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SECTION 002210

AIA A201 - GENERAL CONDITIONS OF THE CONTRACT FOR CONSTRUCTION, 2017 EDITION

PART 1 GENERAL

1.01 DESCRIPTION

- A. The General Conditions of this Contract is the General Condition of the Contract for Construction, AIA Document A201, 2007 Edition, hereinafter referred to as the GENERAL CONDITIONS, as modified. This document, with all modifications, is hereby specifically made a part of the Contract Documents with the same force and effect as if bound herein.
- B. A copy of the document is included in this Section 002210.

END OF DOCUMENT 002210

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ELECTRICAL WORK GENERAL

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1.1 RELATED DOCUMENTS

- A.** General provisions of the contract, including the GENERAL CONDITIONS, SUPPLEMENTARY CONDITIONS and Division 01, GENERAL REQUIREMENTS, apply to the work specified in this section.
- B.** Refer to Section Section 01 25 00 for specified SUBSTITUTION PROCEDURES which apply to all sections of the specification.
- C.** Project is participating in LEED. Contractor shall perform work in compliance with LEED manual for Core and Shell Construction and the points targeted in the project LEED scorecard. Refer to General Conditions of these specifications for additional requirements. Coordinate with all trades involved for adherence to and documentation of all requirements necessary to obtain the target points. Refer to Section 018113 for additional LEED requirements.
- D.** The mechanical, plumbing, fire protection and electrical systems will be commissioned by a third party Commissioning Agent to achieve LEED certification. The contractor is to provide all labor and materials to assist the LEED Commissioning Authority as specified in Division 01. Refer to Section 019100 Whole Building Commissioning for additional requirements.
- E.** For information related to the Construction IAQ Management plan refer to Section 018119.

1.2 DESCRIPTION

- A.** This section includes requirements for all electrical work and applies to all divisions of the specifications covering equipment, materials, or systems that use electricity, or are concerned in any way with the supply, control, or use of electrical power or signals.

1.3 REFERENCES

- A.** The National Electrical Code (NEC) and publications and standards of organizations listed below are referenced by abbreviations noted in parentheses,

with or without additional identifying symbols. Unless otherwise specified, all work shall be manufactured, tested and installed in accordance with latest issues of these standards.

1. American Society for Testing and Materials (ASTM).
2. Underwriters' Laboratories, Inc. (U.L.).
3. National Electrical Manufacturers Association (NEMA).
4. Institute of Electrical and Electronic Engineers (IEEE).
5. American National Standards Institute, Inc. (ANSI).
6. National Fire Protection Association (NFPA).

1.4 UNDERWRITERS' LABORATORIES LABELING

- A. Equipment and materials for which Underwriters' Laboratories labeling service is provided shall be U.L. labeled and listed. Label or listing of Underwriters' Laboratories, Inc., will be accepted as evidence that materials or equipment conform to applicable standards of that agency. In lieu of this listing, submit statement from nationally recognized, adequately equipped testing agency, such as ETL, acceptable to all agencies and authorities having jurisdiction, indicating items have been tested in accordance with required procedures and materials and equipment comply with all requirements.

1.5 DEFINITIONS AND EXPLANATIONS

- A. Specifications are intentionally abbreviated and may include incomplete sentences. Intent as interpreted by the Engineer, rather than sentence structure, shall govern in case of doubt or dispute.
- B. "Provide" means "furnish and install".
"Directed" means "directed by the Architect or Engineer".
"Concealed" means "items referred to are hidden from normal sight".
"Exposed" means "items are not concealed".
"Approved" means "by the Architect or Engineer".
- C. Where any device or part of equipment is herein referred to in the singular number (such as "the panelboard"), such reference applies to as many such devices as are required to complete the installation as shown on the drawings.

1.6 DRAWINGS

- A. The electrical drawings shall be considered to be diagrammatic only. The attention of the Contractor is called to the fact that while these drawings are generally to scale, and are made as accurately as the scale will permit, all important dimensions shall be verified in the field. They are not to be considered to be erection drawings.

They do not indicate every fitting, pull box, etc., which may be required to complete the job. The Contractor shall prepare field erection drawings, as required, to assure proper installation.

- B.** The electrical drawings indicate the general arrangement of circuits and outlets, location of switches, panelboards, conduit and other work. All outlets shall be located uniformly with respect to beams, partitions, ducts, openings, etc. Outlets shall not be installed behind ducts, grilles, nor in other inaccessible places.

1.7 RECORD DRAWINGS

- A.** Provide reproducible record drawings at the completion of work. Record drawings shall show all important information which is changed from contract drawings. Dimensionally locate all underground or in-slab conduit on record drawings.
- B.** The Contractor shall maintain at the site one copy of all drawings, specifications, addenda, approved shop drawings, change orders, and other modifications in good order and clearly marked to record all changes as they occur during construction. These shall be available to the Architect or Engineer for review during construction.

1.8 SUBMISSIONS

- A.** Approval of materials and equipment will be based on the manufacturer's published data.
- B.** A manufacturer's statement indicating complete compliance with the applicable specifications or standards is acceptable except for U.L. compliance as indicated above.
- C.** Shop drawings and other descriptive material shall be submitted in accordance with requirements as specified in Division 01. Submission shall cover all materials and equipment as specified in individual specification sections.
- D.** Within thirty (30) days of award of contract, the Contractor shall submit for approval a "Manufacturers List" for all materials and equipment to be provided under Division 26. No shop drawing or material submissions will be considered until said Manufacturers List is approved.
- E.** Where requested by the Architect or Engineer, the Contractor shall provide for approval one sample each of any device, equipment or material submitted for use on this project. Samples shall be shipped, all charges prepaid, to the address specified by the Architect. Item submitted shall be identical in all details, including finish, to that proposed for use on this project.

1.9 SHORT CIRCUIT, ARC-FLASH, AND OVERCURRENT DEVICE COORDINATION STUDIES

- A.** Provide complete short circuit study and overcurrent protective device coordination study.
 - 1.** For normal power portions of the electrical distribution system for this project, studies shall include all unique feeder circuits and items of distribution equipment from utility company service through branch circuit panelboards.
 - 2.** For emergency life safety and standby power portions of the electrical distribution system for this project, studies shall include all feeder circuits and items of distribution equipment from utility company service through branch circuit panelboards as well as from the emergency standby generator set through branch circuit panelboards. Emergency life safety and standby power portions of the electrical distribution system for this project shall be selectively coordinated as required by National Electric Code Articles 620, 700, and 701.
- B.** Coordination study shall be plotted on standard log-log graph paper and shall show the following superimposed on one graph:
 - 1.** Fuse melting curves.
 - 2.** Circuit breaker trip curves.
 - 3.** Ground fault relay settings.
 - 4.** Transformer magnetic inrush and ANSI point.
- C.** A narrative analysis shall accompany each coordination curve sheet and describe the coordination and protection in explicit detail. All curve sheets shall be multi-color for improved clarity. Areas lacking complete coordination shall be highlighted and either reasons provided for allowing condition to remain or solution(s) provided to resolve condition.
- D.** Results of coordination study shall outline in tabular form all required trip settings for adjustable trip type circuit breakers in order to maximize coordination of the electrical power distribution system.
- E.** Provide arc flash hazard analysis in accordance with IEEE 1584 equations that are presented in NFPA 70E, Annex D.
 - 1.** The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.

2. Safe working distances shall be based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm^2 .
3. Provide and install a 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each work location analyzed.
4. All labels will be based on recommended overcurrent device settings and will be provided after the results of the analysis have been presented to the owner and after any system changes, upgrades or modifications have been incorporated in the system.
5. Labels shall be machine printed, with no field markings. The label shall include the following information, at a minimum:
 - a. Location designation
 - b. Nominal voltage
 - c. Flash protection boundary
 - d. Hazard risk category
 - e. Incident energy
 - f. Working distance
 - g. Engineering report number, revision number and issue date.
6. Provide training for the owner's qualified electrical personnel of the potential arc flash hazards associated with working on energized equipment (minimum of 4 hours). The training shall be certified for continuing education units (CEUs) by the International Association for Continuing Education Training (IACET) or equivalent.

F. Preparer Qualifications:

1. Short circuit, arc-flash, and overcurrent protective device coordination studies shall be performed by a qualified professional firm experienced in the analysis, evaluation, and coordination of electrical distribution systems and similar to the system for this project. Firm must have at a minimum a 4-year record of successful in-service performance. Studies provided by switchboard manufacturers are not acceptable.
2. The studies shall be prepared in accordance with the latest NETA Std. ATS, NFPA 70B, the NEC, ANSI C2 "National Electrical Safety Code", and ANSI/IEEE Guidelines, as well as manufacturer's recommendations.
3. Analysis and Coordination Study shall be performed by a registered Professional Engineer. The Engineer shall have a minimum of eight years of experience in the analysis, evaluation, and coordination of electrical distribution systems.
4. The firm conducting the study shall have one million dollars worth of Professional Liability Insurance in addition of standard general insurance.

G. Submittal Requirements

1. Submit six copies of the protection coordination study (and all other data noted in this specification section) according to Conditions of the Contract

- and Division 01 Specification Sections.
- 2. Shop drawings for equipment affected by the coordination study will not be reviewed until the coordination study has been submitted and approved.
- 3. Qualification data for firms and persons specified in the Preparer Qualifications section above to demonstrate their capabilities and experience. This shall include:
 - a. List of completed similar projects with project names, addresses, names of Engineer and Owner, and other relevant information
 - b. Name(s) and licensure information for personnel performing studies
- H. All distribution equipment, feeders, switches, fuses, panelboards, and branch circuit overcurrent devices shall have listed short circuit rating in compliance with electrical coordination recommendations.
- I. Submit copy of studies and curves in O&M manual.

1.10 OPERATION AND MAINTENANCE MANUALS

- A. Furnish hardbound copies of a composite operation and maintenance manual for the electrical systems. These shall be indexed and shall contain the following information:
 - 1. Brief description of each system and equipment item, with all related system or equipment components.
 - 2. Manufacturers' printed operating and maintenance instructions, parts list, illustrations and diagrams for all components.
 - 3. One copy of each wiring diagram.
 - 4. One approved copy of each shop drawing and the Contractor's drawings.
 - 5. One print of power riser diagram, framed, to be mounted in main electric room.
 - 6. Warranty Certificates.
 - 7. As-built drawings.
 - 8. List of manufacturer and model number of lamps and ballasts actually installed in each light fixture type.
- B. The Contractor shall submit one (1) copy of the operation and maintenance manual to the Architect for approval at least 30 days before the date of final acceptance tests and inspections.
- C. After the manual is reviewed, incorporate comments or changes and furnish two (2) corrected copies to the Architect.

1.11 INSTRUCTION TO OWNER

- A.** Furnish, without additional expense to Owner, services of competent instructor who will give full instruction in care, adjustment and operation of all parts of electrical equipment to Owner's Representative.
- B.** Instructor shall be familiar with all parts of system on which he is to give instruction and be trained in operating theory as well as in practical operation and maintenance work. A factory trained instructor shall be used.
- C.** Unless otherwise required or approved, instruction shall be given during the regular work week after equipment has been accepted and turned over to Owner for regular operation. Duration of instruction shall be as specified below and in individual specification sections. Instruction time shall be at location of equipment.
- D.** Minimum instruction and training periods shall be as follows unless specified otherwise:
 - 1.** Emergency generator and transfer switches: 8 hours or as otherwise specified.
 - 2.** Lighting control system: 16 hours or as otherwise specified.
 - 3.** Fire alarm system: 16 hours or as otherwise specified.
 - 4.** Main switchboard: 4 hours or as otherwise specified.

1.12 COORDINATION

- A.** Refer to Section 01 34 00, COORDINATION DRAWINGS for additional requirements.
- B.** Coordinate electrical work with other sections to avoid interferences between mechanical, electrical, architectural, and structural work.
- C.** Determine interferences between sections before work is fabricated or installed. The Contractor shall be thoroughly familiar with all details of work and working conditions and coordinate work during preliminary stages to ensure actual erection will proceed without interferences. Coordination is of paramount importance and no request for additional payment will be considered where request is based on interference.
- D.** Prepare and submit Coordination Drawings of electrical systems and equipment as required by Division 01 and this Section. Scale not less than 1/8 inch per foot showing on both plan and elevation equipment, pullboxes, conduit and other items contained within all electric room spaces, mechanical room spaces, and penthouse

spaces. Show all mechanical equipment and ductwork, structural and architectural items within required spaces. Show and dimension service feeder ductbank and utility transformer pad. Show and dimension emergency generator and feeder conduits. Show and dimension all openings required for risers. Coordinate drawings with Division 23 Coordination Drawings to provide complete composite drawings. Composite drawings shall be completed, submitted, reviewed, and approved prior to ordering any equipment or any installation work including rough-in.

- E.** Where job conditions require reasonable deviations from contract documents, make such deviations without additional cost to Owner, after obtaining approval of Architect.
- F.** Within limits indicated, provide maximum practicable space for operation, repair, removal, and testing of electrical equipment. Approved deviations may be made to provide required accessibility. Verify prior to submission of shop drawings that each submitted component of electrical equipment will properly fit and function within allotted space and will properly interface with work of other sections.
- G.** Keep conduits, wireways, and similar items as close as possible to ceiling, walls and columns to take up minimum amount of space. Locate not to interfere with intended use of monorails, eyebolts, and other lifting equipment.
- H.** Provide offsets, fittings and similar items necessary to accomplish requirements of coordination without additional expense to Owner.
- I.** Rough-in For Future Connection: Where conduit and equipment are provided for future connection, locate so they can be connected to, and extended in the future without having to relocate them. Do not allow connection points to be blocked or obstructed by other trades.
- J.** Sleeves for Future Use: Where sleeves are shown to be provided for future use, do not use these sleeves for work under this contract. Where sleeves stack floor to floor or line up wall to wall, do not obstruct the access way between sleeves with work installed under this contract.
- K.** Coordinate the location of light fixtures in all equipment rooms with actual installed equipment. Install so that light output is not blocked.

1.13 INSTALLATION AND CONNECTION OF EQUIPMENT

- A.** Install and connect all appliances and equipment for proper operation as specified and shown on the contract drawings in accordance with the manufacturer's instructions and recommendations.
 - 1.** Carefully examine each manufacturer's equipment item to be provided for mechanical, electrical, structural and other connections required.
 - 2.** Before roughing in outlets verify location, voltage, phase, current rating, and type of outlet required from approved shop drawings of the equipment. For owner-furnished equipment verify same from shop drawing or visual inspection of the equipment.
 - 3.** Compare installation requirements for actual equipment to be provided to connections indicated on the drawings or specified.
 - 4.** Notify Architect of any differences between work required to install equipment and work indicated on the drawings before any rough-in work is started.
 - 5.** Obtain manufacturer's installation instructions for each equipment item to be installed. Review instructions and any installation requirements which involve mechanical, electrical, structural and architectural work and coordinate with appropriate contractor.
 - 6.** Provide detailed rough-in and installation requirements with submittals. Prepare coordination drawings as required to supplement manufacturer's data, to assure a complete coordinated installation.
 - 7.** Make all connections to equipment from the walls except where other arrangements are indicated.
 - 8.** Except as otherwise indicated, provide a flush junction box in the wall beneath the operating level of the equipment and connect to the equipment with flexible conduit.
 - 9.** Completely wire equipment having built-in switches as required. Replace, shorten or lengthen plugs and cords on equipment to suit the outlets furnished.
 - 10.** Meet local codes and UL label requirements on all equipment connections.

1.14 PROTECTION

- A.** Protect work against damage from all causes. Provide and maintain protective coverings to exclude dirt, dust, water, paint, etc., from equipment. Close all ducts, conduits, and openings in boxes and equipment to prevent entrance of dirt or construction material.
- B.** Thoroughly clean equipment upon completion of work. Remove dust, dirt, splatter of paint, plaster, other materials, and stains and discolorations of factory finish. Restore finishes to original condition.

- C. Prior to acceptance of work, repair damaged equipment, cables, surfaces and finishes equal to new. Replace broken work and damaged conduit with new.
- D. Prevention of corrosion: Protect metallic materials against corrosion. Give exposed metallic parts of outdoor apparatus rust-inhibiting treatment and standard finish by the manufacturer. Do not use aluminum in contact with earth and, where connected to dissimilar metal, protect by approved fittings and treatment. Parts, such as boxes, bodies, fittings, guards, and miscellaneous parts made of ferrous metals, but not of corrosion resistant steel, shall be zinc-coated ASTM A123 or A153, except where other equivalent protective treatment is specifically approved in writing by the Architect. Provide bituminous coating or non-corrosive sleeve where metallic conduit penetrates poured concrete.
- E. Store equipment in dry areas protected from the elements prior to installation. Do not allow equipment to sit outdoors. Store equipment on pallets and provide and maintain at all times heavy plastic covering over equipment secured tightly to protect it from construction dust, wind-blown rain or snow, and water leaking through the building. If equipment is installed or set in place prior to an area being closed in and fully protected from rain (direct or windblown), construction dust, or from water leakage through the building, this equipment shall be protected by wrapping in heavy minimum 20 mil fibre reinforced plastic sheeting taped and tied secure. Failure to maintain protection of any item of equipment shall be grounds for rejection of that item.
- F. Protect materials that are subject to damage from the elements or construction dust as specified above for equipment.

1.15 PERMITS, FEES AND INSPECTIONS

- A. Obtain and pay for under Division 26 all necessary licenses, fees, and inspections as required for the proper execution and completion of all work as specified under Division 26.
- B. Provide Owner with Final Electrical Inspection Certificate prior to final Owner acceptance.

1.16 WARRANTIES

- A. Comply with requirements of General Conditions, Division 01, and additional requirements specified under Sections of Division 26.
- B. Provide 24 hour, 7 day per week, emergency service by the factory

authorized service representative during the 1 year warranty period for the systems and equipment listed below. The contractor shall ensure that a factory authorized service technician shall be on site within 4 hours of a service request call being placed.

1. Emergency Generator
2. Fire Alarm System
3. Switchboards

- C. Warranty period shall commence at the Date of Substantial completion as accepted in writing by the Architect.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Unless otherwise specified, all equipment, components and materials shall be new and a standard manufactured product of a manufacturer which has manufactured similar products and components for at least three years, and match like items which have been in satisfactory continuous service for a period of not less than two years.

2.2 MOTORS AND CONTROL FOR MECHANICAL EQUIPMENT

- A. Electric motors for plumbing, fire protection, and HVAC equipment shall be as specified under Division 23. Unless furnished as an integral part of driven equipment, starters and disconnects, both individual and group mounted, shall be provided in Division 26.
- B. Other electrical devices such as selector switches, flow switches, pilot lights, thermostats, etc., for control or operation of HVAC and plumbing equipment will be provided and connected in Division 23. Materials and workmanship shall comply with Division 26.
- C. Wiring for automatic temperature control shall be provided under Division 23. Coordinate with Division 23 for provision of power connections for automatic temperature controls.
- D. All environmental HVAC control dampers shall be furnished and installed under Division 23. Wiring for control shall be provided under Division 23. Materials and workmanship shall comply with Division 26.
- E. All control dampers specific to atrium smoke exhaust systems, stairwell pressurization systems, or smoke enclosure systems shall be furnished and installed

under Division 23. Power supply wiring shall be provided under Division 26. Coordinate with Division 23 to ensure dampers are furnished with 120 volt actuators. Dampers shall be controlled by the fire alarm system installed under Division 26.

- F.** Separately mounted variable frequency drives for mechanical equipment shall be furnished under Division 23, installed under Division 26.
- G.** Power supply wiring for all equipment shall be provided in Division 26.

PART 3 - EXECUTION

3.1 GENERAL

- A.** Installation of new equipment, components and wiring for electrical systems such as fire alarm shall be in accordance with requirements of equipment manufacturer.

3.2 LEGENDS AND NAMEPLATES

- A.** Equipment and components shall have nameplates and other legend markings as follows:
 - 1.** Provide nameplates for each major piece of electrical equipment such as switchboards, panelboards, motor control centers, transformers, busway, individual circuit breakers, safety switches and motor starters.
 - a.** Nameplates shall indicate equipment name, voltage and unless directly adjacent shall indicate equipment item served and device fed from.
 - b.** Nameplates shall be engraved laminated plastic with light-colored characters against dark background. Fasten nameplates with stainless steel screws and position on or adjacent to equipment, clearly visible. Equipment name shall be minimum 3/8-inch lettering. Other characters shall be minimum 3/16-inch lettering.
 - 2.** Provide legends for each piece of equipment such as switchboards, motor control centers, panelboards, and distribution panels.
 - a.** Legends shall indicate type of load and location where possible. Legends shall refer to circuit numbers clearly indicated at branch devices.
 - b.** Legends shall be typewritten and mounted behind clear plastic cover.
 - 3.** Submit copies of proposed nameplates and legends to Architect for approval prior to fabrication.

3.3 PAINTING

- A. Factory finishes, shop priming, and special protective coatings are specified in individual sections. Field painting of electrical equipment, but not touch-up painting of factory finished items, is specified in Section PAINTS AND FINISHES. Where factory finishes are provided on equipment and additional field painting is not specified, touch up marred or damaged surfaces or refinish to match factory finish.
- B. Paint all fire alarm system pull boxes, terminal cabinets, and junction boxes red and label "FIRE ALARM" in one-inch high stenciled black letters (2-inch high on junction boxes).

3.4 EQUIPMENT HOUSEKEEPING PADS

- A. Provide 4" concrete housekeeping pad for all floor mounted electrical equipment, including transformers, switchboards, motor control centers, distribution panels, bussed troughs and generator. Concrete as specified in Division 03. All pads to extend not more than 6" beyond outside dimensions of equipment.

3.5 TESTS

- A. Test and adjust equipment and systems installed under these specifications and demonstrate proper operation to Owner's Representative. Tests shall be as specified in individual system sections. No equipment shall be tested, or operated for any purpose, until it has been fully lubricated or prepared for operation in accordance with manufacturer's instructions. Provide all labor, equipment and material (including fuel) to conduct all tests specified in Division 26.
- B. Test feeder circuits and electrical devices insulation resistance after wiring is completed. Make tests with an instrument capable of measuring accurately resistance involved and having voltage rating of 1000 volts. Take readings after voltage has been applied continuously for one minute. Measure insulation resistance between conductors and between each conductor and ground. For wiring completed and connected ready for attachment of equipment, values of insulation resistance shall not be less than twenty (20) megohms. Submit test results for review.
- C. Load Balance Test
 - 1. Make tests by energizing all lighting, motors, and other electrical equipment simultaneously.
 - 2. Take voltage and amperage readings at all panels, circuit connections, fuses, circuit breakers, as required for satisfactory performance. Check the amperage draw, voltage and direction of rotation of each motor. Make all

necessary changes to obtain proper rotation, motor terminal voltage, motor protection, etc. Revise heater elements as necessary for proper motor protection. Similarly check all other electrically connected equipment.

- D. Equipment and Apparatus Factory Tests
 - 1. Manufacturer's normal quality control tests are acceptable, unless specific factory witnessed tests are specified in other sections.
- E. Provide certified factory test reports on equipment by manufacturer or testing laboratory and furnish to Owner.

3.6 LOOSE EQUIPMENT

- A. Provide four keys for every different piece of electrical equipment which is equipped with a lock.
- B. Provide six keys for each different type fire alarm station or lock type switch.
- C. Provide all loose equipment specific/supplied for use with the power distribution, sound, and communication systems.

