SEQUENCE

- A. Coordination of Work

1. The Contractor is responsible for verification of all existing dimensions and conditions in order to include all associated costs in the bid price for a complete installation as detailed in these specifications. It is strongly recommended that the Contractor visit the site prior to completing the bid form.
2. The Contractor is responsible for the demolition of existing equipment, electrical power, and controls and the installation of the new equipment and related accessories as described in this specification. As stated previously this includes all modifications to existing equipment, systems, and structures; piping and valves; mechanical equipment; control systems; and electrical equipment and systems, as specified herein and as required to deliver a complete, operational system, even if an item is required by not specifically detailed in the contract drawings or specifications.
3. For the purpose of preparing progress schedules and estimates for payments to the Contractor, the Work to be performed under this Contract has been divided into lump sum items. The contractor is responsible and obligated to successfully complete the entire project and to complete each and every necessary detail of each and every item specified in the contract specifications regardless of whether or not a particular detail is specifically mentioned.
4. The Contractor shall provide As-built drawings of the entire installation. The drawings shall be legible, neat and of a quality acceptable to the Engineer. Actual installation with all items clearly identified shall be indicated. Location of installed items and any deviations from contract documents shall be so shown with boxes around the as-built numbers or labels.
5. The Contractor is responsible to file and receive all permits for the project through the appropriate Construction Office (electrical, plumbing, etc.) All associated costs shall be included in the lump sum proposal bid price.
6. The Contractor is responsible for all coordination of the construction work of the project.
7. The Engineer will monitor the progress of the project and review the status of the completion of work. If one or more of the subContractors is delaying the progress of the project, it shall be the responsibility of the Contractor to take necessary action to bring that portion of the project back on schedule.
8. All costs related to project coordination shall be included by the Contractor.
9. Movable Furnishings – The Contractor shall be responsible for moving non-fixed furnishings. Coordinate with Owner as required.
10. Fixed Furnishings – Fixed furnishings shall be covered by the Contractor for protection where appropriate. The Contractor shall be responsible of protecting the fixed furnishings from any large debris. Coordinate with Owner as required.
11. Equipment Salvage – The Owner has the right to first ownership of salvaged equipment.
12. The Contractor shall provide dumpsters on-site throughout the construction period as necessary to be used by all subcontractors with the general contractor maintaining responsibility. The Contractor's use of construction dumpsters on-site shall be at the discretion of the Owner and only at pre-approved locations and times.

1.4 CONTRACTOR USE OF PREMISES

A. General:

1. During the construction period the Owner will occupy the site during construction. The Contractor shall limit use of the premises to construction activities in the areas associated with the new work. The Contractor's use of the premises is limited only by the Owner's right to perform work or to retain other contractors on portions of the Project. Contractor is not to interfere with Owner's Operations.
2. The contractor shall coordinate all construction activities with the Owner prior to performing the work. A detailed project schedule shall be provided as specified herein. Contractor shall conform to the Owner's requirements specific to each site.
3. Unless written permission is secured from the Engineer in advance, the Contractor must not use any materials found on or adjacent to the site of the Work.

B. Use of the Site: Limit use of the premises to work in areas indicated. Confine operations to areas within contract limits indicated. Do not disturb portions of the site beyond the areas in which the Work is indicated.

1. Driveways and Entrances: Keep driveways and entrances serving the premises clear and available to the Owner, the Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

1.5 OCCUPANCY REQUIREMENTS

- ##### A. Full Owner Occupancy: The Owner will occupy the site during the entire construction period. Cooperate with the Owner during construction operations to minimize conflicts and facilitate owner usage. Perform the Work so as not to interfere with the Owner's operations.
- ##### B. Each facility shall not be without electrical power or heating at any time during the hours noted herein. Downtime for equipment shall be minimized, and shall be coordinated and approved with the Owner prior to construction. The Contractor will make provisions for this requirement in the proposal. In the event that temporary heating is required during the course of this project, the contractor will provide acceptable temporary heating to the building at no additional cost to the Owner.

1.6 SPECIFICATION FORMATS AND CONVENTIONS

- ##### A. Specification Format: The Specifications are organized into Divisions and Sections using the 16-division format and CSI/CSC's "MasterFormat" numbering system.
1. Section Identification: The Specifications use section numbers and titles to help cross-referencing in the Contract Documents. Sections in the Project Manual are in numeric sequence; however, the sequence is incomplete. Consult the table of contents at the

beginning of the Project Manual to determine numbers and names of sections in the Contract Documents.

- B. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:

1. Abbreviated Language: Language used in the Specifications and other Contract Documents is abbreviated. Words and meanings shall be interpreted as appropriate. Words implied, but not stated, shall be inferred as the sense requires. Singular words shall be interpreted as plural, and plural words shall be interpreted as singular where applicable as the context of the Contract Documents indicates.
2. Imperative mood and streamlined language are generally used in the Specifications. Requirements expressed in the imperative mood are to be performed by Contractor. Occasionally, the indicative or subjunctive mood may be used in the Section Text for clarity to describe responsibilities that must be fulfilled indirectly by Contractor or by others when so noted.
 - a. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION

SECTION 01011 - AS-BUILT DRAWINGS

1.01 GENERAL

The Contractor shall provide a set of reproducible as-built drawings prior to final payment.

2.01 MATERIALS

- A. As-builts shall be a reproducible of the original contract drawings including any additional sheets required. All deviations from the original contract drawings shall be on the as-builts. The drawings shall be legible, neat, and of a quality acceptable to the Engineer.
- B. The Engineer shall provide a set of reproducibles at the beginning of the project.

3.01 EXECUTION

- A. The Contractor shall be responsible for keeping the as-built up-to-date as the project progresses.
- B. Building Construction: Actual installation with all items clearly identified shall be indicated. Location of installed items and any deviations from contract documents shall be so shown with boxes around the as-built numbers or labels.
- C. This section is intended to provide a minimum level of acceptance. Any section with more stringent requirements shall have precedence over this section.

4.01 PAYMENT

No separate payment will be made for work performed under this section.

END OF SECTION 01011

SECTION 01710 – CLEANING AND RESTORATIONS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Contractor shall provide all equipment, labor & materials required to clean and restore the site to at least the existing condition.
- B. Maintain premises and public properties free from accumulations of waste, debris and rubbish caused by work operations.
- C. At completion of work, remove waste materials, rubbish, tools, equipment, machinery and surplus materials; clean all sight exposed surfaces; leave project clean and ready for occupancy.
- D. At completion of work, restore or replace, when and as directed by the Engineer, any public or private property disturbed or damaged by Contractor's work operations to a condition at least equal to that existing prior to beginning work, or as otherwise specified. Materials, equipment and methods shall be approved by the Engineer.

2.01 MATERIALS

- A. For restorations all materials shall comply with the following Articles of the New Jersey Department of Transportation Standard Specifications latest revision and these specifications.

3.01 METHODS OF CONDUCTING WORK - CLEANING

- A. Requirements of regulatory agencies:
The Contractor shall comply with all Federal, State, and local anti-pollution laws, ordinances, codes and regulations when disposing of waste materials, debris and rubbish.

All excess material shall be removed from the site and disposed of by the Contractor. Cost to be included in the unit price bid for all items. The disposal site shall be in permanently established licensed OSWA (Office of Solid Waste Administration, New Jersey Department of Environmental Protection) landfills or a NJDEP certified recycling center if applicable.

- B. Cleaning during construction:

Provide periodic cleaning to keep the work, the site, and adjacent properties free from accumulations of waste materials, rubbish and windblown debris resulting from construction operations.

Provide on-site containers for the collection of waste materials, debris and rubbish. Maintain containers as required.

- C. Dust Control:

The Contractor will be required to maintain all excavations, embankments, stockpiles, haul roads, permanent access roads, plant sites, waste areas, borrow areas, and all other work areas within or without the project boundaries free from dust which would cause a hazard or nuisance to others. Approved temporary methods of stabilization consisting of sprinkling, chemical treatment, light bituminous treatment or similar methods will be permitted to control dust. Sprinkling, to be approved, must be repeated at such intervals as to keep all parts of the disturbed area at least damp at all times, and the Contractor must have sufficient competent equipment on the job to accomplish this if sprinkling is used. Dust control shall be performed as the work proceeds and whenever a dust nuisance or hazard occurs. If any dust control is not done within twenty-four (24) hours after written notice is given by the Engineer, the work may be done by Owner and charged to the Contractor.

3.02 METHODS OF CONDUCTING WORK - RESTORATIONS

- A. General: All existing structures, unpaved areas and paved areas disturbed or damaged during the work under this contract shall be restored or replaced to a condition at least equal to that existing prior to beginning work, or as otherwise specified. The methods of conducting this work shall, as a minimum, conform to the New Jersey Department of Transportation Standard Specifications, latest revision.

- B. All Other Restorations:

Restore in accordance with applicable Sections of the Standard Specifications, or as approved by the Engineer or authorities having jurisdiction.

END OF SECTION 01710

SECTION 01732 - SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Demolition and removal of selected portions of a building or structure.
 - 2. Repair procedures for selective demolition operations.
- B. Related Sections include the following:
 - 1. Applicable Specification Sections for demolishing, cutting, patching, or relocating mechanical items.
 - 2. Applicable Specification Sections for demolishing, cutting, patching, or relocating electrical items.

1.3 DEFINITIONS

- A. Remove: Detach items from existing construction and legally dispose of them off-site, unless indicated to be removed and salvaged or removed and reinstalled.
- B. Remove and Salvage: Detach items from existing construction and deliver them to Owner. All salvage items shall be delivered to the owner ready for reuse.
- C. Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.
- D. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.4 MATERIALS OWNERSHIP

- A. Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, demolished materials shall become Contractor's property and shall be removed from Project site. Owner shall have first right of refusal for all salvaged/demolished items

- B. Historic items, relics, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, antiques, and other items of interest or value to Owner that may be encountered during selective demolition remain Owner's property. Carefully remove and salvage each item or object in a manner to prevent damage and deliver promptly to Owner.
 - 1. Coordinate with Owner and the Engineer who will establish special procedures for removal and salvage. Owner shall have first right of refusal for all salvaged/demolished items

1.5 SUBMITTALS

- A. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of engineers and owners, and other information specified.
- B. Proposed Dust-Control and Noise-Control Measures: Submit statement or drawing that indicates the measures proposed for use, proposed locations, and proposed time frame for their operation. Identify options if proposed measures are later determined to be inadequate.
- C. Schedule of Selective Demolition Activities: Indicate the following:
 - 1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's on-site operations are uninterrupted.
 - 2. Interruption of utility services.
 - 3. Coordination for shutoff, capping, and continuation of utility services.
 - 4. Use of elevator and stairs.
 - 5. Locations of temporary partitions and means of egress.
 - 6. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.
- D. Inventory: After selective demolition is complete, submit a list of items that have been removed and salvaged.
- E. Predemolition Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by selective demolition operations. Submit five (5) copies of the Video or Photographs to the Engineer before Work begins.
- F. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.

1.6 QUALITY ASSURANCE

- A. Demolition Firm Qualifications: An experienced firm that has specialized in demolition work similar in material and extent to that indicated for this Project. Firm will have a Professional Engineer on staff.

- B. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- C. Standards: Comply with ANSI A10.6 and NFPA 241.
- D. Predemolition Conference: Conduct conference at Project site to review methods and procedures related to selective demolition including, but not limited to, the following:
 - 1. Inspect and discuss condition of construction to be selectively demolished.
 - 2. Review structural load limitations of existing structure.
 - 3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
 - 4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.

1.7 PROJECT CONDITIONS

- A. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities.
 - 1. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from authorities having jurisdiction.
- B. Owner assumes no responsibility for condition of areas to be selectively demolished.
 - 1. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
- C. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
 - 1. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Engineer and Owner.
- D. Storage or sale of removed items or materials on-site will not be permitted.
- E. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
 - 1. Maintain fire-protection facilities in service during selective demolition operations.

1.8 WARRANTY

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties.
 - 1. If possible, retain original Installer or fabricator to patch the exposed Work listed below that is damaged during selective demolition. If it is impossible to engage original Installer or fabricator, engage another recognized experienced and specialized firm.

- a. Processed concrete finishes.
- b. Stonework and stone masonry.
- c. Roofing.
- d. Firestopping.
- e. Stucco and ornamental plaster.
- f. Terrazzo.
- g. Wall covering.
- h. HVAC enclosures, cabinets, or covers.

PART 2 - PRODUCTS

2.1 REPAIR MATERIALS

- A. Use repair materials identical to existing materials.
 - 1. If identical materials are unavailable or cannot be used for exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible.
 - 2. Use materials whose installed performance equals or surpasses that of existing materials.
- B. Comply with material and installation requirements specified in individual Specification Sections.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that utilities have been disconnected and capped.
- B. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
- C. Inventory and record the condition of items to be removed and reinstalled and items to be removed and salvaged.
- D. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Engineer.
- E. Engage a professional engineer to survey condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective demolition operations.
- F. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

3.2 UTILITY SERVICES

- A. Existing Utilities: Maintain services indicated to remain and protect them against damage during selective demolition operations.
- B. Do not interrupt existing utilities serving occupied or operating facilities unless authorized in writing by Owner and authorities having jurisdiction. Provide temporary services during interruptions to existing utilities, as acceptable to Owner and to authorities having jurisdiction.
 - 1. Provide at least 72 hours' notice to Owner if shutdown of service is required during changeover.
- C. Utility Requirements: Locate, identify, disconnect, and seal or cap off indicated utilities serving areas to be selectively demolished.
 - 1. Owner will arrange to shut off indicated utilities when requested by Contractor.
 - 2. If utility services are required to be removed, relocated, or abandoned, before proceeding with selective demolition provide temporary utilities that bypass area of selective demolition and that maintain continuity of service to other parts of building.
 - 3. Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing.
- D. Utility Requirements: Refer to applicable Specification Sections for shutting off, disconnecting, removing, and sealing or capping utilities. Do not start selective demolition work until utility disconnecting and sealing have been completed and verified in writing.

3.3 PREPARATION

- A. Dangerous Materials: Drain, purge, or otherwise remove, collect, and dispose of chemicals, gases, explosives, acids, flammables, or other dangerous materials before proceeding with selective demolition operations.
- B. Pest Control: Employ a certified, licensed exterminator to treat building and to control rodents and vermin before and during selective demolition operations.
- C. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
 - 1. Do not close or obstruct streets, walks, walkways, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.
 - 2. Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction.
 - 3. Protect existing site improvements, appurtenances, and landscaping to remain.
 - 4. Erect a plainly visible fence around drip line of individual trees or around perimeter drip line of groups of trees to remain.
- D. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
 2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
 3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
 4. Cover and protect furniture, furnishings, and equipment that have not been removed.
- E. Temporary Enclosures: Provide temporary enclosures for protection of existing building and construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.
1. Where heating or cooling is needed and permanent enclosure is not complete, provide insulated temporary enclosures. Coordinate enclosure with ventilating and material drying or curing requirements to avoid dangerous conditions and effects.
- F. Temporary Partitions: Erect and maintain dustproof partitions and temporary enclosures to limit dust and dirt migration and to separate areas from fumes and noise. The Contractor shall be responsible for coordinating the installation of temporary partitions with the Owner to protect the computer equipment that is to remain operational throughout the duration of this project.
- G. Temporary Shoring: Provide and maintain interior and exterior shoring, bracing, or structural support to preserve stability and prevent movement, settlement, or collapse of construction to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
1. Strengthen or add new supports when required during progress of selective demolition.

