

SECTION 16000 - ELECTRICAL TABLE OF CONTENTS

PART 1 - GENERAL 1

1.1 TIME, MANNER AND REQUIREMENTS FOR SUBMITTING SUB-BIDS 1

1.2 GENERAL REQUIREMENTS 1

1.3 WORK INCLUDED 1

1.4 INTENT 2

1.5 RELATED WORK 2

1.6 STANDARD OF MATERIALS AND WORKMANSHIP 3

1.7 ABBREVIATIONS AND DEFINITIONS 3

1.8 EXAMINATION 4

1.9 CODES, STANDARDS, AND REGULATIONS 4

1.10 DRAWINGS 5

1.11 PERMITTING AND UTILITY COMPANY CHARGES 5

1.12 SUBMITTALS 6

1.13 REQUESTS FOR INTERPRETATION (RFIs) 7

1.14 RECORD DOCUMENTS 7

1.15 OPERATION AND MAINTENANCE DATA 7

1.16 CONNECTIONS TO EQUIPMENT 7

1.17 COORDINATION 8

~~1.18 FIRE ALARM SIGNAL SERVICE~~ 8

1.19 PROTECTION 8

1.20 GUARANTEE 9

1.21 DEMOLITION 9

PART 2 - PRODUCTS 9

2.1 SUPPORTING DEVICES 9

2.2 CONDUCTORS AND CABLES 10

2.3 RACEWAYS AND BOXES 10

2.4 WIRING DEVICES 12

2.5 ELECTRICAL IDENTIFICATION 13

2.6 GROUNDING 14

2.7 PANELBOARD 15

2.8 FUSES 17

2.9 DISCONNECT SWITCHES AND CIRCUIT BREAKERS 17

2.10 MOTOR CONTROLLERS 17

2.11 INTERIOR LIGHTING 18

2.12 EXTERIOR LIGHTING 19

~~2.13 FIRE ALARM SYSTEM~~ 19

2.14 TOUCHUP PAINT 23

PART 3 - INSTALLATION 23

3.1 EXAMINATION 23

3.2 PREPARATION 23

3.3 CUTTING AND PATCHING 23

3.4 ROUGH-IN 23

3.5 ELECTRICAL INSTALLATIONS 24

3.6 ELECTRICAL SUPPORTING METHODS 24

3.7 INSTALLATION OF ELECTRICAL SUPPORTING DEVICES 24

3.8 INSTALLATION OF CONDUCTORS AND CABLES 25

3.9 INSTALLATION OF RACEWAYS AND BOXES 26

3.10 INSTALLATION OF ELECTRICAL IDENTIFICATION 28

3.11 INSTALLATION OF GROUNDING SYSTEMS 29

3.12 INSTALLATION OF PANELBOARDS 30

3.13 INSTALLATION OF DISCONNECTS AND CIRCUIT BREAKERS 31

3.14 INSTALLATION OF INTERIOR LIGHTING 32

3.15 INSTALLATION OF EXTERIOR LIGHTING 32

~~3.16 INSTALLATION OF FIRE ALARM SYSTEMS~~ 33

3.17 TOUCHUP PAINTING 35

PART 1 - GENERAL

1.1 TIME, MANNER AND REQUIREMENTS

- A. The work to be done under this Section is shown on the drawings numbered: E-1, E-2, E-3, E-4, E-5, E-6, and E-7.
- B. The work to be done under this Section shall be fully coordinated with the following drawings and associated specification sections: C2.0.1 through C2.4.2, A.1 through A.22, S.1 through S.9, FP.1, FP.2, P.1, P.2, P.3, M.1D, M.1, M.1A, M.1B, M.2, M.3, M.4, FA.1 and FA.2.

1.2 GENERAL REQUIREMENTS

- A. Specifications and General Conditions, Drawings and sections within Division 1—Requirements which are hereby made a part of this section of the specifications.
- B. Refer to the drawings for further definition of location, extent, and details of the work described herein.
- C. Cooperate and coordinate with all trades in execution of the work described in this Section, so as to provide coordination with all trades for items such as - clearance for equipment maintenance & operation, proper voltages, correct receptacle types, etc.
- D. Where referred to, standard specifications of technical Societies, Manufacturer's Associations, and Federal Agencies shall include all amendments current as the date of issue of these Specifications.
- E. It is intended, for the guidance of the bidders, that the Manufacturer's name used first throughout this Section of the Specification, is that used in the design of the Electrical system. All material submitted shall be equal in all respects to that used in the design.
- F. The SubTrade Contractor for work of this Section shall become familiar with other Sections of the Specifications to determine the type and extent of work there under which affects the work of this trade, whether or not such work is specifically mentioned in this Section.

1.3 WORK INCLUDED

- A. Examine all Drawings and other Sections of Specifications for requirements that affect work of this Section 16000.
- B. Perform work and provide materials and equipment as shown on the Drawings and as specified herein. Work shall include, but not be limited to, all labor, materials, tools, equipment, insurance, transportation, temporary protection, supervision, and incidental items required for a complete installation. Drawings and specifications form complimentary requirements; provide work specified and not shown on drawings and work shown on drawings and not specified as though explicitly shown on both. Completely coordinate work of this Section with work of other Sections and Trades to provide a complete and functional installation.
- C. Provide all labor, equipment, material, implements and materials required to furnish and install all Electrical work, complete as shown on the drawings and noted herein. The following are major items of work included:
 - 1. Hoisting and rigging for equipment and materials specified herein.
 - 2. Core drilling, cutting and channeling for holes five (5) inches and less in diameter.
 - 3. Furnish and maintain in safe and adequate condition, all staging and scaffolding that is required for work of this section.
 - 4. Maintain temporary electrical system throughout building during construction.
 - 5. ~~Distribution panels.~~
 - 6. Panelboards.
 - 7. Disconnect switches and circuit breakers.
 - 8. Fuses.
 - 9. Variable frequency drives.
 - 10. Grounding.
 - 11. Raceways and boxes.
 - 12. Raceway support system.
 - 13. Surface metal raceway (SMR) systems.
 - 14. Conductors and cables.

15. Control / signal conductors.
16. Wiring devices, including but not limited to, receptacles, switches, occupancy sensors, time switches, etc.
17. Lighting control system.
18. Interior lighting.
19. Exterior lighting.
20. Electrical Supporting devices.
21. Pull boxes.
22. Junction boxes.
23. Electrical identification, including but not limited to, nameplates, device markings, cable and conduit identification, etc.
24. Fire and Smoke Stopping. Coordinate materials and methods with Section 07841.
25. Electrical identification, including but not limited to, nameplates, device markings, cable and conduit identification, etc.
- ~~26. Fire alarm system.~~
27. Submittals.
28. Coordination Drawings.
29. Record Documents.
30. Electrical acceptance tests.
31. Operation and Maintenance (O&M) Manuals.
32. System startup, demonstration and training.
33. All else shown and specified in the electrical contract documents.

1.4 INTENT

- A. Description in the Specifications, or the indication on the Drawings of equipment, materials, operation and methods, required that such items shall be of the quantity required, and the systems complete in every respect.
- B. The Specifications shall be considered an integral part of the accompanying Drawings. Any item or subject omitted from one or the other, but which is either mentioned or reasonably implied, shall be considered as properly and sufficiently specified. In the case of a conflict, the more demanding item shall apply.
- C. The Electrical Trade Contractor shall be completely responsible for the acceptable condition and operation of all systems, equipment and components forming part of the installation or directly associated with it. The Electrical Trade Contractor shall provide fully qualified personnel to fulfill this requirement. The Electrical Trade Contractor shall be responsible for prompt replacement of defective materials, equipment and parts of equipment and related damages.
- D. Provide only new ~~service, service equipment,~~ panelboards, circuit breakers, panelboard feeders and raceways as shown on the contract drawings **to match existing panelboards.**

1.5 RELATED WORK

- A. Examine all other sections of the Specifications and all drawings for the relationship of the work under this Section and the work of other trades. Cooperate with all trades and coordinate all work under this section therewith.
- B. The following related items are included under Sections listed below:
 1. Except as specified herein, cutting shall be the responsibility of the General Trade Contractor and patching shall be performed by the respective trades. Refer to the respective Sections.
 2. The Electrical Trade Contractor shall provide all hoisting and rigging for equipment and materials specified herein.
 3. The Electrical Trade Contractor shall provide all core drilling, cutting and channeling for electrical equipment requiring holes five (5) inches and less in diameter.
 4. The Electrical Trade Contractor shall furnish and maintain in safe and adequate condition, all staging and scaffolding that is required for work of this Section.
 5. Temporary light and power for use during construction and testing. See General and Supplementary Conditions Section.

6. Flashing of roof for electrical equipment and electrical power provided by equipment. SECTION 07411-Metal Roof Panels and SECTION 07531-EPDM Membrane Roofing
 7. Painting of all exposed electrical equipment not having enameled surfaces, stainless steel or chromed finishes. SECTION 09900 - PAINTING
 8. In general, all wiring required for equipment provided by the HVAC Trade Contractor that requires Automatic Controls and all interlock wiring for this HVAC equipment that is not shown or indicated on the Electrical Drawings of SECTION 16000 - ELECTRICAL, shall be provided under Section 15600 – HEATING VENTILATION AND AIR CONDITIONING.
 9. The Electrical Trade Contractor shall provide all required fire stopping related to Division 16 work.
 10. The Electrical Trade Contractor shall seal all penetrations through non-rated walls, ceilings, floors, etc related to Division 16 work in accordance with SECTION 07900 – JOINT SEALERS.
 11. The Electrical Trade Contractor shall provide all electrical power, ~~fire alarm~~ and line-voltage control wiring connections to power operated doors, hardware, emergency call buttons, etc. in accordance with and in coordination with Division 8 – DOORS AND WINDOWS with particular attention to SECTION 08710 – FINISH HARDWARE
- C. Furnish the following materials to be installed under other SECTIONS.
1. ~~The Electrical Trade Contractor shall furnish and wire duct smoke detectors installed under SECTION 15600 – HEATING VENTILATION AND AIR CONDITIONING.~~
- D. Wire the following materials furnished and installed under other SECTIONS.
1. ~~Sprinkler flow, tamper, pressure and alarm switches furnished and installed under SECTION 13900 – FIRE SUPPRESSION.~~
 2. ~~Air compressors and excess pressure pumps switches furnished and installed under SECTION 13900 – FIRE SUPPRESSION.~~
 3. Heating, ventilating and air-conditioning equipment furnished and installed under SECTION 15600 – HEATING VENTILATION AND AIR-CONDITIONING.

1.6 STANDARD OF MATERIALS AND WORKMANSHIP

- A. Conditions of the Contract and Division 1, General Requirements, shall be made part of this Section:
1. Workmanship and installation methods shall conform to the highest standard practice. Work shall be performed by skilled tradesmen under the direct supervision of fully qualified personnel.
 2. Install equipment in strict accordance with manufacturer's published recommendations.
 3. When requested, submit samples of materials proposed for review before proceeding with the work.
 4. Install equipment and materials to present a neat appearance. Install ducts and conduit parallel with or perpendicular to building planes.
 5. Conceal conduit and cables in finished areas. Install work so as to require a minimum amount of furring.
 6. Equipment, materials and work shall comply with the requirements of generally recognized agencies, including, but not limited to, agencies listed under SECTION 16000 Article CODES, STANDARDS AND REGULATIONS and shall conform to and be installed in strict accordance with Federal, State and Town requirements and shall meet all of the requirements of all authorities having jurisdiction.