3.7 MARKERS

- A. Furnish and install punched color tape markers, or color coded markers as determined by Owner. Affix to ceiling to indicate which ceiling panel is to be removed to obtain access to what control devices, duct mounted smoke detectors, etc.

3.8 TEMPORARY SERVICE

- A. Provide and operate temporary electrical service, distribution, wiring, power outlets and lighting, including lamps, as required for building construction, personnel safety and site security. Remove system completely when permanent connections have been completed.
- B. Temporary service and wiring shall conform to all applicable codes.
- C. Temporary source and distribution system shall be adequate to serve all required construction equipment (power tools, lifts, tower cranes, temporary heating, air compressors, etc.) and lighting as necessary to construct building complete.
- D. Lighting for adequate working conditions and safety shall be as required to suit the particular location and operation, but shall in no case be less than the equivalent of

1/2 watt of incandescent light per square foot of area.

- E.** Be responsible for any damage or injury to equipment, materials, or personnel caused by improperly operated or protected temporary installations.
- F.** Costs for material and installation for temporary electrical facilities and energy for their operation shall be at expense of the General Contractor up to time of final acceptance.
- G.** See Section TEMPORARY UTILITIES for additional temporary electrical service requirements.



SECTION 26 05 00

ELECTRICAL BASIC MATERIAL AND METHOD

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. General provisions of the contract, including the GENERAL CONDITIONS, SUPPLEMENTARY CONDITIONS, Division 01, GENERAL REQUIREMENTS, and Section 26 01 00 apply to the work specified in this section.

1.2 DESCRIPTION

- A. This section pertains to furnishing of all labor, material, equipment, and services necessary to provide complete power, lighting and miscellaneous systems as indicated and specified.

1.3 SUBMITTALS

- A. Submit following for review:
 - 1. Full descriptive material and shop drawings:
 - a. Raceway
 - b. Wire
 - c. Wiring devices and plates
 - d. Pushbutton stations (for other than HVAC equipment)
 - e. Safety switches
 - f. Motor starters
 - g. Fuses and circuit breakers
 - h. Heat tape
 - i. Contactors
 - j. Panelboards
 - k. Load centers
 - l. Surge Protection Device (SPD)
 - m. Time clocks
 - n. Slab heating system
 - o. Floor boxes – concrete
 - p. Early Streamer Emission (ESE) Lightning Protection
 - q. Submit adhesive and sealants product information on Material Safety Data Sheet (MSDS) showing VOC content information for all products specified under this section.
 - 2. Test reports for:
 - a. Grounding electrode

- b. Feeder insulation resistance
- c. Lightning protection system

1.4 OPERATION AND MAINTENANCE MANUAL

- A. Cover following items in Operation and Maintenance Manual:
 - 1. Pushbutton stations
 - 2. Safety switches
 - 3. Panelboards
 - 4. Load centers
 - 5. Motor starters
 - 6. Fuses and circuit breakers
 - 7. Transformers
 - 8. Slab heating system
 - 9. Heat tape
 - 10. Surge Protection Devices (SPD).
 - 11. Lightning protection system.

PART 2 - PRODUCTS

2.1 RACEWAYS

- A. Rigid Galvanized Steel Conduit - RGS:
 - 1. U.L. Standard 6 and ANSI C80.1.
 - 2. Hot-dipped galvanized exterior and interior surfaces.
 - 3. Supplemental chromate coating to provide additional protection layer against corrosion and abrasion.
 - 4. Acceptable Manufacturers: Allied Tube & Conduit, Wheatland Tube Co., Superior Essex, Inc.
- B. Intermediate Metal Conduit – IMC:
 - 1. U.L. Standard 1242 and ANSI C80.6.
 - 2. Galvanized exterior surface with an organic corrosion resistant interior surface coating.
 - 3. Supplemental chromate coating to provide additional protection layer against corrosion and abrasion.
 - 4. Acceptable Manufacturers: Allied Tube & Conduit, Wheatland Tube Co., Superior Essex, Inc.
- C. Electrical Metallic Tubing – EMT:
 - 1. U.L. Standard 797 and ANCI C80.3.
 - 2. Galvanized exterior surface with an organic corrosion resistant interior surface coating.

3. Supplemental chromate coating to provide additional protection layer against corrosion and abrasion.
 4. Acceptable Manufacturers: Allied Tube & Conduit, Wheatland Tube Co., Superior Essex, Inc.
- D.** Flexible Metallic Conduit:
1. U.L. Standards 1 and 1479.
 2. RWS (reduced wall steel) constructed of continuously interlocked galvanized steel.
 3. Acceptable Manufacturers: AFC Cable Systems, Anamet Electrical, Inc., and Southwire Company.
- E.** Liquidtight Flexible Metallic Conduit:
1. U.L. standard 360.
 2. Constructed of continuously interlocked galvanized steel core with sunlight resistant PVC outer jacket with a temperature range of -20°C to +60°C.
 3. Color coded as follows:
 - a. General Purpose Applications: Gray.
 - b. Computer and Data Processing Equipment Applications: Blue.
 4. Acceptable Manufacturers: AFC Cable Systems, Anamet Electrical, Inc., and Southwire Company.
- F.** Electrical Nonmetallic Tubing – ENT:
1. U.L. Standard 1653 meeting NEMA TC-13.
 2. A pliable, corrugated raceway of circular cross-section constructed of extruded PVC with ambient temperature range of -15°C to +50°C.
 3. Rated for 90°C conductors.
 4. Color coded as follows:
 - a. General Purpose Branch Circuits: Blue.
 - b. Emergency Life Safety & Standby Branch Circuits: Red.
 - c. Low Voltage Cabling (other than fire alarm system): Yellow.
 5. Provide coordinating stub-down fittings, couplings, transition adapters, supports, mud boxes, threaded adapters, etc. manufactured by ENT conduit manufacturer and intended for use in installing ENT in concrete embedment.
 6. Acceptable Manufacturers: Carlon / Thomas & Betts or pre-approved alternative meeting this specification.
- G.** PVC Rigid Conduit:
1. U.L. standard 651 and NEMA TC-2.
 2. **Schedule 40 rated for 90°C conductors.**
 3. Acceptable Manufacturers: CANTEX, Allied Tube and Conduit, Prime Conduit.

2.2 RACEWAY FITTINGS AND ACCESSORIES

- A. Rigid Steel Conduit and Intermediate Metal Conduit:
 - 1. Threadless Connectors: U.L. standard 514; ANSI C80.4 and C33.84; steel or malleable iron construction; zinc plated and chromate coated; nylon insulated throat; set-screw or compression type as specified; U.L. listed concrete-tight where required.
 - 2. Threadless Couplings: U.L. standard 514; ANSI C80.4 and C33.84; steel or malleable iron construction; zinc plated and chromate coated; set-screw or compression type as specified; U.L. listed concrete-tight where required.
 - 3. Threaded Hub Connectors: U.L. standard 514; ANSI C80.4 and C33.84; steel or malleable iron construction; nylon insulated throat; U.L. listed rain-tight.
- B. Electrical Metallic Tubing:
 - 1. Connectors: U.L. standard 514; ANSI C33.84; all steel construction; zinc plated and chromate coated; nylon insulated throat; set-screw or compression type as specified.
 - 2. Couplings: U.L. standard 514; ANSI C33.84; all steel construction; zinc plated and chromate coated; set-screw or compression type as specified.
- C. Flexible Metallic Conduit, , MC Cable:
 - 1. Connectors: U.L. standard 514; steel or malleable iron construction; zinc plated and chromate coated; nylon insulated throat; saddle or squeeze type.
- D. Liquidtight Flexible Metal Conduit:
 - 1. Connectors: U.L. standard 514; steel or malleable iron construction; zinc plated and chromate coated; nylon insulated throat; U.L. listed water-tight.
- E. Acceptable Manufacturers: ABB / Thomas & Betts / Steel City, Bridgeport Fittings, Emerson / Appleton Electric / O-Z Gedney, Hubbell, Inc. / Raco

2.3 WIRE

- A. COPPER Conductors with THHN or XHHW-2 insulation, except as otherwise specified.
- B. Aluminum Alloy Conductors:
 - 1. General: The contractor may, at his option, substitute aluminum alloy conductors in trade sizes No. 6 AWG to 750 kcmil, inclusive, in lieu of copper conductors for use in distribution feeders supplying switchboards, motor control centers, transformers, distribution panelboards, and branch panelboards only. Aluminum conductors shall not be used for any

mechanical equipment feeder or branch circuit connections. Aluminum conductors shall have equal or greater ampacities to that of the copper conductors shown on the plans.

2. Aluminum alloy conductors shall be compact stranded Aluminum Association 8000 Series electrical alloy conductors as manufactured by General Cable / Alcan Cable "Stabiloy AA-8030" or Southwire "Alumaflex AA-8176."
3. Should the Contractor elect to use the aluminum alloy conductor option, he shall be responsible for the following:
 - a. Increasing conduit, raceway and pull box sizes to accommodate any difference in cable size in accordance with the requirements of the National Electric Code.
 - b. Submit shop drawings showing feeder schedules and applicable conversion data supporting the substitution of aluminum for copper conductors.
 - c. The contractor will be responsible for resizing equipment as necessary to avoid any interferences and for providing any structural, mechanical or electrical changes incurred by the substitution.
 - d. The complete installation of similar systems (No. 6 AWG and larger) shall be of the same materials. In no case shall conductors, conduits or duct sizes be reduced from that as required by the contract documents as designed using copper conductors.
 - e. In no case shall aluminum conductors be used to connect electrical or mechanical equipment when not recommended by the equipment manufacturer.
4. If aluminum conductors are furnished, all cables shall be terminated in accordance with manufacturer's Aluminum and Copper 600 Volt Conductors Installation and Application guide and NECA-AA 104-2006 Recommend Practice for Installing Aluminum Building Wire and Cable. Compression type pigtail adaptors are acceptable to use with aluminum conductors. Adaptors are to be installed per the manufacturer's written instructions.

C. Connectors:

1. Provide U.L. listed lugs dual rated "AL7CU or AL9CU" as per the requirements of UL Standard 486B.
2. Wire brush the conductor and apply an oxide inhibiting joint compound, *Penetrox* or equal.
3. Provide the proper torque per the connector manufacturer's recommendation.

D. Minimum size of branch circuit wire: No. 12 AWG. Use solid conductors for wire up through No. 10 AWG; stranded conductors for wire larger than No. 10 AWG;

stranded conductors for control circuits except as otherwise noted. Color code all wires for phase and control circuit identification at locations where it can be inspected. Wire size indicated for portion of run applies to entire run, unless noted otherwise. 600 volt insulation is minimum for branch circuits and feeders.

- E. Homeruns greater than 80 feet in length for 120 volt branch circuits shall be minimum No. 10 AWG. Homeruns greater than 125 feet in length for 120 volt branch circuits shall be minimum No. 8 AWG. Homeruns greater than 150 feet in length for 277 volt branch circuits shall be minimum No. 10 AWG.
- F. For exterior wiring, for wiring in or below slabs, and for in interior damp or wet locations: Type THWN or XHHW-2.
- G. Acceptable Manufacturers: Prysmian Cables and Systems (Pirelli Cable), Okonite Co., Service Wire Co., Superior Essex, General Cable (Alcan Cable), Southwire Co., Belden Wire & Cable.

2.4 CABLES

- A. Type MC Metal Clad Cable:
 - 1. Metal Armor: Galvanized steel or aluminum.
 - 2. Conductors: Copper. Minimum size No. 12 AWG. Use solid conductors for wire up through No. 10 AWG; stranded conductors for wire larger than No. 10 AWG.
 - 3. Conductor Insulation: THHN 90°C.
 - 4. Equipment Ground: Separate insulated green conductor, sized per NEC.
 - 5. U.L. Standards: 83, 1479, 1569.
 - 6. U.L. rated for cable tray and environmental air handling space installation.
 - 7. Acceptable Manufacturers: AFC Cable Systems, Okonite Co., Southwire Co., Prysmian / Draka Cabletek / Tamaqua Cable.
- B. Type MI Mineral Insulated Cable:
 - 1. Type MI mineral insulated, metal-sheathed cable shall be a factory assembly of one or more conductors insulated with highly compacted magnesium oxide insulation and enclosed in a seamless, liquid and gas tight continuous copper sheath.
 - 2. Conductors shall be of solid, high electrical conductivity copper with a cross-section area corresponding to standard AWG sizes.
 - 3. The insulation shall be of highly compressed magnesium oxide that will provide spacing for conductors. Thickness of insulation shall be at least 55 mils for all cable from AGW 12 through 250 kcmil.
 - 4. Type MI cable shall comply with NEC Article 330 and all other applicable provisions and other Articles of NEC. It shall be classified by Underwriters Laboratories as having a 2-hour fire resistive rating.

5. Acceptable Manufacturers: Pyrotenax / Tyco.
- C. **PVC Jacketed Type MC Metal Clad Cable (Parking Deck/Lot Cable):**
 1. Metal Armor Jacketing: Galvanized steel with gray PVC jacket.
 2. Conductors: Copper. Two, three, or four conductors, minimum size No. 12 AWG. Use solid conductors for wire up through No. 10 AWG; stranded conductors for wire larger than No. 10 AWG.
 3. Conductor Insulation: THHN 90°C. Type ACTHH.
 4. Equipment Ground: Separate insulated green conductor, sized per NEC.
 5. U.L. Standards: 83, 1479, 1569, 1581.
 6. U.L. rated for cable tray, concrete encasement, and wet location installation.
 7. UL listed sunlight resistant and oil resistant II.
 8. Acceptable Manufacturers: AFC Cable Systems, Okonite Co., Southwire Co., Prysmian / Draka Cabletek / Tamaqua Cable, Belden Wire & Cable.

2.5 JUNCTION AND PULL BOXES

- A. Install junction or pull boxes wherever required to facilitate wire pulling or connection.
- B. Pullboxes shall be NEMA 1, 2, 3 or 4 as required by area. Provide partitions to separate multiple boxes at same location. **Minimum #14 gauge**. Construct from galvanized sheet steel. Solder or braze all seams, fold edges at openings. Provide matching screw cover.
- C. Label circuits inside each box and on cover exterior with one-half inch high stenciled letters.

2.6 OUTLET BOXES

- A. Outlets, of whatever kind, for all systems, provide suitable box especially designed to receive type of fixture or device mounted. Provide fixture outlets with suitable supports of size and kind required for fixture hung. Fixture studs: 3/8-inch.
- B. Outlet boxes: Boxes outdoors, near exterior walls and in damp locations: FS or FD boxes of suitable design for particular application. Elsewhere, use stamped sheet metal boxes with corrosion-resistant finish to suit raceway and particular application.
- C. Ceiling construction: No. 1900, four-inch square, 2-1/8" deep, or No. 83, four-inch octagonal.
- D. Wall outlet boxes: No. 1900, four-inch square, 2-1/8" deep. Interior partition: No. 1700.

- E. Outlet boxes in glazed tile or block: Use boxes designed for that purpose, with square corners and straight sides.
- F. Provide covers for flush outlet boxes of proper depth for each application, so edge of ring is flush with finish material.
- G. Acceptable Manufacturers:
 - 1. Outlet boxes and fixtures: All-Steel Equipment, Inc., Steel City, Appleton Electric Co., or Raco.
 - 2. Floor boxes: O-Z/Gedney, Hubbell, Thomas & Betts, Russellstoll, Walker / Wiremold, or Steel City.
 - 3. FS and FD boxes: Appleton Electric Co., Crouse Hinds Co., Killark Electric Mfg. Co., or Red Dot.

2.7 PANELBOARDS - STANDARD

- A. NEMA Type 1 with molded case circuit breaker branch circuit overcurrent protective devices, fully distributed phasing connections of devices, phase and neutral bus capacities as indicated and an equipment ground bus. Panelboards: NEMA Standard Publications and standards published by ANSI, IEEE, and U.L.
- B. Phases, neutral and ground bus bars: Copper.
- C. Branch circuit overcurrent protective devices: Bolt-on molded case circuit breakers; NEMA Standards Publication PB1-1995 and the latest issue of standards published by ANSI, IEEE, and U.L. Circuit breakers: Frame size, trip and interrupting ratings indicated. Circuit breakers 225 ampere frame size and larger: Interchangeable trip unit type. Single pole, 20 ampere circuit breakers intended to switch lighting loads shall carry the SWD marking. Provide ground-fault circuit-interrupting (GFCI) type branch circuit breakers, as indicated on the drawings, with a ground fault trip rating of 5mA. Provide ground-fault equipment-protection (GFEP) type branch circuit breakers, as indicated on the drawings, with a ground fault rip rating at 30mA. Provide type HACR-rated branch circuit breakers for all branch circuits serving refrigeration (i.e. air conditioning) equipment. Provide main breakers with lockout capability.
- D. Provide panelboard back boxes and trims conforming to paragraph of this section entitled CABINETS.
- E. Use standard manufactured products of Square D/Schneider Electric, General Electric or Eaton/Cutler-Hammer. Components of the panelboards shall be product of same manufacturer.

- F.** Provide flush tumbler lock and catch on all panelboard doors. Key panelboards alike.
- G.** Finish cabinets of surface-mounted panels and fronts and trim of flush panelboards with neutral gray enamel over rust-inhibiting primer treatment.
- H.** For multi-section panels provide back boxes and trim of same height.
- I.** Mount typewritten schedule of all feeder and branch circuits, with legend approved by Architect, in frame on inside of each panel cabinet door under plastic. Schedules shall be completed prior to substantial completion.
- J.** Circuit numbers indicated are for purpose of clarifying grouping of outlets into circuits. Adjust actual number allotted to circuits in panel, following this numbering as closely as practicable.
- K.** Where "space" or "equipped space" is called for on schedule, provide necessary bus, device supports and connections for future device.
- L.** Provide all panelboards with feed-through lugs for extension of main feeder to future second section.
- M.** Maximum overall panelboard height allowed shall be no greater than 80". Maximum panelboard overall width shall be no greater than 24" for 400 amps and smaller.

2.8 RESIDENTIAL UNIT LOAD CENTERS

- A.** Provide flush installation.
- B.** Phases, neutral and ground bus bars: Aluminum.
- C.** Provide interior easily removed for paint or theft protection during rough-in.
- D.** Circuit breakers: Branch circuit overcurrent protective devices: Plug-on molded case circuit breakers; the latest issue of standards published by ANSI, IEEE, and U.L. Circuit breakers: Frame size, trip and interrupting ratings indicated. Circuit breakers 225 ampere frame size and larger: Interchangeable trip unit type. Single pole, 20 ampere circuit breakers intended to switch lighting loads shall carry the SWD marking. Provide ground-fault circuit-interrupting (GFCI) type branch circuit breakers, as indicated on the drawings, with a ground fault trip rating at 5mA. Provide arc-fault circuit-interrupting (AFCI) type branch circuit breakers, as indicated on the drawings, with arc fault trip characteristics in accordance with U.L. Standard 1699. Provide type HACR-rated branch circuit breakers for all branch

circuits serving refrigeration (i.e. air conditioning) equipment. Provide main breakers with lockout capability.

- E. Provide single captive screw that can't be lost; interior that mounts quickly and easily.
- F. Provide split branch neutral with minimum 25% more terminations than required.
- G. Mount typewritten schedule of all branch circuits in frame on inside of each load center cabinet door. Schedules shall be completed prior to substantial completion.
- H. Load center covers shall be painted by contractor per architectural specification.
- I. Acceptable manufacturers: Square D/Schneider Electric, General Electric or Eaton/Cutler Hammer.

2.9 MOTOR STARTERS

- A. Provide each motor with motor starter of proper design to meet requirements of motor and drive. Starters shall be as specified unless specifically modified by drawings or other Sections provided complete with all contacts and auxiliaries as necessary to accomplish control sequence and features indicated.
- B. Arrange starters for wall, floor, panel or equipment mounting; provide necessary frames, racks and supports.
- C. Enclosures: NEMA Type 1, general purpose; arranged for padlocking; designed so entire starter can be readily removed; and of sufficient size to permit easy access for repair, replacement, and connections, unless otherwise specified.
- D. Horsepower rating not less than rating of motor controlled. Provide contacts to break each ungrounded line to motor. Provide overcurrent device in each ungrounded supply conductor to open all contacts simultaneously. Provide overcurrent device rating in amperes to correspond to motor nameplate rating, and not exceeding that recommended by manufacturer for application. Provide an externally operable reset device for resetting overcurrent trip.
- E. Manual Starters: Manually operated switch equipped with melting alloy type thermal overload relays. Starter shall be inoperative if any thermal units are removed.
- F. Magnetic Starters: Full voltage type magnetic starter, unless otherwise specified. Where reduced voltage starters are indicated, provide closed transition, wye-delta type starters. Coordinate with Division 23 contractor to ensure motors furnished are

compatible with starter. Magnetic starters shall have solid state current sensing overload with integral phase loss and phase unbalance protection. Overload protection shall be provided in all three phases. For 480 volt applications, provide 120-volt control circuit with factory installed control power transformer in starter case. Rating shall suit protected motor. Where indicated, provide combination starters with fusible disconnect switch or molded case, adjustable trip, quick make, quick break, solid state current sensing motor circuit protector circuit breaker. Fused safety switch and motor circuit protector circuit breaker shall comply with short circuit fault current rating indicated or as required by the contractor's short circuit study. Switch shall operate vertically with up position for ON and down position for OFF.

- G.** Solid State Soft Start Starters: Reduced voltage, soft start solid state starters with solid state current sensing overload with integral phase loss and phase unbalance protection, combination fusible switch disconnect switch, adjustable voltage ramp, six thyristor power configuration and adjustable overload protection.
- H.** Locate starters where motor and starter are fully visible from each other, unless otherwise indicated.
- I.** Provide starters for motors as follows unless otherwise noted:
 - 1.** Polyphase motors: Magnetic starters with HOA switches. Provide solid state soft start starters where indicated.
 - 2.** Single phase motors: Manual starters.
- J.** Hand-off-automatic selector switch: Mount in starter case. Connect so motor can be manually operated regardless of position of automatic control device. Connect selector switch to supersede any safety device or safety interlock. Provide hand-off-automatic switch in all magnetic starters and elsewhere as indicated.
- K.** Pilot lights: Provide two pilot lights for each motor starter (red/on, green/stop). Mount in starter case.
- L.** Provide minimum of two field convertible, N.O. to N.C. contacts on magnetic motor starters for interface with BCS, fire alarm, etc.
- M.** Provide two speed starters where indicated. Provide for two speed starters, hard wired, adjustable delay relays to prevent slow speed contacts from closing until a 30 second delay after high speed contacts have opened.
- N.** Acceptable Manufacturers: Square D/Schneider Electric, Eaton/Cutler-Hammer or General Electric.

2.10 WIRING DEVICES

- A. Provide wiring device for each outlet and location indicated.
- B. Devices listed below are intended to convey to the Contractor the general style, type, characteristics, quality, and suitability of the device specified. Devices listed are not intended to restrict the Contractor to the specific brand or manufacturer. All devices shall be commercial specification grade.