3.4 POLLUTION CONTROLS

- A. Dust Control: Use water mist, temporary enclosures, and other suitable methods to limit spread of dust and dirt. Comply with governing environmental-protection regulations and Owner requirements to protect the computer equipment that is to remain operational throughout the duration of this project.
1. Do not use water when it may damage existing construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.
 2. Wet mop floors to eliminate trackable dirt and wipe down walls and doors of demolition enclosure. Vacuum carpeted areas.
- B. Disposal: Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
1. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.

- C. Cleaning: Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

3.5 SELECTIVE DEMOLITION

- A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
 - 1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
 - 2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
 - 3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
 - 4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain fire watch and portable fire-suppression devices during flame-cutting operations.
 - 5. Maintain adequate ventilation when using cutting torches.
 - 6. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
 - 7. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
 - 8. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
 - 9. Dispose of demolished items and materials promptly.
 - 10. Return elements of construction and surfaces that are to remain to condition existing before selective demolition operations began.
- B. Existing Facilities: Comply with building manager's requirements for using and protecting elevators, stairs, walkways, loading docks, building entries, and other building facilities during selective demolition operations.
- C. Removed and Salvaged Items: Comply with the following:
 - 1. Clean salvaged items.
 - 2. Pack or crate items after cleaning. Identify contents of containers.
 - 3. Store items in a secure area until delivery to Owner.
 - 4. Transport items to Owner's storage area designated by Owner.
 - 5. Protect items from damage during transport and storage.
- D. Removed and Reinstalled Items: Comply with the following:

1. Clean and repair items to functional condition adequate for intended reuse. Paint equipment to match new equipment.
 2. Pack or crate items after cleaning and repairing. Identify contents of containers.
 3. Protect items from damage during transport and storage.
 4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.
- E. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Engineer, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.
- F. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals, using power-driven saw, then remove concrete between saw cuts.
- G. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, then remove masonry between saw cuts.
- H. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, then break up and remove.
- I. Resilient Floor Coverings: Remove floor coverings and adhesive according to recommendations in RFCI-WP and its Addendum.
1. Remove residual adhesive and prepare substrate for new floor coverings by one of the methods recommended by RFCI.
- J. Roofing: Remove no more existing roofing than can be covered in one day by new roofing.
- K. Air-Conditioning Equipment: Remove equipment without releasing refrigerants.

3.6 PATCHING AND REPAIRS

- A. General: Promptly repair damage to adjacent construction caused by selective demolition operations.
- B. Repairs: Where repairs to existing surfaces are required, patch to produce surfaces suitable for new materials.
1. Completely fill holes and depressions in existing masonry walls that are to remain with an approved masonry patching material applied according to manufacturer's written recommendations.
- C. Finishes: Restore exposed finishes of patched areas and extend restoration into adjoining construction in a manner that eliminates evidence of patching and refinishing.
- D. Floors and Walls: Where walls or partitions that are demolished extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of

uniform finish color, texture, and appearance. Remove existing floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.

1. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections of these Specifications.
 2. Where patching occurs in a painted surface, apply primer and intermediate paint coats over patch and apply final paint coat over entire unbroken surface containing patch. Provide additional coats until patch blends with adjacent surfaces.
 3. Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.
- E. Ceilings: Patch, repair, or rehang existing ceilings as necessary to provide an even-plane surface of uniform appearance.

3.7 DISPOSAL OF DEMOLISHED MATERIALS

- A. General: Promptly dispose of demolished materials. Do not allow demolished materials to accumulate on-site.
- B. Burning: Do not burn demolished materials.
- C. Disposal: Transport demolished materials off Owner's property and legally dispose of them.

END OF SECTION 01732

SECTION 15050 - BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the contract, including general and supplementary conditions and Division 1 specification sections, apply to this section.

1.2 SUMMARY

- A. This section includes the following basic mechanical materials and methods to compliment other division 15 sections.
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Concrete base construction requirements.
 - 3. Escutcheons
 - 4. Dielectric fittings
 - 5. Flexible connectors
 - 6. Mechanical sleeve seals
 - 7. Equipment nameplate data requirements
 - 8. Non-shrink grout for equipment installations
 - 9. Installation requirements common to equipment specification sections
 - 10. Mechanical demolition
 - 11. Cutting and patching
 - 12. Touchup painting and finishing

1.3 DEFINITIONS

- A. Provide: To purchase and install the device including all facets of the component required for normal operation of the component. Exceptions: Where applicable the control wiring, or power wiring is done by respective contractors.
- B. Supply or Furnish: To purchase a device that is compliant with all of its respective sections of the specifications book and provide it to the owner or named trade. The device must be presented within a timely manner that coordinates with the phasing of the job.
- C. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.
- D. Exposed, Interior Installations: Exposed to view indoors.
- E. Exposed, Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions.
- F. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants.
- G. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures.

H. The following are industry abbreviations for plastic and rubber materials:

1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. CPVC: Chlorinated polyvinyl chloride plastic.
3. NP: Nylon plastic.
4. PE: Polyethylene plastic.
5. PVC: Polyvinyl chloride plastic.
6. CR: Chlorosulfonated polyethylene synthetic rubber.
7. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.4 CORRESPONDENCES

A. All requests for information are to contain the following:

1. Each RFI sheet shall be numbered as follows consecutively:
 - a. M-1,2,3,4,..... For mechanical contracts
 - b. P-1,2,3,4,..... For plumbing contracts
 - c. F-1,2,3,4,..... For fire protection contracts
 - d. Etc...
2. Each item of the RFI shall be numbered.
3. The date of the request.
4. The job name.
5. The name of the person requesting the information and a pager phone #
6. The name and address of the company.

1.5 SUBMITTALS

- A. Submit the following: Product data with performance specs for sheet-metal specialties, plumbing specialties, HVAC/Plumbing/and Fire equipment, pumps, air devices, controls equipment, pipe hangers, plumbing fixtures, valves, air coils, dielectric fittings, flexible connectors, mechanical sleeve seals, and identification materials and devices.
- B. Shop Drawings: Indicate clearly exact item to be used when sending cut sheets with multiple units or variations of units. Identify shop drawing for equipment and specialties with the same equipment tag used on the construction documents.
- C. Coordination Drawings: When requested the contractors must issue 3/8" scale drawings for all trades to use. The location of all equipment, specialties, and fixtures involved on the project as well as piping and sheet metal runs are to be indicated and labeled.
- D. Field Drawings: When there is a discrepancy between the field conditions and the contract documents, the problem can be corrected using methods acquired through experience as approved by the Engineer. The contractor will submit drawings of the solution.
- E. Samples of color, lettering style, and other graphic representation required for each identification material and device.

1.6 QUALITY ASSURANCE

- A. Equipment selection of higher electrical characteristics, physical dimensions, capacities, and ratings may be furnished provided such proposed equipment is approved in writing and connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, and

equipment spaces are increased. Additional costs shall be approved in advance by appropriate Contract Modification for these increases. If minimum energy ratings or efficiencies of equipment are specified, equipment must meet design and commissioning requirements.

- B. Sheet metal construction documents are diagrammatic. Equivalent sizes can be substituted when construction begins as long as aspect ratios are no greater than 3:1 for rectangular, or round instead of square substitutions provide the same static pressure per 100ft. Duct runs are to be coordinated in the field with the other trades. Duct materials can not be changed without the permission of the engineer. Flex ducts are to be no longer than eight feet and must be supported from overhead.

1.7 ITEMS NOT SHOWN OR SPECIFIED

- A. Any item of material not indicated on the drawings and/or not specified, but which is required for the complete and proper installation and/or operation of any part of the work, shall be provided as if indicated and specified, at no additional cost to the Owner.
- B. Any work not indicated on the drawings and/or not specified, but which is required for compliance with applicable codes and regulations, shall be provided as if indicated and specified, at no additional cost to the Owner.

PART 2 - PRODUCTS

2.1 PIPE AND PIPE FITTINGS

- A. Refer to individual Division 15 piping Sections for pipe and fitting materials and joining methods and for special joining materials not listed below.
 - 1. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, suitable for chemical and thermal conditions of piping system contents, and 1/8-inch maximum thickness. Include full-face type for flat-face flanges, narrow-face type for raised-face flanges, and carbon-steel bolts and nuts.
 - 2. Plastic Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer.
 - 3. Solder Filler Metal: ASTM B 32, Alloy Sn95, Alloy Sn94, or Alloy Sb5, unless otherwise indicated.
 - 4. Brazing Filler Metals: AWS A5.8, BCuP Series or Alloy BAg1, unless otherwise indicated.
 - 5. Welding Filler Metals: Comply with AWS D10.12.
 - 6. Solvent Cements: ASTM D 2235 for ABS piping, ASTM F 493 for CPVC piping, and ASTM D 2564 with ASTM F 656 primer for PVC piping.

2.2 DIELECTRIC FITTINGS

- A. Combination of copper alloy and ferrous; threaded, solder, plain, and weld-neck end types matching piping system materials; with insulating material suitable for system fluid, pressure, and temperature.
- B. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

- C. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
- D. Dielectric Couplings: Galvanized-steel coupling with inert and non-corrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
- E. Dielectric Nipples: Electroplated steel nipple with inert and non-corrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

2.3 FLEXIBLE CONNECTORS

- A. Fabricated from materials suitable for system fluid and that will provide flexible pipe connections. Include 125-psig minimum working-pressure rating, threaded ends for 2-inch NPS and smaller, and flanged ends for 2-1/2-inch NPS and larger.
- B. Bronze-Hose Type: Corrugated, bronze, inner tubing covered with bronze wire braid. Include copper-tube ends or bronze flanged ends, braze welded to hose.
- C. Stainless-Steel-Hose/Steel Pipe Type: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include steel nipples or flanges, welded to hose.
- D. Stainless-Steel-Hose/Stainless-Steel Pipe Type: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include stainless-steel nipples or flanges, welded to hose.
- E. Rubber, Flexible Connectors: These connectors are not to be used and will only be permitted when consent by the engineer is given for a particular job. CR or EPDM elastomer rubber construction, with multiple plies of NP fabric, molded and cured in hydraulic presses. Include 125-psig minimum working-pressure rating at 220 deg F.

2.4 MECHANICAL SLEEVE SEALS

- A. Modular design, with interlocking rubber links shaped to continuously fill annular space between pipe and sleeve. Include connecting bolts and pressure plates.

2.5 PIPING SPECIALITIES

- A. Steel, Sheet-Metal Sleeves: 0.0239-inch minimum thickness, galvanized, round tube closed with welded longitudinal joint.
- B. Steel Pipe Sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized, plain ends.
- C. Cast-Iron Wall Pipe: Cast or fabricated, and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop.
- D. PVC Sleeves: Manufactured, permanent, with nailing flange for attaching to wooden forms.
- E. PVC Pipe Sleeves: ASTM D 1785, Schedule 40.
- F. PE Sleeves: Manufactured, reusable, tapered, cup shaped, smooth outer surface, with nailing flange for attaching to wooden forms.

- G. Escutcheons: Manufactured wall, ceiling, and floor plates; deep-pattern type if required to conceal protruding fittings and sleeves. Include ID to closely fit around pipe, tube, and insulation of insulated piping and OD to completely cover opening.
1. Cast Brass: One-piece or split casting, with concealed hinge; set screw; and polished chrome-plated finish.
 2. Stamped Steel: Split plate, with concealed hinge, spring clips, and chrome-plated finish.
 3. Stamped Steel: Split plate, with exposed-rivet hinge, spring clips, and chrome-plated finish.

2.6 IDENTIFYING DEVICES AND LABELS

- A. Provide identifying labels and devices as described below, unless specify otherwise in other Division 15 sections.
- B. Equipment Nameplates: Metal nameplate with operational data engraved or stamped; permanently fastened to equipment in accessible and visible location. Include manufacturer, product name, model number, serial number, capacity, operating and power characteristics, and labels of tested compliances.
- C. Stencils: Standard stencils, prepared for required applications with letter sizes complying with recommendations of ASME A13.1 for piping and similar applications, but not less than 1-1/4-inch- high letters for ductwork and not less than 3/4-inch- high letters for access door signs and similar operational instructions.
1. Material: Fiberboard or brass.
 2. Stencil Paint: Standard exterior-type stenciling enamel; black, unless otherwise indicated; either brushing grade or pressurized spray-can form and grade.
 3. Identification Paint: Standard identification enamel of colors indicated or, if not otherwise indicated for piping systems, comply with ASME A13.1 for colors.
- D. Snap-on non-plastic Pipe Markers: Manufacturer's standard pre-stamped, semi-rigid, snap-on, or color-coded, complying with ASME A13.1.
- E. Pressure-Sensitive Pipe Markers: Manufacturer's standard preprinted, permanent adhesive, color-coded, pressure-sensitive vinyl, complying with ASME A13.1.
- F. Metal Duct Markers: 4"x4" square painted duct markers color-coded and fastened to the respective ducts.
- G. Engraved Plastic-Laminate Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore. Fabricate in sizes required for message, engrave with standard letter style, of sizes and with wording to match equipment identification, punch for mechanical fastening, and 1/16-inch minimum thickness. Include steel screws.
- H. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in mechanical identification, with corresponding designations indicated on the construction documents. Use numbers, lettering, and wording indicated for proper identification and operation/maintenance of mechanical systems and equipment.