1.7 ABBREVIATIONS AND DEFINITIONS

- A. "EC" as mentioned herein means specifically "Electrical Trade Contractor" when used in conjunction with Trade Contractor, equipment, work or articles within this specification.
- B. "HVAC" or "HV" or "AC" as mentioned herein means specifically "Heating, Ventilating and Air Conditioning" or "Heating and Ventilating" or "Air Conditioning" respectively, when used in conjunction with Trade Contractor, equipment, work or articles within this specification.
- C. A.T.C. as mentioned herein means specifically Automatic Temperature Control as it refers to the manufacturer or description of work and equipment

- D. "Provide" may be used in place of "furnish and install" and where used shall mean to deliver, furnish, erect, and connect up complete in readiness for regular operation, the particular work or equipment referred to, unless otherwise specified.
- E. The term "Applicable Section Trade Contractor" or "A.S.C." shall be understood to refer to a Trade Contractor or Trade Contractors other than the E or any Electrical SubTrade Contractor.
- F. "Shown on drawings" as used in the specifications shall mean "noted", "indicated", "scheduled", "detailed", or any other diagrammatic or written reference made on the drawings.
- G. "Material" as used in the specifications shall mean any "product", "equipment", "device", "assembly", or "item" required under the Contract, as indicated by trade or brand name, manufacturer's name, standard specification reference or other description.
- H. "Approved" or "Approval" shall mean the written approval of the Architect.
- I. "Contract Documents" shall mean the entire set of Drawings, fire alarm narrative and Specifications as listed in the Table of Contents of the General Conditions including all bound and unbound material and all items officially issued to date such as addenda, bulletins, job modifications, sketches, etc.
- J. "Specification" shall mean all information contained in the bound or unbound volume, including all "Contract Documents" defined therein, except for the drawings.
- K. "Accessible" shall indicate ease of access with or without the use of ladders and without requiring extensive removal of other equipment, such as ductwork, piping, etc. to gain access. "Accessible Ceiling" indicates acoustic tile type hung ceilings. Concealed spline or sheetrock ceilings with access panels shall not be considered accessible ceilings.
- L. "Concealed" shall mean hidden from sight in chases, furred spaces, shafts, hung ceilings, embedded in construction or in crawl spaces.
- M. "Exposed" shall mean not installed underground or "Concealed" as defined above.
- N. "Electrical SubTrade Contractor" shall refer to the SubTrade Contractor responsible for furnishing and installation of all work indicated on the Electrical Drawings and in the Electrical Specifications.
- O. "Owner" or "OR" shall refer to the Owner or his designated representative.

1.8 EXAMINATION

- A. Examine the Specifications and Drawings, including the Specifications and Drawings of other DIVISIONS before bid.
- B. Before submitting bid, visit and examine the site where work is to be carried out and become familiar with all features and characteristics that affect the work of this SECTION.
- C. Report in writing, any discrepancies or deficiencies which may adversely affect the work, at least six days prior to close of bid.
- D. No allowance will be made for any difficulties encountered due to any features of the building, site or surrounding public and private property that existed up to the time of bid.

1.9 CODES, STANDARDS, AND REGULATIONS

- A. Electrical work shall comply with the latest editions of the following codes which have been accepted by local authorities:
 - 1. 780 CMR Massachusetts State Building Code
 - 2. Massachusetts Energy Code
 - 3. NFPA 13 – Sprinkler Systems
 - 4. NFPA 70 - National Electrical Code with State Amendments
 - 5. **NFPA 70E – Standard for Electrical Safety in the Workplace**
 - 6. NFPA 72 - National Fire Alarm Code with State Amendments
 - 7. NFPA 101 - Life Safety Code
 - 8. ANSI C2 - National Electrical Safety Code
- B. Electrical work shall comply with the current standards of the following organizations:
 - 1. ADA - Americans with Disabilities Act
 - 2. IEEE - Institute of Electrical and Electronics Engineers
 - 3. IES - Illuminating Engineering Society
 - 4. EIA/TIA - Electronic Industries Association/Telecommunications Industry Association
 - a. EIA/TIA-568 Commercial Building Wiring Standard.

- b. EIA/TIA-569 Commercial Building Standard for Telecommunication Pathways and Spaces.
- 5. OSHA - Occupational Safety and Health Act
- 6. FM - Factory Mutual Association
- 7. UL - Underwriters' Laboratories
- 8. ANSI - American National Standards Institute
- 9. NEMA - National Electric Manufacturers Association
- 10. ASTM - American Society for Testing and Materials
- 11. Owner's Insurance Underwriter
- C. When requirements listed in this Section conflict with each other, with the contract documents or with the requirements of applicable Codes, Standards or Regulations, the most stringent requirements shall be adhered to.
- D. In addition to complying with the specified requirements, comply with pertinent regulations of governmental agencies and Authorities Having Jurisdiction (AHJ) including local and state building, plumbing, mechanical, electrical, fire, and health department codes and standards.

1.10 DRAWINGS

- A. The Drawings are schematic in nature and are intended to show approximate locations of apparatus, fixtures, devices, raceways, etc. in diagrammatic form. The Drawings are not intended to show Architectural and Structural details.
- B. Do not scale drawings. Obtain any information requiring accurate dimensions from Architectural and Structural Drawings or from site measurements. Check locations and elevations before proceeding with work.
- C. At no additional cost to the Owner, make all changes or additions to materials and/or equipment necessary to accommodate structural and architectural conditions.
- D. Leave areas clear and unobstructed where space is indicated as reserved for future equipment.
- E. Whether shown on the Drawings or not, provide adequate code required clearances, space and provision for servicing of equipment, removal and reinstallation.
- F. Provide all ceiling mounted components, including light fixtures, smoke detectors, remote test/reset stations, occupancy sensors, access doors, panels, etc., in strict accordance with reflected ceiling plans.

1.11 PERMITTING AND UTILITY COMPANY CHARGES

- A. Apply for, obtain and pay for all permits, inspections and fees required.
- B. Be fully acquainted with and obey all Federal, State, and Municipal laws, by-laws, codes and regulations, and all authorities having jurisdiction.
- C. Before starting any work, submit the required specifications and Drawings to the Governing Authorities for their approval. Comply with any requested changes as part of the Contract, and give any notification immediately of such changes.
- D. Where the Specifications, Instructions, or the Governing Authorities require any work to be tested, inspected or approved, give sufficient notice of its readiness for inspection, and, if the inspection is by a Governing Authority, of the date and time set for such inspection.
- E. Inspections will be made promptly. If any work is covered up without consent, it shall, if required, be uncovered for examination and the required corrections made at not extra cost to the Owner.
- F. Furnish any certificates necessary as evidence that the work conforms to the requirements of all authorities having jurisdiction.
- G. Make changes, if required, to make the work conform to all laws, bylaws, codes, and regulations, as part of SECTION 16000 work.
- H. Electrical Trade Contractor shall give all necessary notices, file and obtain all permits, pay all governmental taxes and fees. Trade Contractor shall also obtain all required Certificates of Inspection for his respective work and deliver same to Architect or Owner's Representative before request for acceptance of his portion of work is made and before final payment. Electrical Trade Contractor shall pay back charges from utility companies and other costs associated with his work.

- I. Electrical Trade Contractor shall assist the owner in applications for and to the local utility company energy rebate programs, including pricing information. The application and pricing information shall be submitted prior to the lighting fixture, lamp and ballast shop drawing submittal.

1.12 SUBMITTALS

- A. Refer to SECTION 01330 - Submittals and specifications for shop drawing requirements. Without limiting the generality thereof, the Electrical SubTrade Contractor shall also submit the additional information noted herein.
- B. General: Follow the procedures specified in Division 1. Unless otherwise noted in Division 1 the required shop drawing submittals shall be reviewed and returned for two full or partial submissions as part of the base Engineering scope of services. All additional submittal reviews shall be billed to the general Trade Contractor at \$750.00 per submittal.
- C. Substitutions: The Division 16 Trade Contractor shall submit on the system, components, materials, manufacture, etc. utilized by the Engineer as the "Basis of Design." The Trade Contractor shall be allowed to utilize one of the listed manufacturers for items that are not listed with a "Basis of Design." When a substitution is allowed by the Architect and/or Engineer it shall be the full responsibility of the Division 16 Trade Contractor to coordinate all differences with field conditions, owner, owners representatives, commissioning agent, other trades, etc. Any costs and schedule delays due to changes, modifications, redesigns, removal and replacement created by the Trade Contractor's substitution or failure to coordinate substitution shall be the responsibility of the Trade Contractor.
- D. Present, not later than three (3) weeks after award of the Contract, a list of Shop Drawings that will be submitted with the name of each manufacturer and supplier. Failure to submit this list will result in the necessity for the Trade Contractor to use that equipment which is scheduled.
- E. Shop drawings of equipment furnished under this Section shall include, but not be limited to, all items listed under Section 16000 – "WORK INCLUDED" and listed within this specification. Allow for two (2) weeks review time by the Architect.
- F. Do not manufacture, deliver or install equipment and materials until final review of Shop Drawings has been completed.
- G. Prior to submission of Shop Drawings, the Electrical SubTrade Contractor shall thoroughly check each shop drawing to ascertain that it complies with the Contract requirements; that the electrical characteristics are correct; and that the dimensions of work submitted fit the available space. Any deviations from the Contract requirements shall be clearly noted on the Shop Drawings. The Electrical SubTrade Contractor shall stamp each submittal with his firm's name, date and approval, thereby representing that the above has been complied with. Shop Drawings not so checked and stamped, shall be returned without being examined by the Architect. Review of the Shop Drawings shall not relieve the Electrical SubTrade Contractor from the responsibility for departures from the Contract Documents. Errors in shop drawings shall be the sole responsibility of the Electrical SubTrade Contractor whether the drawings are reviewed or not.
- H. Shop drawings shall be submitted in groups by systems. For example, all lighting fixtures, lamps, ballasts and accessories shall be submitted simultaneously in one package.
- I. Submit certified Shop Drawings and distribute prints to all trades and manufacturers affected.
- J. Be responsible for presenting the processing of shop drawings to suit manufacturing schedule of equipment and construction schedule of building.
- K. Be responsible for the accuracy of equipment dimensions relative to available space, the performance and the electrical characteristics. When required, submit a complete comparison between accepted alternative equipment and materials, and that which is specified.
- L. Each Shop Drawing shall indicate clearly the correct name and address of the project, the intended use and location of the equipment, the manufacturer and the catalog number of the item being furnished.
- M. Upon receipt of approved Shop Drawings, distribute prints to all trades and manufacturers affected.
- N. Keep one set of reviewed Shop Drawings on the site at all times.
- O. Bind one set of the corrected "Reviewed" Shop Drawings in each Operation and Maintenance Instructions Manual. Refer to SECTION 01330 - SUBMITTALS, SECTION 01770- CLOSEOUT PROCEDURES.

- P. The Electrical SubTrade Contractor shall submit to the General Trade Contractor, for transmittal to the Owner, any samples requested by the Owner. Submittal, review, and approval of samples shall be in accordance with the Conditions of the Contract.

1.13 REQUESTS FOR INTERPRETATION (RFIs)

- A. Prepare Requests for Interpretation/Information (RFIs) in accordance to Division 1 and, in addition, adhere to the following:
- B. RFIs shall originate with the Trade Contractor. RFIs submitted directly by sub-Trade Contractors will be returned with no response. RFIs sent directly to the engineer will be returned with no response. Incomplete RFIs will not be reviewed and will be returned for additional information.
- C. If email RFI submissions are allowed by Division 1 then the RFI and Attachment(s) shall be in Adobe Acrobat PDF format.
- D. Submit RFIs in format specified and in addition include:
1. Specification Section number and title and related paragraphs, as appropriate.
 2. Drawing number, room name, structural grid coordinates and detail references, as appropriate.
 3. Field dimensions and conditions, as appropriate.
 4. Trade Contractor's suggested solution(s). If Trade Contractor's solution(s) impact the Contract Time or the Contract Sum, Trade Contractor shall state impact in the RFI.
 5. Attachments: Include 8 ½" x 11" copies of construction documents highlighting areas requiring interpretation. Include drawings, descriptions, measurements, photos, Product Data, Shop Drawings, and other information necessary to fully describe items needing interpretation and suggested solution(s).
 - a. Supplementary drawings prepared by Trade Contractor shall be to scale and shall include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments.

1.14 RECORD DOCUMENTS

- A. Prepare record documents in accordance with the requirements in Division 1. In addition to the requirements specified in Division 1, indicate installed conditions for:
1. Major raceway systems, size and location, for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; and fuse and circuit breaker size and arrangements.
 2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
 3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.

1.15 OPERATION AND MAINTENANCE DATA

- A. Prepare maintenance manuals in accordance with Section 01770 CLOSEOUT PROCEDURES. In addition to the requirements specified in Division 1, include the following information for equipment items:
1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
 2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
 3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
 4. Servicing instructions and lubrication charts and schedules.