C. Back-of-House Devices:

1. Wall switches, 20 ampere, 120/277 volt service:

<u>Device:</u>	<u>Style:</u>
Single pole switch	Leviton, CS120-2 Series
3-way switches	Leviton, CS320-2 Series
4-way switches	Leviton, CS420-2 Series
Switch & pilot light	Leviton, 5336 Series

2. Receptacles:

<u>Device:</u>	<u>Style:</u>
Single NEMA 5-20R	Leviton, 5801 Series
Duplex NEMA 5-20R	Leviton, CR20 Series
GFCI 5-20R	Leviton, GFTR1 Series

For special receptacles: Provide NEMA types as indicated. Provide matching cordset and cap for each special type receptacle provided.

3. Acceptable Manufacturers: Leviton, Pass & Seymour, Hubbell, Arrow Hart, General Electric, Bryant.

[
D. Lobby / Amenity / Finished Area Devices:

1. Wall switches, 20 ampere, 120/277 volt service:

<u>Device:</u>	<u>Style:</u>
Single pole switch	Lutron SC-1PS Claro series
3-way switches	Lutron SC-3PS Claro series
4-way switches	Lutron SC-4PS Claro series

2. Receptacles:

<u>Device:</u>	<u>Style:</u>
Single NEMA 5-20R	Lutron, SCR-20 Series
Duplex NEMA 5-20R	Lutron, SCR-20 Series
GFCI 5-20R	Lutron, SCR-20-GFST Series

For special receptacles: Provide NEMA types as indicated. Provide matching cordset and cap for each special type receptacle provided.

3. Acceptable Manufacturers: Leviton, Pass & Seymour, Hubbell, Arrow Hart, General Electric, Bryant.
4. See Drawings for locations of device colors.

E. Residential Devices:

1. Wall switches, 120 volt service:

<u>Device:</u>	<u>Style:</u>
Single pole switch	Lutron CA-1PS Claro series
3-way switches	Lutron CA-3PS Claro series
4-way switches	Lutron CA-4PS Claro series

2. Receptacles:

<u>Device:</u>	<u>Style:</u>
Duplex NEMA 5-15R	Lutron, SCR-15-TR Series
Duplex NEMA 5-20R	Lutron, SCR-20-TR Series
GFCI 5-20R	Lutron, SCR-20-GFST Series

For special receptacles: Provide NEMA types as indicated. Provide matching cordset and cap for each special type receptacle provided.

3. Acceptable Manufacturers: Leviton, Pass & Seymour, Hubbell, Arrow Hart, General Electric, Bryant.

F. Individual Dimmer Switches:

1. Dimmers shall be of appropriate application for control and dimming of incandescent or quartz luminaires, low voltage luminaires and fluorescent luminaires.

2. Each dimmer shall be capable of being ganged with other dimmers without breaking off fins or derating.
 3. Each dimmer shall employ square law dimming control and shall be voltage stabilized.
 4. Dimmers shall employ calibrated linear slide control.
 5. All dimmers and tap switches shall have power failure memory. Upon power interruption the lights shall come back on the same levels set prior to the power interruption.
 6. All dimmers shall be equipped with field adjustable maximum lighting level feature which shall have a minimum setting of 5%.
 7. Faceplates shall be of color as specified by the Architect.
 8. Dimmers and/or switches ganged together shall be supplied with single faceplate.
 9. Faceplates: Visible surface shall be free of logos, manufacturer's identity, names, etc. except engraving as specified.
 10. Acceptable Manufacturers: Lutron, Lightolier, Prescolite, thin profile series, slide type.
- G. Unless otherwise specified by the Architect, all devices shall be white except as follows:
- a. Isolated ground receptacles: orange.
 - b. Non-isolated ground receptacles designated for computer use: gray.

2.11 DEVICE PLATES

- A. Provide device plates for all outlets where devices are installed. Where gang combinations are required, provide combination under single multi-gang plate. Adjacent devices of similar types shall be ganged unless otherwise noted.
- B. Device plates listed below are intended to convey to the Contractor the general style, type characteristics, quality and suitability of the device plate specified. Device plates listed are not intended to restrict the Contractor to the specific brand or manufacturer. All device plates shall be commercial specification grade.

[Specifiers note: (Use the below section for commercial Decora style devices – delete otherwise)]

1. Residential, Amenity Area device plates, commercial specification grade, screwless / snap-on mount, no visible hardware, Decora devices. Residential devices are to be white. Amenity areas are to be Stainless Steel Type 302:

<u>Device:</u>	<u>Style:</u>
1-gang toggle	Lutron CW Series
2-gang toggle	Lutron CW Series

3-gang toggle	Lutron CW Series
4-gang toggle	Lutron CW Series

2. Back of House General device plates, commercial specification grade, thermoplastic nylon:

<u>Device:</u>	<u>Style:</u>
1-gang toggle	Leviton, 80701 Series
2-gang toggle	Leviton, 80709 Series
3-gang toggle	Leviton, 80711 Series
4-gang toggle	Leviton, 80712 Series
1-gang duplex	Leviton, 80703 Series
2-gang duplex	Leviton, 80716 Series

3. Weatherproof, die cast zinc with rubber gasket:

<u>Device:</u>	<u>Style:</u>
1-gang duplex	Leviton, M5979 Series
1-gang single switch	Leviton, 4925 Series
1-gang GFCI duplex	Leviton, M5999 Series

- C. For receptacle outlets on Emergency Service, provide red nylon device plate hot stamped "EMERGENCY".
- D. Provide device plates of same manufacturer as devices.
- E. Residential unit floor outlets shall be brushed stainless steel or aluminum finish as directed by Architect.

2.12 FUSES

- A. Provide complete set of suitable and intact fuses with fusible devices. Install fuses in appropriate fuse holders. Provide fuses of 60 ampere size and larger with fuse clamps. Turn over to Owner one spare set (3 fuses each) for each fuse size used. Provide in electric service room an appropriately sized and labeled wall mounted fuse cabinet. Cabinet shall be constructed, finished, and keyed like panelboard enclosures as specified.
- B. Do not install fuses until installation is complete and final tests and inspection have been made prior to energizing equipment, including thorough cleaning, tightening

of all electrical connections, inspection of all ground and grounding conductors and a megger for adequate insulation to ground on all circuits.

- C. Switchboards, motor control centers, distribution panels, switches, etc., shall not be shipped from the factories and/or delivered to the job with the fuses installed in place.
- D. Provide fuses in all switchboards, panelboards, motor control centers, motor controllers, disconnecting switches and all other equipment requiring fuses.
- E. Fuses shall be of same manufacturer, and have characteristics to ensure retention of positive selective coordination as designed, of the sizes shown on riser diagrams and schedules, and where not indicated of required size for proper operation of equipment protected.
- F. Fuses, 601 ampere to 6000 ampere: UL Class L time-delay type. Bussmann KRP-C, constructed using silver links with fusing alloy soldered to link for low temperature overload operation. Utilize an "O" ring seal to ensure positive fit between end-bell and fuse tube to prevent loss of arc quenching sand filler or venting. Design shall provide time-delay of not less than four seconds at 500% of ampere rating and 45 seconds at 300% of ampere rating. Interrupting rating: 200,000 amperes RMS symmetrical.
- G. Fuses rated 600 amperes or less for all general power circuits: Dual Element, UL Class RK-1 time-delay type, Bussmann LPN-RK or LPS-RK, or UL Class J time-delay type, Bussmann LPJ, as required for short circuit and overcurrent coordination. Fuses, 1/10 ampere to 600 ampere: True dual-element construction, incorporating thermal overload element using 284°F melting point alloy, and separate short-circuit element. Design shall provide time-delay of not less than ten seconds at 500% of ampere rating. Interrupting rating: 200,000 amperes RMS symmetrical. Peak let-thru current (I_p) and energy let-thru values (I^2t) shall not exceed values established by Underwriters' Laboratories Standard for Class RK-1.
- H. Fuses installed in individual motor circuits: Dual Element UL Class RK-5 time-delay type, Bussmann LPN-RK or LPS-RK, sized at 125% of motor nameplate current rating or next standard fuse size. Where excessive ambient temperature, high inertia motor loads or frequent "on-off" cycling requires larger fuses, request direction from the Architect. Use fuse reducers where fuse gaps are larger than fuse dimension.
- I. Fuse identification label, showing type and size, shall be placed inside door of each switch.

- J. Submit time current characteristics curves on all types and sizes of fuses proposed for use.
- K. Acceptable Manufacturers: Bussmann, Mersen.
- L. Provide warning labels on all fuse holders, "Use Current Limiting Fuses Only - Do Not Use Type "H" Fuses".

2.13 SAFETY SWITCHES

- A. Heavy duty, front operated type, with number of poles, fuses and capacities as indicated. Interlock front cover with switch. Voltage rating: 250 or 600 volts to suit circuit voltage application. Provide NEMA 3R enclosures for weather-proof switches, and NEMA 1 enclosure elsewhere, except as otherwise noted.
- B. Switches shall be capable of withstanding available fault current or let-through current before fuse operates without damage or change in rating. Design and coordinate fuse clips to accommodate class and type of fuse specified or indicated to be used with switch.
- C. Arrange switches for padlocking in "open" position.
- D. Acceptable Manufacturers: Square D/Schneider Electric, General Electric, or Eaton/Cutler-Hammer.

2.14 INDIVIDUAL PUSHBUTTON STATIONS (FOR OTHER THAN HVAC EQUIPMENT)

- A. Oil-tight, heavy duty, momentary contact type. Mount pushbutton stations on Type FS enclosures with neoprene gaskets. Use transformer base pilot lights where pilot lights are indicated. Label pushbuttons with appropriate legend plates indicating control functions. In addition, identify each station with an engraved laminated plastic nameplate, identifying equipment controlled. Furnish pushbutton stations installed in damp locations with neoprene cover.

2.15 CABINETS

- A. Following requirements apply to cabinets provided for purpose of housing electrical wiring or equipment.
- B. Cabinets: Sheet steel, and have proper means for securing, supporting, and adjusting fronts, standard make and equal in all respects to those bearing Underwriters' Laboratories label. Fabricate cabinets, including boxes, trim and doors of either galvanized steel or of black steel, factory-primed with zinc chromate

paint. In addition to galvanizing of priming coat, inside and outside surfaces of boxes, trims, and doors, shall be given factory finish coat of No. 61 ANSI gray paint. Securely fasten cabinets in place; those set exposed shall be secured by expansion or toggle bolts through back. Cabinets shall have fronts straight and plumb.

- C. Fronts for surface cabinets shall be the same size as cabinets and arranged so that there are no sharp or overhanging edges.
- D. Door or doors may be equipped with half-round molding on the face of front to form rabbet and cover joint between door and frame, or door shall close against rabbet placed all around inside edge of frames with close fitting joint between door and frame. Doors shall be fitted with substantial flush hinges placed not over 24-inches apart, not more than 6-inches from ends of doors, and fastened permanently to door and frame with round-head rivets or spot welds, or with concealed flush piano hinges. Fastening screws of fronts shall be set not over 24-inches apart.
- E. Equip cabinets for applications other than panelboards with factory installed backboards of 5/8-inch minimum plywood. Install terminal strips where specified or indicated. Each strip shall be of one piece construction type and have number of points required. Each terminal point shall consist of two nickel-plated #6-32 screws joined by common nickel plated bus of not less than 15 ampere capacity. Terminal strips shall meet NEMA and UL voltage requirements for industrial control equipment. Terminal strips shall have provisions for application of circuit identification strips on sides or by top mounted circuit designation board.

2.16 BUILDING GROUNDING

- A. Provide and install a permanent grounding system with methods and materials in accordance with applicable codes and standards and able to conduct ground fault currents to the grounded neutral of electrical distribution systems, limit potential differences between conductive systems under fault conditions, and limit potential differences between grounding conductors, raceways and enclosures.
- B. Grounding Materials:
 - 1. Ground Rods: 3/4 inch diameter, 10 feet long.
 - 2. Ground Conductor: Size as per NEC requirements and use only copper wire.
 - 3. Joints and Connections: Molded fusion welding process (Cadweld) using proper mold and the number, size and type cartridge for the joint or connection. Waterpipe connection, silicon bronze approved mechanical connector designed for the pipe and cable to be bonded. Acceptable manufacturers: Burndy, Thomas & Betts.

4. Equipment Room Ground Terminal Bar: Copper 1/4 inch thick by 2-1/2 inch wide by length shown on the drawings, unless otherwise indicated, with two (2) rows of holes on 1-1/2 inch centers for 1/2 inch bolt, to receive cables two (2) directions.
5. Provide shop drawings for all materials.

2.17 TELECOM SYSTEM (TELEPHONE AND DATA OUTLETS)

- A. Provide empty conduit and outlets for telecom system as indicated.
- B. Conduits: One inch unless otherwise noted (with pull wire).
- C. Boxes: Four inches square, galvanized.
- D. Cabinets for telecom system shall comply with paragraph CABINETS of this section.
- E. Telephone backboards shall be 3/4" fire treated plywood, primed and painted white both sides, 8' high by length as indicated.
- F. Provide at each telephone outlet 1/2-inch deep single gang plaster ring and blank plate with one inch grommetted opening in top plate of partition framing with pull cord from accessible ceiling space down through outlet opening. Telecom system installer will provide telephone cable from telephone backboard to outlets.
- G. For block walls, insulated walls, and other similar installations, provide outlet box with one inch empty conduit and pull cord up into accessible ceiling space. Provide coverplate.
- H. Cover plates shall match plates specified for devices. Provide grommetted opening.
- I. Size, arrange and provide raceway and pull boxes as indicated or required for a maximum of 2-90 bends (or a total of 180 degrees of bends) in a conduit run.

2.18 HEATING TAPE

- A. Freeze Protection Heat Tape. Provide UL listed, self regulating, electric heating tape for freeze prevention on outside and interior HVAC system, fire protection and plumbing piping subject to freezing as indicated. Heat tracing system shall be designed to maintain the water temperature within the piping to at least 40°F with an ambient temperature of 0°F and a wind velocity of 20 MPH. The cable shall be controlled by a thermostat that monitors ambient temperature and mounted in a NEMA 4 enclosure. The thermostat shall energize the cable when ambient

temperature drops below 40°F. A contactor shall be provided when more than one heater circuit is required in a given area. Manufacturers: Thermon, Chromlox.

- B. Plumbing Hot Water Pipe Heat Maintenance Tape. As specified for freeze protection heat tracer except ambient sensing thermostat and pilot light is not required. Provide manual starter disconnect for each circuit. System shall be designed to maintain pipe temperature at 100°F at 75°F ambient.
- C. Contractor shall provide GFCP circuit breakers for all circuits serving freeze protection heat tape and heat maintenance tape (for heat tape circuits served from fusible circuit breaker panelboards, the GFCP circuit breaker shall be in addition to the fusible circuit breaker and shall be on the load side of the fusible circuit breaker).
- D. Fire Protection System Additional Requirements: Cable shall contain a third bus wire for continuity monitoring and be approved specifically for fire protection piping systems. The cable manufacturer shall provide control and monitoring system panels as required by local fire authorities. This could include indicating lights, contactors, switches, thermostats, fire alarm interface, etc.
- E. Provide quantity of circuits at voltage as indicated on drawings for heating tape of systems listed.

2.19 SLAB HEATING SYSTEMS

- A. Provide complete electric slab heating systems for the project as specified and indicated. Supply necessary labor and materials for complete and functioning slab heating systems.
- B. Type UL listed, MI (mineral insulated) heating cable: Resistance type wire insulated with compressed magnesium oxide, with a copper or stainless steel sheath overall. Form and install cable in field. Capacity and length as indicated. Cable: One or two conductor type; Pyrotenax USA, Trasor Corporation, or Nuheat. Heater units shall consist of heating section of specified lengths, jointed to cold section of required length to connect to junction boxes or remote thermostats located as indicated. Provide polyethylene, PVC, or nylon protective jacket on cable.
- C. Control thermostats: Arrange heater units for remote control by means of thermostat. Thermostat and all associated auxiliaries and controls shall be standard products of the heating cable manufacturer. House thermostats in NEMA-3R enclosures. Rate thermostats for operation at 22 amperes, 277 volts, 1 phase, 60 hertz. Operating contacts: Heavy duty type with single pole-double throw switching arrangement. Thermostats adjustable temperature range: 30 degrees to

70 degrees Fahrenheit. Set operating temperatures to maintain slab temperature at 65 degrees Fahrenheit. Arrange thermostats so drop in temperature below preset level will activate heater section and maintain active mode until slab temperature rises above set limit.

1. Supply each thermostat with remote temperature sensing bulb with copper capillary tube connection. Locate thermostat to be accessible to maintenance personnel. Provide access as required.
2. Location of all thermostats shall be indicated on record drawings.

2.20 TIME SWITCHES

- A. Provide 7-day solid state time clock with number of control circuits as indicated or required. Provide with manual override, rechargeable batteries, and 120 volt input. Relay contacts with voltage and current rating as required. Acceptable manufacturers: Grasslin, Paragon, Tork, or approved equivalent.

2.21 FUSIBLE DISTRIBUTION PANELBOARDS

- A. Furnish and install distribution panelboards as indicated in the panelboard schedule and where shown on the plans. Panelboards shall be dead front type, equipped with quick-make, quick-break fusible branch switches.
- B. Bussing Assembly: Copper bus. Panelboards bus structure and main lugs or main switch shall have current ratings as shown on the panelboard schedule. The bus structure shall accommodate plug-on branch switches as indicated in the panelboard schedule without modifications to the bus assembly.
- C. Fusible Switches: All fusible branch switches shall be quick-make, quick-break with visible blades and dual horsepower ratings. Switch handles shall physically indicate "ON" and "OFF" positions. Switches shall be lockable only in the "OFF" position and accept three industrial type heavy duty padlocks. Switch covers and handles shall be interlocked to prevent opening in the "ON" position. A means shall be provided to permit authorized personnel to release the interlock for inspection purposes. A circuit identification cardholder shall be provided for each branch switch.
- D. Integrated Equipment Short Circuit Rating: Each panelboard, as a complete unit, shall have a short circuit current rating equal to or greater than the integrated equipment short circuit rating shown on the panelboard schedule or on the plans. This rating shall be established by testing with the fusible switches mounted in the panelboard. Short circuit tests on the overcurrent devices and on the panelboard structure shall be made simultaneously by connecting the fault to each overcurrent device with the panelboard connected to its rated voltage source. Method of short

circuit testing shall be per Underwriters Laboratories Standard UL 67. The source shall be capable of supplying the specified panelboard short circuit current or greater. Testing of panelboard overcurrent devices for short circuit rating only while individually mounted is not acceptable. Also, testing of the bus structure by applying a fixed fault to the bus structure alone is not acceptable. Panelboards shall be marked with their maximum short circuit rating at the supply voltage and shall be UL listed.

Panelboards shall be UL listed for use on a system capable of delivering not more than 200,000 rms symmetrical amperes at 600 volts ac maximum when all branch switches are equipped with appropriately rated Class R, J, L or T fuses.

- E. Cabinet: Panelboard assembly shall be enclosed in a steel cabinet. The rigidity and gauge of steel to be as specified in UL Standard 50 for cabinets. Wiring gutters shall be sized in accordance with UL Standard 67. Cabinets shall be equipped with a four-piece front without door and have concealed, self-adjusting trim clamps. Fronts shall be of full-finished steel with rust-inhibiting primer and baked enamel finish.
- F. UL Listing: Fusible distribution and power panelboards shall be listed by Underwriters Laboratories and shall bear the UL label. When required, panelboards shall be suitable for use as service equipment. Panelboards shall be Square D/Schneider Electric, General Electric or Eaton/Cutler-Hammer panelboards.

2.22 FUSIBLE BRANCH CIRCUIT PANELBOARDS

- A. Furnish and install fusible branch circuit panelboards as indicated on the drawings. Panelboards shall be dead front type, equipped with quick-make, quick-break fusible branch switches.
- B. Panelboard Assembly:
 - 3. Bussing: Tin-plated copper bus with sufficient cross sectional area to meet UL 67 requirements. Panelboards bus structure and main lugs or main switch shall have current ratings as shown on the panelboard schedule.
 - 4. Panelboard Ratings:
 - a. Panelboards shall be labeled with a short-circuit current rating equal to or greater than that indicated on the drawings.
 - b. Panelboard overcurrent protective device interrupting ratings shall be fully rated for the maximum available fault current and have a UL Listed interrupting rating of 300kA.
 - 5. Panelboard Construction:
 - a. Panelboard circuits 100A and less shall incorporate overcurrent protection and branch-circuit rated disconnecting means into a single integrated component.

- b.** Interiors shall be factory assembled.
 - c.** Panelboard shall be equipped with a six-space spare fuse compartment for storing replacement branch circuit fuses. Spare fuse compartment shall be located behind locking panel door.
 - d.** Main lug conductor terminations shall be rated for 60/75°C, Cu-Al.
 - e.** Main disconnect terminations shall be rated for 75°C, Cu only.
 - f.** NEMA 1 panelboards shall be field convertible for top or bottom incoming feed.
- 6.** Main Disconnect:
 - a.** Permanently installed lockout means shall be provided on the main disconnect for lockout tagout procedures.
 - b.** Main disconnect shall be quick-make, quick-break type.
- 7.** Branch Fused Disconnects:
 - a.** Device shall have visible circuit ON/OFF indication with colored and international symbol markings.
 - b.** Device shall provide open fuse indication via permanently installed neon indicating light.
 - c.** Device shall be UL Listed 600Vac/200kA or 125Vdc/100kA voltage/short-circuit current rating, load-break disconnect with amp ratings and number of poles as indicated on the panelboard schedule.
 - d.** Fuse and disconnect assembly shall be a finger-safe component with trim installed.
 - e.** Fuse and disconnect shall be mechanically interlocked so as not to allow fuse removal while fuse terminals are energized.
 - f.** No special tools shall be required for fuse removal.
 - g.** Devices shall have bolt-on style bus connectors.
 - h.** Device housing shall be clearly marked with device amperage.
 - i.** Permanently installed lockout means shall be provided on the device for lockout tagout procedures.
 - j.** Device shall provide fuse amp rating rejection at the following ampacities to ensure continued circuit protection at the specified circuit rating: 15A, 20A, 30A, 40A, 50A, 60A, 70A, 90A & 100A.
- 8.** Main & Branch Overcurrent Protection:
 - a.** All overcurrent protective devices shall have a minimum UL Listed interrupting rating of 300kA.
 - b.** Branch circuit overcurrent protection shall be 600Vac UL Listed minimum 300kA IR finger-safe fuse with Class J performance characteristics.
 - c.** Main overcurrent protective devices shall be 600Vac UL Listed minimum 300kA IR Class J time-delay fuses or Class J performance fuses.

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- L.** Manufacturers: Fusible Panelboards shall be Cooper Bussmann Quik-Spec Coordination Panelboards type QSCP. Substitutions will be accepted only if a written substitution request is submitted providing documentation that the proposed substitution product meets all requirements of this project specification section.