2.7 GROUT

- A. ASTM C 1107, Grade B, non-shrink and nonmetallic, premixed and factory packaged; and 5000-psi, 28-day compressive strength design mix.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping as described below, unless piping Sections specify otherwise. Division 15 piping Sections specify unique installation requirements.
- B. General Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated, unless deviations to layout are approved by the Engineer on Coordination Drawings. The Contractor shall be responsible for providing all pipe, fittings, etc. as required to accommodate any deviations in the piping systems as required to avoid interferences with new or existing field conditions at no additional cost to the Owner.
- C. Install components with pressure rating equal to or greater than system operating pressure.
- D. Install piping in concealed locations, except in equipment rooms and service areas.
- E. Install exposed piping at right angles or parallel to building walls.
- F. Install piping tight to slabs, beams, joists, columns, walls, and other building elements. Allow sufficient space above removable ceiling panels to allow for ceiling panel removal.
- G. Install piping to allow application of insulation plus 1-inch clearance around insulation.
- H. Locate groups of pipes parallel to each other, spaced to permit valve servicing.
- I. Install fittings for changes in direction and branch connections.
- J. Install pipe escutcheons for pipe penetrations of concrete and masonry walls, wall board partitions, and suspended ceilings according to the following:
 - 1. Chrome-Plated Piping: Cast brass, one piece, with set screw, and polished chrome-plated finish. Use split-casting escutcheons if required, for existing piping.
 - 2. Uninsulated Piping Wall Escutcheons: Cast brass or stamped steel, with set screw.
 - 3. Insulated Piping: Cast brass or stamped steel; with concealed hinge, spring clips, and chrome-plated finish.
 - 4. Piping in Utility Areas: Cast brass or stamped steel, with set-screw or spring clips.
- K. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
 - 1. Cut sleeves to length for mounting flush with both surfaces, except extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor.
 - 2. Install sleeves large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

- a. Steel Pipe Sleeves: For pipes smaller than 6-inch NPS, in exterior walls.
 - b. PVC or Steel Pipe Sleeves: For pipes smaller than 6-inch NPS, unless otherwise indicated.
 - c. Steel, Sheet-Metal Sleeves: For pipes 6-inch NPS and larger, penetrating gypsum-board partitions.
 - 3. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using elastomeric joint sealants. Use Type S, Grade NS, Class 25, Use O neutral-curing silicone sealant, unless otherwise indicated.
 - 4. Aboveground, Exterior-Wall, Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeve for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals. Assemble and install mechanical sleeve seals according to manufacturer's written instructions.
 - 5. Underground, Exterior-Wall, Pipe Penetrations: Install cast-iron wall pipes. Seal pipe penetrations using mechanical sleeve seals. Size sleeve for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals. Assemble and install mechanical sleeve seals according to manufacturer's written instructions.
- L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestopping materials.
- M. Verify final equipment locations for roughing-in. Refer to other Sections of these Specifications for roughing-in requirements.
- N. Piping Joint Construction: Join pipe and fittings as follows and as specifically required in individual piping specification Sections. Ream ends of pipes and tubes and remove burrs; bevel plain ends of steel pipe; and remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly. Construct soldered joints according to AWS's "Soldering Manual," Chapter "The Soldering of Pipe and Tube" or CDA's "Copper Tube Handbook"; brazed joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube"; threaded joints according to ASME B1.20.1; and welded joints according to AWS D10.12, "Recommended Practices and Procedures for Welding Low Carbon Steel Pipe."
- 1. Flanged Joints: Align flange surfaces parallel. Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.
 - 2. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Comply with ASTM F 402 for safe handling practice of cleaners, primers, and solvent cements, and join ABS piping according to ASTM D 2235 and ASTM D 2661, CPVC piping according to ASTM D 2846 and ASTM F 493, PVC pressure piping according to ASTM D 2672, and PVC nonpressure piping according to ASTM D 2855.
 - 3. Plastic Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657 procedures and manufacturer's written instructions. Use butt-fusion operation for plain-end pipe and fittings and use socket-fusion operation for plain-end pipe and socket fittings.
- O. Piping Connections: Make connections according to the following, unless otherwise indicated:
- 1. Install unions, in piping 2-inch NPS and smaller, adjacent to each valve and at final connection to each piece of equipment with 2-inch NPS or smaller threaded pipe connection.
 - 2. Install flanges, in piping 2-1/2-inch NPS and larger, adjacent to flanged valves and at final connection to each piece of equipment with flanged pipe connection.

3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.2 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment according to approved submittal data.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations.
- D. Install equipment giving right of way to piping installed at required slope.
- E. Install flexible connectors on equipment side of shut off valves.

3.3 PAINTING AND FINISHING

- A. Apply semi-gloss, acrylic-enamel finish to exposed piping according to the following:
 1. Interior, Ferrous Piping and Ferrous Supports: Finish coat over enamel undercoat and primer.
 2. Interior and Exterior, Galvanized-Steel Piping: Two finish coats over galvanized metal primer.
 3. Exterior, Ferrous Piping and Ferrous Supports: Two finish coats over rust-inhibitive metal primer.
 4. Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.4 CONCRETE BASES

- A. Construct concrete equipment bases of dimensions 4" high extending 6" beyond all points of the foot print of the equipment. Follow supported equipment manufacturer's setting templates for anchor bolt and tie locations. Use 3000-psi, 28-day compressive-strength concrete and reinforcement.

3.5 ERECTION OF METAL SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment. Comply with AWS D1.1, "Structural Welding Code--Steel," for welding. All exposed fasteners of support frames are to be welded or mechanically modified to prevent back out of fasteners.

3.6 DEMOLITION

- A. Disconnect, demolish and remove work specified in Division 15 sections.

- B. If pipe, ductwork, insulation or equipment to remain is damaged or disturbed, remove damaged portions and install new products of equal capacity and quality.
- C. Accessible work: remove indicated exposed pipe and ductwork in its entirety.
- D. Work abandoned in place: cut and remove pipe and ductwork a minimum of 2 inches beyond face of adjacent construction. Cap and patch surface to match existing finish.
- E. Removal: remove indicated equipment from project site, unless otherwise noted.
- F. Temporary disconnection: remove, store, clean, reinstall, reconnect, and make operational equipment indicated for relocation.

3.7 CUTTING AND PATCHING

- A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of trades involved. Repair cut surfaces to match adjacent surfaces.

3.8 GROUTING

- A. Install nonmetallic non-shrink grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors.

3.9 CONTROLS COORDINATION

- A. For electrical interface of controls the following is the method to be coordinated with division 16. Division 16 is to provide junction box with cover, conduit, and power to JB. The cover is to be labeled with its respective panel number and breaker number. Control contractor will provide the control transformers and all wiring there after to devices and is to coordinate with Division 16 in the field.

END OF SECTION 15050

SECTION 15900 – HVAC INSTRUMENTATION AND CONTROLS

1. GENERAL

1.1. SUMMARY

Intent of this specification is to design, supply, install, commission and service a complete and operating Facility Management System (FMS), utilizing Direct Digital Controls as shown on the drawings and as described herein. This shall include DDC Controls for CO, sensors and relays, all trending, reporting and maintenance management functions related to normal building operations all as indicated on the drawings or elsewhere in this specification.

The FMS Contractor shall furnish all labor, material, equipment, software or any other services not specifically referred to herein or on the plans, those are required to meet the functional intent of this specification, shall be provided without additional cost to the Owner.

The intent of this specification is to expand and upgrade the existing AC Convention Center/Honeywell Enterprise Building Integrator (EBI) software package to accommodate new controls required for and specified for this project. Provide all required hardware and software for BACnet integration of new Honeywell E3 Point CO Sensor system, and new Honeywell DDC controls for control of exhaust fans as part of this project to the existing Honeywell EBI platform. Upgrade existing EBI platform to latest version. Controls contractor shall provide a complete BACnet control system up to and including connectivity to the existing Honeywell building automation system/network. Provide all required software including point database expansion, point mapping and graphic programming to integrate new system into EBI platform shall be provided under this contract. Upgrade system as required to assure all front-end software, if required, is at current revision.

1.2. Definitions

- i. *Algorithm*: A software procedure for solving a recurrent mathematical or logical problem.
- ii. *Analog*: A continuously varying signal or value (temperature, current, velocity, etc.).
- iii. *Binary*: A two-state system where an “ON” condition is represented by a high signal level and an “OFF” condition is represented by a low signal level.
- iv. *Facility Management System (FMS)*: The entire system of hardware and software specifically designed to centrally manage building HVAC and related utilities with seamless integration between various sub-systems within the facility.
- v. *FMS Contractor*: The Facility Management System Contractor responsible for the design, supply, install, commission and service of the Facility Management Control System specified herein.
- vi. *Control Process*: The software required to perform a complete control loop from input signal to interlock logic, process calculation to final output signal control.
- vii. *Control Wiring*: Includes conduit, wire and wiring devices to install a complete Control System including motor control circuits, interlocks, thermostats, switches and like devices. Includes all wiring from a DDC cabinet to all sensors and points defined in the Points List summary or specified herein and required to execute the sequence of operation. Includes necessary power wiring to all FMS devices, digital controllers including terminal units and actuators.
- viii. *Direct Digital Control System*: The portion of the FMS, which provides closed loop control of all CO and associated equipment.
- ix. *Distributed Control*: A system whereby all control processing is decentralized and independent of a central computer. The control system is built up of stand-alone controllers. A single controller failure shall not impact more than one system within the FMS

- x. *Integration:* The ability of control system components from different manufacturers to connect and provide coordinated control via real-time data exchange through a common communications data exchange protocol. Integration shall extend to the operator's workstation software, which shall support user interaction with all control system components.
- xi. *Open technology Offering:* The solution offered must be based on open protocol technology like BACnet®. The specification includes general requirements for the system offered as well as specific clauses detailing requirements of the open technologies that could be offered. The solutions offered must be based on one technology only. Hybrid solutions utilizing multiple protocols at different levels are not acceptable. The system shall provide a direct BACnet® interface. This interface shall provide the functionality to operate a building management system based on Native BACnet® DDC controllers and other BACnet® devices. Solutions requiring gateways or data servers are not acceptable.
- xii. *Network:* A system of distributed control units that are linked together on a communication highway. A network allows sharing of point information between all control units. Additionally, a network provides central monitoring and control of the entire system from any distributed control unit location. First tier networks shall provide "Peer-to-Peer" communications. Second tier networks shall provide either "Peer-to-Peer", Master-Slave or Supervised Token Passing communications.
- xiii. *Operator-Machine Interface:* A method by which an operator communicates with a FMS System. Operator-machine interfacing allows an operator to command, monitor and program the system.
- xiv. *Peripheral:* Input / Output equipment used to communicate with the computer and make copies of system outputs. Peripherals include CRT, printer, tape deck, diskette, etc.
- xv. *PID Control Loop:* A mathematical calculation used to evaluate a control input and determine the control output value required to maintain the input value at set-point. The PID (Proportional, Integral, Derivative) control loop shall have operator adjustable maximum rate of change, P and D gains and loop response time delay. The loop shall be self-integrating so that no integral constant is required and the loop shall not be subject to "Integral Windup".
- xvi. The term "provide" means "provide complete in place", that is, furnished and installed and ready for operation and use.

1.3. QUALIFICATION OF BIDDERS

- a) All bidders must be in the business of installing & servicing similar BMS systems using direct digital controls for over ten (10) years. Contractors with less than 10 years' experience shall submit qualifications to the Engineer before bidding for approval to bid.
- b) All bidders must be original equipment manufacturers and shall have been regularly engaged in engineering, programming, installation and service of such systems or licensed representatives and installers of the approved original equipment manufacturers specified here in. Bidders must also be a Certified Systems Integrator for the products specified with similar experience as per point a) above.
- c) All bidders shall have a local engineering and service offices and should be able to support the project with the required manpower and equipment resource – details of which shall be submitted along with the bid for evaluation purpose.
- d) The FMS contractor shall coordinate with other trade contractors regarding the location and size of pipes, equipment, fixtures, conduits, ducts, openings, switches, outlets and so forth, in order to eliminate any delays in the progress of the job.
- e) The ATC Contractor shall be certified by the State of New Jersey, Department of the Treasury, Division of Construction, Trenton, New Jersey. A copy of this certification shall be part of the bid package and shall include the following information:

Class 043- Control Systems (HVAC): 10 million dollars

f) **APPROVED CONTROL SYSTEM MANUFACTURING CONTRACTORS**

The following are the approved control system contractors and manufacturers:

Company	Product Line	Address/Location	Contact
Honeywell	EBI/CP-Open	534 Fellowship Rd, Mt Laurel, NJ	Brad Strauss (609-969-1568)

The manufacturing contractors shall use only products corresponding to the product line listed.

g) A list of approved manufacturer is listed below:

Sl. No.	Item / Products	Approved Make
1	FMS Software	Honeywell
2	DDC Controllers	Honeywell Native BACnet® Controllers
3	CO Sensors	Honeywell

1.4. Submittals

- A. Each submittal shall have a cover sheet with the following information provided: submittal ID number; date; project name, address, and title; BMS Contractor name, address and phone number; BMS Contractor project manager, quality control manager, and project engineer names and phone numbers.
- B. Each submittal shall include the following information.
1. BMS riser diagram showing all DDC controllers, operator workstations, CO Sensors, networks repeaters if necessary, and network wiring.
 2. One-line schematics and system flow diagrams showing the location of all control devices.
 3. Points list for each DDC controller, including: Tag, Point Type, System Name, Object Name, Expanded ID, Display Units, Controller Type, Address, Cable Destination, Module Type, Terminal ID, Panel, Slot Number, Reference Drawing, and Cable Number.
 4. Contractor's own written description for each sequence of operations, to include the following:
 - a) Sequences shall reference input/output and software parameters by name and description.
 - b) The sequences of operations provided in the submittal by the BMS Contractor shall represent the detailed analysis needed to create actual programming code from the design documents.
 - c) Points shall be referenced by name, including all software points such as programmable setpoints, range limits, time delays, and so forth.
 - d) The sequence of operations shall cover normal operation and operation under the various alarm conditions applicable to that system.
 - e) Control Valve Schedules. This spreadsheet type schedule shall include a separate line for each valve and a column for each of the valve attributes, including: Code Number, Configuration, Fail Position, Pipe Size, Valve Size, Body Configuration, Close off Pressure, Capacity, Valve CV, Calculated CV, Design Pressure, Actual Pressure, and Actuator Type.
 - f) Catalogued cut sheets of all equipment used. This includes, but is not limited to, the following: DDC panels, peripherals, sensors, actuators, dampers, control air system components, and so forth.
 - g) Hardware data sheets for all operator workstations, DDC controllers, DDC panels, DDC panel mounted operator interface terminals, sensors, valves & actuators and other field devices .

1.5. O&M Manuals

1. Submit three sets of each manual. Include the following documentation in the Hardware Manual:
 - a) General description and cut sheets for all components.
 - b) Detailed wiring and installation illustrations and complete calibration procedures for each field and panel device.
 - c) Complete trouble-shooting procedures and guidelines.
 - d) Complete operating instructions for all systems.
 - e) Maintenance Instructions: Document all maintenance and repair/replacement procedures.
2. Include the following documentation in the DDC Software Manual:
 - a) Sequence of Operations
 - b) Flow Chart Diagrams of Programming Objects.
 - c) Printed listing of controller and operator workstation database files.
 - d) Software Point Name, Abbreviation List. Include Name, Description, Controller Where Located, Point Type and Point ID.
 - e) I/O Point List: Include Point Name, Controller Location, Point Number, Control Device, Range and Span.
 - f) Printouts of all; Reports, Group Listings and Alarm Messages.
 - g) Index of all DDC point names with documentation manual page number references.
3. Provide three copies of all manufacturers manuals covering the installed system. This shall include, as a minimum:
 - a) System Engineering Manual
 - b) System Installation Manual
 - c) Programming Manual
 - d) Engineering and Troubleshooting Bulletins
 - e) Operator Workstation Software Manual
 - f) All other pertinent manuals published by the control system manufacturer.

1.6. AGENCY AND CODE APPROVALS

All products of the FMS shall be provided with the following agency approvals. Verification that the approvals exist for all submitted products shall be provided with the submittal package. Systems or products not currently offering the following approvals are not acceptable.

- UL-916; Energy Management Systems
- ULC; UL - Canadian Standards Association
- FCC Part 15 Subpart B:2009
- CE Certification for products tested according to EN 61326 – 1: 2006
- BTL Tested and Certified as per applicable device profile.

1.7. SOFTWARE LICENSE AGREEMENT

The Owner shall sign a copy of the manufacturer's standard software and firmware licensing agreement as a condition of this contract. Such license shall grant use of all programs and application software to Owner as defined by the manufacturer's license agreement, but shall protect manufacturer's rights to disclosure of trade secrets contained within such software.