1.16 CONNECTIONS TO EQUIPMENT

- A. The Electrical Trade Contractor shall provide all electrical and control connections to equipment provided under other sections of the specifications, as shown on the contract documents and herein specified including final connections to equipment to result in a complete system, fully opera-

tional. Coordinate the locations of all equipment with Architect. Obtain installation diagrams and methods of installation of all equipment from manufacturers. Follow instructions strictly.

1.17 COORDINATION

- A. Fully coordinate with other trades to ensure that work is carried out in the best interests of all concerned. Install work in proper sequence to conserve headroom and space.
- B. Coordinate work with other trades to provide maximum accessibility for maintenance and operation of all equipment installed by all trades. COORDINATION DRAWINGS REQUIRED – See Division One.
- C. Give notices of requirements for holes, recessed openings, pits and chases.
- D. Coordinate electrical power, control and interlock wiring requirements with the HVAC, Plumbing and Fire Protection Trade Contractors, and Owner's Equipment two (2) weeks after receipt of signed contract to allow proper coordination between trades.
- E. Verify with the electrical characteristics of mechanical equipment with the Division 15 Trade Contractors before ordering any equipment and/or installation of any electrical equipment.
- F. Verify the electrical characteristics and requirements of the wheelchair lift with the lift Trade Contractor and general Trade Contractor.
- G. Verify smoke and damper actuator requirements with the general Trade Contractor and Division 15 Trade Contractors before ordering any equipment and/or installation of any electrical equipment.
- ~~H. Coordinate Duct Smoke detector sampling tube lengths and requirements with HVAC Trade Contractor.~~
- ~~I. Coordinate sprinkler flow switch and tamper switch locations and requirements with fire protection Trade Contractor.~~
- J. Wire all motor starters, control devices, relays, pilot lights, accessories, contactors, wiring diagrams, and the like required for proper operation, connection and control of motorized equipment, provided by the HVAC, Plumbing and Fire Protection Trade Contractor as specified and/or shown on the drawings.
- K. Electrical Trade Contractor shall be responsible for the following:
 - 1. Mount and connect motor starters, VFD, controllers and disconnects, except where specified to be factory wired and mounted on the equipment.
 - 2. Provide all required power connections for all motor driven equipment.
 - 3. Provide power wiring to control transformers and control panels.
- L. HVAC Trade Contractor provides low and line voltage control wiring to all equipment requiring control unless specifically called for on the Electrical drawings or specifications.
- M. General Trade Contractor shall provide all roof openings. Roof openings shall be the minimum size required for conduit penetrations.

~~1.18 FIRE ALARM SIGNAL SERVICE~~

- ~~A. The new Fire Alarm Control panel shall be connected to two (2) leased telephone lines in accordance with NFPA 72 for reporting all alarm signals to a central station monitoring company.~~
- ~~B. The electrical Trade Contractor shall be responsible to submit and review a complete set of fire alarm drawings and specifications to the local authorities having jurisdiction (AHJ). The results of the meeting shall be documented in a report and shall indicate any changes requested by the local AHJ's. The report shall be submitted as a shop drawing submittal.~~

1.19 PROTECTION

- A. Protect all electrical equipment, system and work from damage. Keep all equipment dry and clean at all times.
- B. Cover openings in equipment, and conduits, with caps or heavy gauge plastic sheeting until final connections are made.
- C. Correct at no cost to the Owner, any damage caused by improper storage, handling, or installation of equipment and materials.
- D. Protect equipment, conduit and temporary services provided under Section 16000 from weather damage.

1.20 GUARANTEE

- A. Conform to the requirements of Section 01770 Project Closeout Procedures.
- B. All equipment, material and workmanship shall be unconditionally guaranteed, as set forth in the Contract, or for longer periods when stated in the Specifications. Extensions to the standard equipment warranty periods shall be arranged by the Electrical Trade Contractor to enable the period to commence upon beneficial usage by the Owner.
- C. If any equipment or material does not match the manufacturer's published data or specifically supplied rating schedules during performance tests, replace without delay the defective equipment or materials. Bear all associated costs and adjust all components at no charge to the Owner and adjust all components to achieve the proper rating.
- D. Correct defects and deficiencies, and pay for resulting damage to Mechanical or other work, and to property and person, which appear or originate during the guaranteed period
- E. The Owner shall give notice of observed defects promptly in writing.

1.21 DEMOLITION

- A. The following systems were made obsolete by the new layout shall be included for demolition as part of this project:
 - 1. Distribution panels.
 - 2. Panelboards.
 - 3. Disconnect switches and circuit breakers.
 - 4. Fuses.
 - 5. Motor controllers.
 - 6. Raceways and boxes.
 - 7. Raceway support system.
 - 8. Conductors and cables.
 - 9. Control / signal conductors.
 - 10. Wiring devices, including but not limited to, receptacles, switches, occupancy sensors, time switches, etc.
 - 11. Lighting control system.
 - 12. Interior lighting.
 - 13. Exterior lighting.
 - 14. Electrical Supporting devices.
 - 15. Pull boxes.
 - 16. Junction boxes.
 - 17. Fire alarm system.
 - 18. Intercommunications system.
 - 19. Intrusion detection system.
 - 20. Electric heating cables.
- B. The Electrical Trade Contractor shall work with the demolition Trade Contractor to de-energize, cut and make safe all electrical systems.

PART 2 - PRODUCTS**2.1 SUPPORTING DEVICES**

- A. Channel and angle support systems, hangers, anchors, sleeves, brackets, fabricated items, and fasteners are designed to provide secure support from the building structure for electrical components.
 - 1. Material: Steel, except as otherwise indicated, protected from corrosion with zinc coating or with treatment of equivalent corrosion resistance using approved alternative finish or inherent material characteristics.
 - 2. Metal Items for Use in Damp Locations: Hot-dip galvanized steel, except as otherwise indicated.
- B. Steel channel supports have 9/16-inch (14-mm) diameter holes at a maximum of 8 inches (203 mm) o.c., in at least 1 surface.
 - 1. Fittings and accessories mate and match with channels and are from the same manufacturer.

- C. 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.

2.2 CONDUCTORS AND CABLES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Wires and Cables:
 - a. American Insulated Wire Corp.; Leviton Manufacturing Co.
 - b. BICC Brand-Rex Company.
 - c. Carol Cable Co., Inc.
 - d. Senator Wire & Cable Company.
 - e. Southwire Company.
 - 2. Connectors for Wires and Cables:
 - a. AMP Incorporated.
 - b. General Signal; O-Z/Gedney Unit.
 - c. Monogram Co.; AFC.
 - d. Square D Co.; Anderson.
 - e. 3M Company; Electrical Products Division.
- B. Building Wires and Cables
 - 1. UL-listed building wires and cables with conductor material, insulation type, cable construction, and rating as specified in Part 3 "INSTALLATION OF CONDUCTORS AND CABLES", "Wire and Insulation Applications" paragraph.
 - 2. Rubber Insulation Material: Comply with NEMA WC 3.
 - 3. Thermoplastic Insulation Material: Comply with NEMA WC 5.
 - 4. Cross-Linked Polyethylene Insulation Material: Comply with NEMA WC 7.
 - 5. Ethylene Propylene Rubber Insulation Material: Comply with NEMA WC 8.
 - 6. Conductor Material: Copper.
 - 7. Stranding: Solid conductor for No. 10 AWG and smaller; stranded conductor for larger than No. 10 AWG.
- C. Connectors and Splices
 - 1. UL-listed, factory-fabricated wiring connectors of size, ampacity rating, material, type, and class for application and service indicated. Comply with Project's installation requirements and as specified in Part 3 "INSTALLATION OF CONDUCTORS AND CABLES", "Wire and Insulation Applications" paragraph.

2.3 RACEWAYS AND BOXES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Metal Conduit and Tubing:
 - a. Alfex Corp.
 - b. Anamet, Inc.; Anaconda Metal Hose.
 - c. Anixter Brothers, Inc.
 - d. Carol Cable Co., Inc.
 - e. Cole-Flex Corp.
 - f. Electri-Flex Co.
 - g. Flexcon, Inc.; Coleman Cable Systems, Inc.
 - h. Grinnell Co.; Allied Tube and Conduit Div.
 - i. Monogram Co.; AFC.
 - j. Spiraduct, Inc.
 - k. Triangle PWC, Inc.
 - l. Wheatland Tube Co.
 - 2. Nonmetallic Conduit and Tubing:
 - a. Anamet, Inc.; Anaconda Metal Hose.
 - b. Arnco Corp.
 - c. Breeze-Illinois, Inc.

- d. Cantex Industries; Harsco Corp.
 - e. Certainteed Corp.; Pipe & Plastics Group.
 - f. Cole-Flex Corp.
 - g. Condux International; Electrical Products.
 - h. Electri-Flex Co.
 - i. George-Ingraham Corp.
 - j. Hubbell, Inc.; Raco, Inc.
 - k. Lamson & Sessions; Carlon Electrical Products.
 - l. R&G Sloan Manufacturing Co., Inc.
 - m. Spiraduct, Inc.
 - n. Thomas & Betts Corp.
3. Conduit Bodies and Fittings:
- a. American Electric; Construction Materials Group.
 - b. Crouse-Hinds; Div. of Cooper Industries.
 - c. Emerson Electric Co.; Appleton Electric Co.
 - d. Hubbell, Inc.; Killark Electric Manufacturing Co.
 - e. Lamson & Sessions; Carlon Electrical Products.
 - f. O-Z/Gedney; Unit of General Signal.
 - g. Scott Fetzer Co.; Adalet-PLM.
 - h. Spring City Electrical Manufacturing Co.
4. Metal Wireways:
- a. Hoffman Engineering Co.
 - b. Keystone/Rees, Inc.
 - c. Square D Co.
5. Surface Metal Raceways:
- a. Airey-Thompson Co., Inc.; A-T Power Systems.
 - b. American Electric; Construction Materials Group.
 - c. Butler Manufacturing Co.; Walker Division.
 - d. Wiremold Co. (The); Electrical Sales Division.
 - e. United Telecom; Premier Telecom Products, Inc.
 - f. Wiremold Co. (The); Electrical Sales Division.
6. Boxes, Enclosures, and Cabinets:
- a. American Electric; FL Industries.
 - b. Butler Manufacturing Co.; Walker Division.
 - c. Crouse-Hinds; Div. of Cooper Industries.
 - d. Electric Panelboard Co., Inc.
 - e. Erickson Electrical Equipment Co.
 - f. Hoffman Engineering Co.; Federal-Hoffman, Inc.
 - g. Hubbell Inc.; Killark Electric Manufacturing Co.
 - h. Hubbell Inc.; Raco, Inc.
 - i. Lamson & Sessions; Carlon Electrical Products.
 - j. O-Z/Gedney; Unit of General Signal.
 - k. Parker Electrical Manufacturing Co.
 - l. Robroy Industries, Inc.; Electrical Division.
 - m. Scott Fetzer Co.; Adalet-PLM.
 - n. Spring City Electrical Manufacturing Co.
 - o. Thomas & Betts Corp.
 - p. Woodhead Industries, Inc.; Daniel Woodhead Co.
- B. Metal Conduit And Tubing
- 1. Rigid Steel Conduit: ANSI C80.1.
 - 2. Rigid Aluminum Conduit: ANSI C80.5.
 - 3. IMC: ANSI C80.6.
 - 4. Plastic-Coated Steel Conduit and Fittings: NEMA RN 1.
 - 5. Plastic-Coated IMC and Fittings: NEMA RN 1.
 - 6. EMT and Fittings ANSI C80.3.
 - a. Fittings: Set-screw or compression type.