2.23 EARLY STREAMER EMISSION (ESE) LIGHTNING PROTECTION

- A.** The E.S.E. Lightning Protection System shall consist of:
- 1.** Early Streamer Emission Air Terminal with high pulse voltage at air terminal tip in order to emit the brush discharges in optimum condition.
 - 2.** Minimum of (2) down conductors for each E.S.E. Air Terminal.
 - 3.** Lightning Strike Counter.
- B.** Installer/Designer Qualifications: Authorized by manufacturer, trained and approved for installation of units required for this Project.
- 1.** VFC Lightning Protection
90 Cutler Drive
North Salt Lake, UT 84054
Phone: (800) 825-1948
 - 2.** Or by approved installer with the following requirements:
 - a.** 5 years minimum experience as a Lightning Protection Installation Firm.
 - b.** LPI Certified Master Designer on staff at the Lightning Protection Installation firm.
 - c.** LPI Master and Journeyman installers on site to complete actual installation.
 - d.** Participate in UL's "Alternate Quality Management System Inspection Program".
- C.** System Certificate: A Lightning Protection System Certificate shall be provided with the installed Lightning Protection System.
- D.** Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 780, "Definitions" Article.
- E.** Coordination:
- 1.** Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.
 - 2.** Coordinate installation of air terminals attached to roof systems with roofing manufacturer and Installer.

3. Flashings of through-roof assemblies shall comply with roofing manufacturers' specifications.
- F. Lightning Protection System Components:**
1. The design of the E.S.E. Air Terminal shall be tested in accordance with ABB Standards and Guidelines for ESEAT Systems or the current edition of NF C 17-102.
 2. E.S.E. Air Terminal Unit.
 - a. Components:
 - 1) Stainless steel tip.
 - 2) Stainless steel massive external spark gap.
 - 3) RodCheck system lightning strike indicator.
 - 4) HV electronic block.
 - 5) Stainless steel mast.
 - b. The operation of the unit shall not be dependent on batteries or solar power, radioactive, nor require special licensing.
 - c. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) ABB Helta® OPR Lightning Protection Systems.
 - d. Test Certificate: Provide test certificate by one of the following independent Laboratories as evidence of efficiency and electrical and environmental test as described in ABB Standards and Guidelines for ESEAT Systems, for acceptance and approval.
 - 1) APAVE Testing Laboratory.
 3. Main and Bonding Conductors: Copper
 - a. 28 strands of 14-gauge wire rope lay, with a net weight of 375 pounds per 1,000 feet, minimum.
 - b. All conductors shall be secured every 3'-0" maximum.
 4. Ground Loop Conductor: The same size and type as the main conductor.
 5. Ground Rods: Copper-clad steel, 3/4-inch in diameter by 10-feet long.
- G. Installation:**
1. Install lightning protection components and system according to ABB Standards and Guidelines for ESEAT Systems.
 2. Install conductors with direct paths from E.S.E. Air Terminal to ground connections. Avoid sharp bends.
 3. Conceal down conductors in 1-inch PVC conduit within exterior wall of structure.
 4. Cable Connections: Use bolted connections for all conductor splices and connections between conductors and other components. Use exothermic-welded connections in underground portions of the system.
 5. Ground Loop: Install ground-level potential equalization conductor and extend around the perimeter of structure.
 - a. Bury ground ring not less than 24-inches from building foundation.

- b. Bond ground terminals to the ground loop.
 - c. Bond grounded building systems to the ground loop conductor within 12-feet of grade level.
- H. Sleeve and Sleeve-Seal Installation for Electrical Penetrations:
 - 1. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.
- I. Field Quality Control:
 - 1. Notify Architect at least 48 hours in advance of inspection before concealing lightning protection components.
 - 2. Testing, commissioning, and maintenance of the Lightning Protection System shall be in accordance with the recommendations of the manufacturer and in accordance with ABB Standards and Guidelines for ESEAT Systems.
 - 3. Test completed grounding system and individual ground rods. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 81.
- J. Demonstrate that the total ground resistance is below 10-ohms. If resistance requirement is not met, perform a soils resistivity test and provide results to the owner for further consideration.

2.24 ADHESIVES AND SEALANTS

- A. Field-applied adhesives shall have no more than 250g/l VOC content.
- B. Field-applied sealants shall have no more than 100g/l VOC content.

PART 3 - EXECUTION

3.1 WIRING METHODS

- A. Install wiring in metal raceways, except where metal clad cable (MC) or mineral insulated cable (MI) is indicated or specified. Size raceways as required by National Electrical Code, except where larger sizes are indicated or specified. Minimum raceway size unless otherwise noted: 1/2-inch.
- B. Outdoors:
 - 1. Exposed: IMC with U.L. listed rain-tight fittings.

2. Below Grade: Schedule 40 PVC or galvanized rigid steel conduit with U.L. listed rain-tight fittings.
3. Embedded in Concrete Slab: Schedule 40 PVC or galvanized rigid steel conduit with U.L. listed concrete-tight fittings.
4. Concrete Encased Ductbank: Schedule 40 PVC.
5. Connections to vibrating equipment, including transformers and motors: Liquidtight flexible metal conduit with U.L. listed rain-tight fittings.

C. Indoors:

1. Exposed or Concealed Dry Locations: EMT with set-screw type fittings, except where another wiring method is indicated or specified.
2. Exposed or Concealed Damp Locations: EMT with set-screw type fittings.
3. Exposed or Concealed Wet Locations: EMT with U.L. listed rain-tight fittings.
4. Embedded in Concrete Slab:
 - a. Schedule 40 PVC with U.L. listed concrete-tight fittings.
 - b. Galvanized rigid steel conduit with U.L. listed concrete-tight fittings.
 - c. ENT with U.L. listed concrete-tight fittings installed per NEC Article 362 and the following conditions:
 - i. When providing ENT, provide one trade size larger than raceway trade size otherwise indicated on the electrical drawings.
 - ii. Maximum ENT raceway trade size permitted is 2".
 - iii. Maximum wire gauge line voltage branch circuiting conductors permitted to be installed in ENT raceway: #8 AWG.
 - iv. ENT raceway is permitted for use in routing line voltage branch circuiting, but not electrical feeder sets serving electrical distribution equipment.
 - v. ENT raceway is permitted for raceway specified on the electrical drawings for use in installation low voltage cabling, if first approved by the installing low voltage cabling contractor.
 - vi. ENT raceway is not permitted for routing of fire alarm system low voltage cabling.
 - d. PVC jacketed cable is permitted only for embedded garage lighting circuits.
5. Exposed in Equipment Rooms: EMT with set-screw type fittings.
6. Connections to vibrating equipment, including transformers and motors, in dry location: Flexible metallic conduit.
7. Connections to vibrating equipment, including transformers and motors, in wet or damp locations: Liquidtight flexible metal conduit with U.L. listed rain-tight fittings.

8. Concealed Below Raised Access Flooring: EMT with set-screw type fittings, except computer and data processing equipment applications use liquidtight flexible metal conduit.
 9. Where permitted by NEC and local authorities having jurisdiction, the following fabricated cable assemblies shall be used in the lieu of EMT for branch circuits concealed in accessible ceiling spaces or run in stud-type partitions:
 - a. Branch Circuits for General Lighting: Type MC cable. Provide separate neutral conductor for each lighting branch circuit or zone controlled through a lighting control or dimming system.
 - b. Branch Circuits for General Purpose Receptacles and Appliances: Type MC cable.
 - c. Branch Circuits with Separate Insulated Ground Conductor: Type MC cable.
 - d. Branch Circuits for Isolated Ground Receptacles: Type MC cable with additional green/yellow stripe insulated copper grounding conductor.
- D. Conceal wiring as necessary to meet requirements for flush outlets. Make wall outlets flush, unless otherwise indicated.
- E. In block walls, install in voids without cutting block.
- F. Limit flexible metallic conduit and liquidtight flexible metallic conduit lengths to 6 feet.
- G. Use joint compound on threaded joints for exterior runs of rigid steel conduit; red lead or "Alcoa thread lubricant".
- H. Install conduits to ensure against collection of trapped condensation; arrange to be free from traps wherever possible. Use screw fittings and boxes during construction. Do not install wire in conduits until after concrete or plastering is complete. Conduits in which moisture has collected must be swabbed out before pulling in wire.
- I. Equip empty conduit with minimum 200 pound test nylon cord of wire, fished continuous from outlet to outlet. Use nylon or hemp pulling ropes in non-ferrous conduit.
- J. Run exposed raceway parallel to building lines making turns with approved conduit fittings, manufactured ells, concentric field bends or pull boxes. Use oversize conduit fittings for control cables and other runs where required.

- K.** Maintain six-inch minimum clearance between wiring and parallel runs of hot water pipes, engine exhausts or flues.
- L.** Use insulated bushings on conduits over one-inch size entering panels, pull boxes, etc. Use insulated grounding bushings for conduits entering bottom of open base equipment, such as switchboards.
- M.** Install concealed conduits while floors are being poured and walls are built, except in special cases as may be determined by Owner's Representative on premises.
- N.** Set risers, boxes, etc., into walls, concealed. Place vertical conduits passing through floors or beams before concrete is poured.
- O.** Check door swings and install room light switches associated with doors on strike side regardless of indication on electrical drawings.
- P.** Install conduit sleeves where shown on drawings. Fire stop all unused conduit sleeves.
- Q.** Provide expansion fittings where raceways cross building expansion joints.
- R.** Completely seal and waterproof all conduit penetrations through exterior walls.
- S.** Structural system for this project is post-tensioned concrete. The following restrictions shall apply:
 - 1.** Conduit greater than ¾" dia. shall not be placed in slab without written authorization of structural engineer.
 - 2.** All conduit shall be placed in the middle third of the depth of the slab. (In order to achieve this requirement, the contractor may not be able to run diagonally across a slab, but rather run at right angles or parallel to the cables).
 - 3.** The electrical contractor shall provide his own support system for the conduit and shall not be permitted to fasten to any of the post-tensioned support steel. (This ensures that no unapproved adjustments are made in the field to the post-tensioned support locations).
 - 4.** All conduit runs of 2 or more conduits shall maintain 2 inches clear between all conduits to allow proper concrete placement.
 - 5.** Any bundled conduits of six or more should be detailed by the electrical contractor and approved by the structural engineer before installation.

3.2 WIRING

- A.** General Installation Requirements:
 - 1.** Examine all wire and cable prior to installation. Do not use wire and cable with bruised, cut, or abraded insulation, wire and cable that does not pass a

- continuity test, or any wire and cable delivered to the job site with ends of conductors not sealed to prevent entrance of moisture.
2. All conductors shall be minimum #12 AWG copper unless indicated or specified otherwise.
 3. Provide separate green insulated equipment ground conductor in each raceway.
 4. Install all conductors and other associated items in compliance with manufacturer's recommendations.
 5. Use wire and cable with a voltage rating equal to or above the applied system voltage.
 6. Do not substitute small conductors with higher temperature rated insulations in lieu of conductor size shown on drawings.
 7. When factory assembled multiple conductor, control, and signal cables are run in ceiling plenums, use only cables specifically approved and U.L. listed for the purpose.
 8. Do not use aluminum, copper-clad aluminum, or aluminum alloy conductors unless indicated or specified otherwise.
 9. Do not use non-metallic sheathed cable.
 10. The use of lubricating materials to help install non-lead conductors is to be avoided. Where absolutely necessary, Ideal-Aqua-Gel, Polywater, or Yellow 77 shall be used.
 11. Color code, branch circuit and feeder wiring:

120/208

<u>Phase</u>	<u>Color</u>
A	Black
B	Red
C	Blue
Neutral	White
Ground	Green

12. Conductor #10 AWG and Smaller: Color impregnated in conductor insulation.
13. Conductors #8 AWG and larger may use color impregnated in conductor insulation or conductor ends may be taped. Taping: Solid color electrical tape, lap wound, readily visible without removing dead-front covers in electrical equipment, and at least 3 inches visible at all terminations and electrical boxes.
14. Arrangement of Phases in all Electrical Equipment:
A, B, or C: front to rear.
A, B, or C: top to bottom.
A, B, or C: left to right when facing equipment wiring access area from establishing front of equipment.
15. Use conductors with 90°C insulation when wiring is within seven feet of,

passing over, or attached to the following:

- a. Heat producing equipment.
- b. Hot water heaters.

B. Testing:

- 1. All service and feeder cable and insulation shall be tested for grounds or shorts, after installation, by use of a megger and prior to energizing the circuit. Submit test results prior to substantial completion.
- 2. All outlets shall be tested with a Daniel Woodhead or equal tester, for polarity, opens, or grounds after a branch circuit is energized.
- 3. Faulty cables shall be removed and be replaced; faulty outlet connections shall be corrected; all at no additional cost to the Owner.

C. Cable terminals, taps, and splices shall be made with solderless pressure type connectors, unless otherwise specified. Provide proper lug connectors for cable terminations at switchboard and panel feeder connections.

D. Make all splices in wire No. 8 AWG and smaller with patented and UL approved crimped units with neoprene insulation or “Scotchlocks” of latest design having solid metal case to prevent puncture of insulation. Install in accordance with manufacturer’s instructions.

E. Make splices in wire No. 6 AWG and larger with Burndy “Polytap” type connectors and covers.

F. For wire identification, use Brady “Quik-Labels” on conductors at termination of run and in outlets. Coding scheme is responsibility of Contractor. Arrange coding scheme to provide quick and easy identification of conductors. Identify each feeder conductor in pull and junction boxes with permanent identification tag.

3.3 FASTENINGS AND SUPPORTS

A. Rigid Steel Conduit: Within 3 feet of outlet, junction box, cabinet, fitting, or other conduit termination, and at maximum intervals as follows:

Trade Size	Max. Distance (Ft.)
¾”	10
1”	12
1 ¼” – 1 ½”	14
2” – 2 ½”	16
3” & larger	20

B. Intermediate Metal Conduit (IMC): Within 3 feet of outlet, junction box, cabinet, fitting, or other conduit termination, and at maximum intervals of 10 feet.

- C. Electrical Metallic Tubing (EMT): Within 3 feet of outlet, junction box, cabinet, fitting, or other conduit termination, and at maximum intervals of 10 feet.
- D. Securely support and fasten raceways in place with pipe straps, wall brackets, hangers or ceiling trapeze. Fastenings shall be by wood screws or screw-type nails to wood, by toggle bolts on hollow masonry units, by expansion bolts on brick, by machine screws, welded threaded studs, or spring-tension clamps on steel work.
- E. Secure all conduit, light fixtures, and equipment to the structure with approved fasteners, anchors and inserts as specified herein.
- F. Where conduit, light fixtures, or equipment is supported using inserts installed in existing concrete structure, conform to the following:
 - 1. Where supported from the sides of columns, sides of beams, slab on grade from walls or from the top of floating slabs, use load rated, steel shell, self-drilling or pre-drilled inserts or use powder driven inserts. Embedment shall be as required.
 - 2. Where supported from the underside or top of floor or roof slabs (except slab on grade), use pre-drilled hole, load rated steel shell inserts. Prior to drilling each hole, locate and mark reinforcing steel and post tension tendons in the vicinity. Locate inserts so as not to hit reinforcing steel or tendons. Drill holes for inserts only with a drill powered by a controller which is designed and actually set to automatically disconnect power to the drill if any embedded steel is touched by the drill bit (DS-69A Drill Stop by Drillco Equipment Co.). Do not drill into or cut reinforcing steel or tendons. Hole locations with locations of reinforcing steel or tendons marked on the slab shall be reviewed and approved by the Architect prior to drilling. Provide 48 hours advance notice to the Architect.
 - 3. Power driven inserts with embedment lengths of 5/8 inch and less may be used in the underside and top of floor slabs without prior X-ray inspection.
- G. In partitions of light steel construction, sheet metal screws may be used, and bar hangers may be attached with saddle ties or not less than No. 16 AWG double-stranded zinc-coated steel wire. In suspended ceiling construction, no raceways shall be fastened to the ceiling supports.
- H. Except where indicated on masonry partitions and as otherwise shown, support electrical equipment, including but not limited to switches, starters, fixtures and cabinets with 1-5/8-inch by 1-5/8-inch steel structural channels. Use same type channels, hot-dip galvanized, for exterior work. Where used as lighting fixture supports or for similar overhead bracing and support indoors, use manufacturer's standard corrosion-resistant finish.

- I.** Hardware and accessories for use with structural steel channels shall be manufacturer's standard components, hot-dip galvanized where used with galvanized channel.
- J.** Miscellaneous hardware: Steel fastening devices, brackets and appurtenances required for support of outdoor conduit and other electrical equipment shall be galvanized except where basic device is of corrosion-resistant material. Ensure that fastenings, supports, clamps, anchors, etc., which are used are of type manufactured for specific purpose.
- K.** Provide conductor supports in compliance with NEC Article 300.
- L.** All cables including but not necessarily limited to data, voice, alarm, and security system cables and wires shall be self-supported with an approved hanger device when cables or wires are not installed in an electrical raceway. Cables shall be supported at no greater than twelve foot intervals and securely fastened to the building structure. Installation to be in accordance with NEC 725.

3.4 LABELING OF JUNCTION BOXES

- A.** Label all pull boxes and junction boxes to indicate voltage. Labels shall be pressure sensitive type or paint and stencil. Distinctive fluorescent-colored markings shall be used for each voltage. Emergency junction boxes shall be painted red.

3.5 GROUNDING

- A.** General:
 - 1.** All equipment, whether furnished by this Division or by others, shall be grounded.
 - 2.** Provide building grounding as indicated.
 - 3.** Provide ground connection for electric power service.
 - 4.** Provide ground connection for telephone service.
 - 5.** All transformer enclosures and secondary neutrals shall be grounded to an approved grounding electrode.
- B.** Installation:
 - 1.** Service Grounding:
 - a.** Ground connections shall be made to the incoming water service on the street side of the water meter; to driven ground rods and to a concrete encased electrode.
 - b.** Grounding conductors shall be copper conductors installed in conduits, of sizes indicated on the Contract Documents.

2. Make fusion welds in strict accordance with supplier's instructions. Clamp cables securely in place independent of mold. Clean and inspect all welds. Provide corrosion protection in acid soils.
3. All connections below grade shall be made with nonmechanical means.
4. Drive ground rods to a minimum depth of ten feet, or more if necessary to reach permanent moisture. Ground rods shall be driven at least two feet away from the footing and top of rod 24" minimum below grade.
5. Make grounding connections electrically ahead of any overcurrent or disconnect device or tap connection such that disconnection of neutral load conductors does not interfere with or remove the system ground connection. Use separate lugs on the transformer neutral terminal for neutral and main grounding jumper when cable is used for transformer connections.
6. For each separately derived system, install a grounding electrode conductor between each system enclosure ground bus (or bolted connection to enclosure where ground bus is not present) and a cold water pipe of one (1) inch size or larger near the separately derived system ground connection. Make connections to water pipes accessible for easy inspection.
7. Install a complete grounding electrode system with interconnecting cables and terminations at the equipment room ground terminal bar.
8. Make all connections to the grounding electrode system accessible.
9. Install equipment room ground terminal bar in equipment rooms where indicated. Mount bar by anchors and bolts using 1-1/2 inch long segments of 1/2 inch rigid conduit as spaced between bar and wall. Use a minimum of two supports 18 inches on center. Connect all grounding electrode system conductors, system enclosure ground bus, and other indicated electrode systems to the terminal bar.
10. Unless indicated otherwise, form the equipment ground circuit with rigid metallic raceways (e.g., EMT, IMC, rigid steel conduit) where used. Install a bonding jumper for continuity around all fittings and terminations where the conductive raceway is made non-continuous.
11. Install a separate insulated ground conductor in each raceway to augment the circuit formed by the metallic raceway system. Bond the conductor to each box or enclosure in which access is possible. Size conductor as specified, indicated, or required by Code, whichever is larger. Install a grounding bushing and bonding jumper to the enclosure or contained ground bus for the following: each termination of conduits 1 inch trade size and larger at a switchboard, panelboard, or other enclosure; each location where multiple ring knockouts are damaged during conduit installation; each location where conduits are stubbed up into floor mounted enclosures; each conduit termination at a painted enclosure where paint is not removed before installation of raceway and each feeder.
12. Install a separate insulated ground conductor inside all flexible raceways (e.g., flexible steel, liquid-tight). Bond the conductor to the enclosure or ground bus in the nearest box or access on either side of the flexible section.

Size conductor as specified, indicated, or required by Code, whichever is larger.

13. Install a separate insulated ground conductor in all sectional raceways with removable covers for access (e.g., plug-in strips, surface raceway systems, and wireways) unless specified otherwise. Size conductor in accordance with the NEC for the largest phase conductor size installed in raceway, or as indicated. Bond all sections of the raceway to the ground conductors. Connect all receptacle ground terminals in the raceway to the ground conductor, and make other ground connections indicated on the Drawings.
14. Bond all grounding conductors to boxes or enclosures at each access point. Do not use building steel as equipment grounding path. Use welded ground connections, at slabs on grade, or embedded in concrete.
15. Bond all conductive metallic piping system in each mechanical equipment room as required by NEC 250-80/B. Minimum size of conductors as required by NEC. Locate all connections where access is unrestricted for inspection. Looping of conductor from one system to another is acceptable provided the conductor is without splice.
16. Where isolated ground receptacles are indicated on the drawings, install an additional insulated ground conductor for isolated grounding in branch circuits from panelboards furnished with isolated ground bus.

C. Tests:

1. Verify that the ground resistance, as measured by a suitable ground resistance test set operated in strict accordance with the manufacturer's instructions, of each low voltage service does not exceed 3 ohms. Submit test results.
2. Verify there are no accidental grounds on the service by measuring the resistance between the neutral and ground, with the bonding jumper(s) open. Submit test results.

3.6 EQUIPMENT MOUNTING

- A. Except as otherwise specified, surface-mounted panelboards, individual control services, circuit breakers, disconnect switches, transfer switches, starters and other similar equipment shall be mounted on frameworks of steel channel: Unistrut 2000, Kindorf or Steel City.
- B. Transformer Installation:
 1. Wall mounted: Install on bracket support fabricated from channel framing. Provide rubber-in-shear vibration isolators between transformer base and bracket. Make connections to transformer with liquid-tight flexible conduit. Provide slack.
 2. Floor mounted: Install on housekeeping pad (Section 26 01 00) at least 6" clear of walls or other obstructions. Provide rubber-in-shear vibration

isolators between transformer and base. Secure transformer to base using anchor bolts. Provide rubber-in-shear vibration isolators between flat washer under bolt head and transformer base. Provide a soft rubber sleeve to prevent bolt shank contacting transformer base.

3. Ceiling mounted: Install on trapeze hanger support fabricated from channel framing and rod. Provide rubber-in-shear vibration isolators between transformer base and trapeze. Secure transformer to base by rubber-in-shear vibration pads between the flat washer under the bolt head and transformer base. Provide a soft rubber sleeve to prevent bolt shank contacting the transformer base.

3.7 BALANCING

- A. Connect various systems of feeder and branch circuits for power and lighting to panelboard busses in manner that connected loads will be balanced on all phases as closely as practicable. Should there be any unfavorable condition of balance on any part of electrical systems, make changes required to remedy unbalanced condition.

3.8 MECHANICAL EQUIPMENT LABELING

- A. Provide a type-written label on the control panel of each VAV box with electric heat, each electric duct heater, each electric unit/wall heater, attached to the door or cabinet with permanent adhesive. Approximate size 5x3 inch and reads as follows:

INCOMING POWER IS LIVE UNLESS DISCONNECTED AT BRANCH CIRCUIT BREAKER. BRANCH CIRCUIT BREAKER IS LOCATED IN: ELECTRIC CLOSET LOCATION: ELECTRIC PANEL NUMBER: _____ CIRCUIT BREAKER NUMBER: _____

Fill out electric closet location, panel and circuit breaker number prior to requesting electric inspection.