1.8. DELIVERY, STORAGE AND HANDLING

Provide factory-shipping cartons for each piece of equipment and control device. Maintain cartons through shipping, storage, and handling as required to prevent equipment damage. Store equipment and materials inside and protected from weather.

1.9. JOB CONDITIONS

Cooperation with Other Trades: Coordinate the Work of this section with that of other sections to insure that the Work will be carried out in an orderly fashion. It shall be this Contractor's responsibility to check the Contract Documents for possible conflicts between his Work and that of other crafts in equipment location, pipe, duct and conduit runs, electrical outlets and fixtures, air diffusers, and structural and architectural features.

1.10. QUALITY ASSURANCE

The Manufacturer of the FMS digital controllers shall provide documentation supporting compliance with ISO-9001 (Model for Quality Assurance in Design/Development, Production, Installation and Servicing).

2. MATERIALS

2.1. SYSTEM DESCRIPTION

The entire Facility Management System (FMS) shall be comprised of a network of interoperable, stand-alone digital controllers communicating on an open protocol communication network to the existing Honeywell Enterprise Building Integrator (EBI) host server within the AC Convention Center Network.

The basic controls system also includes all sensors, controllers, instruments, valves, pneumatic actuators, devices, installation and service for a complete and functional controls system. All control devices (valves, dampers, actuators, etc.) are included under the contract unless specifically specified elsewhere in

The Installed system shall provide secure password access to all features, functions and data within the overall FMS in a defined hierarchy.

It is the intent of this project and specification have all existing controls residing on the EBI platform to be on the latest revision of EBI. Provide, if required upgraded software and hardware required to meet this intent.

2.2. OPEN, INTEROPERABLE, INTEGRATED ARCHITECTURES

- a) The intent of this specification is to provide an Open System solution that utilizes industry standard communications protocols consisting of peer-to-peer networked, stand-alone, distributed controls in compliance with ANSI/ASHRAE Standard 135-1995/2004 BACnet® communication protocol in one open, interoperable system. Open System communication protocols shall be utilized Top-to-Bottom from front-end Graphical User Interface (GUI) to the field level distributed controllers. Proprietary communications, objects, or communication "Tiers" are not acceptable allowing highest level of interoperability between control devices and systems.
- b) The existing Honeywell Enterprise Building Integrator software shall employ object-oriented technology (OOT) for representation of all data and control devices within the system. In addition, adherence to industry standards including ANSI / ASHRAE™ Standard 135-1995/2004 BACnet® to assure interoperability between all system components is required. For all native BACnet® device, the device supplier must provide a PICS document showing the installed device's compliance level, or BIBB's listing supported objects, properties, and services. All native BACnet® Controllers should confirm to BIBB's profile for B-BC, B-ASC, B-AAC as applicable with the ability to support minimum data read and write functionality listed in the associated control drawings and points list.. Physical connection of BACnet® devices shall be via Ethernet utilizing BACnet® over IP without the need for additional hardware viz. routers and / or gateways.

- c) All network controllers supplied under this contract shall be true “peer-to-peer” communicating devices. Plant controllers requiring “polling” by a host to pass data shall not be acceptable.
- d) A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer’s internal Intranet network. Systems employing a “flat” single tiered architecture shall not be acceptable.

2.3. NETWORKS

- a) The Local Area Network (LAN) shall be either a 10 or 100 Megabits/sec Ethernet network supporting BACnet®, Java, XML, HTTP, and CORBA IIOP for maximum flexibility for integration of building data with enterprise information systems and providing support for multiple Network Area Controllers (NACs), user workstations and, a local host computer system.
- b) Local area network minimum physical and media access requirements:
 - 1. Ethernet; IEEE standard 802.3
 - 2. Cable; 10 Base-T, UTP-8 wire, category 5
 - 3. Minimum throughput; 10 Mbps, with ability to increase to 100 Mbps

2.4. NETWORK CONTROLLER (NC)

- a) The Network Controller (NC) shall be a Native BACnet® controller based on 32 bit technology to provide the interface between the LAN or WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the NC. The NC shall conform to BACnet® Building Controller (B-BC) profile and be provided with appropriate PIC statement defining BACnet® services and objects supported. BACnet® Data Sharing BIBBs supported shall include at a minimum: RP, RPM, WP, WPM, COV. Alarm and Event, Trending, and scheduling including SCHED-A BIBBs support shall also be supported in BACnet® native communications. The NC shall physically connect to the LAN without the need for additional Router hardware. The NC shall support transmitting and receiving segmented messages as well as BACnet® Broadcast Messages over IP. It should be possible to define any NC in an IP subnet as a BBMD device. The NC shall also support both Secure (<https://>) and non-secure (<http://>) remote web server access using commonly used web browsers. It shall be capable of executing application control programs to provide:
 - 1. Calendar functions
 - 2. Scheduling
 - 3. Trending and Trending Backfill
 - 4. Alarm monitoring and routing
 - 5. Time synchronization
 - 6. Integration of BACnet® devices and BACnet® controller data
 - 7. Integration of MODBUS devices and MODBUS controller data
- b) The Network Controller must provide the following hardware features as a minimum:
 - 1. One Ethernet Port -10 / 100 Mbps RJ45
 - 2. One RS-232 port
 - 3. One RS 485 port
 - 4. Three independent BACnet® MS/TP Channel capable of supporting up to 90 Unitary controllers

5. A minimum of 24 On-board I/O, expandable up to 128 hardware points
6. Battery Backup using Gold Capacitor to avoid low battery alarms and subsequent replacement during service life of the controller.
7. Flash memory for long term data backup (If battery backup or flash memory is not supplied, the controller must contain a hard disk with at least 1 gigabyte storage capacity)
8. A Reset Button
9. The NC must be capable of operation over a temperature range of 0 to 50°C
10. The NC must be capable of withstanding storage temperatures of between 5 and 70°C
11. The NC must be capable of operation over a humidity range of 5 to 93% RH, non-condensing

c) Integration

1. Any or all the 3 independent MS/TP channels may be used to integrate MODBUS devices like Energy Meters etc. or BACnet® devices and BACnet® controller data. The FMS contractor shall include if any, license required for this interface within their scope.

d) Event Alarm Notification and actions

1. The NC shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
2. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but limited to:
 - a. To alarm
 - b. Return to normal
 - c. To fault
3. Provide for the creation of an unlimited number of alarm classes for the purpose of routing types and or classes of alarms based on priority
4. Provide timed (schedule) routing of alarms by class, object, group, or priority.
5. Provide alarm generation from binary object “runtime” and /or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.

d) Control equipment and network failures shall be treated as alarms and annunciated.

e) A log of alarms shall be maintained by the NC

f) Provide a “query” feature to allow review of specific alarms by user defined parameters.

g) A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.

h) An Error Log to record invalid property changes or commands shall be provided and available for review by the user.

2.5. Native BACnet® Advanced Application Specific Controller (B-AAC)

1. Controller shall be 32 bit microprocessor based BACnet® Advanced Application Controller in accordance with the ANSI/ASHRAE Standard 135-2004 The application control program shall be resident within the same enclosure as the input/output circuitry, which translates the sensor

signals. The system supplier must provide a PICS document showing the installed systems compliance level to the ANSI/ASHRAE Standard 135-2004.

2. All Advanced Application Controller shall be fully programmable with the help of Windows based software programming tool and shall at all times maintain their BACnet® compliance. Controllers offering application selection only (non-programmable), require a 15% spare point capacity to be provided for all applications. All control sequences within or programmed into the B-AAC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained.
3. Stand-alone, Native BACnet®, UL Listed Application Controllers shall be used to provide direct digital control of HVAC equipment. In addition to their standalone capabilities, they shall also provide the ability networked in a peer-to-peer, BACnet® MS/TP field network to other MS/TP controllers, and VAV/SPC zone controllers on the single MS/TP channel. These controllers may be used to optimize the energy consumption by implementing various control strategies such as temperature setup/setback etc.
4. Standard features for all Advanced Application Controllers shall include:
 - a. 32 bit microprocessor based controllers
 - b. Stand-alone or networked peer-to-peer capabilities on single MS/TP channel, Masters to slave devices are not acceptable
 - c. Should have on-board Real Time Clock
 - d. Should support BACnet® intrinsic alarm reporting
 - e. Should support calendar objects for scheduling
 - f. Should comply to BACnet® B-AAC device profile
 - g. Flexibility to be used and connected to Network Controller to expand the I/O capacity of network controller
 - h. BACnet® MS/TP LAN with configurable baud rate from 9600 to 76.8k baud
 - i. All Inputs to be Universal Inputs with 12 bit resolution- software selectable as analog or digital with standard and custom ranges.
 - j. Pulse counting shall be available for any one of binary inputs up to 15Hz frequency
 - k. Standard P, PI, or PID BACnet® Loop Objects
 - l. Minimum of one Loop Object for each output

2.6. PACKAGING AND ENVIRONMENT

1. Distributed unitary controller enclosures (panels) shall be locking type, metal cabinet, with common keying. The panels shall have a metal print pocket suitable for storing wiring, service and log information. Indoor panels shall be NEMA 1 enclosures with gaskets. Any panels in cooling tower or chemically treated areas shall be stainless steel (Fiberglass enclosures rated for outside applications are acceptable). VAV box controllers shall have a safety cover but no enclosure is required.

2. The panel, when required, must functionally operate over a temperature range of 0 to 50 , and a humidity range of 0 - 93% non-condensing.
3. DDC panels shall come with a minimum of six pre-existing available knockouts for ease of wiring during installation.
4. The electrical requirements shall be identified and coordinated by the Controls Contractor. Any 230 VAC requirements are to be coordinated with controls/Electrical Contractor. The controls/Electrical Contractor shall provide 230 VAC power circuits to each panel. 230 VAC power should not be installed in the same panel as 24 VAC. However, if 230 VAC power must be installed in the same panel with 24 VAC power due to design and/or system constraints, the 230 VAC side of the panel shall be physically isolated from the 24VAC side and clearly labeled. Use panduits in each control panel to conceal all wiring. Fuse all transformers.
5. Control panels shall be clearly identified by labels (2" lettering).
6. Provide and install as-built wiring diagrams to indicate the control points on all equipment. Also provide laminated point lists in all control panels.

2.7. GRAPHICAL USER INTERFACE SOFTWARE

Operating System:

The GUI shall run on Microsoft Windows XP or Microsoft Windows 2012 or 2016 Server.

Server Computer

The system server computer shall comprise of the following minimum hardware:

- Intel Core 2 Duo 2.66Ghz
- 4GB of RAM
- Graphics card capable of 1280x1024 pixel resolution and 65K colors
- 12 function-key keyboard
- Mouse pointing device
- 80 GB Hard disk drive
- DVD ROM drive
- TCP/IP adaptor
- UL Listed server computer platform shall be used when UL compliant system is required.

2.8. SYSTEM PROGRAMMING

1. Modify the existing EBI Graphical User Interface software (GUI) with new graphics representing new equipment being installed as part of the project. Existing GUI shall provide the ability to perform system programming and graphic display engineering as part of a complete software package. Access to the programming functions and features of the GUI shall be through password access as assigned by the system administrator.
2. A library of control, application, and graphic objects shall be provided to enable the creation of all applications and user interface screens. Applications are to be created by selecting the desired control objects from the library, dragging or pasting them on the screen, and linking them together using a built in graphical connection tool. Completed applications may be stored in the library for future use. Graphical User Interface screens shall be created in the same fashion.

3. EXECUTION

3.1 INSTALLATION

1. All work described in this section shall be installed, wired, circuit tested and calibrated by factory certified technicians qualified for this work and in the regular employment of the FMS system manufacturer or its exclusive factory authorized installing contracting field office (representative). The installing office shall have a minimum of five years of installation experience with the manufacturer and shall provide documentation in submittal package verifying longevity of the installing company's relationship with the manufacturer. Supervision, calibration and checkout of the system shall be by the employees of the local exclusive factory authorized FMS contracting field office (branch or representative).
2. Install system and materials in accordance with manufacturer's instructions, and as detailed on the project drawing set.
3. Drawings of FMS are diagrammatic only and any apparatus not shown, such as relays, accessories, etc., but required to make the system operative to the complete satisfaction of the Architect shall be furnished and installed without additional cost.
4. Line and low voltage electrical connections to control equipment shown specified or shown on the control diagrams shall be furnished and installed by the FMS sub-contractor in accordance with these specifications.
5. Equipment furnished by the FMS Contractor that is normally wired before installation shall be furnished completely wired. Control wiring normally performed in the field will be furnished and installed by the FMS sub-contractor.
6. All control devices mounted on the face of control panels shall be clearly identified as to function and system served with permanently engraved phenolic labels.

3.2 WIRING

All electrical control wiring and power wiring to the control panels shall be the responsibility of the FMS contractor.

All wiring shall be in accordance with the Project Electrical Specifications, the National Electrical Code and any applicable local codes. All FMS wiring shall be installed in the conduit types specified in the Project Electrical Specifications unless otherwise allowed by the National Electrical Code or applicable local codes. Where FMS plenum rated cable wiring is allowed it shall be run parallel to or at right angles to the structure, properly supported and installed in a neat and workmanlike manner.

3.3 WARRANTY

Equipment, materials and workmanship incorporated into the work shall be warranted for a period of one year from the time of system acceptance.

Within this period, upon notice by the Owner, any defects in the FMS due to faulty materials, methods of installation or workmanship shall be promptly (within 48 hours after receipt of notice) repaired or replaced by the FMS sub-contractor at no expense to the Owner

3.4 WARRANTY ACCESS

The Owner shall grant to the FMS sub-contractor, reasonable access to the FMS during the warranty period.

3.5 ACCEPTANCE TESTING

Upon completion of the installation, the FMS sub-contractor shall load all system software and start-up the system. The FMS sub-contractor shall perform all necessary calibration, testing and de-bugging and perform

all required operational checks to insure that the system is functioning in full accordance with these specifications.

The FMS sub-contractor shall perform tests to verify proper performance of components, routines, and points. Repeat tests until proper performance results. This testing shall include a point-by-point log to validate 100% of the input and output points of the DDC system operation.

Upon completion of the performance tests described above, repeat these tests, point by point as described in the validation log above in presence of Owner's Representative, as required. Properly schedule these tests so testing is complete at a time directed by the Owner's Representative. Do not delay tests so as to prevent delay of occupancy permits or building occupancy.

System Acceptance: Satisfactory completion is when the FMS sub-contractor has performed successfully all the required testing to show performance compliance with the requirements of the Contract Documents to the satisfaction of the Owner's Representative. System acceptance shall be contingent upon completion and review of all corrected deficiencies.

3.6 OPERATOR INSTRUCTION, TRAINING

During system commissioning and at such time acceptable performance of the FMS hardware and software has been established the FMS sub-contractor shall provide on-site operator instruction to the owner's operating personnel. Operator instruction shall be done during normal working hours and shall be performed by a competent representative familiar with the system hardware, software and accessories.

The FMS sub-contractor shall provide 40 hours of instruction to the owner's designated personnel on the operation of the FMS and describe its intended use with respect to the programmed functions specified. Operator orientation of the FMS shall include, but not be limited to; the overall operation program, equipment functions (both individually and as part of the total integrated system), commands, systems generation, advisories, and appropriate operator intervention required in responding to the System's operation.