- b. Fittings: Set-screw type.
 - c. Fittings: Compression type.
 - d. Fittings: Compression type for conduit size up to 1 ¼", set screw type for conduit size 1 ½" and above.
7. FMC: Aluminum.
 8. FMC: Zinc-coated steel.
 9. LFMC: Flexible steel conduit with PVC jacket.
 10. Fittings: NEMA FB 1; compatible with conduit/tubing materials.
- C. Nonmetallic Conduit And Tubing
1. ENT: NEMA TC 13.
 2. RNC: NEMA TC 2, Schedule 40 or 80 PVC.
 3. ENT and RNC Fittings: NEMA TC 3; match to conduit or conduit/tubing type and material.
 4. LFNC: UL 1660.
- D. Metal Wireways
1. Material: Sheet metal sized and shaped as required.
 2. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
 3. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.
 4. Wireway Covers: Screw-cover type.
 5. Finish: Manufacturer's standard enamel finish.
- E. Surface Raceways
1. Surface Metal Raceways: Galvanized steel with snap-on covers. Finish with manufacturer's standard prime coating.
 2. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.
- F. Outlet And Device Boxes
1. Sheet Metal Boxes: NEMA OS 1.
 2. Cast-Metal Boxes: NEMA FB 1, Type FD, cast box with gasketed cover.
- G. Pull and Junction Boxes
1. Small Sheet Metal Boxes: NEMA OS 1.
 2. Cast-Metal Boxes: NEMA FB 1, cast aluminum with gasketed cover.
- H. Enclosures And Cabinets
1. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch.
 - a. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - b. Nonmetallic Enclosures: Plastic, finished inside with radio-frequency-resistant paint.
 2. 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.

2.4 WIRING DEVICES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:
1. Wiring Devices:
 - a. Arrow Hart Div., Cooper Industries.
 - b. Bryant Electric, Inc.
 - c. Hubbell Inc.
 - d. Leviton Mfg. Co., Inc.
 - e. Pass & Seymour/Legrand.
 2. Multi-Outlet Assemblies:
 - a. Isoduct Systems.
 - b. Hubbell, Inc.
 - c. Wiremold Co.

B. Wiring Devices

1. Comply with NEMA Standard WD 1, "General Purpose Wiring Devices."
2. Enclosures: NEMA 1 equivalent, except as otherwise indicated.
3. Color: Ivory except as otherwise indicated or required by Code.
4. Receptacles, Straight-Blade and Locking Type: Comply with UL Standard 498, "Electrical Attachment Plugs and Receptacles," heavy-duty grade except as otherwise indicated.
5. Receptacles, Straight-Blade, Special Features: Comply with the basic requirements specified above for straight-blade receptacles of the class and type indicated, and with the following additional requirements:
 - a. Ground-Fault Circuit Interrupter (GFCI) Receptacles: UL Standard 943, "Ground Fault Circuit Interrupters," feed-through type, with integral NEMA 5-20R duplex receptacle arranged to protect connected downstream receptacles on the same circuit. Design units for installation in a 2-3/4-inch (70-mm) deep outlet box without an adapter.
6. Snap Switches: Quiet-type a.c. switches, NRTL listed and labeled as complying with UL Standard 20 "General Use Snap Switches," and with Federal Specification W-S-896.
7. Wall Plates: Single and combination types that mate and match with corresponding wiring devices. Features include the following:
 - a. Color: White.
 - b. Plate-Securing Screws: White.
 - c. Material for Finished Spaces: 0.04-inch-thick, type 302, satin-finished stainless steel, except as otherwise indicated.
 - d. Material for Unfinished Spaces: Galvanized steel.

C. Multi-Outlet Assemblies

1. Comply with Standard UL 5, "Surface Metal Raceways and Fittings."
2. Components of Assemblies: Products of a single manufacturer designed to be used together to provide a complete matching assembly of raceways and receptacles.
3. Raceway Material: Metal, with manufacturer's standard corrosion-resistant finish.
4. Wire: No. 12 AWG.

D. Telephone/Power Service Poles

1. Description: Factory-assembled and -wired units designed to extend power, telephone, and data service from distribution wiring located at the ceiling to devices or outlets in the pole near the floor. Features include the following:
 - a. Poles: Nominal 2.5-inch- (65-mm-) square cross section, with height adequate to extend from floor to at least 6 inches (150 mm) to junction box. Separate channels for power and signal wiring.
 - b. Mounting Provisions: positive connection to ceiling support members. Pole foot with carpet pad attachment.
 - c. Finishes: Match the multi-outlet raceway selection.
 - d. Wiring: Three No. 12 AWG power and ground conductors, 2-CAT5E except as otherwise indicated.
 - e. Power Receptacles: Two single, 20-ampere, heavy-duty NEMA 5-20R units except as otherwise indicated.
 - f. Signal Outlets: Blank insert with bushed cable opening except as otherwise indicated.

2.5 ELECTRICAL IDENTIFICATION

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:
 1. American Labelmark Co.; Labelmaster Subsidiary.
 2. Brady USA, Inc.; Industrial Products Div.
 3. Calpico, Inc.
 4. Carlton Industries, Inc.
 5. Champion American, Inc.
 6. Cole-Flex Corp.
 7. D&G Sign and Label.
 8. EMED Co., Inc.
 9. George-Ingraham Corp. (The).

10. Grimco, Inc.
 11. Ideal Industries, Inc.
 12. Kraftbilt.
 13. LEM Products, Inc.
 14. Markal Corp.
 15. National Band & Tag Co.
 16. Panduit Corp.
 17. Radar Engineers.
 18. Ready Made Sign Co.; Cornerstone Direct Corp. Div.
 19. Seton Name Plate Co.
 20. Standard Signs, Inc.
- B. Engraved Nameplates And Signs
1. Manufacturer's Standard Products: Where more than one type is listed for a specified application, selection is Installer's option, but provide single type for each application category. Use colors prescribed by ANSI A13.1, NFPA 70, and these Specifications.
 2. Engraving stock, melamine plastic laminate, 1/16-inch (1.6-mm) minimum thick for signs up to 20 sq. in. (129 sq. cm), 1/8 inch (3.2 mm) thick for larger sizes.
 - a. Engraved Legend: Black letters on white face.
 - b. Punched for mechanical fasteners.
 3. Baked-Enamel Signs for Interior Use: Preprinted aluminum signs, punched for fasteners, with colors, legend, and size as indicated or as otherwise required for the application. 1/4-inch (6.4-mm) grommets in corners for mounting.
 4. Exterior, Metal-Backed, Butyrate Signs: Weather-resistant, nonfading, preprinted, cellulose acetate butyrate signs with 0.0396-inch (1-mm), galvanized steel backing, with colors, legend, and size appropriate to the application. 1/4-inch (6.4-mm) grommets in corners for mounting.
 5. Fasteners for Plastic-Laminated and Metal Signs: Self-tapping stainless-steel screws or No. 10/32 stainless-steel machine screws with nuts and flat and lock washers. Adhesives will not be allowed.
- C. Miscellaneous Identification Products
1. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties with the following features:
 - a. Minimum Width: 3/16 inch (5 mm).
 - b. Tensile Strength: 50 lb (22.3 kg) minimum.
 - c. Temperature Range: Minus 40 to 185 deg F (Minus 4 to 85 deg C).
 - d. Color: As indicated where used for color coding.
 2. Paint: Alkyd-urethane enamel over primer as recommended by enamel manufacturer.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - b. BBA Corp.
 - c. Best-Lites; Best Power Technology, Inc.
 - d. Chloride Systems.
 - e. Dual-Lite.
 - f. Exide Lightguard.
 - g. Holophane Corp.
 - h. Hubbell Lighting Corp.
 - i. Kaufel Group Co.; Emergi-Lite, Inc. Div.
 - j. Kaufel Group Co.; Lightalarms Electronics Corp. Div.
 - k. Lithonia Lighting Emergency Lighting Systems.

2.6 GROUNDING

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Apache Grounding; Nashville Wire Products.
 2. Boggs: H. L. Boggs & Co.

3. Chance: A. B. Chance Co.
 4. Dossert Corp.
 5. Erico Inc.; Electrical Products Group.
 6. Galvan Industries, Inc.
 7. Hastings Fiber Glass Products, Inc.
 8. Heary Brothers Lightning Protection Co.
 9. Ideal Industries, Inc.
 10. ILSCO.
 11. Kearney.
 12. Korn: C. C. Korn Co.
 13. Lightning Master Corp.
 14. Lyncole XIT Grounding.
 15. O-Z/Gedney Co.
 16. Raco, Inc.
 17. Salisbury: W.H. Salisbury & Co., Utility.
 18. Thomas & Betts, Electrical.
 19. Utilco Co.
- B. Grounding and Bonding Products
1. Governing Requirements: Where types, sizes, ratings, and quantities indicated are in excess of National Electrical Code (NEC) requirements, the more stringent requirements and the greater size, rating, and quantity indications govern.
- C. Wire and Cable Grounding Conductors
1. Comply with Division 16 Section "Wires and Cables." Conform to NEC Table 8, except as otherwise indicated, for conductor properties, including stranding.
 - a. Material: Copper Only.
 2. Equipment Grounding Conductors: Insulated with green color insulation.
 3. Grounding-Electrode Conductors: Stranded cable.
 4. Underground Conductors: Bare, tinned, stranded, except as otherwise indicated.
 5. Bare Copper Conductors: Conform to the following:
 - a. Solid Conductors: ASTM B 3.
 - b. Assembly of Stranded Conductors: ASTM B 8.
 - c. Tinned Conductors: ASTM B 33.
 6. Miscellaneous Conductors
 - a. Grounding Bus: Bare, annealed-copper bars of rectangular cross section.
 - b. Braided Bonding Jumpers: Copper tape, braided No. 30 AWG bare copper wire, terminated with copper ferrules.
 - c. Bonding Straps: Soft copper, 0.05 inch (1 mm) thick and 2 inches (50 mm) wide, except as indicated.
 7. Connector Products
 - a. Pressure Connectors: High-conductivity-plated units.
 - b. Bolted Clamps: Heavy-duty type.
 - c. Exothermic-Welded Connections: Provided in kit form and selected per manufacturer's written instructions for specific types, sizes, and combinations of conductors and connected items.
- D. Grounding Electrodes and Test Wells
1. Grounding Rods: Copper-clad steel.
 - a. Size: 3/4 inch by 120 inches (19 by 3000 mm).
 - b. Size: 5/8 inch by 96 inches (16 by 2400 mm).
 2. Plate Electrodes: Copper, square or rectangular shape. Minimum 0.10 inch (3 mm) thick, size as indicated.

2.7 PANELBOARD

- A. Available Manufacturers: **Match existing panelboards**
- ~~B. Panelboard Fabrication~~
- ~~1. Enclosures: Flush or surface-mounted cabinets as indicated. NEMA PB 1, Type 1.~~

- ~~2. Front: All laboratory panelboards and lighting panelboards shall have hinged cover, no exceptions. Distribution panel shall have trim latch clamps. Front for surface-mounted panelboards shall be same dimensions as box. Fronts for flush panelboards shall overlap box, unless otherwise indicated.~~
 - ~~3. Directory Frame: Metal, mounted inside each panelboard door.~~
 - ~~4. Bus: Hard drawn copper of 98 percent conductivity.~~
 - ~~5. Main and Neutral Lugs: Compression type.~~
 - ~~6. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors. Bonded to box.~~
 - ~~7. Main Distribution Panel, listed for use as service equipment for panelboards with main service disconnect.~~
 - ~~8. Future Devices: Equip with mounting brackets, bus connections, and necessary appurtenances, for the overcurrent protective device ampere ratings indicated for future installation of devices.~~
 - ~~9. Special Features: Include the following features for panelboards as indicated:
 - ~~a. Isolated Equipment Ground Bus: Adequate for branch-circuit equipment ground conductors; insulated from box.~~
 - ~~b. Hinged Front Cover: Entire front trim hinged to box with standard door within hinged trim cover.~~~~
 - ~~10. Feed through Lugs: Sized to accommodate feeders indicated.~~
- ~~C. Load Centers~~
- ~~1. Overcurrent Protective Devices: Plug-in, full-module circuit breaker.
 - ~~a. Circuit Breakers for Switching Lights at Panelboards: Indicated as Type SWD.~~
 - ~~b. Circuit Breakers for Equipment Marked Type HACR: Indicated as Type HACR.~~~~
 - ~~2. Conductor Connectors: Mechanical type for main, neutral, and ground lugs and buses.~~
- ~~D. Lighting and Appliance Branch-Circuit Panelboards~~
- ~~1. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.~~
 - ~~2. Doors: In panelboard front, with concealed hinges. Secure with flush catch and tumbler lock, all keyed alike.~~
- ~~E. Distribution Panelboard~~
- ~~1. Doors: In panelboard front, except omit in fusible switch panelboard, unless otherwise indicated. Secure door with vault type latch with tumbler lock, all keyed alike.~~
 - ~~2. Branch-Circuit Breakers: Where overcurrent protective devices are indicated to be circuit breakers, use bolt-on circuit breakers, except circuit breakers 225-A frame size and greater may be plug-in type where individual positive-locking device requires mechanical release for removal.~~
- ~~F. Overcurrent Protective Devices~~
- ~~1. Molded-Case Circuit Breaker: NEMA AB-1, handle lockable.
 - ~~a. Characteristics: Frame size, trip rating, number of poles, and auxiliary devices as indicated and interrupting capacity rating to meet available fault current.~~
 - ~~b. Application Listing: Appropriate for application, including Type SWD for switching fluorescent lighting loads and Type HACR for heating, air-conditioning, and refrigerating equipment.~~
 - ~~c. Circuit Breakers, 200 A and Larger: Trip units interchangeable within frame size.~~
 - ~~d. Circuit Breakers, 400 A and Larger: Field-adjustable short-time and continuous current settings.~~
 - ~~e. Current-Limiting Trips: Where indicated, let-through ratings less than NEMA FU-1, Class RK-5.~~
 - ~~f. Current Limiters: Where indicated, integral fuse listed for circuit breaker.~~
 - ~~g. Lugs: Mechanical lugs and power-distribution connectors for number, size, and material of conductors indicated.~~~~
 - ~~2. Fusible Switch: NEMA KS-1, Type HD, clips to accommodate specified fuses, handle lockable.~~