SECTION 26 16 30

ELECTRICAL DISTRIBUTION EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. General provisions of the contract, including the GENERAL CONDITIONS, SUPPLEMENTARY CONDITIONS, Division 01, GENERAL REQUIREMENTS, and Section 26 01 00, apply to the work specified in this section.

1.2 DESCRIPTION

- A. This section pertains to the furnishing of labor, material, equipment, and services necessary to provide complete electrical service equipment as indicated and specified.

1.3 SUBMITTALS

- A. Submit following for review:
 - 1. Complete shop drawings.
 - 2. Incoming line section drawing bearing approval by utility company.
 - 3. Proposed nameplate schedule.
 - 4. Verification that switchboard meets short circuit requirements as called for in Section 26 01 00.

1.4 OPERATION AND MAINTENANCE MANUAL

- A. Following items shall be covered in Operations and Maintenance Manual:
 - 1. Complete switchboard shop drawings, including incoming line section drawing.
 - 2. Complete descriptive material on main switch and feeder overcurrent devices with all related auxiliaries.
 - 3. Complete set of manufacturers instruction and maintenance manuals for all switchboard components.

PART 2 - PRODUCTS

2.1 SWITCHBOARDS

- A. Switchboard: Square D, General Electric or Cutler-Hammer and consist of required number of vertical sections bolted together to form one rigid metal enclosed switchboard. Sides, top rear and front shall be covered with removable screw-on

code gauge steel plates. Switchboards shall include switches, protective devices and equipment as listed with necessary interconnections, instrumentation and control wiring, and contain necessary provisions for extension to future vertical sections.

- B.** Switchboard: NEMA, ANSI, IEEE, and UL standards and applicable requirements. Switchboard structure shall be dead-front, free standing, indoor type with group mounted overcurrent devices as indicated.
- C.** Incoming service section where indicated shall be complete with necessary bus work and current transformer installation provision, and meet the requirements of serving utility company. Approval of the service arrangement shall be obtained from the utility company prior to submittal of switchboard shop drawings for approval.
- D.** Bus construction: Copper or aluminum, sized in conformance with NEMA Standard PB 2-1995 Table 2-4. Bus bars: Voltage and ampere rating as indicated, for three phase, four wire service and mounted on supports of high impact non-tracking insulating material and braced to withstand mechanical forces exerted during short circuit conditions when connected directly to power source capable of delivering fault currents as indicated. Arrange buses A-B-C, left-to-right, top-to-bottom and front-to-rear throughout. Neutral bus of equal amperage as phase buses. Provide ground bus throughout secured to each vertical section. Provide disconnect link between neutral and ground bus.
- E.** Small wiring: Provide necessary fuse blocks and terminal blocks within the switchboard. Groups of control wires leaving switchboard shall be provided with terminal blocks with suitable numbering strips. In addition, provide separate identification label for each individual circuit.
- F.** Chemically clean and treat steel surfaces to provide bond between paint and metal surfaces to help prevent the entrance of moisture and formation of rust under paint film. Hardware used on conductors: High tensile strength and have suitable protective finish.
- G.** Short Circuit Current Rating: Each switchboard, as complete unit, shall be given single short circuit current rating by manufacturer. Establish rating by actual tests by manufacturer, in accordance with UL specifications, on equipment constructed similarly to subject switchboard.
- H.** Main switch: Fusible, electrically operated bolted pressure type of ampacity indicated. Switches: Dead front and equipped with quick-made tease-proof operators. Arrange operating handle with position indicator flags, and provision for padlocking in open position with at least three padlocks. Switches shall have accommodations for Class "L" fuses. Switches shall meet test requirements of UL 98 and/or UL 977 and approved for use on circuits capable of delivering 200,000

RMS symmetrical amperes at 250 volts AC. Equip switches in mains with shunt trip operators. Provide switch with single phase protection and ground fault protection connected to zero sequence sensing device with indicating lamps. Settings as specified below. Anti-single phasing protection shall protect against both blown fuse single phasing and line side supply (utility) single phasing.

- I.** Fusible branch switch units over 1600 amperes: Same as main switches except no ground fault protection is required for these switches unless otherwise indicated.
- J.** Fusible branch switch units 1600 amperes and below: Fusible type, quick-make, quick-break operating mechanisms designed for current limiting fuses only. Switches UL rated and approved as service equipment. Enclose each switch in sheet steel enclosure with an external operating handle which may be locked in either "ON" or "OFF" position. Switch units shall be front connected and removable from the front without disturbing adjacent units or removing main bus, branch bus connections, or any metal enclosures other than that associated with individual switch unit. Separate bus bars from switch and fuse compartment so it will be impossible to contact bus from switch or fuse compartment. If plastic is used for separation, it shall be at least 1/8-inch in thickness and perforated to permit adequate ventilation. Refer to switchboard schedules on drawings for fusible branch switch sizes and quantities.
- K.** Circuit Breaker Group Mounted Branch Devices: The switchboard group-mounted circuit breaker branch devices are to be totally front accessible and front connectable. The circuit breaker connections to the distribution panel bussing shall be of a "blow-on" design such that the connections grip the bus bars firmly under high-fault conditions. Refer to switchboard schedules on drawings for circuit breaker branch device sizes and quantities.
- L.** Ground Fault Protection System: Include a current sensor and appropriate relaying equipment. Current sensor shall enclose all phase (and neutral, if present) conductors of circuit monitored. Construct current sensor frame so one leg can be opened to allow removal or installation around cables or bussing without disturbing cables or requiring drop-links in bussing. Provide test winding to simulate flow of ground fault current through current sensor, in order to test complete system, including sensor pick-up, relaying equipment and electric trip mechanism of switch.

Ground fault relay: Solid state construction and have adjustable pick-up for ground fault currents from 200 amperes to 1200 amperes. Settings for individual relays: 800 amperes. Time delay provided by ground fault relay circuitry: Nominally .2 second and permanently calibrated to preclude tampering with time delay after installation.
- M.** Switchboard Construction: Free standing indoor type. Sections of switchboard: Rear-aligned and completely front accessible. Group mount branch protective

devices with necessary bus connection straps. Device line and load connections shall be accessible from front. Arrange feeder connections for top access. Where space for future is called for, furnish all necessary bus work except device connecting straps.

- N.** Provide pull boxes as required.
- O.** Provide digital meters for each switchboard to indicate phase amps and volts, kVA, kW, kVAR, peak kVA, peak kW. Provide interface communications card, software and programming to allow this data to be read by the (Building Control System) BCS furnished under Section 23 92 50. Coordinate with the Section 23 92 50 contractor.
- P.** Provide surge protection device (SPD) unit integral to each switchboard's main disconnect section. SPD unit shall have characteristics indicated on the electrical power riser diagram. Provide a minimum of (1) set of contacts to allow SPD unit status to read by the building BCS furnished under Section 23 92 50. Coordinate with the Section 23 92 50 contractor.

2.2 METER CENTERS

- A.** Enclosures shall be constructed of formed and welded code gauge galvanized steel NEMA 1 with gray baked electrodeposited enamel finish, over cleaned galvanized.
- B.** No device disassembly is to be required before mounting.
- C.** All devices must be bonded together with bolted connections.
- D.** All compartments containing unmetered circuits shall be provided with a sealing means.
- E.** All components shall be factory assembled and all current carrying parts shall be plated bus bars.
- F.** Individual units shall be constructed with an integral sliding one bolt joint-pak assembly for a completely bussed meter center. This single bolt is to be torque indicating type for tightening without a torque wrench.
- G.** Sockets shall be rated 125 or 200 amperes continuous duty, as specified on the drawings.
- H.** Horizontal bus shall be rated a minimum of 800 A.
- I.** Circuit breakers shall be Square D, Cutler Hammer, or GE, thermal magnetic trip,

with an integral crossbar to provide simultaneous opening of all poles in multi-pole circuit breakers.

- J.** Breakers shall have an overcenter, tripfree, toggle-type operating mechanism with quick-make, quick-break action and positive handle indication.
- K.** Handles shall have ON, and OFF, and Tripped positions. In addition, breakers shall include TRIP indicator appearing in the window of the breaker case.
- L.** Circuit breakers shall be UL listed in accordance with UL standard 489 with current ratings as noted on the plans. Interrupting ratings shall be selected to provide the required short circuit current rating.
- M.** Short circuit current ratings shall be provided per the schedule. This rating shall be established by manufacturer testing of a representative meter center with branch overcurrent devices installed.

PART 3 - EXECUTION

3.1 SWITCHBOARD MOUNTING

- A.** Provide 4-inch high reinforced concrete mounting base except where noted otherwise with mounting channels per switchboard Manufacturer's recommendations. Concrete as specified in Section 03300. Base shall not extend more than 6-inches in all directions beyond the maximum dimensions of switchboard. Level and bolt switchboard securely to the floor.



SECTION 26 21 00

EMERGENCY GENERATOR – NATURAL GAS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. General provisions of the contract, including the GENERAL CONDITIONS, SUPPLEMENTARY CONDITIONS, Division 1, GENERAL REQUIREMENTS, and Section 16010, apply to the work specified in this Section.

1.2 DESCRIPTION

- A. Work required under this section includes furnishing and installing a complete pre-assembled and tested packaged natural gas engine driven generator system; complete with control panel, transfer switches, safety devices, remote annunciator, etc., as specified, indicated on the contract drawings, and required for a complete operating system.

1.3 QUALITY ASSURANCE

- A. Standard products: Except as specified herein, material and equipment provided shall be standard catalog product of manufacturer regularly engaged in manufacturing of engine-generator sets and be latest standard design that conforms to specification requirements. Natural gas engine-generator set shall be manufactured by Generac. Other substitute manufacturers may be accepted only if the quiet site generator enclosure meets the dimensioned requirements listed within the construction documents. Otherwise substitutions will not be accepted. Substitutions are also subject to compliance with all of the criteria specified within this Section.
- B. Standards: Except as otherwise specified, applicable rules and regulations of following standards shall be considered as minimum requirements:
 - 1. Institute of Electrical and Electronics Engineers.
 - 2. The National Electrical Manufacturers Association.
 - 3. Internal Combustion Engine Institute.
 - 4. NFPA 70 - National Electrical Code.
 - 5. NFPA 110 - Standard for Emergency and Standby Power Systems.
 - 6. UL2200 - "Stationary Engine Generator Assemblies".
 - 7. UL1008 - "Standard for Safety, Automatic Transfer Switches".
 - 8. Unites States Environmental Protection - The Clean Air Act OF 1990.
- C. Manufacturer Qualifications: Supplier of the electric plant and associated items shall have permanent service facilities within 120 miles of the installation location. These

facilities shall comprise a permanent force of EGSA certified and factory trained and certified Generator Technicians. Service personnel shall be on 24-hour call, experienced in servicing this type of equipment, providing warranty and routine maintenance service to afford the owner maximum protection.

1.4 SUBMITTALS

- A.** Provide complete shop drawings and such other descriptive data as may be required to demonstrate compliance with Contract Documents. Shop drawings shall include drawings, details, and instructions necessary for installation of engine-generator unit, associated equipment, piping, wiring and devices. Shop drawings shall be submitted for following items at one time in order to demonstrate that these items of equipment have been properly coordinated and will function properly with each other.
1. Engine-generator set complete with base and all attachments.
 2. Starting system including battery, charger, controls and wiring.
 3. Vibration isolation provisions.
 4. Water jacket heater.
 5. Exhaust system, including muffler and required piping.
 6. Automatic transfer switches, including withstand rating data.
 7. Engine-generator control and instrument panel.
 8. Remote annunciator panel.
 9. Alternator data sheet.
 10. UL 2200 Listing for generator set model number being provided
 11. Unites States Environmental Protection Agency 2011 Model Year Certificate of conformity with The Clean Air Act OF 1990.
 12. Manufacturer's Master Generator Technician Certification
 13. Generator Technician EGSA Certification
 14. Certified summary of prototype-unit test report

1.5 OPERATION AND MAINTENANCE MANUAL

- A.** Following equipment and systems specified in this Section shall be covered in Operation and Maintenance Manual. Include complete submittal data as approved, and manufacturer's complete operation and maintenance manuals for system components noted below.
1. Engine-generator set
 2. Transfer switches
 3. Engine cooling system controls
 4. Starting system
 5. Exhaust system
 6. Engine-generator control and instrument panel
 7. UL 2200 Listing for generator set model number being provided
 8. Unites States Environmental Protection Agency 2011 Model Year Certificate of conformity with The Clean Air Act OF 1990.

- 9. Manufacturer's Master Generator Technician Certification
- 10. Generator Technician EGSA Certification

1.6 SUPERVISION

- A. Installation shall be supervised, checked, and tested after the installation by qualified representative of manufacturer. Representative shall instruct Owner's operating personnel in proper operation of engine-generator set.

1.7 INSTRUCTION TO OWNER'S PERSONNEL

- A. Upon completion of installation and testing of system, provide one four-hour period of instruction to Owner's personnel. Instruction shall cover complete operation and maintenance of system, and shall be conducted by an EGSA Certified, manufacturer's Master Certified Technician.

1.8 DIVISION OF WORK

- A. Engine-generator set, complete with safety devices, starting panel, batteries, control panel, remote annunciator, and transfer switches shall be provided complete and functioning in this Section.
- B. Engine-generator muffler shall be furnished in this Section and installed under Division 23. Exhaust system work and connections shall be provided under Division 23.
- C. Engine cooling system discharge duct assembly shall be provided under Division 23. Bracket flanges for duct connections shall be provided in this Section.
- D. Coordinate work and materials to be interfaced with Division 23 as required for complete and functioning engine-generator system. Provide workmen of other trades with necessary mounting and connection criteria, instructions and supervision as required for complete and coordinated installation.

PART 2 - PRODUCTS

2.1 ENGINE - GENERATOR

- A. AC Generator:
 - 1. The AC generator shall be; synchronous, four pole, revolving field, dripproof construction, single prelubricated sealed bearing, air cooled by a direct drive centrifugal blower fan, and directly connected to the engine with flexible drive disc(s).
 - 2. All insulation system components shall meet NEMA MG1 temperature limits

for Class H insulation system. Actual temperature rise measured by resistance method at full load shall not exceed 130 degrees Centigrade.

3. The generator shall be capable of delivering rated output (kVA) at rated frequency and power factor at voltage not more than 5% above or below rated voltage.
4. Subtransient reactance shall not exceed 12%.
5. Engine-generator shall be capable of 100% full nameplate standby rating in a single step, in compliance with NFPA 110.

B. Engine:

1. The engine shall be natural gas, 4 cycle, 1800 RPM, radiator and fan cooled. Two cycle engines are not acceptable.
2. The engine exhaust emissions shall meet the EPA emission requirements for standby power generation.
3. Complete with devices normally furnished and any other devices required.
4. Suitable for driving generator specified and arranged for operation on natural gas.
5. An electronic governor shall provide automatic frequency regulation adjustable to within $\pm 0.5\%$. The governor shall have provision for paralleling with the addition of load sharing controls. The engine governing system shall not utilize any exposed operating linkage.
6. The engine shall be cooled by a mounted closed loop radiator system rated for full load operation in 122 degrees F (50 degrees C) ambient as measured at the generator air inlet. Radiators shall be provided with a duct adaptor flange. The cooling system shall be filled with 50/50 ethylene glycol/water mixture by the equipment supplier. Rotating parts shall be guarded against accidental contact.
7. The engine/alternator shall be mounted with internal vibration isolation onto a welded steel base. These units shall not need external vibration isolation for normal pad mounted applications.
8. Motor starting KVA as specified on the Emergency Generator schedule on the drawing.

2.2 ENGINE ACCESSORY EQUIPMENT

A. The engine-generator set shall include the engine accessories as follows:

1. An electric starter(s) capable of three complete cranking cycles without overheating, before overcrank shutdown (75 seconds).
2. Positive displacement, mechanical, full pressure, lubrication oil pump. Full flow lubrication oil filters with replaceable spin-on canister elements and dipstick oil level indicator. Provide engine with full amount of lubricating oil of type as recommended by manufacturer.
3. Engine mounted battery charging alternator, 40 ampere minimum, and solid-state voltage regulator.

4. Provide an air cleaner of sufficient capacity to effectively protect working parts of engine from dust and grit.

2.3 BASE

- A. The engine-generator set shall be mounted on a heavy duty steel base to maintain alignment between components. The base shall incorporate a battery tray with holdown clamps within the rails.

2.4 GENERATOR SET AUXILIARY EQUIPMENT AND ACCESSORIES

- A. Generator Main Circuit Breakers: Set-mounted and wired, UL listed, 100% rated, molded case electronic LSI (long-time, short-time, instantaneous) adjustable. Quantity and trip ratings as specified on the electrical drawings.
- B. Coolant Heater: Engine mounted, thermostatically controlled, water jacket heater(s) for each engine. The heater(s) shall be sized as recommended by the equipment supplier. Heater voltage shall be as required.
- C. Starting and Control Batteries: Starting Batteries, lead acid type, 24 volt DC, sized as recommended by the generator set manufacturer, shall be supplied for each generator set with battery cables and connectors, as required to interconnect batteries to DC apparatus.
- D. Battery Charger: A 10 amp voltage regulated battery charger shall be provided for the engine-generator set. Input AC voltage and DC output voltage shall be as required. Protect both input and output circuits by circuit breakers. Chargers shall be equipped with float, taper and equalize charge settings. Operational monitors shall provide visual output along with individual forms C contacts rated at 4 amps, 120 VAV, 30 VDC for remote indication of:
 1. Loss of AC power - red light
 2. Low battery voltage - red light
 3. High battery voltage - red light
 4. Power ON - green light (no relay contact)

Coordinate charger with an engine mounted DC alternator with transistorized voltage regulator, arranged to float and charge starting battery during engine run. Install charger inside generator set housing.

2.5 ENGINE EXHAUST SYSTEM

- A. Exhaust muffler shall be provided for engine, size and type as recommended by the generator set manufacturer. The muffler shall be hospital grade. Exhaust system shall be installed according to the generator set manufacturer's recommendations and

applicable codes and standards.

- B. Provide weathercap on exhaust pipes.

2.6 ENGINE-GENERATOR SET CONTROL SYSTEM

- A. Factory wired and assembled, integrally mounted generator control and engine instrument panel. Panel and components; applicable ANSI Standards for this class of equipment fully enclosed of dead-front type. To support EPA emission requirements, gensets larger than 80 kW will incorporate an active air-fuel-ratio controller. The air-fuel-ratio controller shall be integrated into the generator controller to ensure security of settings and to support monitoring and remote diagnostics. External air-fuel-ratio controllers are not acceptable. Mount panel on generator frame with vibration isolating mountings. Panel shall include following:

- 1. Genset Controller:

- a. The generator control system shall be a fully integrated microprocessor based control system for standby emergency engine generators meeting all requirements of NFPA 110 level 1. The generator control system shall be a fully integrated control system. The generator controller shall provide integrated and digital control over all generator functions including: engine protection, alternator protection, speed governing, voltage regulation, synchronizing, load-sharing (real and reactive) and all related generator operations.
- b. The control system shall provide an environmentally sealed design including encapsulated circuit boards and sealed automotive style plugs for all sensors and circuit board connections. The use of non-encapsulated boards, edge cards, and pc ribbon cable connections are considered unacceptable.
- c. Circuit boards shall utilize surface mount technology to provide vibration durability. Circuit boards that utilize large capacitors or heat sinks must utilize encapsulation methods to securely support these components.
- d. A predictive maintenance algorithm that alarms when maintenance is required. The controller shall have the capability to call out to the local servicing dealer when maintenance is required.
- e. Diagnostic capabilities should include time-stamped event and alarm logs, ability to capture operational parameters during events, simultaneous monitoring of all input or output parameters, callout capabilities, support for multi-channel digital strip chart functionality and .2 msec data logging capabilities.
- f. In addition to standard NFPA 110 alarms, the application loads should also be protected through instantaneous and steady state protective settings on system voltage, frequency, and power levels.

A. Provide and install a remote alarm annunciator located as shown on the drawings.

The remote annunciator shall provide all the indications and audible alarms called for by NFPA Standard 110 as provided on the engine-generator set control panel; and in addition shall provide indications for high battery voltage, low battery voltage, normal battery voltage, battery charger malfunction. Alarm silence and lamp test switches shall be provided.

2.8 VIBRATION ISOLATION

- A. Mount unit on steel base with a minimum of four spring type isolators installed between mounting base and building structure.

2.9 AUTOMATIC TRANSFER SWITCH

- A. General:
 - 1. Automatic transfer switches; to the requirements of Underwriters' Laboratories, Inc., "Standard for Safety, Automatic Transfer Switches, UL 1008", and as specified.
 - 2. Transfer switches: Electrically operated, and mechanically held.
 - 3. Transfer switches shall not include integral overcurrent protection for main power circuits.
 - 4. Electrical characteristics for transfer switches are indicated on drawings.
 - 5. Automatic transfer switches: Completely wired and assembled in one enclosure of NEMA 1 construction.
 - 6. Automatic transfer switches utilizing components of molded case circuit breakers, contactors, or parts which have not been intended for continuous duty or repetitive load transfer switching are not acceptable.
 - 7. Automatic transfer switch withstand ratings shall be fully coordinated with all power distribution system components. Individual automatic transfer switch withstand ratings shall not be less than the load side connected system component specified withstand rating.
 - 8. Where an automatic transfer switch is protected by upstream fuses, provide specific manufacturer coordinated breaker withstand ratings per UL 1008 for review.
 - 9. Automatic transfer switch acceptable manufacturers: Generac Power Systems, Zenith or ASCO.
- B. Operation:
 - 1. Operating mechanism of each transfer switch shall be such that load cannot remain simultaneously disconnected from both normal and alternate sources.
 - 2. Each transfer switch shall be furnished with a manual operating handle for maintenance purposes which will allow manual operation under full load.
 - 3. Transfer switch shall contain all control circuits, relays, and other devices to accomplish following sequence of operation:

- a. Transfer sequence from normal to emergency source shall be initiated when normal voltage source, in one or more phases, drops to 85 percent or less of normal voltage. Transfer switch shall start engine-generator unit after time-delay to permit override of momentary dips in the normal power source. Time-delay: Field adjustable from 0 to 6 seconds.
 - b. Transfer switch shall transfer load from normal to emergency power source when frequency and voltage of engine-generator set has attained 90 percent of rated value.
 - c. Transfer switch shall retransfer load from emergency to normal power source upon restoration of normal supply in all phases to 90 percent or more of normal voltage and after time-delay to permit stabilization of normal voltage. Time-delay: Field adjustable from zero to 30 minutes. Factory set for 2 minutes. Should emergency source fail during timing, transfer switch shall immediately transfer to normal when this source is available.
 - d. After retransfer to normal source, time-delay shall permit engine-generator to run and cool off at no load before shutdown. Time-delay: Field adjustment from zero to five minutes.
4. Provide the following accessories for transfer switch:
- a. Indicating lights with nameplates to indicate switch position. Lenses shall have different colors.
 - b. Test switch, momentary type, to simulate normal failure.
 - c. Two auxiliary contacts, one NO and one NC shall be provided for use other than control function of the ATS.
 - d. Engine starting contacts. Aluminum Alloy.
 - e. Time delay transfer emergency, 0-1 minute adjustable, set at 0 unless otherwise specified.
 - f. Operators manual for each transfer switch shall be furnished.
 - g. Engine generator exercising timer switch under load, adjustable in 15 minute increments for exercising once a week.
 - h. In-phase monitor controls for transfer and retransfer of motor loads.
 - i. Solid neutral with full terminals.
 - j. Auxiliary control contacts shall be provided as required for coordination with elevator system.