The training shall be in three sessions as follows:

Initial Training: One day session (8 hours) after system is started up and at least one week before first acceptance test. Manual shall have been submitted at least two weeks prior to training so that the owners' personnel can start to familiarize themselves with the system before classroom instruction begins.

First Follow-Up Training: Two days (16 hours total) approximately two weeks after initial training, and before Formal Acceptance. These sessions will deal with more advanced topics and answer questions.

Warranty Follow Up: Two days (16 hours total) in no less than 4 hour increments, to be scheduled at the request of the owner during the one year warranty period. These sessions shall cover topics as requested by the owner such as; how to add additional points, create and gather data for trends, graphic screen generation or modification of control routines.

END OF SPECIFICATION

SECTION 16030 - ELECTRICAL DEMOLITION & RENOVATION

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 REFERENCE CODES AND STANDARDS

- A. The work shall conform to:
 - 1. National Electrical Code
 - 2. State and Local Codes

PART 2 - PRODUCTS

- 2.1 Materials used for this work shall be in accordance with the applicable specification sections in Division 13 and Division 16.

PART 3 - EXECUTION

- 3.1 Provide demolition, relocation, and alteration of electrical construction as required.
 - A. The contractor shall notify the owner 48 hours in advance of any interruptions of electric service to any area of the building.
 - B. All interruptions of electric service shall be kept to a minimum. Where power is to be interrupted longer than two (2) hours, the work shall be done after normal business hours, and where necessary, temporary power shall be provided by means of additional temporary feeds or by means of a generator.
 - C. Should the electrical service be disrupted do to construction while the building is occupied the contractor shall provide temporary electrical power at no additional cost to the contract.
- 3.2 Check the locations of all existing electrical work, such as lighting fixtures, electrical conduit, wiring, fittings, controls, starters and other electrical construction and provide the removing, relocating, rerouting, and reconnecting of this work due to demolition and new construction. Any existing apparatus or wiring device to be retained shall be disconnected, relocated and reinstalled as required, to allow for new wall, floor or ceiling finishes.
- 3.3 Methods of installation and standards of workmanship shall be in accordance with the applicable specification sections under Division 16.

- 3.4 Where existing equipment will remain in service during construction, provide rerouting and reconnection of electrical service as required.
- 3.5 Protect existing electrical equipment and installations indicated to remain. If damaged or disturbed in the course of the work, remove damaged portions and install new products of equal capacity, quality, and functionality.
- 3.6 Accessible Work: Remove exposed electrical equipment and installations, indicated to be demolished, in their entirety.
- 3.7 Abandoned Work: Cut and remove buried raceway and wiring, indicated to be abandoned in place, 2 inches (50 mm), below the surface of adjacent construction. Cap raceways and patch surface to match existing finish.
- 3.8 Remove demolished material from project site. Any particular equipment that the owner wants saved shall be stored as directed.
- 3.9 Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.
- 3.10 Feeders or circuits, whether spliced, extended, relocated or new, shall maintain amperage and continuity of that respective feeder or circuit.
- 3.11 Where new work interferes with existing work or other trades, relocate such existing work without additional cost. Approval by the Owner's Representative must be given before any relocation work can begin. The relocation work shall be done in a manner acceptable to the Owner. Engage Contractor of the appropriate trade to do the work.

END OF SECTION 16030

SECTION 16050 – COMMON WORK RESULTS FOR ELECTRICAL – MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Raceways.
 - 2. Building wire and connectors.
 - 3. Supporting devices for electrical components.
 - 4. Electrical identification.
 - 5. Utility company electricity-metering components.
 - 6. Concrete equipment bases.
 - 7. Electrical demolition.
 - 8. Cutting and patching for electrical construction.

1.2 SUBMITTALS

- A. Product Data: For utility company electricity-metering components.
- B. Shop Drawings: Dimensioned plans and sections or elevation layouts and single-line diagram of electricity-metering component assemblies specific to this Project.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. The contractor shall be fully responsible for all coordination of the electrical work required to meet the design intent and the scope of work related to the project. This includes but not limited to all other trades, material handling, equipment rentals, tools, automobiles, parking and travel expenses, engineering review and consult, as-built drawings and any/all construction site requirements that are necessary to provide a turnkey electrical installation.
- C. The 'Basis of Design' is the product that is specified which supports the design data contained within the contract documents. Should the contractor elect to use an alternate manufacturer listed within the specifications the contractor is still required to meet the full intent and specifications and the contract documents. Any deviation of the contract documents will be the sole responsibility of the contractor to maintain specification requirements at no additional cost to the owner.
- D. It shall be the contractor's responsibility to acknowledge any long lead delivery items with written response from the manufacturer, at the time of Notice to Proceed. Should the contractor fail to inform the client and the A/E of any material or equipment delays at the time Notice to

Proceed has been given, the contractor will take full responsibility in completing the project in the same allowed construction period, based on the approved construction schedule.

- E. The contractor shall be fully responsible in the coordination and installation of all electrical products as per the manufacturer's recommendations. Should the contractor alter or change the manufacturer's installation recommendations, the contractor shall submit a certified installation report from the manufacturer's representative stating the installed is acceptable. Any discrepancies in the installation shall be corrected per the manufacturer's requirements at no additional cost to the owner and before final closeout of the project.
- F. Devices for Utility Company Electricity Metering: Comply and coordinate with local utility company requirements and Specification Section 16211 – Electricity Metering.
- G. Comply with NFPA 70.

1.4 COORDINATION

- A. Coordinate chases, slots, inserts, sleeves, and openings for electrical supports, raceways, and cable with general construction work and all trades.
- B. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment that requires positioning before closing in the building or space.
- C. Coordinate all electrical service connections to components furnished by utility companies.
 - 1. Coordinate installation and connection of exterior underground and overhead utilities and services, including provision for service entrances and electricity-metering components.
- D. Coordinate location of access panels and doors for electrical items that are concealed by finished surfaces. Access doors and panels are specified in Division 8 Section "Access Doors and Frames."
- E. Where electrical identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface.

1.5 ITEMS NOT SHOWN OR SPECIFIED

- A. Any item of material not indicated on the drawings and/or not specified, but which is required for the complete and proper installation and/or operation of any part of the work, shall be provided as if indicated and specified, at no additional cost to the Owner.
- B. Any work not indicated on the drawings and/or not specified, but which is required for compliance with applicable codes and regulations, shall be provided as if indicated and specified, at no additional cost to the Owner.

PART 2 - PRODUCTS

2.1 RACEWAYS

- A. EMT: Electrical metallic tubing; ANSI C80.3, zinc-coated steel, with compression fittings.
- B. FMC: Flexible metal conduit; zinc-coated steel.
- C. IMC: Intermediate metal conduit; ANSI C80.6, zinc-coated steel, with threaded fittings.
- D. LFMC: Liquidtight flexible metal conduit; zinc-coated steel with sunlight-resistant and mineral-oil-resistant plastic jacket.
- E. RMC: Rigid metal conduit; galvanized rigid steel; ANSI C80.1.
- F. RNC: Rigid nonmetallic conduit; NEMA TC 2, Schedule 40 PVC, with NEMA TC3 fittings.
- G. Raceway Fittings: Specifically designed for raceway type with which used.

2.2 WIRES, CABLES, AND CONNECTIONS

- A. Conductors, No. 10 AWG and Smaller: Solid or stranded copper.
- B. Conductors, Larger than No. 10 AWG: Stranded copper.
- C. Insulation: Thermoplastic, rated 600 V, 75 deg C minimum, Type THW, THHN-THWN, or USE depending on application.
- D. Wire Connectors and Splices: Units of size, ampacity rating, material, type, and class suitable for service indicated.

2.3 SUPPORTING DEVICES

- A. Material: Cold-formed steel, with corrosion-resistant coating.
- B. Metal Items for Use Outdoors or in Damp Locations: Hot-dip galvanized steel.
- C. Slotted-Steel Channel: Flange edges turned toward web, and 9/16-inch- (14-mm-) diameter slotted holes at a maximum of 2 inches (50 mm) o.c., in webs. Strength rating to suit structural loading.
- D. Nonmetallic Slotted Channel and Angle: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch- (14-mm-) diameter holes at a maximum of 8 inches (203 mm) o.c., in at least one surface. Strength rating to suit structural loading.
- E. Slotted Channel Fittings and Accessories: Recommended by the manufacturer for use with the type and size of channel with which used.
 - 1. Materials: Same as channels and angles, except metal items may be stainless steel.
- F. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring-steel clamps or click-type hangers.

- G. Pipe Sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.
- H. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for non-armored electrical cables in riser conduits. Plugs have number and size of conductor gripping holes as required to suit individual risers. Body constructed of malleable-iron casting with hot-dip galvanized finish.
- I. Expansion Anchors: Carbon-steel wedge or sleeve type.
- J. Toggle Bolts: All-steel springhead type.
- K. Powder-Driven Threaded Studs: Heat-treated steel.

2.4 ELECTRICAL IDENTIFICATION

- A. Identification Device Colors: Use those prescribed by ANSI A13.1, NFPA 70, and these Specifications.
- B. Colored Adhesive Marking Tape for Raceways, Wires, and Cables: Self-adhesive vinyl tape, not less than 1 inch wide by 3 mils thick (25 mm wide by 0.08 mm thick).
- C. Tape Markers for Conductors: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.
- D. Color-Coding Cable Ties: Type 6/6 nylon, self-locking type. Colors to suit coding scheme.
- E. Underground Warning Tape: Permanent, bright-colored, continuous-printed, vinyl tape compounded for permanent direct-burial service, and with the following features:
 - 1. Not less than 6 inches wide by 4 mils thick (150 mm wide by 0.102 mm thick).
 - 2. Embedded continuous metallic strip or core.
 - 3. Printed legend that indicates type of underground line.
- F. Engraved-Plastic Labels, Signs, and Instruction Plates: Engraving stock, melamine plastic laminate punched or drilled for mechanical fasteners 1/16-inch (1.6-mm) minimum thickness for signs up to 20 sq. in. (129 sq. cm) and 1/8-inch (3.2-mm) minimum thickness for larger sizes. Engraved legend in black letters on white background.
- G. Warning and Caution Signs: Preprinted; comply with 29 CFR 1910.145, Chapter XVII. Colors, legend, and size appropriate to each application.
 - 1. Interior Units: Aluminum, baked-enamel-finish, punched or drilled for mechanical fasteners.
 - 2. Exterior Units: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate with 0.0396-inch (1-mm), galvanized-steel backing. 1/4-inch (6-mm) grommets in corners for mounting.
- H. Fasteners for Nameplates and Signs: Self-tapping, stainless-steel screws or No. 10/32 stainless-steel machine screws with nuts and flat and lock washers.

2.5 EQUIPMENT FOR UTILITY COMPANY'S ELECTRICITY METERING (When required)

- A. Comply and provide all requirements of the local electrical power utility company for meter sockets and current transformer cabinet.
- B. Provide Cold Sequence Meter Protection Switch as required by the Local Utility Company.
- C. Provide service entrance wiring and equipment for electrical requirements necessary for the complete installation of all associated work within the project Scope of Work.

2.6 COMMUNICATION SERVICES

- A. Provide all necessary requirements to accommodate the local Telephone, Cable and Ethernet requirements within the project site. The contractor shall provide full coordination of the requirements dictated by the local service companies providing for the project site.
- B. The contractor shall include all required underground raceways for each of the service companies nearest source location within the property limits.

2.7 CONCRETE BASES

- A. Provide as per details indicated on the drawings.
- B. Provide a 4" high above finished elevation (floor of grade) concrete housekeeping pad under all floor or pad mounted electrical equipment located at all locations (unless noted otherwise).

PART 3 - EXECUTION

3.1 ELECTRICAL EQUIPMENT INSTALLATION

- A. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom.
- B. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.
- C. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.
- D. Right of Way: Give to raceways and piping systems installed at a required slope.

3.2 RACEWAY APPLICATION

- A. Outdoor Installations:
 - 1. Exposed: RMC.
 - 2. Concealed: RNC.

3. Underground, Single Run: RNC.
4. Underground, Grouped: RNC.
5. Connection to Vibrating Equipment: LFMC.
6. Boxes and Enclosures: NEMA 250, Type 3R or Type 4, unless otherwise indicated.

B. Indoor Installations:

1. Exposed: EMT except in wet or damp locations, use IMC.
2. Concealed in Walls or Ceilings: FMC.
3. In Concrete Slab: RNC.
4. Below Slab on Grade or in Crawlspace: RNC
5. Connection to Vibrating Equipment: FMC; except in wet or damp locations: LFMC.
6. Boxes and Enclosures: NEMA 250, Type 1, unless otherwise indicated.

3.3 RACEWAY AND CABLE INSTALLATION

- A. Conceal raceways and cables, unless otherwise indicated, within finished walls, ceilings, and floors.
- B. Keep legs of raceway bends in the same plane and keep straight legs of offsets parallel.
- C. Use RMC elbows where RNC turns out of slab.
- D. Where required to provide a Rough-in Only device application concealed within the vertical walls the contractor shall provide the device work box and 3/4" EMT raceway to above the ceiling with a 90 degree bend turned into the ceiling space and apply an open end plastic bushing or cap for future wiring application.
- E. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or woven polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wires.
- F. Connect motors and equipment subject to vibration, noise transmission, or movement with a maximum of 72-inches (1830-mm) flexible conduit. Install LFMC in wet or damp locations. Install separate ground conductor across flexible connections.

3.4 WIRING METHODS FOR POWER, LIGHTING, AND CONTROL CIRCUITS

- A. Application: Use wiring methods specified below to the extent permitted by applicable codes as interpreted by authorities having jurisdiction.
- B. Exposed Feeders: Insulated single conductors in raceway.
- C. Concealed Feeders in Concrete: Insulated single conductors in PVC raceway.
- D. Exposed Branch Circuits Insulated single conductors in raceway.
- E. Concealed Branch Circuits: Insulated single conductors in FMC raceway.
- F. Underground Feeders and Branch Circuits: Insulated single conductors in raceway.

- G. Remote-Control Signaling and Power-Limited Circuits, Classes 1, 2, and 3: Insulated conductors in FMC raceway unless otherwise indicated.

3.5 WIRING INSTALLATION

- A. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than un-spliced conductors.

3.6 ELECTRICAL SUPPORTING DEVICE APPLICATION

- A. Damp Locations and Outdoors: Hot-dip galvanized materials or nonmetallic, slotted channel system components.
- B. Dry Locations: Steel materials.
- C. Strength of Supports: Adequate to carry present and future loads, times a safety factor of at least four with, 200-lb (90-kg) minimum design load for each support element.