2.8 FUSES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering fuses that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Cooper Industries, Inc.; Busmann Div.
 - 2. Eagle Electric Mfg. Co., Inc.
 - 3. Ferraz Corp.
 - 4. General Electric Co.; Wiring Devices Div.
 - 5. Gould Shawmut.
 - 6. Tracor, Inc.; Littelfuse, Inc. Subsidiary.
- B. Fuses
 - 1. Dual element time delay

2.9 DISCONNECT SWITCHES AND CIRCUIT BREAKERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering disconnect switches and circuit breakers that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Fusible Switches:
 - a. Eaton Corp.; Cutler-Hammer Products.
 - b. General Electric Co.; Electrical Distribution and Control Division.
 - c. General Switch Corp.
 - d. Siemens Energy & Automation, Inc.
 - e. Square D Co.
 - f. Westinghouse Electric Corp.; Distribution & Control Business Unit.
 - 2. Molded-Case Circuit Breakers:
 - a. American Circuit Breaker Corp.
 - b. Eaton Corp.; Cutler-Hammer Products.
 - c. General Electric Co.; Electrical Distribution and Control Division.
 - d. General Switch Corp.
 - e. Klockner-Moeller.
 - f. Siemens Energy & Automation, Inc.
 - g. Square D Co.
 - h. Westinghouse Electric Corp.; Distribution & Control Business Unit.
 - 3. Molded-Case, Current-Limiting Circuit Breakers:
 - a. General Electric Co.; Electrical Distribution and Control Division.
 - b. Siemens Energy & Automation, Inc.
 - c. Square D Co.
 - d. Westinghouse Electric Corp.; Distribution & Control Business Unit.
 - 4. Integrally Fused, Molded-Case Circuit Breakers:
 - a. General Electric Co.; Electrical Distribution and Control Division.
 - b. Siemens Energy & Automation, Inc.
 - c. Westinghouse Electric Corp.; Distribution & Control Business Unit.
- B. Disconnect Switches
 - 1. Enclosed, Nonfusible Switch: NEMA KS 1, Type HD, with lockable handle.
 - 2. Enclosed, Fusible Switch, 800 A and Smaller: NEMA KS 1, Type HD, clips to accommodate specified fuses, enclosure consistent with environment where located, handle lockable with 2 padlocks, and interlocked with cover in CLOSED position.
 - 3. Enclosure: NEMA KS 1, Type 1, unless otherwise specified or required to meet environmental conditions of installed location.
 - a. Outdoor Locations: Type 3R.
 - b. Other Wet or Damp Indoor Locations: Type 4.

2.10 MOTOR CONTROLLERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. ABB Power Distribution, Inc.; ABB Control, Inc. Subsidiary.

2. Allen-Bradley Co.; Industrial Control Group.
3. Eaton Corp.; Westinghouse & Cutler-Hammer Products.
4. Furnas Electric Co.
5. General Electric Co.; Electrical Distribution & Control Div.
6. Siemens Energy & Automation, Inc.
7. Square D Co.

B. Manual Motor Controllers

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

2.11 INTERIOR LIGHTING

A. Products: Subject to compliance with requirements, provide one of the products specified in the Lighting Fixture Schedule on the Drawings.

B. Fixtures and Fixture Components, General

1. Metal Parts: Free from burrs, sharp corners, and edges.
2. Sheet Metal Components: Steel, except as indicated. Form and support to prevent warping and sagging.
3. Fluorescent Fixtures: Conform to UL 1570.
4. Fluorescent Ballasts: Electronic integrated circuit, solid-state, full-light-output, energy-efficient type compatible with lamps and lamp combinations to which connected.
 - a. Certification by Electrical Testing Laboratory (ETL).
 - b. Labeling by Certified Ballast Manufacturers Association (CBM).
 - c. Type: Class P, high power factor, except as otherwise indicated.
 - d. Sound Rating: "A" rating, except as otherwise indicated.
 - e. Voltage: Match connected circuits.
 - f. Lamp Flicker: Less than 5 percent.
 - g. Minimum Power Factor: 90 percent.
 - h. Total Harmonic Distortion (THD) of Ballast Current: Less than 10 percent.
 - i. Conform to FCC Regulations Part 15, Subpart J for electromagnetic interference.
 - j. Conform to IEEE C62.41, Category A, for resistance to voltage surges for normal and common modes.
 - k. Multilamp Ballasts: Use 2, 3, or 4 lamp ballasts for multilamp fixtures where possible.
 - l. Lamp-ballast connection method does not reduce normal rated life of lamps.
 - m. Low-Temperature Fluorescent Ballasts: Comply with above requirements, except ballast may be Class P electromagnetic type. Starting temperature is minus 20 deg C or colder.
5. Electromagnetic Interference (EMI) Filters: Integral to fixture assembly. Provide one filter for each ballast. Suppress EMI as required by MIL-STD-461.
6. Self-Powered Exit Signs (Battery Type): Integral automatic high/low trickle charger in a self-contained power pack.
 - a. Battery: Sealed, maintenance-free, nickel-cadmium type with special warranty.
7. Emergency Lighting Units: Conform to UL 924. Provide self-contained units with the following features:
 - a. Battery: Sealed, maintenance-free, lead-acid type with minimum 10-year nominal life and special warranty.
 - b. Charger: Minimum 2-rate, fully automatic, solid-state type, with sealed transfer relay.
 - c. Operation: Relay automatically turns lamp on when supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. Relay disconnects lamps and battery and automatically recharges and floats on trickle charger when normal voltage is restored.

C. Lamps

1. Comply with ANSI C78 series that is applicable to each type of lamp.
2. Fluorescent Color Temperature and Minimum Color-Rendering Index (CRI): 3500 K and 82 CRI, in all office spaces.
3. Fluorescent Color Temperature and Minimum Color-Rendering Index (CRI): 4100 K and 82 CRI, in laboratories and unfinished areas.

4. Non compact Fluorescent Lamp Life: Rated average is 20,000 hours at 3 hours per start when used on rapid start circuits.

D. Finishes

1. Manufacturer's standard, except as otherwise indicated, applied over corrosion-resistant treatment or primer, free of streaks, runs, holidays, stains, blisters, and similar defects.

2.12 EXTERIOR LIGHTING

- A. Products: Subject to compliance with requirements, provide one of the products specified in the Lighting Fixture Schedule on the Drawings.

B. Fixtures and Fixture Components, General

1. Metal Parts: Free from burrs, sharp edges, and corners.
2. Sheet Metal Components: Corrosion-resistant aluminum, except as otherwise indicated. Form and support to prevent warping and sagging.
3. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed fixtures.
4. Doors, Frames, and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit relamping without use of tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent accidental falling during relamping and when secured in operating position. Provide for door removal for cleaning or replacing lens. Arrange for door opening to disconnect ballast.
5. Exposed Hardware Material: Stainless steel.
6. Reflecting Surfaces: Minimum reflectances as follows, except as otherwise indicated:
 - a. White Surfaces: 85 percent.
 - b. Specular Surfaces: 83 percent.
 - c. Diffusing Specular Surfaces: 75 percent.
7. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
8. Lenses and Refractors: Materials as indicated. Use heat- and aging-resistant, resilient gaskets to seal and cushion lens and refractor mounting in fixture doors.
9. Photoelectric Relays: Conform to UL 773.
 - a. Contact Relays: Single throw, arranged to fail in the ON position and factory set to turn light unit on at 1.5 to 3 foot-candles (16 to 32 lux) and off at 4.5 to 10 foot-candles (48 to 108 lux) with 15-second minimum time delay.
 - b. Relay Mounting: In fixture housing.
10. Fluorescent Fixtures: Conform to UL 1570.
11. Fluorescent Ballasts: Class P, low-temperature, electromagnetic type, compatible with the lamps and lamp combinations to which connected.
 - a. Certification by Electrical Testing Laboratory (ETL).
 - b. Labeling by Certified Ballast Manufacturers Association (CBM).
 - c. Sound Rating: "A" rating, except as otherwise indicated.
 - d. Voltage: Match connected circuits.
 - e. Minimum Power Factor: 90 percent.
 - f. Total Harmonic Distortion (THD) of Ballast Current: Less than 20 percent.
 - g. Conform to FCC Regulations Part 15, Subpart J for electromagnetic interference.
 - h. Conform to IEEE C62.41, Category A, for resistance to voltage surges for normal and common modes.
 - i. Minimum Starting Temperature: Minus 20 deg C.

2.13 ~~FIRE ALARM SYSTEM~~

- ~~A. This section of the specification includes the furnishing, installation, connection and testing of the microprocessor controlled, intelligent reporting fire alarm equipment required to form a complete, operative, coordinated system. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, Fire Alarm Control Panel (FACP), and wiring as shown on the drawings and specified herein.~~

- ~~B. The fire alarm system shall comply with requirements of NFPA Standard 72 for Protected Premises Signaling Systems except as modified and supplemented by this specification. The system shall be electrically supervised and monitor the integrity of all conductors.~~
- ~~C. The fire alarm system shall be manufactured by an ISO 9001 certified company and meet the requirements of BS EN9001: ANSI/ASQC Q9001-1994.~~
- ~~D. The FACP and peripheral devices shall be manufactured 100% by a single U.S. manufacturer (or division thereof).~~
- ~~E. The system and its components shall be Underwriters Laboratories, Inc. listed under the appropriate UL testing standard as listed herein for fire alarm applications and the installation shall be in compliance with the UL listing.~~
- ~~F. The installing company shall employ NICET (minimum Level II Fire Alarm Technology) technicians on-site to guide the final checkout and to ensure the systems integrity.~~
- ~~G. Manufacturers: Subject to compliance with requirements, provide products by one of the following:~~
- ~~1. Notifier~~
 - ~~2. Fire Control Instruments, Inc.~~
 - ~~3. Fire Lite Alarms, Inc.~~
 - ~~4. Gamewell Co. (The).~~
- ~~H. Equipment and material, general:~~
- ~~1. All equipment and components shall be new, and the manufacturer's current model. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approvals agency for use as part of a protective signaling system, meeting the National Fire Alarm Code.~~
 - ~~2. All equipment and components shall be installed in strict compliance with manufacturers' recommendations. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc., before beginning system installation.~~
 - ~~3. All equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.~~
- ~~I. Description of System~~
- ~~1. Include the following system functions and operating features plus those additional functions and features required by the authorities having jurisdiction:~~
 - ~~a. Priority of Signals: Accomplish automatic response functions by the first address initiated. Alarm functions resulting from initiation by the first device are not altered by subsequent alarms. The highest priority is an alarm signal. Supervisory and trouble signals have second and third-level priority respectively. Higher priority signals take precedence over signals of lower priority, even though the lower priority condition occurred first. Annunciate all alarm signals regardless of priority or order received.~~
 - ~~b. Non-interfering: Zone, power, wire, and supervise the system so a signal on one device does not prevent the receipt of signals from any other device. All zones are manually resettable from the FACP only after the initiating device or devices are restored to normal. Systems that require batteries or battery back-up for the programming function are unacceptable.~~
 - ~~c. Fire Alarm Control Panel (FACP) Response: The manual or automatic operation of an alarm-initiating device causes the FACP to transmit an appropriate signal including the following:~~
 - ~~d. General alarm.~~
 - ~~e. Fire suppression system operation alarm.~~
 - ~~f. Fan shutdown.~~
 - ~~g. Transmission to Remote Central Station: Automatically route alarm, supervisory, and trouble signals to a remote central station service.~~
 - ~~h. Silencing at the FACP: Switches provide capability for acknowledgment of alarm, supervisory, trouble, and other specified signals at the FACP; and capability to silence the local audible signal and light a light-emitting diode (LED). Subsequent zone alarms shall cause the audible signal to sound again until silenced by switch operation. Restoring alarm, supervisory, and trouble conditions to normal extinguishes the associated LED~~