PART 3 - EXECUTION

3.1 TESTS

- A. Test combined engine-generator unit at the plant of engine-generator manufacturer for period of not less than 4 hours while carrying full KW load at 0.8 power factor. Submit copy of test reports for review. Inform Engineer of test date so that at his

option, Engineer may witness test. Submit test results for approval.

- B.** Before shipment of the equipment, the engine-generator set shall be factory tested under rated load for performance and proper functioning of control and interfacing circuits. Tests shall include:

 - 1. Verifying all safety shutdowns are functioning properly.
 - 2. Verify single step load pick-up per NFPA 110-2005.
 - 3. Verify transient and voltage dip responses and steady state voltage and speed (frequency) checks.
- C.** Upon completion of installation, conduct a second test of combined engine-generator unit at job site. Test combined unit for a period of 4 hours while carrying full KW load at unity power factor. Provide at no additional cost to Owner, all necessary instruments, materials, equipment, and personnel required for conducting test. Test equipment and materials shall include but not be limited to dummy load banks. Instruments shall include voltmeter and ammeter. Schedule test with Owner minimum of one week in advance, and perform in his presence. Factory representative of generator set manufacturer shall be present for test. Submit test results for approval.
- D.** Perform battery starting test consisting of three cranking cycles of 15 seconds "ON" and 15 seconds "OFF".
- E.** Test complete system to indicate the satisfactory operation and function of all controls, safety features, and system alarms.

3.2 GROUNDING

- A.** Where 3-pole transfer switches are used in a 3-phase, 4-wire system, the generator shall be grounded as a non-separately derived system in accordance with NEC 250. Remove any manufacturer's installed neutral to ground bonding jumpers. Provide solidly connected and unbroken equipment grounding conductor from the service equipment to each transfer switch and from each transfer switch to the generator.



SECTION 26 50 00

BACK OF HOUSE LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. General provisions of the contract, including the GENERAL CONDITIONS, SUPPLEMENTARY CONDITIONS, Division 01, GENERAL REQUIREMENTS, and Section 26 01 00, apply to the work specified in this section.

1.2 DESCRIPTION

- A. This section covers a complete lighting system as specified and indicated and includes provision of lighting fixtures and lamps indicated in back of house areas.

1.3 REQUIREMENTS

- A. Lighting fixtures shall be as specified and as indicated. Manufacturers and catalog numbers listed establish fixture quality and appearance. Other manufacturers' fixtures of the same quality of construction, performance, and appearance, as judged by Engineer, may be submitted for approval.
- B. Catalog numbers indicate the manufacturer and general type of fixture for each application, but do not necessarily reflect all accessories and features that may be required for each application to meet mounting requirements and other application conditions. Provide accessories and features as are required for each fixture and show complete catalog numbers in submittal data.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. Provide fully detailed catalog cut sheet data for each type of luminaire. Cut sheets shall indicate finished dimensions, metal thickness and gauges, material finishes, electrical and mechanical connections, and fasteners.
- B. Product Data:
 - 1. For all low-voltage, fluorescent, and LED luminaires:
 - a. Provide fully detailed catalog cutsheet data for each transformer/ballast/driver. Cutsheet shall include manufacturer, power factor, input watts, ballast factor, and physical dimensions.

- Contractor shall note transformer/ballast/driver quantities and locations.
 - b.** For remote transformers / ballasts / drivers, cutsheet shall indicate mounting distance limitations and standard wire sizes.
 - 2.** Indicate quantity, type, and manufacturer of lamps to be used. For LED luminaires, contractor shall indicate quantity, type, and manufacturer of LED modules.
 - 3.** Provide independent laboratory photometric data for all luminaire types. Photometric testing and reporting shall conform to IES procedures, including (as relevant) ANSI/IES LM-63-02 and LM-79-08 Where the lamps and/or ballasts specified are other than ones for which published photometric data is available, additional test data shall be submitted to the Engineer.
 - 4.** For all lamps containing mercury, submit Material Safety Data Sheets (MSDS) and/or other independent technical test data for each lamp type provided showing average lamp lumen hours and mercury content of lamps (in milligrams).
- C.** Samples:
 - 1.** Provide "samples" as called for in the Contract Documents. Supply a completely operable fixture with a plug and cord for standard 120-volt service. Provide lamps and component parts as specifically requested by Architect or Engineer. Provide samples for all custom designed luminaries.
 - 2.** In addition to the above, submit to Architect:
 - a.** Samples of any lens, louvers, or diffusers as requested. A two-inch by four-inch sample is the minimum size acceptable.
 - b.** Samples of any colors or finishes as requested.
 - 3.** Where a sample is submitted or requested, do not fabricate that fixture type until the sample is approved. Resubmit samples until approved.
 - 4.** Tag samples with the name of the project, referenced specification, paragraph or drawing number, the fixture type, and any other identifying data. Ship the sample to the address specified by Architect. After review, the sample shall be shipped to Architect. All transportation charges for samples shall be paid for by Contractor. Do not install any sample fixtures in project.
 - 5.** If samples are not approved by Architect, samples shall be returned to Contractor at his expense. Upon receipt of sample disapproval, immediately make a new submission of samples meeting the contract requirements.

1.5 QUALITY ASSURANCE

- A.** Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:

1. Underwriters Laboratories (U.L.)
 2. National Electric Code (NEC)
 3. National Fire Protection Agency (N.F.P.A.)
 4. Certified Ballast Manufacturers Association (C.B.M.)
 5. Illuminating Engineering Society (I.E.S.)
 6. American Society for Testing and Materials (A.S.T.M.)
 7. American National Standards Institute (A.N.S.I.)
 8. National Electrical Manufacturers Association (N.E.M.A.)
- B.** Guarantee ballasts, drivers, and transformers against defects for a period of two (2) years, except electronic ballast guarantee shall be for five (5) years. Guarantee shall include material and labor to replace defective ballasts/drivers/transformers for a period of one (1) year, and material only for the remainder of the ballast warranty period.

1.6 OPERATION AND MAINTENANCE MANUAL

- A.** Following items shall be covered in Operation and Maintenance Manual:
1. Complete fixture cuts and descriptive materials including all necessary auxiliaries for proper installation and operation per approved shop drawing submission.
 2. Complete lamping data for each fixture type to include:
 - a. Quantity, type, and manufacturer of lamps / LED module used per luminaire;
 - b. Lamp wattage;
 - c. ANSI code number;
 - d. Average lamp life.
 - e. For LED luminaires, the L70 rating (the number of hours before light output will drop to 70% of initial output) as tested in accordance with IES LM-80-08.
 - f. Ballast/driver/transformer type and manufacturer (where applicable);

PART 2 - PRODUCTS

2.1 MARKING OF FIXTURES

- A.** Plainly mark fixtures equipped with ballasts for operation of rapid start lamps "Use Rapid Start Lamps Only." Similarly, mark other fixtures according to proper lamp type. Clearly mark ballasts that have multilevel outputs, and indicate proper terminals for the various outputs. Provide markings that are clear and that are readily visible to service personnel. Marking shall not be visible from normal viewing angles when lamps are in place.

2.2 FABRICATION AND MATERIALS

- A.** Provide fixtures completely factory-assembled and wired, and equipped with necessary sockets, ballast/driver, transformer as needed, wiring, shielding, reflectors, channels, lenses and other parts necessary to complete the fixture installation, and deliver to project site ready for installation.
- B.** Unless otherwise noted, use only completely concealed hardware. Weld exposed metal at joints, fill with weld material, grind smooth, and make free from light leaks. Gasket wet location fixtures with overlapping trim. Weld ballast support studs, socket saddle studs and reflector support studs to fixture body. Self-threading screws are not approved. Ventilate ballast compartments and firmly secure ballast to conducting metal surface. Provide fixtures using bottom re-lamping, unless otherwise noted.
- C.** Provide housings for discharge lamp (fluorescent) fixtures that make electrical components easily accessible and replaceable, without removing the fixture body from its mounting.

2.3 FINISHES

- A.** Cadmium plate screws, bolts, nuts and other fastening or latching hardware.
- B.** Unless specifically indicated otherwise, provide fixtures with a high-temperature baked enamel coating or color and finish as specified. Unless otherwise specified, provide white baked enamel reflective surfaces with a minimum reflectance of 86%. Give all parts proper etched surface preparation prior to painting to assure paint adherence and durability.

2.4 ACCEPTABLE FIXTURE MANUFACTURERS

- A.** Acceptable manufacturers are listed in the Lighting Fixture Schedule / Luminaire Schedule in the Contract Documents. The designations indicated on the Lighting Fixture Schedule / Luminaire Schedule are a design series reference (not necessarily a complete catalog number), and do not necessarily represent all of the special requirements as specified in the Contract Documents. Contractor is responsible for meeting all requirements of the Contract Documents and applicable codes.
- B.** The listing of a manufacturer as "acceptable" does not assure approval. It is the sole responsibility of the Contractor to ensure that any price quotations and submittals made are for lighting equipment that meet or exceed the specifications included herein.

- C. All custom fixtures shall be provided with factory installed U.L. or approved independent laboratory test label.

2.5 BALLASTS

A. General:

1. Provide ballasts that are suitable for the electrical characteristics of the supply circuits to which they are to be connected, and which are suitable for operating the specified lamps. No extra compensation will be allowed for failure to properly coordinate ballast voltage with circuitry.
2. Provide ballasts that are listed with Underwriters Laboratories and that bear the U.L. label. All ballasts shall be designed, built, and tested in accordance with ANSI and NEC standards.
3. Provide ballasts having the lowest sound rating available for the lamps specified; clearly show their respective sound ratings. Replace ballasts found by Architect or Engineer to be too noisy without charge, prior to acceptance of project.
4. Provide Class "P" protected ballasts, indicating that the ballasts have an integral self-resetting, thermally-actuated device that will remove the ballast from line when excessive ballast temperature is reached, and allow reconnection to line when normal temperature is resumed.
5. Provide identical ballasts within each fixture type. All ballasts within the same luminaire must be of the same manufacturer.
6. Ballast shall not contain polychlorinated biphenyls (PCB's).
7. Ballasts shall be of the high power factor type, with a power factor of 0.9 or higher.

B. Fluorescent - Electromagnetic:

1. Provide ETL/CBM certified ballasts that are super low heat, energy-saving, rapid start type, unless noted otherwise. Multi-lamp rapid start ballasts shall be of the series sequence type.
2. Rapid start ballast shall start lamps by first heating the filaments for at least 450 milliseconds.
3. Minimum starting temperature shall be 60°F for energy saving lamps and 50°F for standard lamps.
4. For outdoor use and wherever ballasts are used outside a heated environment (such as parking garage areas), provide fluorescent ballasts capable of lamp-starting at any temperature down to 0°F. (These ballasts will not have CBM certification.).
5. Ballasts shall withstand line transients as defined in IEEE publication 587, Category A.

C. Fluorescent - Electronic:

1. Multi-lamp ballasts may be of the series (rapid start) or parallel (instant start) type, except as follows:
 - a. Occupancy Sensor Controlled Ballasts: Series (rapid start) only.
 - b. Dimming Ballasts: Series (rapid start) or programmed start only.
2. Series ballasts shall have a sequenced start progression that first heats cathode filaments and then ignites the lamp. Parallel ballasts shall instant start rapid-start lamps. Rated lamp life shall not have reduced more than 25%, based on three hours per start.
3. Total Harmonic Distortion shall not exceed 10%.
4. Light output (ballast factor) shall be 89% or greater.
5. Ballast shall maintain constant light output ($\pm 5\%$) of all 4-foot rapid start fluorescent lamps in the proper lamp/ballast combination within operating ranges of $\pm 10\%$ of nominal voltages of 120 V or 277 V.
6. Ballasts shall meet the requirements of the Federal Communications Commission Rules and Regulations, Part 18, regarding radio frequency interference (RFI) and electromagnetic interference (EMI).
7. Starting filament voltage shall not exceed 4.5 volts.
8. Ballast shall have a frequency of operation of 20 KHz or greater, and incorporate adequate 60 Hz filtering in order to operate with less than 5% flicker (maximum .20 Flicker Index) with any tri-phosphor lamp suitable for the ballast. The 60 Hz envelope shall not exceed .6 of the peak light output.
9. Electronic ballasts that disconnect the lamp heat filament of rapid start or heater cutout lamps are not acceptable.
10. Electronic ballasts shall have an average current crest factor of 1.7 or less, [peak to RMS], or comply with ANSI C82.1A high frequency ballast standard.
11. Minimum starting temperature shall be 60°F for energy saving lamps and 50°F for standard lamps.
12. For outdoor use and whenever ballasts are used outside a heated environment (such as parking garage areas), provide fluorescent ballasts capable of lamp - starting at any temperature down to 0°F.
13. Ballast shall withstand line transients as defined in ANSI/IEEE C62.41, Category A.
14. Provide ballasts for multi-lamp fluorescent lighting fixtures as follows:
 - a. Two-Lamp Fixtures: Provide one (1) two-lamp ballast.

D. Compact Fluorescent Lamps

1. Electronic-programmed rapid-start type, complying with UL 935 and with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated.
2. Lamp end-of-life detection and shutdown circuit.
3. Automatic lamp starting after lamp replacement.

4. Sound Rating: Class A.
5. Total Harmonic Distortion Rating: Less than 20 percent.
6. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
7. Operating Frequency: 20 kHz or higher.
8. Lamp Current Crest Factor: 1.7 or less.
9. BF: 0.95 or higher unless otherwise indicated.
10. Power Factor: 0.95 or higher.
11. Interference: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for non-consumer equipment.

E. LED Drivers:

1. Provide LED drivers that are U.L. listed for use suitable for its specified application. Drivers that have not been specifically tested by U.L. in combination with the LED modules being used will not be accepted.
2. Drivers that are only a U.L. recognized component must be installed in the luminaire by the manufacturer and must be listed by U.L. as an assembly with the luminaire.
3. Any driver installed by the contractor separate from other luminaire components in the field must be U.L. listed.
4. All drivers must be rated for a minimum of 50,000 hours.
5. Power Factor: 0.90 or higher
6. Energy consumed while luminaire is off shall be limited to no more than 0.5 Watts,
7. Manufacturer shall provide specific guidelines on operating temperature range to ensure that maximum junction temperature is not exceeded when luminaire is operated at highest ambient operating temperature.
8. Dimming Characteristics: All drivers shall be fully compatible with specified controls. All 0-10V dimmable drivers shall be capable of dimming LED modules down to no more than 10% of rated lumen output.

F. Acceptable Ballast Manufacturers:

1. Electromagnetic: Philips Advance, MagneTek, General Electric, Valmont, Jefferson, Universal.
2. Electronic: Philips Advance, Universal Lighting Technologies, General Electric, Osram Sylvania, MagneTek, Motorola.
3. Dimming: Philips Advance, Lutron, Universal Lighting Technologies.

2.6 FIXTURE WIRING

- A.** Provide wiring between fluorescent lampholders and associated operating and starting equipment, of similar or heavier gauge than the leads furnished with the approved types of ballasts, and having equal or better insulating and heat resisting

characteristics. Provide internal wiring of fixtures containing a minimum number of splices. Make splices with approved mechanical insulated steel spring type connectors, suitable for the temperature and voltage conditions to which the splices are to be subjected.

- B.** Make connections of wires to lampholder terminals and other accessories in a neat and workmanlike manner, electrically and mechanically secure, with no loose strands protruding. Provide the number of wires extending to or from the terminals of a lampholder or other accessory that does not exceed the number that the accessory is designed to accommodate.
- C.** Provide wiring channels and wireways free from projections and rough or sharp edges. At points or edges over which conductors shall pass and may be subject to injury or wear, round bush to make a smooth contact surface with the conductors.
- D.** Install insulated bushings at points of entrances and exit of flexible wiring.

2.7 LAMPS AND LED MODULES

- A.** General:
 - 1.** Furnish required lamps for all light fixtures specified to provide for artificial illumination of the project.
 - 2.** Acceptable Manufacturers:
 - a.** For Lamps: General Electric, Sylvania, Philips
 - b.** For LED Modules: Philips, General Electric, Sylvania, CREE, Samsung, Nichia.
 - c.** In situations where a specific lamp manufacturer is noted on the Light Fixture Schedule / Luminaire Schedule, only that manufacturer shall be acceptable.
 - 3.** Install quantity, type, wattage and color lamp(s), as indicated for each light fixture in fixture schedule.
 - 4.** All lamps shall be free from product imperfections and handling.
 - 5.** Any lamp whose color, in the opinion of the Architect, is determined to be unsatisfactory shall be replaced at no additional expense to the Owner.
- B.** Compact Fluorescent Lamps:
 - 1.** Provide biax or double biax lamps as indicated, or, as required by the light fixture.
 - 2.** Provide pin base configuration as indicated, or, as required by the light fixture.
 - 3.** T4 single biax lamps shall be preheat lamps with starters built into the base.
 - 4.** T4 double biax lamps with 2-pin bases shall be preheat lamps with starters built into the base. T-4 double biax lamps with 2-pin bases shall not be used with electronic ballasts.

5. T4 double biax lamps with 4-pin bases shall not have starters, and shall be suitable for operation on dimming ballasts or electronic ballasts designed for that product.
6. Self-ballasted compact fluorescent lamps will only be permitted if specifically noted on the Light Fixture Schedule. All self-ballasted compact fluorescent lamps shall be fully compatible with any dimming system(s) specified, and the combination of lamp / dimming system shall have been previously tested by the dimming system manufacturer.
7. Minimum average rated life of 12,000 hours.
8. Minimum CRI shall be 82.
9. Color temperature 3500 K, unless otherwise indicated.
10. Mercury content shall not exceed the below limits for each indicated wattage
 - a. 42 watts: 66 picograms of mercury per lumen hour
 - b. 32 watts: 87 picograms of mercury per lumen hour
 - c. 26 watts: 164 picograms of mercury per lumen hour
 - d. 18 watts: 182 picograms of mercury per lumen hour

C. Light Emitting Diode (LED):

1. Color Rendering Index (CRI): All white light sources must have a minimum CRI of 80, tested under Ra14 and tested in accordance with ANSI/IES procedures.
2. Correlated Color Temperature (CCT): All white light sources must have a designated CCT, tested in accordance with ANSI/IES procedure. Refer to Light Fixture Schedule / Luminaire Schedule for CCT specification for each luminaire type. CCT of provided product shall be within 100K of specified nominal CCT.
3. Color Shift: Color shift while dimming and color shift over the life of the luminaire shall be limited to no more than +/- 100K.
4. Lumen Maintenance: Luminaire shall maintain minimum 70% of initial lumen output after 50,000 hours of operation, tested per IES LM-80-08 procedures.
5. Field Replacement: All LED modules shall be replaceable in the field without voiding component/luminaire warranty or listing.
6. All LED modules shall be mercury-free, lead-free, and RoHS compliant.
7. Photometric Distribution: Manufacturer must indicate luminous intensity distribution per IES LM-79-08 procedures. Testing shall be for specific LED module / luminaire used.
8. Self-ballasted LED lamps will only be permitted if specifically noted on the Light Fixture Schedule. All self-ballasted LED lamps shall be fully compatible with any dimming system(s) specified, and the combination of lamp / dimming system shall have been previously tested by the dimming system manufacturer.

- D. Tungsten Halogen:
 - 1. Tungsten halogen shall be clear or outside frosted, as required by light fixture.

2.8 LAMPHOLDERS

- A. Provide incandescent lamp sockets with porcelain housings over copper screw shells, with medium base sockets rated at 660W. Plastic or metal sheet sockets are not acceptable.
- B. Provide fluorescent fixture sockets that are white, of heat resistant plastic, and rated at 660W. Fluorescent lamp sockets operating with an open circuit voltage in excess of 300 volts shall be of the safety type that opens the supply circuit when the lamp is removed from the sockets.
- C. Rigidly and securely attach lamp-holding sockets to the fixture enclosure or husk.
- D. Where pull-chains are included, provide an insulating joint.
- E. Provide sockets suitable for specified lamps, and set to position the lamps in optically correct spacing and relationship to lenses, reflectors, filters, and baffles.
- F. Where fluorescent lamps are to be used "bare," without diffusers or lenses, provide at least two acceptable lamp retaining clips per fluorescent lamp, for safety.

2.9 REFLECTORS

- A. Aluminum Reflectors:
 - 1. Provide reflectors and reflecting cones or baffles fabricated from #12 aluminum reflector sheet, .057 inch (15 gauge) or heavier; and absolutely free of tooling marks including spinning lines, and free of marks or indentation caused by riveting or other assembly techniques. No rivets, springs, or other hardware shall be visible after installation.
 - 2. Provide reflectors and baffles of first-quality polished, buffed, and anodized finish, "Alzak" or approved equal, and with specular finish color as selected by Architect.
 - 3. Provide other aluminum reflectors where required; formed and finished as noted on Drawings and elsewhere in the specifications. Provide only reflectors free from blemishes, scratches, or indentations that would distort their reflective function and finish by means of the "Alzak" process, or approved equal, unless otherwise noted.
- B. Painted Reflectors:

1. Provide painted reflectors completely formed before application of primer and enamel paint. Make reflectors and reflector bodies for fluorescent fixtures, having baked-on white enamel finish, applied to meet the following requirements and tests: Provide minimum tested reflectance of 86%. After 100 hours exposure to fade-o-meter, reflectance may not be less than 86%, and finish may show no visible color change. Exposure to 100% humidity at 100EF, for 100 hours (cook box test) may show no blistering or other effects. Salt spray (20% sodium chloride) for 150 hours may cause no breakdown of film. When requested by Architect, submit a sufficient quantity of flat steel panels having the same primer and paint, applied in the same manner as proposed for the contract items, for subjection to any one or all of the tests listed above by an approved independent testing laboratory. Contractor will pay the cost of the tests. Tests will be required only in case of dispute about reflector characteristics. Reflectors that do not meet the criteria expressed here shall be replaced at Contractor's expense.

2.10 LENSES, FACEPLATES AND TRIMS

- A. Plastic lenses shall be of virgin methyl methacrylate, unless otherwise indicated. No polystyrene lenses will be accepted.
- B. Make lenses, louvers, or other light diffusing elements contained in frames, removable but positively held within the frames so that hinging or other motion of the frame will not cause the diffusing element to drop out.
- C. Provide faceplates of incandescent recessed fixtures which open for access to the interior of the fixture, serve as a ceiling trim, and are positively held to the fixture body by adjustable means that permit the faceplate to be drawn up to the ceiling as tight as necessary to insure complete contact of faceplate with ceiling.
- D. Provide ceiling trims for rectangular recessed fixtures with mitered corners, continuously welded and smoothed before shop finishing. Lapping of trim metal is not acceptable.