3.7 SUPPORT INSTALLATION

- A. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.
- B. Size supports for multiple raceway or cable runs so capacity can be increased by a 25 percent minimum in the future.
- C. Support individual horizontal single raceways with separate, malleable-iron pipe hangers or clamps.
- D. Install sleeves for cable and raceway penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.
- E. Secure electrical items and their supports to building structure, using the following methods unless other fastening methods are indicated:
 - 1. Wood: Wood screws or screw-type nails.
 - 2. Gypsum Board: Toggle bolts. Seal around sleeves with joint compound, both sides of wall.
 - 3. Masonry: Toggle bolts on hollow block and expansion bolts on solid block. Seal around sleeves with mortar, both sides of wall.
 - 4. New Concrete: Concrete inserts with machine screws and bolts.
 - 5. Existing Concrete: Expansion bolts or threaded studs driven by powder charge and provided with lock washers.
 - 6. Structural Steel: Welded threaded studs.
 - a. Comply with AWS D1.1 for field welding.
 - 7. Light Steel Framing: Sheet metal screws.

8. Fasteners for Damp, Wet, or Weather-Exposed Locations: Stainless steel.
9. Light Steel: Sheet-metal screws.
10. Fasteners: Select so load applied to each fastener does not exceed 25 percent of its proof-test load.

3.8 FIRESTOPPING

- A. Apply firestopping to cable and raceway sleeves and other penetrations of fire-rated floor and wall assemblies to provide or restore the assembly to its original undisturbed or proposed fire-resistance rating. The system shall have an F-rating and T-rating of not less than the required rating of the assembly penetrated. Provide a single component silicone sealant firestop material in accordance with ASTM E814 (UL1479), ASTM E 1966 (UL 2079) and ASTM E 2307. Basis of Design: 3M Fire Barrier Water Tight Sealant 1003 SL. Alternate manufacturers: Hilti, Tremco, or approved equal.

3.9 DEMOLITION

- A. Protect existing electrical equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.
- B. Accessible Work: Remove exposed electrical equipment and installations, indicated to be demolished, in their entirety and back to electrical panel source.
- C. Abandoned Work: Cut and remove buried raceway and wiring, indicated to be abandoned in place, 2 inches (50 mm) below the surface of adjacent construction. Cap raceways and patch surface to match existing finish.
- D. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.

3.10 TEMPORARY ELECTRICAL POWER / SERVICES

- A. Provide all necessary temporary electrical construction power by either a temporary service power pole or by portable generator to maintain adequate electrical power requirements for the duration of construction, at no additional cost to the project or owner.
- B. Should the project include demolition or disruption of an existing electrical service the contractor shall provide temporary back-up power source and connection that meets the demand requirements of the disturbed service at no additional cost to the project or owner.

3.11 DISPOSAL

- A. The contractor shall assume all cost and service fees for the removal of all construction debris generated by demolition and installation of new work throughout the entire project construction period.

- B. The disposal of all debris generated from the construction project shall be disposed of in a legal and safe manner as regulated by the local Authority Having Jurisdiction and the State of New Jersey Department of Environmental Protection.

3.12 CUTTING AND PATCHING

- A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.
- B. The contractor shall not disturb any existing surfaces, furnishings, equipment, or building appurtenances without assuming that the contractor will be required to repair, patch and/or replace any damages caused by construction.
- C. Repair, refinish and touch up disturbed finish materials and other surfaces to match adjacent undisturbed surfaces.

END OF SECTION 16050

SECTION 16075 – ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes electrical identification materials and devices required to comply with ANSI C2, NFPA 70, OSHA standards, and authorities having jurisdiction.

1.3 SUBMITTALS

- A. No submittals.

1.4 QUALITY ASSURANCE

- A. Comply with ANSI C2.
- B. Comply with NFPA 70.
- C. Comply with ANSI A13.1 and NFPA 70 for color-coding.

PART 2 - PRODUCTS

2.1 RACEWAY AND CABLE LABELS

- A. Comply with ANSI A13.1, Table 3, for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
 - 1. Color: Black letters on orange field.
 - 2. Legend: Indicates voltage and service.
- B. Adhesive Labels: Preprinted, flexible, self-adhesive vinyl with legend overlaminated with a clear, weather- and chemical-resistant coating.
- C. Pretensioned, Wraparound Plastic Sleeves: Flexible, preprinted, color-coded, acrylic band sized to suit the diameter of the line it identifies and arranged to stay in place by pretensioned gripping action when placed in position.
- D. Consider alternatives before specifying self-adhesive product in paragraph below. See Editing Instruction No. 1 in the Evaluations.
- E. Colored Adhesive Tape: Self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide (0.08 mm thick by 25 to 51 mm wide).
- F. Underground-Line Warning Tape: Permanent, bright-colored, continuous-printed, vinyl tape.

1. Not less than 6 inches wide by 4 mils thick (152 mm wide by 0.102 mm thick).
 2. Compounded for permanent direct-burial service.
 3. Embedded continuous metallic strip or core.
 4. Printed legend indicating type of underground line.
- G. Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.
- H. Aluminum, Wraparound Marker Bands: Bands cut from 0.014-inch- (0.4-mm-) thick aluminum sheet, with stamped or embossed legend, and fitted with slots or ears for permanently securing around wire or cable jacket or around groups of conductors.

2.2 NAMEPLATES AND SIGNS

- A. Safety Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145.
- B. Engraved Plastic Nameplates and Signs: Engraving stock, melamine plastic laminate, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. in. (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.
1. Engraved legend with black letters on white face.
 2. Punched or drilled for mechanical fasteners.
- C. Baked-Enamel Signs for Interior Use: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for the application. 1/4-inch (6.4-mm) grommets in corners for mounting.
- D. Exterior, Metal-Backed, Butyrate Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for the application. 1/4-inch (6.4-mm) grommets in corners for mounting.
- E. Fasteners for Nameplates and Signs: Self-tapping, stainless-steel screws or No. 10/32, stainless-steel machine screws with nuts and flat and lock washers.

2.3 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking, Type 6/6 nylon cable ties.
1. Minimum Width: 3/16 inch (5 mm).
 2. Tensile Strength: 50 lb (22.3 kg) minimum.
 3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
 4. Color: According to color-coding.
- B. Paint: Formulated for the type of surface and intended use.
1. Primer for Galvanized Metal: Single-component acrylic vehicle formulated for galvanized surfaces.
 2. Primer for Concrete Masonry Units: Heavy-duty-resin block filler.
 3. Primer for Concrete: Clear, alkali-resistant, binder-type sealer.

4. Enamel: Silicone-alkyd or alkyd urethane as recommended by primer manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Identification Materials and Devices: Install at locations for most convenient viewing without interference with operation and maintenance of equipment.
- B. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and other designations with corresponding designations in the Contract Documents or with those required by codes and standards. Use consistent designations throughout Project.
- C. Sequence of Work: If identification is applied to surfaces that require finish, install identification after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before applying.
- E. Circuits with More Than 600 V: Identify raceway and cable with "DANGER--HIGH VOLTAGE" in black letters 2 inches (51 mm) high, stenciled with paint at 10-foot (3-m) intervals over a continuous, painted orange background. Identify the following:
 1. Entire floor area directly above conduits running beneath and within 12 inches (305 mm) of a basement or ground floor that is in contact with earth or is framed above unexcavated space.
 2. Wall surfaces directly external to conduits concealed within wall.
 3. All accessible surfaces of concrete envelope around conduits in vertical shafts, exposed in the building, or concealed above suspended ceilings.
 4. Entire surface of exposed conduits.
- F. Install painted identification according to manufacturer's written instructions and as follows:
 1. Clean surfaces of dust, loose material, and oily films before painting.
 2. Prime surfaces using type of primer specified for surface.
 3. Apply one intermediate and one finish coat of enamel.
- G. Color Banding Raceways and Exposed Cables: Band exposed and accessible raceways of the systems listed below:
 1. Bands: Pretensioned, wraparound plastic sleeves; colored adhesive tape; or a combination of both. Make each color band 2 inches (51 mm) wide, completely encircling conduit, and place adjacent bands of two-color markings in contact, side by side.
 2. Band Locations: At changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.
 3. Apply the following colors to the systems listed below:
 - a. Fire Alarm System: Red.
 - b. Fire-Suppression Supervisory and Control System: Red and yellow.
 - c. Combined Fire Alarm and Security System: Red and blue.

- d. Security System: Blue and yellow.
 - e. Mechanical and Electrical Supervisory System: Green and blue.
 - f. Telecommunication System: Green and yellow.
- H. Caution Labels for Indoor Boxes and Enclosures for Power and Lighting: Install pressure-sensitive, self-adhesive labels identifying system voltage with black letters on orange background. Install on exterior of door or cover.
- I. Circuit Identification Labels on Boxes: Install labels externally.
 - 1. Exposed Boxes: Pressure-sensitive, self-adhesive plastic label on cover.
 - 2. Concealed Boxes: Plasticized card-stock tags.
 - 3. Labeling Legend: Permanent, waterproof listing of panel and circuit number or equivalent.
- J. Paths of Underground Electrical Lines: During trench backfilling, for exterior underground power, control, signal, and communication lines, install continuous underground plastic line marker located directly above line at 6 to 8 inches (150 to 200 mm) below finished grade. Where width of multiple lines installed in a common trench or concrete envelope does not exceed 16 inches (400 mm) overall, use a single line marker. Install line marker for underground wiring, both direct-buried cables and cables in raceway.
- K. Color-Coding of Secondary Phase Conductors: Use the following colors for service feeder, and branch-circuit phase conductors:
 - 1. 208/120-V Conductors:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - 2. 480/277-V Conductors:
 - a. Phase A: Brown.
 - b. Phase B: Orange.
 - c. Phase C: Yellow
 - 3. Factory apply color the entire length of conductors, except the following field-applied, color-coding methods may be used instead of factory-coded wire for sizes larger than No. 10 AWG:
 - a. Colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Use 1-inch- (25-mm-) wide tape in colors specified. Adjust tape bands to avoid obscuring cable identification markings.
 - b. Colored cable ties applied in groups of three ties of specified color to each wire at each terminal or splice point starting 3 inches (76 mm) from the terminal and spaced 3 inches (76 mm) apart. Apply with a special tool or pliers, tighten to a snug fit, and cut off excess length.
- L. Power-Circuit Identification: Metal tags or aluminum, wraparound marker bands for cables, feeders, and power circuits in vaults, pull and junction boxes, manholes, and switchboard rooms.

1. Legend: 1/4-inch- (6.4-mm-) steel letter and number stamping or embossing with legend corresponding to indicated circuit designations.
 2. Tag Fasteners: Nylon cable ties.
 3. Band Fasteners: Integral ears.
- M. Apply identification to conductors as follows:
1. Conductors to Be Extended in the Future: Indicate source and circuit numbers.
 2. Multiple Power or Lighting Circuits in the Same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color-coding to identify circuits' voltage and phase.
 3. Multiple Control and Communication Circuits in the Same Enclosure: Identify each conductor by its system and circuit designation. Use a consistent system of tags, color-coding, or cable marking tape.
- N. Apply warning, caution, and instruction signs as follows:
1. Warnings, Cautions, and Instructions: Install to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.
 2. Emergency Operation: Install engraved laminated signs with white legend on red background with minimum 3/8-inch- (9-mm-) high lettering for emergency instructions on power transfer, load shedding, and other emergency operations.
- O. Equipment Identification Labels: Engraved plastic laminate. Install on each unit of equipment, including central or master unit of each system. This includes power, lighting, communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high lettering on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high. Use white lettering on black field. Apply labels for each unit of the following categories of equipment using mechanical fasteners:
1. Panelboards, electrical cabinets, and enclosures.
 2. Access doors and panels for concealed electrical items.
 3. Electrical switchgear and switchboards.
 4. Emergency system boxes and enclosures.
 5. Disconnect switches.
 6. Enclosed circuit breakers.
 7. Motor starters.
 8. Push-button stations.
 9. Power transfer equipment.
 10. Contactors.
 11. Remote-controlled switches.
 12. Control devices.
 13. Transformers.
 14. Power-generating units.
 15. Telephone switching equipment.
 16. Clock/program master equipment.
 17. Fire alarm master station or control panel.

END OF SECTION 16075

SECTION 16120 - CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

1.3 SUBMITTALS

- A. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.4 QUALITY ASSURANCE

- A. Listing and Labeling: Provide wires and cables specified in this Section that are listed and labeled.
 - 1. The Terms "Listed" and "Labeled" as defined in NFPA 70, Article 100.
 - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.
- B. Comply with NFPA 70.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver wires and cables according to NEMA WC 26.

1.6 COORDINATION

- A. Coordinate layout and installation of cables with other installations.
- B. Revise locations and elevations from those indicated, as required to suit field conditions and as approved by Engineer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

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

2.2 CONDUCTORS AND CABLES

A. Manufacturers:

1. American Insulated Wire Corp.; a Leviton Company.
2. General Cable Corporation.
3. Rome Cable Company.
4. Southwire Co.

- B. Refer to Part 3 "Conductor and Insulation Applications" Article for insulation type, cable construction, and ratings.

- C. Conductor Material: Copper complying with NEMA WC 5 or 7; solid conductor for No. 10 AWG and smaller, stranded for No. 8 AWG and larger.

- D. Conductor Insulation Types: Type THW, THHN-THWN, XHHW and SO complying with NEMA WC 5 or 7.

- E. Multiconductor Cable: Armored cable Type AC, Metal-clad cable Type MC, and Type SO with ground wire. Armor shall be steel interlocked covering.

2.3 CONNECTORS AND SPLICES

A. Manufacturers:

1. AFC Cable Systems, Inc.
2. AMP Incorporated/Tyco International.
3. Hubbell/Anderson.
4. O-Z/Gedney; EGS Electrical Group LLC.
5. 3M Company; Electrical Products Division.

- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.4 HEAT TRACE CABLES AND COMPONENTS

- A. Provide a heat trace freeze protection system for above ground piping with a minimum rating of -20°F. Basis of Design: Raychem by Tyco Thermal Controls.

Other Approved Manufacturers:

1. Nelson Heat Trace – Emerson Industrial Automation

- B. The Raychem XL-Trace System shall be provided with all required control monitoring devices and 30-mA ground fault protection device.

- C. System shall be UL listed and FM approved for non-hazardous locations. Where hazardous locations apply comply with all current NFPA and EPA requirements.
- D. The self regulating, Raychem 12XL2 (12 watt/ft) heating cable shall be permanently secured to the metallic pipes with Raychem GT-66 glass reinforced tape. The cable shall be minimum 20 amp, 208 volt rated.
- E. For above ground system include the following devices:
 - 1. Power Connector – RayClip-PC
 - 2. Electronic thermostat – Raychem model EC-TS-AM8.
 - 3. Splices – RayClic-S
 - 4. Tees – RayClic-T
 - 5. End seal – RayClic – E
 - 6. Provide all miscellaneous installation components required by the manufacturer for a turnkey installation.

PART 3 - EXECUTION

3.1 CONDUCTOR AND INSULATION APPLICATIONS

- A. Service Entrance: Type THHN-THWN, single conductors in raceway, XHHW, single conductors in raceway.
- B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and in Crawlspace: Type THHN-THWN, single conductors in raceway.
- E. Exposed Branch Circuits, including in Crawlspace: Type THHN-THWN, single conductors in raceway.
- F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway, Armored cable Type AC, Metal-clad cable Type MC.
- G. Branch Circuits Concealed in Concrete and below Slabs-on-Grade: Type THHN-THWN, single conductors in raceway.
- H. Branch circuit homeruns exposed: Type THHN-THWN, single conductors in EMT or RMC.
- I. Cord Drops and Portable Appliance Connections: Type SO, hard service cord.
- J. Fire Alarm Circuits: Type THHN-THWN, in raceway or Power-limited, fire-protective, signaling circuit cable in steel armor spiral cover, colored red.
- K. Class 1 Control Circuits: Type THHN-THWN, in raceway.
- L. Class 2 Control Circuits: Power-limited cable, concealed in building finishes.