- and causes the audible signal to sound again until restoration is acknowledged by switch operation.
- i. ~~Loss of primary power sounds a trouble signal at the FACP. The FACP indicates when the fire alarm system is operating on an alternate power supply.~~
 - j. ~~Loss of primary power at the FACP sounds a trouble signal. An emergency power light is illuminated when the system is operating on an alternate power supply.~~
 - k. ~~FACP Alphanumeric Display: Displays plain English language descriptions, locations and addresses of initiating devices, alarms, trouble signals, supervisory signals, monitoring actions, system and component status, and system commands.~~
 - l. ~~General Alarm: A system general alarm includes the following:~~
 - m. ~~Indicating the general alarm condition at the FACP.~~
 - n. ~~Identifying the device that is the source of the alarm at the FACP.~~
 - o. ~~Initiating audible and visible alarm signals throughout the building.~~
 - p. ~~Stopping supply and return fans serving zone where alarm is initiated.~~
 - q. ~~Initiating transmission of alarm signal to remote central station via the digital communicator.~~
 - r. ~~Manual station alarm operation initiates a general alarm.~~
 - s. ~~Water-flow alarm switch operation Initiates~~
 - t. ~~A general alarm~~
 - u. ~~The location-indicating light to flash for the device that has operated.~~
 - v. ~~Smoke detection initiates a general alarm.~~
 - w. ~~Heat detection initiates a general alarm.~~
 - x. ~~Sprinkler valve tamper switch operation causes or initiates the following:~~
 - y. ~~A supervisory, audible, and visible "valve tamper" signal indication at the FACP.~~
 - z. ~~The location-indicating light to flash for the device that has operated.~~
 - aa. ~~Transmission of supervisory signal to remote central station.~~
- J. ~~Addressable Devices~~
- 1. ~~Alarm-Initiating Devices: Classified as addressable devices according to NFPA 72.~~
 - a. ~~Communication Transmitter and Receiver: Integral to device. Provides each device with a unique identification and capability for status reporting to the FACP.~~
 - b. ~~External Addressable Interface Unit: May be used where specified devices are not manufactured and labeled with integral multiplex transmitter and receiver. Arrange to monitor status of each device individually.~~
- K. ~~Manual Pull Stations~~
- 1. ~~Description: Double-action type, fabricated of metal or plastic, and finished in red with molded, raised letter operating instructions of contrasting color.~~
 - a. ~~Station Reset: Key or wrench operated, double pole, double throw, switch rated for the voltage and current at which it operates. Stations have screw terminals for connections.~~
- L. ~~Smoke Detectors~~
- 1. ~~General: Comply with UL 268. Include the following features:~~
 - a. ~~Factory Nameplate: Serial number and type identification.~~
 - b. ~~Operating Voltage: 24-V dc, nominal.~~
 - c. ~~Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.~~
 - d. ~~Plug-in Arrangement: Detector and associated encapsulated electronic components are mounted in a module that connects to a fixed base with a twist-locking plug connection. The plug connection requires no springs for secure mounting and contact maintenance. Terminals in the fixed base accept building wiring.~~
 - e. ~~Integral Visual Indicating Light: Connect to indicate detector has operated.~~
 - f. ~~Remote Controllability: Individually monitor detectors at the FACP for calibration, sensitivity, and alarm condition, and individually adjust for sensitivity from the FACP.~~
 - 2. ~~Photoelectric Smoke Detectors: Include the following features:~~
 - a. ~~Detector Sensitivity: Between 2.5- and 3.5-percent-per-foot (0.008- and 0.011-percent-per-mm) smoke obscuration when tested according to UL 268.~~
 - b. ~~Sensor: An infrared detector light source with matching silicon cell receiver.~~
 - 3. ~~Duct Smoke Detector: Ionization type.~~

- a. ~~Sampling Tube: Design and dimensions as recommended by the manufacturer for the specific duct size and installation conditions where applied.~~
 - b. ~~Relay Fan Shutdown: Rated to interrupt fan motor control circuit.~~
- M. ~~Other Detectors~~
- 1. ~~Thermal Detector: Combination fixed temperature and rate-of-rise unit with mounting plate arranged for outlet box mounting; 135 deg F (57 deg C) fixed temperature setting, except as indicated.~~
- N. ~~Alarm Indicating Devices~~
- 1. ~~General: Equip alarm indicating devices for mounting as indicated. Provide terminal blocks for system connections.~~
 - 2. ~~Horns: Electric vibrating polarized type, operating on 24-V dc, with provision for housing the operating mechanism behind a grille. Horns produce a sound pressure level of 90 dB, measured 10 feet (3 m) from the source.~~
 - 3. ~~Visual Alarm Devices: Synchronous, Xenon strobe lights with clear or nominal white polycarbonate lens. Mount lenses on an aluminum faceplate. The word "FIRE" is engraved in minimum 1 inch (25 mm) high letters on the lens.~~
 - a. ~~Devices have a minimum light output as indicated on the Drawings.~~
 - b. ~~Strobe Leads: Factory connected to screw terminals.~~
 - c. ~~Combination devices consist of factory combined, audible and visual alarm units in a single mounting assembly.~~
 - 4. ~~Remote Alarm Indicator: LED type, mounted flush in a single gang wall plate.~~
 - a. ~~Connected to indicate the alarm operation of a single detector or other device.~~
 - b. ~~Legend: "Alarm."~~
- O. ~~Central Fire Alarm Control Panel (FACP)~~
- 1. ~~General: Comply with UL 864.~~
 - 2. ~~Cabinet: Lockable steel enclosure. Arrange panel so all operations required for testing or for normal care and maintenance of the system are performed from the front of the enclosure. If more than a single unit is required to form a complete control panel, provide exactly matching modular unit enclosures. Accommodate all components and allow ample gutter space for interconnection of panels and field wiring. Identify each enclosure by an engraved, red, laminated, phenolic-resin nameplate. Lettering on the enclosure's nameplate shall not be less than 1 inch (25 mm) high. Identify individual components and modules within the cabinets with permanent labels.~~
 - 3. ~~Systems: Alarm and supervisory systems are separate and independent in the FACP. The alarm-initiating zone boards in the FACP consist of plug-in cards. Construction requiring removal of field wiring for module replacement is unacceptable.~~
 - 4. ~~Control Modules: Types and capacities required to perform all functions of the fire alarm systems. Local, visible, and audible signals announce alarm, supervisory, and trouble conditions. Each type of audible alarm has a different sound.~~
 - 5. ~~Indicating Lights: An LED test switch for each FACP section illuminates all LED devices on that section of the control panel. Manual toggle test switches or push test buttons do not require a key to operate. Alarm and supervisory signals light a red LED of the associated zone. Trouble signals light an amber LED for the associated zone.~~
 - 6. ~~Resetting: Provide the necessary controls to prevent the resetting of any alarm, supervisory, or trouble signal while the alarm or trouble condition still exists.~~
 - 7. ~~Alphanumeric Display and System Controls: Arrange to provide the basic interface between human operator at the FACP and addressable system components, including annunciation and supervision. A display with a minimum of 32 characters shows alarm, supervisory, and component status messages. Arrange keypad for use in entering and executing control commands.~~
 - 8. ~~Instructions: Printed or typewritten instruction card mounted behind a lexan plastic or glass cover in a stainless-steel or aluminum frame. Install the frame in a location observable from the FACP. Include interpretation and appropriate response for displays and signals, and briefly describe the functional operation of the system under normal, alarm, and trouble conditions.~~
- P. ~~Emergency Power Supply~~

- ~~1. General: Components include valve-regulated, recombinant lead acid battery, charger, and an automatic transfer switch. Battery nominal life expectancy is 10 years, minimum.~~
- ~~2. General: Components include nickel-cadmium type battery, charger, and an automatic transfer switch. Battery nominal life expectancy is 20 years, minimum.~~
- ~~3. Battery capacity is adequate to operate the complete alarm system in normal or supervisory (nonalarm) mode for a period of 24 hours. At the end of this period, the battery has sufficient capacity to operate the system, including alarm-indicating devices in either alarm for a period of 15 minutes.~~
- ~~4. Battery Charger: Solid-state, fully automatic, variable-charging-rate type. Provide capacity for 150 percent of the connected system load while maintaining the batteries at full charge. In the event batteries are fully discharged, the charger recharges them completely within 4 hours. Charger output is supervised as part of system power supply supervision.~~
- ~~5. Integral Automatic Transfer Switch: Transfers the load to the battery without loss of signals or status indications when normal power fails.~~

~~Q. Wire~~

- ~~1. Wire: Solid copper conductors with 600 V rated, 75 deg C, color-coded insulation.
 - ~~a. Low Voltage Circuits: No. 16 AWG, minimum.~~
 - ~~b. Line Voltage Circuits: No. 12 AWG, minimum.~~~~

2.14 TOUCHUP PAINT

- A. For Equipment: Provided by equipment manufacturer and selected to match equipment finish.
- B. For Nonequipment Surfaces: Matching type and color of undamaged, existing adjacent finish.

PART 3 - INSTALLATION

3.1 EXAMINATION

- A. Verify that field measurements and circulating arrangements are as shown on Drawings.
- B. Verify that all obsolete equipment, wiring, Raceways, equipment and devices have been completely demolished and removed from the site.

3.2 PREPARATION

- A. Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.
- B. Coordinate utility service outages with Utility Company, owner, owners representative and Construction Site Superintendent.
- C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment, feeders or branch circuits, use personnel experienced in such operations.
- D. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Obtain permission from or notify Owner and Architect/Engineer at least 24 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.

3.3 CUTTING AND PATCHING

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

3.4 ROUGH-IN

- A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
- B. Refer to equipment specifications, drawings, elevations and shop drawings in Divisions 2 through 16 to verify rough-in requirements.

3.5 ELECTRICAL INSTALLATIONS

- A. General: Sequence, coordinate, and integrate the various elements of electrical systems, materials, and equipment. Comply with the following requirements:
1. Coordinate electrical systems, equipment, and materials installation with other building components.
 2. Verify all dimensions by field measurements.
 3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for electrical installations.
 4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
 5. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the Work.
 6. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
 7. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.
 8. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
 9. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
 10. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

3.6 ELECTRICAL SUPPORTING METHODS

- A. Damp Locations and Outdoors: Hot-dip galvanized materials or nonmetallic, U-channel system components.
- B. Dry Locations: Steel materials.
- C. Support Clamps for PVC Raceways: Click-type clamp system.
- D. Conform to manufacturer's recommendations for selecting supports.
- E. Strength of Supports: Adequate to carry all present and future loads, times a safety factor of at least 4; 200-lb- (90-kg-) minimum design load.