2.11 EXTERIOR FIXTURES

- A. Provide fixtures designed and manufactured specifically for outdoor service. Make components, including nuts, bolts, rivets, springs, and similar parts, of corrosion resistant materials or of materials that will assure such resistance.
- B. Provide fixtures for use outdoors, or in areas designated as damp locations, which are suitably and effectively gasketed to prevent access of moisture into electrical components or enclosing diffusers, lenses, or globes. Outdoor fixtures that are

directly exposed to the elements shall be rated for wet locations. Fixtures that are aimed up shall be approved for wet locations in this position.

- C. Metal parts of fixtures requiring painting shall be painted with suitable weather and moisture-resisting paint equal to epoxy-based coatings.
- D. Provide anodized aluminum for aluminum parts of exterior fixtures that are not specified as requiring a painted finish.

2.12 ACCESSORIES

- A. Recessed incandescent luminaires shall be furnished with thermal protection in accordance with Article 410-65 of the NEC.
- B. Where utilized as raceways, luminaires shall be suitable for use as raceways. Provide feed through splice boxes where necessary.
- C. Provide plaster frames or mounting frames for fixtures that require them. Such frames shall be appropriate for the ceiling construction in which they shall be installed.
- D. Provide necessary hardware with fixtures, such as stems, plates, plaster frames, hangers, and similar items, for safe support of fixtures for the ceiling construction in which they shall be installed. Provide plaster frames made of non-ferrous metal, or of steel that has been suitably rustproofed after fabrication.
- E. For fluorescent luminaires used indoors, where ballast sound rating of "A" is not available, provide acoustic mounting pads between luminaire housing and ballast to minimize vibration and noise level. Pads shall be installed to Architect's approval.
- F. Provide tempered glass lenses for all metal halide fixtures.
- G. Provide fastening devices of a positive locking type, which do not require special tools to apply or remove them. Do not use tie wires in place of fastening devices.
- H. Attach reflectors to housing by means of safety chains, to prevent reflectors from falling. No part of the chain may be visible after installation, when viewed from any angle up to 45 degrees from horizontal.
- I. Provide an approved ceiling canopy for each stem, exactly matching stem finish, unless otherwise requested by the Architect.
- J. Provide wire guards on fixtures where indicated and where required by code.

PART 3 - EXECUTION

3.1 GENERAL

- A.** Fixture locations as indicated on the Electrical Drawings are generalized and approximate. Carefully verify locations with Architect's plans, reflected ceiling plans, and other reference data prior to installation. Check for adequacy of headroom and non-interference with other equipment, such as ducts, pipes, conduit, or openings. Bring conflicts to Architect's attention before proceeding with work. Spaces for fixture insertion will be provided by the trade that installs the ceiling.
- B.** Although the location of equipment may be shown on the Contract Drawings in certain places, actual construction may disclose that the work does not make its position easily and quickly accessible. In such cases, call Architect's attention to this situation before installing this work, and comply with his installation instructions.
- C.** Verify ceiling conditions and furnish appropriate luminaire mounting accessories for each fixture. Such mounting details shall be approved by Architect.
- D.** Locations shown for fixtures in equipment rooms are approximate. Install fixtures in equipment rooms after equipment, ductwork, conduit and piping installation. Coordinate the location and mounting height of fixtures with ductwork, piping, and equipment; install fixtures in locations and heights to properly illuminate equipment and spaces as approved by the Engineer. If required, suspend or wall mount fixtures so that serviceable equipment is illuminated.
- E.** Install fixtures complete with lamps, as indicated, and with equipment, materials, parts, attachments, devices, hardware, hangers, cables, supports, channels, frames and brackets necessary to make a safe, complete, and fully operative installation.
- F.** Verify and provide fixtures that are appropriate for the ceiling mounting conditions of the project.
- G.** Reject and do not install blemished, damaged, or unsatisfactory fixtures. Replace imperfect or unsatisfactory fixtures, if installed, as directed by the Architect.
- H.** When installed, fixture shall be free of light leaks, warps, or other irregularities. No light leaks are permitted at the ceiling line or from any visible part or joint of the fixtures.

- I.** Provide finish for exposed parts or trims as specified or indicated on the Drawings. If finish for exposed parts is not indicated, provide a finish as directed by the Architect.
- J.** Do not install reflector cones, aperture plates, lenses, diffusers, louvers, and decorative elements of fixtures until completion of wet work, plastering, painting, and general clean-up in the area of the fixtures. All reflector cones, aperture plates, lenses, diffusers, louvers, and decorative elements shall be free of scratches, dents, dust, fingerprints, etc. at close of job.
- K.** Mount fixtures at heights and locations indicated on the Architectural Drawings. Contractor shall confirm with Architect the location, pendant length and exact final A.F.F. mounting height for all suspended fixture types. Contractor shall confirm with Architect the exact center line A.F.F. mounting height of all junction boxes for wall mounted fixture types.
- L.** Adequately protect the housing of recessed lighting fixtures during installation by internal blocking or framing to prevent distortion of sides, or dislocation of threaded lugs, which, upon completion, shall be in perfect alignment and match the corresponding holes in frames and rims. Holding screws shall be inserted freely without forcing, and shall remain easily removable for servicing. Threads intended to receive holding screws shall be chased after plating and finished to insure easy installation and removal of knurled headed screws.
- M.** Parabolic luminaires shall be installed with Mylar cover over louvers; cover shall be U.L. listed for temporary lighting. Upon completion of work, remove Mylar cover with white gloves.
- N.** Fixture supports shall be adequate to support the weight of the fixtures.
- O.** Provide visible hanging devices that are finished to match the fixture finish, unless indicated otherwise.
- P.** Where necessary to meet fire resistance requirements of Building Code authorities, provide enclosure housings for recessed fixtures that are constructed to provide required fire resistance rating.
- Q.** Stem Mounting: Use self-aligning hangers in canopies to hang fixtures true to vertical. Take care not to deface ceiling or walls. Locate hangers at intersections of joints or at centers of blocks in rooms with patterned type ceiling materials such as acoustic tile. Use hangers capable of supporting four times fixture weight. Align continuous rows of fixtures maintaining fixtures level without rotation about the longitudinal axis. Rigidly support outlet box from building structure and independent of ceiling system. Where obstructions prevent direct support of outlet,

provide offset or trapeze hangers for outlet box. Stem shall be supported directly from building structure on maximum 4'-0" centers with a minimum of two (2) stems per individual four (4) foot light fixture, and three (3) stems per individual eight (8) foot light fixture.

- R.** Ceiling Mounting: Mount surface fixtures tight to surface without distorting it. Space fixtures in continuous rows to correspond to ceiling joint intersections, continuous row fixtures may be fed by a single outlet where fixtures contain approved wireways and suitable wiring is used. Provide hangers for each fixture, each rated to support four times the fixture weight. Provide offset or trapeze hangers where required as for stem fixtures. Supports shall be provided on a maximum of 4'-0" centers with four (4) foot light fixture and three (3) hangers per individual eight (8) foot light fixture. Hangers shall be supported from the building structure and independently from ceiling system or other building services.
- S.** Recessed Mounting: Verify ceiling construction and material prior to ordering light fixtures. Coordinate fixture locations with ceiling supplier and installer. Cooperate with the ceiling installer. Provide necessary mounting hardware and accessories to adapt fixture to ceiling construction. Provide gaskets, trims, flanges, etc. as required to prevent light leaks around trim. Where installing "lay-in" type fixtures, provide supports at all four (4) corners of the fixture where said supports are not provided by the ceiling installer.
- T.** Wall Mounting: Mounting shall be similar to ceiling fixtures except fixture supports shall be braced to sustain a vertical or horizontal load of 250 pounds minimum.
- U.** Fixture manufacturer shall coordinate conduit entry locations with installing contractor.
- V.** All exit signs shall be as indicated on fixture schedule with face and arrow arrangement shown on the drawings.
- W.** For all recessed fixtures not prewired, use junction box 12" from openings with 4 ft. of 1/2 in. flexible metal conduit with #12 AWG wire from junction box to fixture.
- X.** All remote step-down transformers shall be properly wired to fixtures in order to completely eliminate any malfunctions related to voltage drop, regardless of transformers' locations. Locate transformers to be accessible.
- Y.** All cross-baffle louvered downlight fixtures shall be installed with cross-baffle louvers aligned and parallel with building lines.

- Z.** Light fixtures surface mounted to the underside of insulated floor slabs shall be offset or stem mounted as required to align top of fixture housing with the underside of insulation. Light fixtures shall not be buried within insulation.
- AA.** All parabolic louvered 2x2 fluorescent light fixtures shall be installed with lamps and parabolic louvers aligned in the same direction, and consistent with adjacent parabolic louvered 2x4 fluorescent light fixtures.

3.2 ACCESSIBILITY

- A.** Install equipment such as junction and pull boxes, fixture housings, transformers, ballasts, switches and controls, and other apparatus that requires occasional access for operation and maintenance, to be easily accessible and appropriate for mounting and ceiling conditions.

3.3 ADJUSTMENT

- A.** Provide manpower and tools for final focusing and adjustment, under the Architect's supervision, of all adjustable fixtures (including fixtures with variable socket positions) after regular working hours, whenever necessary, at no additional cost to Owner.

3.4 CLEANING

- A.** Immediately prior to occupancy, clean reflector cones, reflectors, aperture plates, lenses, louvers, lamps and decorative elements. De-staticize lenses after cleaning, installing them to leave no finger or dirt marks. At the time of final inspection, fixtures shall be clean and free from marks, dust, spotting or other defects. Replace any broken or defective parts prior to final inspection. Replace or make good all defects revealed by final inspection. Replace all lamps found to have failed.



SECTION 26 55 00

BACK OF HOUSE LIGHTING CONTROL SYSTEMS AND DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. General provisions of the contract, including the GENERAL CONDITIONS, SUPPLEMENTARY CONDITIONS, Division 01, GENERAL REQUIREMENTS, Section 26 01 00, and Section 26 50 00 apply to the work specified in this section.

1.2 DESCRIPTION

- A. This section covers a complete lighting control system as specified and indicated and includes provision for control of lighting fixtures and lamps indicated in back of house areas.

1.3 REQUIREMENTS

- A. Lighting control devices and systems shall be as specified and as indicated. Manufacturers and catalog numbers listed establish quality and appearance. Other manufacturers' devices/systems of the same quality of construction, performance, and appearance, as judged by Engineer and Architect, may be submitted for approval.
- B. All contractors and manufacturers shall fully inform themselves of the conditions under which the work is to be performed, the site of the delivery, installation, wiring typology, and all other relevant information concerning the work to be performed. If the contractor or manufacturer are in any doubt as to the true meaning or any part of the lighting control design documentation (drawings, specifications, etc.), they shall submit a written request for interpretation through standard procedures defined in other sections of the specification.
- C. Catalog numbers indicate the manufacturer and general type of device / system for each application, but do not necessarily reflect all accessories and features that may be required for each application to be fully functional. Provide accessories and features as are required for a complete and fully functional installation.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. For all standalone lighting control devices / decentralized systems:

- a. Provide complete wiring details
 - b. Provide complete and clear floor plans of the system, including all system components and wiring (with a clear legend).
 - c. Provide all occupancy sensor and daylight sensor programming details and schedules.
 - d. Provide a full lighting control system intent description for review against the designed intent.
- B. Product Data:
 - 1. Provide catalog cutsheets for all components of the lighting control system. This shall include, but is not limited to:
 - a. Lighting switches
 - b. Dimming switches
 - c. Low-voltage switches
 - d. Keypads
 - e. Occupancy sensors
 - f. Daylight sensors / photocells
 - g. Relay packs / controllers
 - h. Power packs
 - i. Lighting control panels
 - j. Dimming panels
 - k. Timeclocks
 - l. Programming interfaces
 - m. Interfaces with non-compatible lighting systems

1.5 QUALITY ASSURANCE

- A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:
 - 1. Underwriters Laboratories (U.L.)
 - 2. National Electric Code (NEC)
 - 3. National Fire Protection Agency (N.F.P.A.)
 - 4. Illuminating Engineering Society (I.E.S.)
 - 5. American Society for Testing and Materials (A.S.T.M.)
 - 6. American National Standards Institute (A.N.S.I.)
 - 7. National Electrical Manufacturers Association (N.E.M.A.)
- B. Manufacturer shall have a minimum of 20 years of continuous experience in the manufacturer of lighting controls.
- C. All system components shall be UL Listed specifically for the types of loads they are controlling.

- D. Guarantee full system against defects for a period of two (2) years. The warranty shall cover all parts and manufacturer's labor costs required. Warranty coverage shall begin on the date that the equipment is energized.
- E. Provide software support for a minimum of 2 years.
- F. Provide all system components that have been manufactured, assembled, and installed to maintain performance criteria stated by manufacturer without defects, damage, or failure. All system components shall be tested by manufacturer prior to shipment (sample testing is not acceptable).
- G. Contractor shall ensure that lighting system control devices and assemblies are fully compatible and can be integrated into a system that operates as described in the lighting control notes on drawings and as described within this specification. Any incompatibilities between devices, assemblies, and system controllers shall be resolved between the contractor and the system provider, as required to ensure proper system operation and maintainability.
- H. Contractor shall ensure the compatibility between all luminaires and the devices / systems controlling them. Contractor shall be responsible for ensuring lighting control system manufacturer is in receipt of the approved lighting submittals and shop drawings in order to ensure all necessary components and interfaces are provided. If necessary to change a luminaire or control type for compatibility, this shall be completed in as efficient a manner as possible and at no additional cost to Owner.

1.6 OPERATION AND MAINTENANCE MANUAL

- A. Following items shall be covered in Operation and Maintenance Manual:
 - 1. Complete catalog cuts and descriptive materials including all necessary auxiliaries for proper installation and operation per approved shop drawing submission.
 - 2. Complete programming information for the system
 - 3. Contact information for manufacturer and local manufacturer's representative

1.7 COMMISSIONING

- A. Refer to other sections of this specification for requirements for lighting control commissioning by a certified Commissioning Agent. This section is intended for factory commissioning, and is not intended to replace the commissioning required by Code or Project Goals.

- B.** A factory-qualified Field Engineer employed by the Dealer shall visit the site upon completion of the installation of the lighting control system. The purpose of this visit shall be to:

 - 1.** Verify connection of power feeds;
 - 2.** Verify connection and location of all controls
 - 3.** Energize lighting control system (and download any required programming)
 - 4.** Verify proper connection of all panel links (low voltage or wireless)
 - 5.** Check switching and dimming panel load types
 - 6.** Verify system operation for all loads on the system and all controls on the system
 - 7.** Verify proper operation of manufacturer's interfacing equipment;
 - 8.** Obtain sign-off on system function.
- C.** Manufacturer shall provide (1) visit by Field Engineer for programming and commissioning, working with the Lighting Consultant, Architect and Owner to set scenes, program buttons, and adjust sensors.
- D.** Manufacturer shall provide a minimum of (12) hours of training for Owner by Field Engineer. Training shall include education on operation, maintenance, and programming of all system components, and shall be scheduled as directed by Owner.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A.** Basis of design for each lighting control system is specified on the electrical engineering drawings.
- B.** Proposals for equipment from other manufacturers will be considered, provided:

 - 1.** Notification of alternate manufacturer bid is submitted by questions due date as described in the General Conditions, and no exception is taken by Design Team or Owner;
 - 2.** The equipment conforms to all portions of this specification;

2.2 LIGHT SWITCHES

- A.** Refer to specification section 26 05 00 for requirements and acceptable manufacturers for toggle light switches (single, 3-way, 4-way, pilot). Provide compatible coverplate per specification section 26 05 00.

- B. Toggle switches are only permitted for applications where no occupancy sensor is installed, or where an occupancy sensor can be configured to turn all lighting in the space on automatically upon sensing an occupant (this is also known as automatic-on). Where code or the design restricts the amount of lighting in a space that an occupancy sensor trigger can automatically turn on to anything less than 100%, toggle switches are not permissible and shall not be installed. This includes strategies using vacancy sensors, manual-on, and automatic-on to 50%.

2.3 DIMMERS / DIMMING SWITCHES

- A. Refer to specification section 26 05 00 for requirements and acceptable manufacturers for dimming switches. Provide compatible coverplate per specification section 26 05 00.
- B. Line-voltage dimming switches are only permitted for applications where no occupancy sensor is installed, or where an occupancy sensor can be configured to turn all lighting in the space on automatically upon sensing an occupant (this is also known as automatic-on). Where code or the design restricts the amount of lighting in a space that an occupancy sensor trigger can automatically turn on to anything less than 100%, line-voltage dimming switches are not permissible and shall not be installed. This includes strategies using vacancy sensors, manual-on, and automatic-on to 50%.

2.4 LOW-VOLTAGE SWITCHES

- A. All low-voltage switches shall be white unless otherwise directed by Architect. All low-voltage switches shall have locator lights, and shall be engraved (if directed) as directed by Architect and design drawings.
- B. Provide compatible coverplate per specification section 26 05 00.

2.5 KEYPADS AND SCENE CONTROLLERS

- A. All low-voltage switches shall be white unless otherwise directed by Architect. All low-voltage switches shall have locator lights, and shall be engraved (if directed) as directed by Architect and design drawings.
- B. Provide compatible coverplate per specification section 26 05 00.
- C. Scene controller and keypads shall be configured as consistently with the design documentation as possible. Substitution of different button types, technologies, alignments, etc. shall be subject to review and approval by Architect, Engineer, and Owner.

2.6 OCCUPANCY SENSORS

- A. The occupancy sensor system shall sense the presence of human activity within the desired space and fully control the on/off function of the lights.
- B. Where occupancy sensors were shown to be part of a digital / networked lighting control system, networked occupancy sensors and associated accessories must be provided.
- C. All wired sensors shall utilize multiple occupancy/vacancy detection technologies unless otherwise specified on plan. Passive infrared (PIR) is required as one technology for any multi-technology device. Wireless sensors are permitted to be passive infrared only, subject to requirements below.
 - 1. Passive Infrared (PIR)
 - a. Coverage area of PIR technology must meet or exceed basis of design shown on drawings for both major motions (e.g. walking) and minor motions (e.g. slight hand movements)
 - b. All sensors using PIR technology shall be factory calibrated for optimum performance for its installed PIR lens.
 - c. Sensors employing PIR technology shall be located a minimum of 4 feet from any air supply diffuser.
 - d. Sensors employing PIR technology as the only technology, or sensors employing PIR technology to allow lighting to turn on, must be mounted to avoid obstructions.
 - e. Wireless sensors (if not the Basis of Design) are permissible, provided that Contractor obtains all approvals from Architect, Owner, and Engineer; that Contractor provide drawings with sensors / device layouts for entire project with coverage areas to prove overall system performance meets or exceeds basis of design shown on drawings; and that Contractor complies with all portions of this specification.
 - 2. Ultrasonic Technology
 - a. If the “Basis of Design” product line shown on the drawings does not include ultrasonic technology:
 - 1) Contractor must obtain all approvals from Architect, Owner, and Engineer to substitute technology.
 - 2) Contractor must provide drawings with sensors / device layouts for entire project with coverage areas to prove overall system performance. Coverage area of ultrasonic technology must meet or exceed basis of design shown on drawings.
 - 3) Contractor shall also provide any additional power supplies and circuiting required at no additional cost to Owner (if results in higher power requirements).

- b. Sensors employing ultrasonic technology shall be located a minimum of 6 feet from any air supply diffuser.
 - c. Sensors employing ultrasonic technology shall not be located in spaces subject to regular vibrations (e.g. parking garage). For these spaces, ultrasonic technology shall either be disabled or not provided.
 - d. Sensors employing ultrasonic technology shall not be located in spaces where the transmitted waves can interfere with equipment operation (e.g. MRI equipment). Ultrasonic technology shall either be disabled or not provided.
- 3. Acoustic / Microphonic Technology
 - a. If the “Basis of Design” product line shown on the drawings does not include acoustic / microphonic technology (here forth stated as “microphonic technology”):
 - 1) Contractor must obtain all approvals from Architect, Owner, and Engineer to substitute technology.
 - 2) Contractor must provide drawings with sensors / device layouts for entire project with coverage areas to prove overall system performance. Coverage area of microphonic technology must meet or exceed basis of design shown on drawings.
 - 3) Contractor shall also provide any additional power supplies and circuiting required at no additional cost to Owner (if results in higher power requirements).
 - b. Sensors employing microphonic technology shall be located a minimum of 4 feet from any air supply diffuser.
 - c. Sensors employing microphonic technology shall not be located in spaces subject to regular vibrations (e.g. parking garage). For these spaces, microphonic technology shall either be disabled or not provided.
- 4. Microwave Technology
 - a. If the “Basis of Design” product line shown on the drawings does not include microwave technology:
 - 1) Contractor must obtain all approvals from Architect, Owner, and Engineer to substitute technology.
 - 2) Contractor must provide drawings with sensors / device layouts for entire project with coverage areas to prove overall system performance. Coverage area of microwave technology must meet or exceed basis of design shown on drawings.
 - 3) Contractor shall also provide any additional power supplies and circuiting required at no additional cost to Owner (if results in higher power requirements).

- b. Sensors employing microwave technology shall not be located in spaces where the transmitted waves can interfere with equipment operation (e.g. MRI equipment). Microwave technology shall either be disabled or not provided.

D. Wall Switch Sensors.

- 1. Wall switches with integral occupancy sensors shall only be permissible where shown on the drawings and where an entire space falls into the coverage patterns of the device.
- 2. Refer to specification section above for sensor technologies.
- 3. For applications requiring independent control of two loads, a sensor with dual relays and dual override switches shall be provided. Each relay shall have independently programmable occupancy settings.
- 4. Sensor shall be recessed into a single gang (minimum) switch box and fit a “Decora” style faceplate (to be provided by Contractor to match other faceplates).
- 5. Wall switch sensors shall have field programmable adjustments for selecting operational modes, occupancy time delays, and minimum on time.
- 6. All models shall be capable of operating using Automatic-on or Manual-on. This function shall be modifiable in the field.

E. Ceiling-Mounted or Corner-Mounted Sensors.

- 1. Corner-mounted occupancy sensors shall only be permissible where shown on the drawings and where an entire space falls into the coverage patterns of the device.
- 2. Refer to specification section above for sensor technologies.
- 3. Line voltage occupancy sensors shall operate at the same voltage (and on the same circuit) as the lighting being controlled. Line voltage occupancy sensors are only permitted for applications where the occupancy sensor is being configured to turn all lighting in the space on automatically upon sensing an occupant (this is also known as automatic-on). Where code or the design restricts the amount of lighting in a space that an occupancy sensor trigger can automatically turn on to anything less than 100%, line-voltage occupancy sensors are not permissible and cannot be submitted. This includes strategies using vacancy sensors, manual-on, and automatic-on to 50%.
- 4. Low voltage occupancy sensors shall operate in the range of 12-24 VDC and be powered by a power pack of the same manufacturer and product line. See power pack and relay pack / room controller sections of this specification. Provide all low-voltage control wirings to power device and to provide control pathway for device to communicate with power pack / lighting control system.