3.2 INSTALLATION

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Use pulling means; including fish tape, cable, rope, and basket-weave wire/cable grips, which will not damage cables or raceway.
- D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.
- E. Support cables according to Division 16 Section "Common work results for Electrical – Materials and Methods."
- F. Provide an additional three hundred linear feet of cable/conductor and accessories of each type and size used on the project to accommodate any changes required to resolve interferences or directed by the Engineer.
- G. Seal around cables penetrating fire-rated elements according to Division 7 Section "Through-Penetration Firestop Systems."
- H. Identify and color-code conductors and cables according to Division 16 Section "Electrical Identification."

3.3 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than un-spliced conductors.
 - 1. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches (300 mm) of slack.

3.4 FIELD QUALITY CONTROL

- A. Testing: Perform the following field quality-control testing:
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test for compliance with requirements.
 - 2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.3.1. Certify compliance with test parameters.

B. Test Reports: Prepare a written report to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

END OF SECTION 16120

SECTION 16130 – RACEWAYS & BOXES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
- B. Related Sections include the following:
 - 1. Division 16 Section "Underground Ducts" for exterior ductbanks, manholes, and underground utility construction.
 - 2. Division 16 Section "Fire Rated Penetration Systems" for firestopping materials and installation at penetrations through walls, ceilings, and other fire-rated elements.
 - 3. Division 16 Section "Common Work Results for Electrical – Materials and Methods" for supports, anchors, and identification products.
 - 4. Division 16 Section "Wiring Devices" for devices installed in boxes and for floor-box service fittings.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. ENT: Electrical nonmetallic tubing.
- C. FMC: Flexible metal conduit.
- D. IMC: Intermediate metal conduit.
- E. LFMC: Liquidtight flexible metal conduit.
- F. LFNC: Liquidtight flexible metal conduit.
- G. RMC: Rigid Metal Conduit.
- H. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

- B. Comply with NFPA 70.

1.6 COORDINATION

- A. Coordinate layout and installation of raceways, boxes, enclosures, cabinets, and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 METAL CONDUIT AND TUBING

- A. Manufacturer:
 - 1. AFC Cable Systems, Inc.
 - 2. Alflec Inc.
 - 3. Anamet Electrical, Inc.; Anaconda Metal Hose.
 - 4. Electri-Flex Co.
 - 5. Grinnell Co./Tyco International; Allied Tube and Conduit Div.
 - 6. LTV Steel Tubular Products Company.
 - 7. Manhattan/CDT/Cole-Flex.
 - 8. O-Z Gedney; Unit of General Signal.
 - 9. Wheatland Tube Co.
- B. Rigid Steel Conduit: ANSI C80.1.
- C. IMC: ANSI C80.6.
- D. EMT and Fittings: ANSI C80.3.
 - 1. Fittings: Compression type up to 1-1/2 in. conduit, 2 in. and larger use set screw type.
- E. FMC: Zinc-coated steel.
- F. LFMC: Flexible steel conduit with PVC jacket.
- G. Fittings: NEMA FB 1; compatible with conduit and tubing materials.

2.3 METAL WIREWAYS

- A. Manufacturer:

1. Hoffman.
 2. Square D.
- .
- B. Material and Construction: Sheet metal sized and shaped as indicated, NEMA 1 or 3R.
 - C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, plastic edge covers, and other fittings to match and mate with wireways as required for complete system.
 - D. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.
 - E. Wireway Covers: Screw cover type, Flanged and gasketed type at exterior.
 - F. Finish: Manufacturer's standard enamel finish.

2.4 SURFACE RACEWAYS

- A. Surface Metal Raceways: Galvanized steel with snap-on covers. Finish with manufacturer's standard grey finish coat.
 1. Manufacturer:
 - a. Walker Systems, Inc.; Wiremold Company (The).
 - b. Wiremold Company (The); Electrical Sales Division.
- B. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.
- C. Surface Non-Metallic Raceways: Polyvinyl with snap-on covers. Finish with manufacturer's light ivory color.
 1. Manufacturer:
 - a. Hubbell Inc.
 - B. Legrand (Wiremold)
- D. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.
 1. Single channel polyvinyl (raceway for branch circuit power and/or low potential services shall be Premise Trak (Latching) as manufactured by Hubbell.
 2. The two-piece single channel shall consist of a base section, 5 feet length, latching snap on cover, 0.38 in 2 channel base. Provide 1-gang or 2-gang boxes as required. Apply channel with adhesive.
 3. Two channel polyvinyl raceway for branch circuit power and low potential services shall be Wall Trak as manufactured by Hubbell.
 4. The two-piece, two channel raceway shall consist of a base section, 5 feet length, latching snap on cover, 0.81 in 2 and 0.79 in 2 channel bases. Provide 1-gang or 2-gang boxes as required. Apply base with adhesive.

2.5 BOXES, ENCLOSURES, AND CABINETS

RACEWAYS AND BOXES

A. Manufacturer:

1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
2. Emerson/General Signal; Appleton Electric Company.
3. Erickson Electrical Equipment Co.
4. Hoffman.
5. Hubbell, Inc.; Killark Electric Manufacturing Co.
6. O-Z/Gedney; Unit of General Signal.
7. RACO; Division of Hubbell, Inc.
8. Robroy Industries, Inc.; Enclosure Division.
9. Scott Fetzer Com.; Adalet-PLM Division.
10. Spring City Electrical Manufacturing Co.
11. Thomas & Betts Corporation.
12. Walker Systems, Inc.; Wiremold Company (The).
13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.

B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover.

D. Floor Boxes: Cast metal, fully adjustable, rectangular.

E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

F. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.

G. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures: Plastic, finished inside with radio-frequency-resistant paint.

H. Grade pull boxes and handholes: Stackable assembly with minimum lid load capacity of 15,000 lbs per ANSI/SCTE 77. Covers/lids shall have logo tag "ELEC" for all lighting and convenience circuitry ONLY. Recommended manufacturer "Quazite" by Hubbell Lenior City, Inc. See details on construction drawings for sizes and locations.

I. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage and include accessory feet where required for freestanding equipment.

2.6 FACTORY FINISHES

A. Finish: For raceway, enclosure, or cabinet components, provide manufacturer's standard gray paint applied to factory-assembled surface raceways, enclosures, and cabinets before shipping.

PART 3 - EXECUTION

RACEWAYS AND BOXES

16130-4

3.1 RACEWAY APPLICATION

A. Outdoors:

1. Exposed: Rigid steel or IMC.
2. Concealed: Rigid steel or IMC.
3. Underground, Single Run: RMC or RNC.
4. Underground, Grouped: RMC or RNC.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
6. Boxes and Enclosures: NEMA 250, Type 3R or 4.

B. Indoors:

1. Exposed: EMT, surface metal raceway.
2. Concealed: EMT.
3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC; except use LFMC in damp or wet locations.
4. Damp or Wet Locations: Rigid steel conduit.
5. Boxes and Enclosures: NEMA 250, Type 1, except as follows:
 - a. Damp or Wet Locations: NEMA 250, Type 4..

C. Minimum Raceway Size: 3/4-inch trade size (DN 21)

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.

3.2 INSTALLATION

- A. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- B. Complete raceway installation before starting conductor installation.
- C. Support raceways as specified in Division 16 Section "Common Work Results for Electrical – Materials and Methods."
- D. Install temporary closures to prevent foreign matter from entering raceways.
- E. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.
- F. Provide an additional one hundred feet of raceway and accessories of each type and size used on the project to accommodate any changes required to resolve interferences or as directed by the Engineer.

- G. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.
- H. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
 - 1. Install concealed raceways with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.
- I. Raceways Embedded in Slabs: Install in middle 1/3 of slab thickness where practical and leave at least 2 inches (50 mm) of concrete cover.
 - 1. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
 - 2. Space raceways laterally to prevent voids in concrete.
 - 3. Run conduit larger than 1-inch trade size (DN 27) parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
 - 4. Change from nonmetallic tubing to Schedule 40 nonmetallic conduit, rigid steel conduit, or IMC before rising above the floor.
- J. Install exposed raceways parallel or at right angles to nearby surfaces or structural members and follow surface contours as much as possible.
 - 1. Run parallel or banked raceways together on common supports.
 - 2. Make parallel bends in parallel or banked runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.
- K. Join raceways with fittings designed and approved for that purpose and make joints tight.
 - 1. Use insulating bushings to protect conductors.
- L. Terminations:
 - 1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.
 - 2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.
- M. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire.
- N. Telephone and Signal System Raceways, 2-Inch Trade Size (DN 53) and Smaller: In addition to above requirements, install raceways in maximum lengths of 150 feet (45 m) and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements

- O. Install raceway sealing fittings at suitable, approved, and 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:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2. Where otherwise required by NFPA 70.
- P. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches (150 mm) above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.
- Q. Flexible Connections: Use maximum of 72 inches (1830 mm) of flexible conduit for recessed and semirecessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use LFMC in damp or wet locations. Install separate ground conductor across flexible connections.
- R. Provide five additional boxes (floor, junction, etc.) and accessories of each size and type used on the project to accommodate any changes required to resolve interferences.
- S. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying raceways to receptacle or fixture ground terminals.
- T. Set floor boxes level and flush with finished floor surface.
- U. Set floor boxes level. Trim after installation to fit flush with finished floor surface.
- V. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

3.3 PROTECTION

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.4 CLEANING

- A. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes and repair damaged finishes.

END OF SECTION 16130

SECTION 16410 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes individually mounted enclosed switches and circuit breakers used for the following:
 - 1. Service disconnecting means.
 - 2. Feeder and branch-circuit protection.
 - 3. Motor and equipment disconnecting means.
- B. Related Sections include the following:
 - 1. Division 16 Section "Wiring Devices" for attachment plugs, receptacles, and toggle switches used for disconnecting means.
 - 2. Division 16 Section "Switchboards" for individually enclosed, fusible switches used as feeder protection.
 - 3. Division 16 Section "Fuses" for fusible devices.

1.3 DEFINITIONS

- A. GFCI: Ground-fault circuit interrupter.
- B. RMS: Root mean square.
- C. SPDT: Single pole, double throw.

1.4 SUBMITTALS

- A. Product Data: For each type of switch, circuit breaker, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each switch and circuit breaker.
 - 1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:

- a. Enclosure types and details for types other than NEMA 250, Type 1.
 - b. Current and voltage ratings.
 - c. Short-circuit current rating.
 - d. UL listing for series rating of installed devices.
 - e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
- 2. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
- C. Qualification Data: Submit data for testing agencies indicating that they comply with qualifications specified in "Quality Assurance" Article.
- D. Field Test Reports: Submit written test reports and include the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- E. Manufacturer's field service report.
- F. Maintenance Data: For enclosed switches and circuit breakers and for components to include in maintenance manuals specified in Division 1. In addition to requirements specified in Division 1 Section "Closeout Procedures," include the following:
 - 1. Routine maintenance requirements for components.
 - 2. Manufacturer's written instructions for testing and adjusting switches and circuit breakers.
 - 3. Time-current curves, including selectable ranges for each type of circuit breaker.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Testing agency that is a member company of the InterNational Electrical Testing Association and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NEMA AB 1 and NEMA KS 1.
- D. Comply with NFPA 70.

- E. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
 - 1. Ambient Temperature: Not less than **minus 22 deg F (minus 30 deg C)** and not exceeding **104 deg F (40 deg C)**.
 - 2. Altitude: Not exceeding **6600 feet (2000 m)**.

1.7 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Spares: For the following:
 - a. Potential Transformer Fuses-Provide an additional 6 fuses of each type utilized on this project.
 - b. Control-Power Fuses-Provide an additional 6 fuses of each type utilized on this project.
 - c. Fuses and Fusible Devices for Fused Circuit Breakers-Provide an additional 6 fuses of each type utilized on this project.
 - d. Fuses for Fused Switches-Provide an additional 10 fuses of each type utilized on this project.
 - e. Fuses for Fused Power-Circuit Devices-Provide an additional 10 fuses of each type utilized on this project.
 - 2. Spare Indicating Lights-Provide an additional 6 lights of each type utilized on this project.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Fusible Switches:
 - a. Eaton Corp.; Cutler-Hammer Products.
 - b. General Electric Co.; Electrical Distribution & Control Division.
 - c. Siemens Energy & Automation, Inc.
 - d. Square D Co.
2. Molded-Case Circuit Breakers:
 - a. Eaton Corp.; Cutler-Hammer Products.
 - b. General Electric Co.; Electrical Distribution & Control Division.
 - c. Klockner-Moeller.
 - d. Siemens Energy & Automation, Inc.
 - e. Square D Co.
3. Combination Circuit Breaker and Ground-Fault Trip:
 - a. Eaton Corp.; Cutler-Hammer Products.
 - b. General Electric Co.; Electrical Distribution & Control Division.
 - c. Siemens Energy & Automation, Inc.
 - d. Square D Co.
4. Molded-Case, Current-Limiting Circuit Breakers:
 - a. Eaton Corp.; Cutler-Hammer Products.
 - b. General Electric Co.; Electrical Distribution & Control Division.
 - c. Siemens Energy & Automation, Inc.
 - d. Square D Co.
5. Integrally Fused, Molded-Case Circuit Breakers:
 - a. Eaton Corp.; Cutler-Hammer Products.
 - b. General Electric Co.; Electrical Distribution & Control Division.
 - c. Siemens Energy & Automation, Inc.
 - d. Square D Co.

2.2 ENCLOSED SWITCHES

- A. Enclosed, Nonfusible Switch: NEMA KS 1, Type HD, with lockable handle.
- B. Enclosed, Fusible Switch, 800 A and Smaller: NEMA KS 1, Type HD, with clips to accommodate specified fuses, lockable handle with two padlocks, and interlocked with cover in closed position.

2.3 ENCLOSED CIRCUIT BREAKERS

- A. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 3. Electronic Trip Unit Circuit Breakers: RMS sensing; field-replaceable rating plug; with the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response.
 4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
 5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
 6. GFCI Circuit Breakers: Single- and two-pole configurations with 5-mA trip sensitivity.
 7. Molded-Case Switch: Molded-case circuit breaker without trip units.
- B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.
1. Lugs: Mechanical style suitable for number, size, trip ratings, and material of conductors.
 2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
 3. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 4. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system.
 5. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
 6. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
 7. Auxiliary Switch: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
 8. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
 9. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.

2.4 ENCLOSURES

- A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions of installed location.
1. Outdoor Locations: NEMA 250, Type 3R.
 2. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
 3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

4. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

2.5 FACTORY FINISHES

- A. Manufacturer's standard prime-coat finish ready for field painting.
- B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested enclosures before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance.
 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with mounting and anchoring requirements specified in Division 16 Section "Seismic Controls for Electrical Work."
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- C. Provide an additional ten branch breakers with enclosures and accessories of each size, phase and voltage as required to accommodate changes to resolve interferences or as directed by the Engineer.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 16 Section "Common Work Results for Electrical – Materials and Methods"
- B. Enclosure Nameplates: Label each enclosure with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.4 CONNECTIONS

- A. Install equipment grounding connections for switches and circuit breakers with ground continuity to main electrical ground bus.
- B. Install power wiring. Install wiring between switches and circuit breakers, and control and indication devices.

- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each enclosed switch, circuit breaker, component, and control circuit.
 - 2. Test continuity of each line- and load-side circuit.
- B. Testing: After installing enclosed switches and circuit breakers and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
 - 1. Procedures: Perform each visual and mechanical inspection and electrical test indicated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- C. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Open or remove doors or panels so connections are accessible to portable scanner.
 - 1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each unit 11 months after date of Substantial Completion.
 - 2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 3. Record of Infrared Scanning: Prepare a certified report that identifies switches and circuit breakers checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

- A. Set field-adjustable switches and circuit-breaker trip ranges.

3.7 CLEANING

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

END OF SECTION 16410

SECTION 16420 - ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes ac general-purpose controllers rated 600 V and less that are supplied as enclosed units.
- B. Related Sections include the following:
 - 1. Division 16 Section "Transient Voltage Suppression" for low-voltage power, control, and communication surge suppressors.
 - 2. Division 16 Section "Fuses" for fuses in fusible switches.

1.3 SUBMITTALS

- A. Product Data: For each type of enclosed controller. Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each enclosed controller.
 - 1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Enclosure types and details.
 - b. Nameplate legends.
 - c. Short-circuit current rating of integrated unit.
 - d. UL listing for series rating of overcurrent protective devices in combination controllers.
 - e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices in combination controllers.
 - 2. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
- C. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around enclosed controllers where pipe and ducts are prohibited. Show enclosed controller layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

- D. Qualification Data: For firms and persons specified in "Quality Assurance" Article.
- E. Field Test Reports: Written reports specified in Part 3.
- F. Manufacturer's field service report.
- G. Maintenance Data: For enclosed controllers and components to include in maintenance manuals specified in Division 1. In addition to requirements specified in Division 1 Section "Closeout Procedures," include the following:
 - 1. Routine maintenance requirements for enclosed controllers and all installed components.
 - 2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
- H. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.
- I. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that dip switch settings for motor running overload protection suit actual motor to be protected.
- J. Should the contractor submit any substitution (including other approved manufacturers) other than the specified product the contractor shall be responsible for all electrical, mechanical, structural, and architectural revisions as required to accommodate the installation of the substituted equipment at no additional cost to the owner.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Maintain, within 100 miles (160 km) of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.
- B. Testing Agency Qualifications: An independent testing agency with the experience and capability to satisfactorily conduct the testing indicated, as documented according to ASTM E 548.
- C. Source Limitations: Obtain enclosed controllers of a single type through one source from a single manufacturer.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Comply with NFPA 70.
- F. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed controllers, including clearances between enclosed controllers, and for adjacent surfaces and other items. Comply with indicated maximum dimensions.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- B. If stored in areas subjected to weather, cover enclosed controllers to protect from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install electric heating of sufficient wattage to prevent condensation.

1.6 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Architect at least two days in advance of proposed utility interruptions. Identify extent and duration of utility interruptions.
 - 2. Indicate method of providing temporary utilities.
 - 3. Do not proceed with utility interruptions without Architect's written permission.

1.7 COORDINATION

- A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3 Section "Cast-in-Place Concrete."
- C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."
- D. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.
- E. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Spare Fuses: Furnish three spare for every six installed, but not less than one set of three of each type and rating.

2. Indicating Lights: Two of each type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Manual and Magnetic Enclosed Controllers:
 - a. ABB Power Distribution, Inc.; ABB Control, Inc. Subsidiary.
 - b. Eaton Corp.; Cutler-Hammer Products.
 - c. Rockwell Automation Allen-Bradley Co.; Industrial Control Group.
 - d. Siemens/Furnas Controls.
 - e. Square D Co.
 2. Variable-Frequency Controllers:
 - a. ABB Power Distribution, Inc.; ABB Control, Inc. Subsidiary.
 - b. Eaton Corp.; Cutler-Hammer Products.
 - c. MagneTek Drives and Systems.
 - d. Rockwell Automation Allen-Bradley Co.; Industrial Control Group.
 - e. Siemens/Furnas Controls.
 - f. Square D Co.

2.2 MANUAL ENCLOSED CONTROLLERS

- A. Description: NEMA ICS 2, general purpose, Class A, with toggle action and overload element.

2.3 MAGNETIC ENCLOSED CONTROLLERS

- A. Description: NEMA ICS 2, Class A, full voltage, nonreversing, across the line, unless otherwise indicated.
- B. Control Circuit: 120 V; obtained from integral control power transformer with a control power transformer of sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.
- C. Combination Controller: Factory-assembled combination controller and disconnect switch.
 1. Circuit-Breaker Disconnecting Means: NEMA AB 1, motor-circuit protector with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
- D. Overload Relay: Ambient-compensated type with inverse-time-current characteristic and NEMA ICS 2, Class 10 tripping characteristic. Provide with heaters or sensors in each phase matched to nameplate full-load current of specific motor to which they connect and with appropriate adjustment for duty cycle.

- E. Adjustable Overload Relay: Dip switch selectable for motor running overload protection with NEMA ICS 2, Class 10 tripping characteristic, and selected to protect motor against voltage and current unbalance and single phasing. Provide relay with Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
- F. Multispeed Enclosed Controller: Match controller to motor type, application, and number of speeds; include the following accessories:
 - 1. Compelling relay to ensure motor will start only at low speed.
 - 2. Accelerating relay to ensure properly timed acceleration through speeds lower than that selected.
 - 3. Decelerating relay to ensure automatically timed deceleration through each speed.
- G. Star-Delta Controller: NEMA ICS 2, closed transition with adjustable time delay.
- H. Part-Winding Controller: NEMA ICS 2, closed transition with separate overload relays for starting and running sequences.
- I. Autotransformer Reduced-Voltage Controller: NEMA ICS 2, closed transition.
- J. Solid-State, Reduced-Voltage Controller: NEMA ICS 2, suitable for use with NEMA MG 1, Design B, polyphase, medium induction motors.
 - 1. Adjustable acceleration rate control utilizing voltage or current ramp, and adjustable starting torque control with up to 500 percent current limitation for 20 seconds.
 - 2. Surge suppressor in solid-state power circuits providing 3-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
 - 3. LED indicators showing motor and control status, including the following conditions:
 - a. Control power available.
 - b. Controller on.
 - c. Overload trip.
 - d. Loss of phase.
 - e. Shorted silicon-controlled rectifier.
 - 4. Automatic voltage-reduction controls to reduce voltage when motor is running at light load.
 - 5. Motor running contactor operating automatically when full voltage is applied to motor.

2.4 VARIABLE-FREQUENCY CONTROLLERS

- A. Description: NEMA ICS 2, pulse-width-modulated, variable-frequency controller; listed and labeled as a complete unit and arranged to provide variable speed of a NEMA MG 1, Design B, 3-phase, induction motor by adjusting output voltage and frequency.
- B. Design and Rating: Match load type such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.
- C. Isolation Transformer: Match transformer voltage ratings and capacity to system and motor voltages; and controller, motor, drive, and load characteristics.

- D. Output Rating: 3-phase; 6 to 120 Hz, with horsepower constant throughout speed range.
- E. Starting Torque: 100 percent of rated torque or as indicated.
- F. Speed Regulation: Plus or minus 1 percent.
- G. Ambient Temperature: 0 to 40 deg C.
- H. Efficiency: 95 percent minimum at full load and 60 Hz.
- I. Minimum Displacement Power Factor at Input Terminals: 95 percent.
- J. Isolated control interface allows controller to follow control signal over an 11:1 speed range.
 - 1. Electrical Signal: 4 to 20 mA at 24 V.
 - 2. Pneumatic Signal: 3 to 15 psig (20 to 104 kPa).
- K. Internal Adjustability: Include the following internal adjustment capabilities:
 - 1. Minimum Speed: 5 to 25 percent of maximum rpm.
 - 2. Maximum Speed: 80 to 100 percent of maximum rpm.
 - 3. Acceleration: 2 to 22 seconds.
 - 4. Deceleration: 2 to 22 seconds.
 - 5. Current Limit: 50 to 110 percent of maximum rating.
- L. Multiple-Motor Capability: Controller suitable for service to multiple motors and having a separate overload relay and protection for each controlled motor. Overload relay shall shut off controller and motors served by it when overload relay is tripped.
- M. Self-protection and reliability features shall include the following:
 - 1. Input transient protection by means of surge suppressors.
 - 2. Snubber networks to protect against malfunction due to system voltage transients.
 - 3. Motor Overload Relay: Adjustable and capable of NEMA 250, Class 10 performance.
 - 4. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
 - 5. Instantaneous overcurrent trip.
 - 6. Loss-of-phase protection.
 - 7. Reverse-phase protection.
 - 8. Under- and overvoltage trips.
 - 9. Overtemperature trip.
 - 10. Short-circuit protection.
- N. Automatic Reset/Restart: Attempt three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Restarting during deceleration shall not damage controller, motor, or load.
- O. Power-Interruption Protection: Prevents motor from re-energizing after a power interruption until motor has stopped.
- P. Status Lights: Door-mounted LED indicators shall indicate the following conditions:

1. Power on.
 2. Run.
 3. Overvoltage.
 4. Line fault.
 5. Overcurrent.
 6. External fault.
- Q. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual speed control potentiometer and elapsed time meter.
- R. Indicating Devices: Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate controller output current, voltage, and frequency.
- S. Manual Bypass: Magnetic contactor shall be arranged to safely transfer motor between controller output and bypass controller circuit when motor is at zero speed. Controller-off-bypass, selector-switch indicator lights set and indicate mode selection.
- T. Integral Disconnecting Means: NEMA AB 1, instantaneous-trip circuit breaker with lockable handle.
- U. Bypass Controller: NEMA ICS 2, full-voltage, nonreversing enclosed controller with across-the-line starting capability in manual-bypass mode. Provide motor overload protection under both modes of operation with control logic that allows common start-stop capability in either mode.
- V. Isolating Switch: Non-load-break switch arranged to isolate variable-frequency controller and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode.
- W. Remote Indicating Circuit Terminals: Mode selection, controller status, and controller fault.

2.5 ENCLOSURES

- A. Description: Flush- or surface-mounted cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to comply with environmental conditions at installed location.
1. Outdoor Locations: NEMA 250, Type 3R.
 2. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
 3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 4. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

2.6 ACCESSORIES

- A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.
- B. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.
- C. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

- D. Control Relays: Auxiliary and adjustable time-delay relays.
- E. Elapsed Time Meters: Heavy duty with digital readout in hours.
- F. Meters: Panel type, 2-1/2-inch (64-mm) minimum size with 90- or 120-degree scale and plus or minus 2 percent accuracy. Where indicated, provide transfer device with an off position. Meters shall indicate the following:
 - 1. Ammeter: Output current, with current sensors rated to suit application.
 - 2. Voltmeter: Output voltage.
 - 3. Frequency Meter: Output frequency.
- G. Phase-Failure and Undervoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connection. Provide adjustable undervoltage setting.
- H. Current-Sensing, Phase-Failure Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connection; arranged to operate on phase failure, phase reversal, current unbalance of from 30 to 40 percent, or loss of supply voltage; with adjustable response delay.

2.7 FACTORY FINISHES

- A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested enclosed controllers before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and surfaces to receive enclosed controllers for compliance with requirements, installation tolerances, and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Select features of each enclosed controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, drive, and load; and configuration of pilot device and control circuit affecting controller functions.
- B. Select horsepower rating of controllers to suit motor controlled.

3.3 INSTALLATION

- A. See Division 16 Section "Common Work Results for Electrical – Materials and Methods" for general installation requirements.

- B. For control equipment at walls, bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 16 Section "Common Work Results for Electrical – Materials and Methods."
- C. Install freestanding equipment on concrete bases complying with Division 3 Section "Cast-in-Place Concrete."
- D. Provide an additional two controllers with enclosures and accessories of each size, phase and voltage as required to accommodate changes to resolve interferences or as directed by the Engineer.
- E. Enclosed Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 16 Section "Fuses."

3.4 IDENTIFICATION

- A. Identify enclosed controller components and control wiring according to Division 16 Section "Common Work Results for Electrical – Materials and Methods."

3.5 CONTROL WIRING INSTALLATION

- A. Install wiring between enclosed controllers according to Division 16 Section "Conductors and Cables."
- B. Bundle, train, and support wiring in enclosures.
- C. Connect hand-off-automatic switch and other automatic-control devices where applicable.
 - 1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
 - 2. Connect selector switches with enclosed controller circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.6 CONNECTIONS

- A. Conduit installation requirements are specified in other Division 16 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.
- B. Ground equipment.
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.7 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each enclosed controller bus, component, connecting supply, feeder, and control circuit.
 2. Test continuity of each circuit.
- B. Testing: Perform the following field quality-control testing:
1. Perform each electrical test and visual and mechanical inspection indicated in NETA ATS, Sections 7.5, 7.6, and 7.16.
 2. Certify compliance with test parameters.
 3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including pretesting and adjusting solid-state controllers.
- D. Test Reports: Prepare a written report to record the following:
1. Test procedures used.
 2. Test results that comply with requirements.
 3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

3.8 ADJUSTING

- A. Set field-adjustable switches and circuit-breaker trip ranges.

3.9 CLEANING

- A. Clean enclosed controllers internally, on completion of installation, according to manufacturer's written instructions. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

3.10 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Verify that enclosed controllers are installed and connected according to the Contract Documents.
- C. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 16 Sections.
- D. Complete installation and startup checks according to manufacturer's written instructions.

3.11 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers and variable-frequency drives.

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
2. Review data in maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."
3. Schedule training with Owner, through Architect, with at least seven days' advance notice.

END OF SECTION 16420

SECTION 16941 - FUSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cartridge fuses rated 600 V ac and less for use in the following:
 - a. Control circuits.
 - b. Motor-control centers.
 - c. Panelboards.
 - d. Switchboards.
 - e. Enclosed controllers.
 - f. Enclosed switches.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Bussmann, by Eaton
 2. Edison
 3. Littlefuse, Inc.
 4. Mersen USA

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.
1. Type RK-1: 250-V, zero- to 600-A rating, 200 kAIC, time delay.
 2. Type RK-5: 250-V, zero- to 600-A rating, 200 kAIC, time delay.
 3. Type CC: 600-V, zero- to 30-A rating, 200 kAIC, fast acting.

4. Type CD: 600-V, 31- to 60-A rating, 200 kAIC, fast acting.
 5. Type J: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
 6. Type L: 600-V, 601- to 6000-A rating, 200 kAIC, time delay.
 7. Type T: 600-V, zero- to 1200-A rating, 200 kAIC, very fast acting.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - C. Comply with NEMA FU 1 for cartridge fuses.
 - D. Comply with NFPA 70.
 - E. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- B. Install spare-fuse cabinet(s) in location shown on the Drawings or as indicated in the field by Owner.

3.2 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Section 16075 "Electrical Identification" and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 16491