3.7 INSTALLATION OF ELECTRICAL SUPPORTING DEVICES

- A. Install devices to securely and permanently fasten and support electrical components.
- B. Raceway Supports: Comply with NFPA 70 and the following requirements:
1. Conform to manufacturer's recommendations for selecting and installing supports.
 2. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.
 3. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.
 4. Spare Capacity: Size supports for multiple conduits so capacity can be increased by a 25 percent minimum in the future.
 5. Support individual horizontal raceways with separate, malleable iron pipe hangers or clamps.
 6. Hanger Rods: 3/8-inch diameter or larger threaded steel, except as otherwise indicated.
 7. Spring Steel Fasteners: Specifically designed for supporting single conduits or tubing. May be used in lieu of malleable iron hangers for 1-1/2-inch (38-mm) and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings and for fastening raceways to channel and slotted angle supports.

8. In vertical runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports, with no weight load on raceway terminals.
 - C. In open overhead spaces, cast boxes threaded to raceways need not be separately supported, except where used for fixture support; support sheet-metal boxes directly from the building structure or by bar hangers. Where bar hangers are used, attach the bar to raceways on opposite sides of the box and support the raceway with an approved fastener not more than 24 inches (610 mm) from the box.
 - D. Fastening: Unless otherwise indicated, securely fasten electrical items and their supporting hardware to the building structure. Perform fastening according to the following:
 1. Fasten by means of machine screws, welded threaded studs, or spring-tension clamps on steel.
 2. Select fasteners so the load applied to any fastener does not exceed 25 percent of the proof-test load.
- 3.8 INSTALLATION OF CONDUCTORS AND CABLES
- A. Wire and Insulation Applications
 1. Feeders: Type THHN/THWN, in raceway.
 2. Branch Circuits: Type THHN/THWN, in raceway.
 3. Branch Circuits:
 - a. General: Type THHN/THWN, copper conductor, in EMT.
 4. ~~Fire Alarm Circuits:~~
 - a. ~~Fire Alarm MC cable with "red" armor~~
 - b. ~~Type THHN/THWN, in "red" conduit.~~
 - c. ~~Class 1 Control Circuits: Type THHN/THWN, in raceway.~~
 - d. ~~Class 2 Control Circuits: Type THHN/THWN, in raceway.~~
 - B. Installation
 1. Install wires and cables as indicated, according to manufacturer's written instructions and NECA's "Standard of Installation."
 2. Pull Conductors: 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.
 3. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
 4. Identify wires and cables according to Division 16 Section "Electrical Identification."
 - C. Connections
 1. Conductor Splices: Keep to minimum.
 2. Install splices and tapes that possess equivalent or better mechanical strength and insulation ratings than conductors being spliced.
 3. Use splice and tap connectors compatible with conductor material.
 4. Use oxide inhibitor in each splice and tap connector for aluminum conductors.
 5. Wiring at Outlets: Install conductor at each outlet, leave at least 8 inches of slack.
 6. Connect outlets and components to wiring and to ground as indicated and instructed by manufacturer.
 7. 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.
 - D. Equipment Connections
 1. Circuit numbers on Drawings are for reference only to indicate number of devices on a single circuit. Exact circuit numbers shall be determined in the field .
 2. Each branch circuit homerun containing two or more circuits with a common neutral shall be connected to the circuit breaker or switch in a three- or four-wire branch circuit panelboard so that no two of the circuits will be fed from the same phase.
 3. Provide all wiring to and between motors, starters, line voltage (120-600 volt) control devices, disconnect switches, and other related electrical equipment, except where such items are factory wired.

4. Terminate power wiring for elevator system at the controller, and be in compliance with the manufacturer's approved shop drawings.
 5. Provide power and wiring connections to the control devices for electrically operated overhead doors, door operators, and control devices which will be provided under other divisions.
- E. Maximum Branch Circuit Lengths
1. The following indicates maximum installed length a circuit can have and still maintain an adequate voltage level at the last point of use. If the circuit length exceeds the length listed, use the next largest wire size. Multiple circuit runs in the same raceway shall have all conductors sized the same based on worst case circuit lengths.
- F. Field Quality Control
1. Testing Agency: Engage a qualified independent testing agency to perform field quality-control testing.
 2. Testing: On installation of wires and cables and before electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
 3. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.3.1. Certify compliance with test parameters.
 4. Correct malfunctioning conductors and cables at Project site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

3.9 INSTALLATION OF RACEWAYS AND BOXES

- A. Examine surfaces to receive raceways, boxes, enclosures, and cabinets for compliance with installation tolerances and other conditions affecting performance of raceway installation. Do not proceed with installation until unsatisfactory conditions have been corrected.
- B. Wiring Methods
1. Outdoors: Use the following wiring methods:
 - a. Exposed: Rigid steel or IMC.
 - b. Concealed: Rigid steel or IMC.
 - c. Underground, Single Run: Schedule 80 PVC.
 - d. Underground, Grouped: Schedule 80 PVC.
 - e. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 - f. Underground schedule 80 PVC to within 5 feet of turning up from underground transition to RSC to equipment. Schedule 80 PVC will be allowed exposed within Main Electric Room.
 - g. Boxes and Enclosures: NEMA 250, Type 3R or Type 4.
 2. Indoors: Use the following wiring methods:
 - a. Exposed: EMT
 - b. Concealed: EMT, ENT, or RNC.
 - c. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC; except in wet or damp locations, use LFMC.
 - d. Damp or Wet Locations: Rigid steel conduit.
 - e. Boxes and Enclosures: NEMA 250, Type 1, except as follows:
 - f. Damp or Wet Locations: NEMA 250, Type 4, stainless steel.
 - g. Damp or Wet Locations: NEMA 250, Type 4, nonmetallic.
- C. Installation
1. Install raceways, boxes, enclosures, and cabinets as indicated, according to manufacturer's written instructions.
 2. Minimum Raceway Size: 3/4-inch trade size (DN21).
 3. Conceal conduit and EMT, unless otherwise indicated, within finished walls, ceilings, and floors.
 4. 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.
 5. Install raceways level and square and at proper elevations. Provide adequate headroom.
 6. Complete raceway installation before starting conductor installation.

7. Support raceways as specified in Division 16 Section "Basic Electrical Materials and Methods."
8. Use temporary closures to prevent foreign matter from entering raceways.
9. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portion of bends is not visible above the finished slab.
10. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and straight legs of offsets parallel, unless otherwise indicated.
11. Use raceway fittings compatible with raceways and suitable for use and location. For intermediate steel conduit, use threaded rigid steel conduit fittings, unless otherwise indicated.
12. Run concealed raceways, with a minimum of bends, in the shortest practical distance considering the type of building construction and obstructions, unless otherwise indicated.
13. Raceways Embedded in Slabs: Install in middle third of slab thickness where practical, and leave at least 1-inch (25-mm) concrete cover.
 - a. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
 - b. Space raceways laterally to prevent voids in concrete.
 - c. Run conduit larger than 1-inch trade size (DN27) parallel to or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
 - d. Transition from nonmetallic tubing to Schedule 80 nonmetallic conduit, rigid steel conduit, or IMC before rising above floor.
14. Install exposed raceways parallel to or at right angles to nearby surfaces or structural members, and follow the surface contours as much as practical.
 - a. Run parallel or banked raceways together, on common supports where practical.
 - b. Make bends in parallel or banked runs from same centerline to make bends parallel. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.
15. Join raceways with fittings designed and approved for the purpose and make joints tight.
 - a. Make raceway terminations tight. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.
 - b. Use insulating bushings to protect conductors.
16. Tighten set screws of threadless fittings with suitable tools.
17. Terminations: Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against the box. Where terminations are not secure with 1 locknut, use 2 locknuts: 1 inside and 1 outside the box.
18. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align raceways so the coupling is square to the box and tighten the chase nipple so no threads are exposed.
19. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel 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 the pull wire.
20. Telephone and Signal System Raceways, 2-Inch Trade Size (DN53) and Smaller: In addition to the 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.
21. 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 the 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 flush plugs flush with floor for future equipment connections.
22. Flexible Connections: Use maximum of 6 feet (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 liquidtight flexible conduit in wet or damp locations. Install separate ground conductor across flexible connections.

23. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in a nonmetallic sleeve.
24. Do not install aluminum conduits embedded in or in contact with concrete.
25. PVC Externally Coated, Rigid Steel Conduits: Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduits.
26. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying the raceways to receptacle ground terminals. Mount raceways on walls at counter height behind lab tables and on top of tables where shown on drawings.

D. Protection

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

E. Cleaning

1. On completion of installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

3.10 INSTALLATION OF ELECTRICAL IDENTIFICATION

- A. Install identification devices according to manufacturer's written instructions.
- B. Install labels where indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.
- C. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and other designations used for electrical identification with corresponding designations used in the Contract Documents or required by codes and standards. Use consistent designations throughout the Project.
- D. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.
- E. Self-Adhesive Identification Products: Clean surfaces of dust, loose material, and oily films before applying.
- F. Install painted identification as follows:
 1. Clean surfaces of dust, loose material, and oily films before painting.
 2. Prime Surfaces: For galvanized metal, use single-component, acrylic vehicle coating formulated for galvanized surfaces. For concrete masonry units, use heavy-duty, acrylic-resin block filler. For concrete surfaces, use clear, alkali-resistant, alkyd binder-type sealer.
 3. Apply one intermediate and one finish coat of silicone alkyd enamel.
 4. Apply primer and finish materials according to manufacturer's instructions.
- G. Install Circuit Identification Labels on all Boxes: Label externally as follows:
 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.
- H. Color-Code Conductors: Secondary service and feeder conductors throughout the secondary electrical system.
 1. 208/120-V System: As follows:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - d. Neutral: White.
 - e. Ground: Green.
 2. Factory-apply color the entire length of the conductors, except the following field-applied, color-coding methods may be used in lieu 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 the last 2 turns of tape with no tension to prevent possible unwinding. Use 1-inch- (25-mm-) wide tape in colors as specified. Adjust tape bands to avoid obscuring cable identification markings.
 - b. Colored cable ties applied in groups of 3 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.
- I. Device Coverplate Identification: Plastic adhesive with 1/8 inch high white capital letters designating as follows:
1. All receptacle coverplates, shall be engraved with the following branch circuit source information:
 - a. Panelboard number.
 - b. Circuit number.
 - c. Example: "LP2 - 5"
- J. Install identification as follows:
1. Apply equipment identification labels of engraved plastic laminate on each major unit of equipment, including central or master unit of each system. ~~This includes communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification. Except as 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 2 lines of text are required, use lettering 2 inches (51 mm) high. Use white lettering on black field. Apply labels for each unit of the following categories of equipment.
 - a. Panelboards, electrical cabinets, and enclosures.
 - b. Motor starters.
 2. Apply designation labels of engraved plastic laminate for disconnect switches, breakers, push buttons, and similar items for power distribution and control components above, except panelboards and alarm/signal components where labeling is specified elsewhere.
 3. For panelboards, provide framed, typed circuit schedules with explicit description and identification of items controlled by each individual breaker.

3.11 INSTALLATION OF GROUNDING SYSTEMS

- A. General: Ground electrical systems and equipment according to NEC requirements, except where Drawings or Specifications exceed NEC requirements.
- ~~B. Grounding Rods: Locate a minimum of 1-rod length from each other and at least the same distance from any other grounding electrode.~~
- ~~1. Drive until tops are 2 inches (50 mm) below finished floor or final grade, except as otherwise indicated.~~
 - ~~2. Interconnect with grounding electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make these connections without damaging copper coating or exposing steel.~~
- ~~C. Grounding Conductors: Route along the shortest and straightest paths possible, except as otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.~~
- ~~D. Underground Grounding Conductors: Use bare copper wire. Bury at least 24 inches (600 mm) below grade.~~
- ~~E. Metal Water Service Pipe: Provide insulated copper grounding conductors, sized as indicated, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes by grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Do not install a grounding jumper across dielectric fittings. Bond grounding conductor conduit to conductor at each end.~~
- ~~F. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding clamp connectors.~~

~~G. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide a No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4 by 2 by 12-inch (6 by 50 by 300 mm) grounding bus.~~

~~H. Connections~~

- ~~1. General: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.~~
- ~~a. Use electroplated or hot tin coated materials to assure high conductivity and to make contact points closer in order of galvanic series.~~
- ~~b. Make connections with clean, bare metal at points of contact.~~
- ~~c. Make aluminum to steel connections with stainless steel separators and mechanical clamps.~~
- ~~d. Make aluminum to galvanized steel connections with tin-plated copper jumpers and mechanical clamps.~~
- ~~e. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.~~
- ~~2. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections, except those at test wells. Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.~~
3. Equipment Grounding-Wire Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.
4. Noncontact Metal Raceway Terminations: Where metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at both entrances and exits with grounding bushings and bare grounding conductors, except as otherwise indicated.
5. Connections at Test Wells: Use compression-type connectors on conductors and make bolted- and clamped-type connections between conductors and grounding rods.
6. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. Where these requirements are not available, use those specified in UL 486A and UL 486B.
7. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by manufacturer of connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.
8. Moisture Protection: Where insulated grounding conductors are connected to grounding rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

I. Adjusting and Cleaning

1. Restore surface features, including vegetation, at areas disturbed by work of this Section. Reestablish original grades, except as otherwise indicated. Where sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Include topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 2 Section "Landscaping." Maintain restored surfaces. Restore disturbed paving as indicated.

3.12 INSTALLATION OF PANELBOARDS

- A. Install panelboards and accessory items according to NEMA PB 1.1.
- B. Mounting Heights: Top of trim 74 inches (1880 mm) above finished floor, unless otherwise indicated.

- C. Mounting: Plumb and rigid without distortion of box. Mount flush panelboards uniformly flush with wall finish.
 - D. Circuit Directory: Type directory to indicate installed circuit loads after balancing panelboard loads. Obtain approval before installing.
 - E. Install filler plates in unused spaces.
 - F. Provision for Future Circuits Stub four 1-inch (27-GRC) empty conduits from panelboard and terminate at ceiling.
 - G. Wiring in Panelboard Gutters: Arrange conductors into groups, and bundle and wrap with wire ties after completing load balancing.
 - H. IDENTIFICATION
 - 1. Identify field-installed wiring and components and provide warning signs as specified in Division 16 Section "Electrical Identification."
 - 2. Panelboard Nameplates: Label each panelboard with engraved laminated-plastic or metal nameplates mounted with corrosion-resistant screws.
 - I. Grounding
 - 1. Make equipment grounding connections for panelboards as indicated.
 - 2. Provide ground continuity to main electrical ground bus as indicated.
 - J. Connections
 - 1. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
 - 2. Testing: After installing panelboards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
 - a. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
 - b. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units, and retest.
 - 3. Balancing Loads: After Substantial Completion, but not more than 2 months after Final Acceptance, conduct load-balancing measurements and make circuit changes as follows:
 - a. Perform measurements during period of normal working load as advised by Owner.
 - b. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility. Make special arrangements with Owner to avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
 - c. Recheck loads after circuit changes during normal load period. Record all load readings before and after changes and submit test records.
 - d. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as required to meet this minimum requirement.
 - K. Cleaning
 - 1. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.
- 3.13 INSTALLATION OF DISCONNECTS AND CIRCUIT BREAKERS
- A. Install disconnect switches and circuit breakers in locations as indicated, according to manufacturer's written instructions.
 - B. Install disconnect switches and circuit breakers level and plumb.
 - C. Install wiring between disconnect switches, circuit breakers, control, and indication devices.
 - D. Connect disconnect switches and circuit breakers and components to wiring system and to ground as indicated and instructed by manufacturer.
 - 1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

- E. Identify each disconnect switch and circuit breaker according to requirements specified in Division 16 Section "Electrical Identification."
- F. Field Quality Control
 - 1. Testing: After installing disconnect switches and circuit breakers and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
 - a. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.5 for disconnect 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, remove and replace with new units and retest.
- G. Cleaning
 - 1. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish including chips, scratches, and abrasions.

3.14 INSTALLATION OF INTERIOR LIGHTING

- A. Set units plumb, square, and level with ceiling and walls, and secure according to manufacturer's written instructions and approved Shop Drawings. Support fixtures according to requirements of Division 16 Section "Basic Electrical Materials and Methods."
- B. Support for Suspended Fixtures: Brace pendants and rods over 48 inches (1200 mm) long to limit swinging. Support stem-mounted, single-unit, suspended fluorescent fixtures with twin-stem hangers. For continuous rows, use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of chassis, including one at each end.
- C. Connections
 - 1. Ground lighting units. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- D. Field Quality Control
 - 1. Inspect each installed fixture for damage. Replace damaged fixtures and components.
 - 2. Give advance notice of dates and times for field tests.
 - 3. Provide instruments to make and record test results.
 - 4. Tests: Verify normal operation of each fixture after fixtures have been installed and circuits have been energized with normal power source. Interrupt electrical energy to demonstrate proper operation of emergency lighting installation. Include the following information in tests of emergency lighting equipment:
 - a. Duration of supply.
 - b. Low battery voltage shutdown.
 - c. Normal transfer to battery source and retransfer to normal.
 - d. Low supply voltage transfer.
 - 5. Replace or repair malfunctioning fixtures and components, then retest. Repeat procedure until all units operate properly.
 - 6. Report results of tests.
 - 7. Replace fixtures that show evidence of corrosion during Project warranty period.
- E. Adjusting and Cleaning
 - 1. Clean fixtures after installation. Use methods and materials recommended by manufacturer.
 - 2. Adjust aimable fixtures to provide required light intensities.

3.15 INSTALLATION OF EXTERIOR LIGHTING

- A. Set units plumb, square, level, and secure according to manufacturer's written instructions and approved Shop Drawings.
- B. Fixture Attachment: Fasten to indicated structural supports.
- C. Fixture Attachment with Adjustable Features or Aiming: Attach fixtures and supports to allow aiming for indicated light distribution.
- D. Lamp fixtures with indicated lamps according to manufacturer's written instructions. Replace malfunctioning lamps.

E. Field Quality Control

1. Inspect each installed unit for damage. Replace damaged fixtures and components.
2. Give advance notice of dates and times for field tests.
3. Provide instruments to make and record test results.
4. Tests and Observations: Verify normal operation of lighting units after installing fixtures and energizing circuits with normal power source. Include the following:
 - a. Photometric Tests: Measure light intensities at night in 15 foot increments centered on fixture to property line. Use photometers with calibration referenced to National Institute of Standards and Technology (NIST) standards.
 - b. Check for intensity of illumination.
 - c. Check for uniformity of illumination.
 - d. Check for excessively noisy ballasts.
 - e. Prepare written report of tests indicating actual illumination results.
5. Replace or repair damaged and malfunctioning units, make necessary adjustments, and re-test. Repeat procedure until all units operate properly.

F. Adjusting And Cleaning

1. Clean units after installation. Use methods and materials recommended by manufacturer.
2. Adjust aim-able fixtures to provide required light intensities.

3.16 — INSTALLATION OF FIRE ALARM SYSTEMS

- ~~A. Manual Pull Stations: Mount semiflush in recessed back boxes with operating handles 48 inches (1220 mm) above the finished floor or lower as indicated.~~
- ~~B. Water-Flow Detectors and Valve Supervisory Switches: Connect interface modules for each sprinkler valve station required to be supervised.~~
- ~~C. Smoke Detectors: Install ceiling-mounted detectors not less than 4 inches (100 mm) from a side wall to the near edge. Install detectors located on the wall at least 4 inches (100 mm), but not more than 12 inches (300 mm), below the ceiling. For exposed solid joist construction, mount detectors on the bottom of the joists. On smooth ceilings, install detectors not over 30 feet (9 m) apart in any direction. Install detectors no closer than 60 inches (1520 mm) from air registers.~~
- ~~D. Audible/Visual Alarm-Indicating Appliances: Install not less than 80 inches above the finished floor nor less than 6 inches (150 mm) below the ceiling. Install horns on flush-mounted back boxes with the device operating mechanism concealed behind a grille or as indicated. Combine audible and visual alarms at the same location into a single unit.~~
- ~~E. FACP: Flush mount with top of cabinet not more than 72 inches (1830 mm) above the finished floor.~~
- ~~F. Install system according to NFPA standards referenced in Parts 1 and 2 of this Section.~~
- ~~G. Fire Alarm Power Supply Disconnect: Paint red and label "FIRE ALARM." Provide with lockable handle or cover.~~

H. WIRING INSTALLATION

- ~~1. Wiring Method: Install wiring in metal raceway according to Division 16 Section "Raceways, Boxes, and Cabinets." Conceal raceway except in unfinished spaces and as indicated.~~
- ~~2. Wiring within Enclosures: Install conductors parallel with or at right angles to the sides and back of the enclosure. Bundle, lace, and train the conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.~~
- ~~3. Cable Taps: Use numbered terminal strips in junction, pull or outlet boxes, cabinets, or equipment enclosures where circuit connections are made.~~
- ~~4. Color Coding: Color code fire alarm conductors differently from the normal building power wiring. Use one color code for alarm circuit wiring and a different color code for supervisory circuits. Color code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visual alarm-indicating devices. Paint fire alarm system junction boxes and covers red.~~

I. Field Quality Control

- ~~1. Manufacturer's Field Service: Provide services of a factory-authorized service representative to perform all programming and supervise the field assembly and connection of components and the pretesting, testing, and adjustment of the system.~~
 - ~~2. Pretesting: After installation, align, adjust, and balance the system and perform complete pretesting. Determine, through pretesting, the conformance of the system to the requirements of the Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new ones and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.~~
 - ~~3. Report of Pretesting: After pretesting is complete, provide a letter certifying the installation is complete and fully operable, including the names and titles of the witnesses to the preliminary tests.~~
 - ~~4. Final Test Notice: Provide a 10-day minimum notice to the Owner, Engineer and Barnstable Fire Department in writing when the system is ready for final acceptance testing by same.~~
 - ~~5. Minimum System Tests: Test the system according to the procedures outlined in NFPA 72. Minimum required tests are as follows:
 - ~~a. Verify the absence of unwanted voltages between circuit conductors and ground.~~
 - ~~b. Test all conductors for short circuits using an insulation testing device.~~
 - ~~c. With each circuit pair, short circuit at the far end of the circuit and measure the circuit resistance with an ohmmeter. Record the circuit resistance of each circuit on the record drawings.~~
 - ~~d. Verify that the control unit is in the normal condition as detailed in the manufacturer's operation and maintenance manual.~~
 - ~~e. Test initiating and indicating circuits for proper signal transmission under open circuit conditions. One connection each should be opened at not less than 10 percent of the initiating and indicating devices. Observe proper signal transmission according to class of wiring used.~~
 - ~~f. Test each initiating and indicating device for alarm operation and proper response at the control unit. Test smoke detectors with actual products of combustion.~~
 - ~~g. Test the system for all specified functions according to the approved operation and maintenance manual. Systematically initiate specified functional performance items at each station, including making all possible alarm and monitoring initiations and using all communications options. For each item, observe related performance at all devices required to be affected by the item under all system sequences. Observe indicating lights, displays, signal tones, and annunciator indications. Observe all voice audio for routing, clarity, quality, freedom from noise and distortion, and proper volume level.~~
 - ~~h. Test Both Primary and Secondary Power: Verify by test that the secondary power system is capable of operating the system for the period and in the manner specified.~~~~
 - ~~6. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets the Specifications and complies with applicable standards.~~
 - ~~7. Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test results in the form of a test log. Submit log upon the satisfactory completion of tests.~~
 - ~~8. Tag all equipment, stations, and other components at which tests have been satisfactorily completed.~~
- ~~J. Cleaning And Adjusting~~
- ~~1. Cleaning: Remove paint splatters and other spots, dirt, and debris. Touch up scratches and marred finish to match original finish. Clean unit internally using methods and materials recommended by manufacturer.~~
- ~~K. Demonstration~~
- ~~1. Startup Services: Engage a factory-authorized service representative to provide startup service and to demonstrate and train Owner's maintenance personnel as specified below.
 - ~~a. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, adjusting, and preventive maintenance. Provide a minimum of 8 hours' training.~~~~

- ~~b. Training Aid: Use the approved final version of the operation and maintenance manual as a training aid.~~
- c. Schedule training with Owner with at least 7 days' advance notice.

3.17 TOUCHUP PAINTING

- A. Thoroughly clean damaged areas and provide primer, intermediate, and finish coats to suit the degree of damage at each location.
- B. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.

* * * END OF SECTION 16000 * * *