5. All low-voltage models shall be capable of operating using Automatic-on or Manual-on. This function shall be modifiable in the field, and can be achieved at either the sensor or the corresponding relay pack.
 6. Style and finish of all sensors shall be as specified on the drawings. All sensors shall be white unless otherwise directed by Architect.
 7. All sensors shall have field programmable adjustments for selecting operational modes, occupancy time delays, and minimum on time.
- F. Occupancy sensors shall be capable of being manually overridden via wall-mounted switches or keypads as shown on the electrical engineering drawings. For line-voltage sensors and switches, wall-mounted switches shall be installed on the load side of the occupancy sensor or occupancy sensor power pack, if applicable. Power packs and occupancy sensors shall remain energized at all times except in the event of power loss to the building (to prevent memory loss to the occupancy sensor).
- G. Occupancy sensor time-out delay settings shall be programmed for 15-minutes unless otherwise noted.
- H. Provide occupancy sensor power packs with auxiliary power supplies as required per manufacturer's recommendations where more occupancy sensors are to be connected to a power pack than can be powered by a single power pack or where otherwise specified. Auxiliary power supplies shall operate with 277/120 line voltage input as required.
- I. Where code or the design restricts the amount of lighting in a space that an occupancy sensor trigger can automatically turn on to anything less than 100%, line-voltage occupancy sensors are not permissible and cannot be submitted. This includes strategies using manual-on, and automatic-on to 50%. Provide low voltage occupancy sensors for these areas. Provide power packs as required by manufacturer recommendations. Power packs shall operate with 277/120 line voltage input as indicated on plans. Provide occupancy sensors (as indicated on plans) or approved equal. Refer to occupancy sensor symbols in electrical symbols list for additional information.
- J. Sensor schematic wiring detail(s) on drawings are intended to aid the contractor in understanding the intended various occupancy sensor / wall mounted override switch schemes. These details are schematic in nature and are not intended to replace the manufacturer's installation instructions or wiring diagrams.
- K. Sensitivity settings of all occupancy sensors shall be set based upon the manufacturer's recommendations for the environment in which each occupancy sensor is installed unless noted otherwise.

- L. Where dual technology (passive infrared/ultrasonic) occupancy sensors are specified to be installed, the logic of the sensors shall be configured so that "initial occupancy", "maintain occupancy" and "re-trigger" are all actuated by either the passive infrared or ultrasonic components of the occupancy sensor.
- M. All occupancy sensors, power packs and auxiliary power supplies shall be manufactured by the same manufacturer.
- N. Where occupancy sensor symbols include arrows indicating the intended orientation for occupancy sensor installation, sensors shall be oriented as shown on the electrical plans. Where occupancy sensor symbols do not include arrows indicating the intended orientation for occupancy sensor installation, sensor orientation shall be coordinated per the manufacturer's requirements based upon the geometry of the space within which the occupancy sensor is specified to be installed.

2.7 DAYLIGHT SENSORS / PHOTOCELLS

- A. The daylight sensor system shall sense the presence of daylight within the desired space and fully control the on/off/dim function of the lights.
- B. Where daylight sensors were shown to be part of a digital / networked lighting control system, networked daylight sensors and associated accessories must be provided.
- C. Switched daylight sensors are not acceptable for use in an interior daylight harvesting system – all daylight sensors shall be configured to dim lighting smoothly and gradually. The daylight sensor shall also be able to switch lighting off after the lighting has been dimmed to its lowest level possible.
- D. Switched photocells will be permissible when installed for the purpose of exterior lighting control. Photocell shall be wet-location listed, and oriented facing north as high in the building as possible to minimize obstructions.

2.8 RELAY PACKS / CONTROLLERS

- A. Relay packs / room controllers for lighting zones, fixtures and/or plug loads automatically bind room loads to the connected control devices in the space without commissioning or the use of any tools. Provide relay packs / room controllers (hereforth used interchangeably for the purpose of this specification) to match the room lighting and plug load control requirements.
- B. Control units include the following features
 - 1. Automatic room configuration to the most energy-efficient sequence of

- operation based upon the devices in the room.
- 2. Simple replacement using the default automatic configuration capabilities, so a relay pack may be replaced with an off-the-shelf device.
- 3. Multiple relay packs connected together in a local network must automatically arbitrate with each other, without requiring any configuration or setup
- 4. Device Status LEDs to indicate:
 - a. Data transmission
 - b. Device has power
 - c. Status for each load
 - d. Configuration status
- 5. Quick installation features including:
 - a. Standard junction box mounting
 - b. Quick low voltage connections using standard RJ-45 patch cable
- 6. Each load be configurable to operate in the following sequences based on occupancy:
 - a. Auto-on/Auto-off
 - b. Manual-on/Auto-off
- 7. UL 2043 plenum rated.
- 8. Dimming Relay Packs shall share the following features:
 - a. Fade rates for dimming loads shall be specific to bound switch buttons, and the load shall maintain a default value for any bound buttons that do not specify a unique value.
 - b. The following dimming attributes may be changed or selected using configuration tools:
 - 1) Establish preset level for each load from 0-100 percent
 - 2) Set high and low trim for each load
 - 3) Initiate lamp burn in for each load of either 0, 12 or 100 hours
 - c. Each dimming output channel shall have an independently configurable minimum and maximum calibration trim level to set the dimming range to match the true dynamic range of the connected ballast or driver.
 - d. Each dimming output channel shall have an independently configurable minimum and maximum trim level to set the dynamic range of the output within the new 0-100 percent dimming range defined by the minimum and maximum calibration trim.
 - e. Calibration and trim levels must be set per output channel. Devices that set calibration or trim levels per controller (as opposed to per load) are not acceptable.
- 9. If the basis of design features digital configuration, Contractor must provide digital relay packs / room controllers - devices that set calibration or trim levels per output channel via trim pots or dip-switches are not acceptable.

2.9 POWER PACKS

- A.** All power packs for use in the lighting control system shall either be provided by the lighting control system manufacturer or shall be specifically recommended by use in their systems.
- B.** Manufacturer shall provide universal voltage input power packs if available in their product line.

2.10 LIGHTING CONTROL PANELS

- A.** Description: Lighting control panels using mechanically latched relays to control lighting and appliances. The panels shall be capable of being interconnected with digital communications to appear to the operator as a single lighting control system.
- B.** Lighting Control Panels Components:
 - 1.** A single enclosure with incoming lighting branch circuits, control circuits, switching relays, and on-board timing and control unit.
 - 2.** A barrier separating branch circuits from control wiring.
- C.** Master/Main Lighting Control Panels Components:
 - 1.** Components installed in the main lighting control panel only; powered from the branch circuit of the standard control unit.
 - 2.** Ethernet Communications: Comply with TCP/IP protocol. The main control unit shall provide for programming of all control functions of the main and all networked remote lighting control panels including timing, sequencing, and overriding.
 - 3.** Compliance with ASHRAE 135: Controllers shall support serial MS/TP and Ethernet IP communications, and shall be able to communicate directly via BAS RS-485 serial networks and Ethernet 10Base-T networks as a native device.
 - 4.** Web Server: Display information listed below over a standard Web-enabled server for displaying information over a standard browser.
 - a.** A secure, password-protected login screen for modifying operational parameters, accessible to authorized users via Web page interface.
 - b.** Panel summary showing the master and slave panels connected to the controller.
 - c.** Controller diagnostic information.
 - d.** Show front panel mimic screens for setting up controller parameters, input types, zones, and operating schedules. These

mimic screens shall also allow direct breaker control and zone overrides.

5. Timing Unit: Refer to timeclock specification below. The timing unit shall be updated/synchronized with the network time server not less than once every four (4) hours.
 6. Sequencing Control with Override:
 - a. Automatic sequenced on and off switching of selected relays at times set at the timing unit, allowing timed overrides from external switches.
 - b. Sequencing control shall operate relays one at a time, completing the operation of all connected relays in not more than 10 seconds.
 - c. Override control shall allow any relay connected to it to be switched on or off by a field-deployed manual switch or by an automatic switch, such as an occupancy sensor.
 - d. Override control "blinking warning" shall warn occupants approximately five minutes before actuating the off sequence.
 - e. Activity log, storing previous relay operation, including the time and cause of the change of status.
 7. Firmware shall be the latest version offered by manufacturer.
- D. Standard/Remote Lighting Control Panels Components:**
1. Components installed in all lighting control panels; powered from the branch circuit of the standard control unit. Contain electronic controls for programming the operation of the relays in the control panel, contain the status of relays, and contain communications link to enable the digital functions of the main control unit. Comply with UL 916.
 2. Electronic control for operating and monitoring individual relays, and display relay on-time.
 3. Nonvolatile memory shall retain all setup configurations. After a power failure, the controller shall automatically reboot and return to normal system operation.
 4. Integral keypad and digital-display front panel for local setup, including the following:
 - a. Blink notice, time adjustable from software.
 - b. Ability to log and display relay on-time.
 - c. Capability for accepting downloadable firmware so that the latest production features may be added in the future without replacing the module.
- E. Relays:** Electrically operated, mechanically held single-pole switch, rated at 20 A at 120V tungsten, 30 A at 277V ballast/driver, 1.5 hp at 120 V, and 3 hp at 277 V. Short-circuit current rating shall be not less than 14 kA or as directed by the short circuit analysis.

- F. Power Supply: NFPA 70, Class 2, UL listed, sized for connected equipment, plus not less than 20 percent spare capacity. Powered from a branch circuit of the panelboard that supplies power to the line side of the relays, sized to provide control power for the local panel-mounted relays, bus system, low-voltage inputs, field-installed occupancy sensors, and low-voltage photo sensors.
- G. Operator Interface: At the main control unit, provide interface for a tethered connection for configuring all networked lighting control panels using setup software designed for the specified operating system. Include one portable device for initial programming of the system and training of Owner's personnel. That device shall remain the property of Owner.
- H. Software:
 - 1. Menu-driven data entry.
 - 2. Online and offline programming and editing.
 - 3. Provide for entry of the room or space designation for the load side of each relay.
 - 4. Monitor and control all relays, showing actual relay state and the name of the automatic actuating control, if any.
 - 5. Size the software appropriate to the system.

2.11 DIMMING PANELS

- A. Factory wired and suitable to control designated lighting equipment or accessory functions.
- B. Wall-mounted dimming panels, if not the Basis of Design, need review and approval by Architect, Owner, and Engineer during the bid process – it shall not be assumed that wall / floor space will be available in acceptable locations.
- C. Dimmer Cabinet Assembly: NRTL listed and labeled.
- D. Cabinet Type: Plug in, modular, and accepting dimmers of each specified type in any plug-in position. 10,000 A RMS symmetrical, or as required by the short current analysis.
- E. Lighting Dimmers: Solid-state SCR dimmers.
 - 1. Primary Protection: Magnetic or thermal-magnetic circuit breaker, also serving as the disconnecting means.
 - 2. Dimmer response to control signal shall follow the "Square Law Dimming Curve" specified in IESNA's "IESNA Lighting Handbook."
 - 3. Dimming Range: 0 to 100 percent, full output voltage not less than 98% percent of line voltage.
 - 4. Protect controls of each dimmer with a fuse and / or and transient voltage

- surge suppression.
- 5. Non-dimmable (switching) modules shall include relays with contacts rated to switch 20A tungsten-filament load at 120V and 20A electronic ballast/driver load at 277V.
- F. Accessory function control modules shall be compatible with requirement of the accessory being controlled.
- G. Digital Control Network:
 - 1. Dimmers shall receive digital signals from digital network control stations that are linked to the dimmer cabinet with a common network data cable.
 - 2. Functions of digital network control stations shall be set up at the dimmer cabinet's electronic controls that include indicated number and arrangement of scene presets, channels, and fade times.

2.12 TIMECLOCKS

- A. Where a timeclock is specified, intent is for Contractor to provide an astronomical timeclock with a 365-day calendar, and automatic adjustments for daylight savings and leap year.
- B. A minimum of 40 independent schedules shall be available for customization.
- C. Timeclock shall permit scheduling events based on weekday/weekend, holidays, special events, etc. and allow for repeated events. Events shall be programmable down to the minute.

2.13 PROGRAMMING INTERFACES

- A. Provide any required devices for programming (remote configuration tools, routers, integral head-end equipment, etc.) as is compatible with the system being provided.
- B. Contractor shall provide dedicated phone line to any head-end equipment.

2.14 INTERFACES WITH NON-COMPATIBLE LIGHTING SYSTEMS

- A. Manufacturer shall provide as few interfaces as possible while achieving the required control, particularly in series on the zone level. Manufacturer may propose system alterations (subject to review and approval) to reduce quantity of interfaces, provided that arrangement does not increase wall space used or cost to Owner.
- B. Contractor shall provide all required power connection to lighting interfaces.

- C. It is not acceptable for any luminaire specified to dim to be installed as a switched-only load or to dim significantly more restricted than specified.

2.15 CONDUCTORS AND CABLES

- A. Refer to specification section 260500 for requirements for all line-voltage cabling.
- B. Low-voltage cabling shall be consistent with standards set forth in the Structured Cabling Systems specification, or the cabling standards set forth by the lighting control system manufacturer (whichever is more stringent).

2.16 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Equipment labeling shall be consistent with other Division 26 equipment.
- B. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior). Do not paint any finished devices, power packs, or any panels that by painting would void the warranty.
- C. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 GENERAL

- A. Although the location of equipment may be shown on the Contract Drawings in certain places, actual construction may disclose that the work does not make its position easily and quickly accessible. In such cases, call Architect's attention to this situation before installing this work, and comply with his installation instructions.
- B. Reject and do not install blemished, damaged, or unsatisfactory system components. Replace imperfect or unsatisfactory system component, if installed, as directed by the Architect or Engineer.
- C. Provide finish for exposed parts or trims as specified or indicated on the Drawings. If finish for exposed parts is not indicated, provide a finish as directed by the Architect.

- D. Mount controls at heights and locations indicated on the Architectural Drawings. Contractor shall confirm with Architect the exact centerline A.F.F. mounting height of all junction boxes for wall mounted devices.
- E. Installation of raceways, junction boxes, wiring devices, cabling, conductors, and panels shall be consistent with other Division 26 components and specifications.

3.2 ACCESSIBILITY

- A. Install equipment such as junction and pull boxes, power packs, switches and controls, and other apparatus that requires occasional access for operation and maintenance, to be easily accessible and appropriate for mounting and ceiling conditions.

3.3 CLEANING

- A. Immediately prior to occupancy, clean lenses, buttons, faceplates, and any decorative elements. Leave no finger or dirt marks. At the time of final inspection, all components shall be clean and free from marks, dust, spotting or other defects. Replace any broken or defective parts prior to final inspection. Replace or make good all defects revealed by final inspection. Replace all system components found to have failed.



SECTION 26 72 10

HIGH-RISE FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. General provisions of the contract, including the GENERAL CONDITIONS, SUPPLEMENTARY CONDITIONS, Division 01, GENERAL REQUIREMENTS, and Section 26 01 00, apply to the work specified in this section.

1.2 DESCRIPTION

- A. Work required by this Section includes designing, furnishing and installing an "on premises" fire alarm system. The system shall be device addressable, analog detecting, low voltage and modular with multiplex communication techniques in full compliance with all applicable codes and standards.
- B. The fire alarm system shall include the following integrated systems:
1. Fire alarm and detection system.
 2. Remote, manual, and automatic control and monitoring of elevators, stairwell pressurization fans, air handling units, sprinkler systems, electric door locks, fire pump and emergency power systems.
 3. Dual path supervised voice alarm and public address system.
- C. The equipment specified was selected to meet the special requirements for design of this project. Features, capacities, and sizes as specified, were selected to satisfy these requirements and shall be adhered to.
- D. Acceptable Manufacturers: Johnson Controls/Simplex, Notifier, GE-EST, Gamewell-FCI. GE-EST Genesis Series notification appliances are not acceptable.
- E. Provide unit price for the following devices, including installation, conduit, boxes, wiring and programming:
1. Smoke detector
 2. Heat detector
 3. Manual station
 4. Visual strobes
 5. Voice reproducing speakers

1.3 SUBMITTALS

- A. The contractor shall include the following information in the equipment shop

drawing submittal for review and approval:

1. Power calculations:
 - a. Battery capacity calculations.
 - b. Supervisory power requirements for all equipment.
 - c. Alarm power requirements for all equipment.
 - d. Voltage drop calculations for wiring runs in worst case condition.
 - e. Load and capacity of each notification appliance power supply and circuit. Specified spare capacity requirements shall be verified.
 2. Complete manufacturer's catalog data including supervisory power usage, alarm power usage, physical dimensions, finish and mounting requirements. Submit panel configuration and interconnection of modules and all other data as required to demonstrate product suitability. At a minimum, data shall be submitted on the following:
 - a. Master system CPU including all modules.
 - b. Circuit interface panels including all modules.
 - c. Power supplies, batteries and battery chargers.
 - d. Equipment enclosures, terminal cabinets, and terminal strips.
 - e. Intelligent addressable manual pull stations, heat detectors, analog smoke detectors, alarm monitoring modules and supervised control modules.
 - f. Conventional non-addressable devices as required for conformance to this specification.
 - g. Annunciator panels, and printers.
 - h. Audible and visual evacuation signal devices.
 - i. Load control relays with enclosures.
 - j. Wiring and raceway.
 - k. Fireman's telephone sets.
 - l. Instruction cards and frames.
 3. Complete system wiring diagrams for system components and interfaces. Wiring diagrams shall be point to point type and indicate all connections.
 4. Complete sequence of operations for system components.
 5. Detailed graphic annunciator layout.
 6. Analog addressable device lists and loop assignments.
 7. Accurately scaled floor plans indicating the location of all devices and equipment.
 8. Accurately scaled floor plan of the fire control room indicating the location of all devices and equipment.
 9. Fire alarm riser diagrams.
- B.** Data describing more than one type of item shall be clearly marked to indicate the type the contractor intends to provide for a given application. The reviewing authority will assume that all options not crossed out in submittal material will be furnished for the project. All submittal material shall be complete. Partial submittal will not be accepted. The contractor shall submit copies of UL listing or FM approval

data showing compatibility of the proposed device or appliance and the panel being provided.

- C. Not less than thirty days prior to final acceptance testing prepare and submit detailed "As-Built" drawings. The drawings shall include complete wiring diagrams showing connections between all devices and equipment, both factory and field wired. Include a riser diagram and drawings showing the as built location of all devices and equipment. The drawings shall show the system as installed, including all deviations from both the project drawings and the approved shop drawings. The drawings shall be prepared on uniform sized sheets the same size as the project drawings.

1.4 OPERATION AND MAINTENANCE MANUAL

- A. Following items shall be covered in Operation and Maintenance Manual:
 - 1. Schematic wiring and interconnection diagrams of circuits, internal and external, for equipment installed in building.
 - 2. Complete, as-installed, riser diagrams indicating wiring sequence of alarm-initiating devices, supervisory devices, and indicating devices on signal loops.
 - 3. Complete description of system operation.
 - 4. Complete description data for system components.
- B. Provide Owner with the minimum of 5 keys for each lock.
- C. Provide two copies of the approved Operations and Maintenance Manuals to the Owner.
- D. Provide one additional copy of above fire alarm system material encased in an accessible plastic envelope permanently affixed to inside door of fire alarm system control panel.

1.5 WARRANTY

- A. Warrant equipment and wiring free from inherent mechanical and electrical defects for a period of one year from the date of installation. Manufacturer shall furnish, at no additional charge to Owner, an inspection service with written report of manufacturer's equipment at the end of the first year of the warranty.

1.6 QUALITY ASSURANCE

- A. The system as described shall be installed, tested, and delivered to the owner in first class condition. The system shall include all required hardware, raceways, interconnecting wiring and software to accomplish the requirements of this specification and the contract drawings, whether itemized or not.

- B.** **Manufacturer Qualifications:** All components of each system shall be furnished by a single manufacturer, shall be of current design and shall be in regular and recurrent production.
- C.** **Approved Equipment:** Provide materials, equipment and devices that have been tested by a nationally recognized testing laboratory, such as Underwriters' Laboratories or Factory Mutual Laboratories, and listed or approved for fire protection service when so required by NFPA 72 or this specification.
- D.** **Installer Requirements:** Design shall be by a NICET Level III or IV Technician or a Registered Fire Protection Engineer. Designer and installer shall have an office, which has been in existence for at least three years, within a 40 mile radius of the U.S. Capitol. Installation shall be accomplished by an electrical contractor with a minimum of five years experience in the installation of fire alarm systems. The services of a technician provided by the system manufacturer shall be provided to supervise installation, adjustments, and tests of the system.
- E.** **Service Organization:** The contractor shall furnish evidence that the fire alarm equipment supplier has an experienced and effective service organization which carries a stock of repair parts for the system to be furnished.
- F.** The publications listed below form a part of this publication to the extent referenced. The publications are referenced in the text by the basic designation only. The latest version of each listed publication shall be used as a guide unless the authority having jurisdiction has adopted an earlier version.

 - 1.** **Factory Mutual (FM):**

 - a.** P7825 Approval Guide
 - 2.** **National Fire Protection Association (NFPA):**

 - a.** NFPA 13 Standard For The Installation of Sprinkler Systems.
 - b.** NFPA 70 National Electrical Code.
 - c.** NFPA 72 National Fire Alarm Code.
 - d.** NFPA 90A Standard For The Installation of Air Conditioning And Ventilating Systems.
 - e.** NFPA 101 Life Safety Code.
 - 3.** **Underwriters' Laboratories, Inc. (UL):**

 - a.** 217- Single and Multiple Station Smoke Detectors.
 - b.** 268 - Smoke Detectors for Fire Protective Signaling Systems.
 - c.** Fire Protection Equipment Directory.
 - d.** Electrical Construction Materials Directory.
 - 4.** **American Society for Testing and Materials (ASTM):**

 - a.** E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
 - b.** E 119 - Standard Test Methods for Fire Tests of Building

- Construction and Materials.
- c. State and Local Building Codes as adopted by the Local Authority Having Jurisdiction.
- 5. Department of Justice rules for Building Accessibility by The Handicapped. All applicable features must comply with Americans with Disabilities Act (ADA).

1.7 SYSTEM FUNCTION

- A. The system shall be a complete, electrically supervised multiplex style fire alarm system conforming to NFPA 72. The system shall provide intelligent analog alarm initiation and be device addressable and annunciated as described and shown on the drawings.
- B. A single signaling circuit with any combination of system inputs and system control outputs shall not serve an area larger than three floors.
 - 1. Devices attached to the signaling circuit shall be individually identifiable at the control panel for alarm and trouble indication. Smoke detectors shall be interrogated for sensitivity settings from the control panel, logged for sensitivity changes indicating the requirement for cleaning, and tested by a single technician using the panel field test routine.
 - 2. Sensitivity settings of individual detectors shall be automatically or manually adjustable from the control panel to reduce the incidence of false alarms caused by environmental conditions.
 - 3. The analog signaling circuits shall be installed in the fire alarm control panel enclosure or in remote transponder panel enclosures.
- C. The system shall be capable of supporting both intelligent addressable and conventional non-addressable devices including smoke detection, thermal devices, manual stations, water flow, supervisory, security, status monitoring devices, audible and voice/visual circuits.
- D. The panel shall be UL listed as a test instrument for the measurement of the sensitivity of connected intelligent analog ionization and photoelectric smoke detectors to comply with the testing requirements of NFPA 72.
 - 1. The measurements shall be discrete percent of obscuration readings, accurate to .02% per square foot. The readings shall be dynamic, providing a constant display of smoke obscuration when in the sensitivity test mode.
 - 2. The control panel shall provide a display and a printed list of these sensitivity measurements as a permanent record of the required sensitivity testing.
 - 3. When programmed, any system connected ionization or light refraction style smoke detector shall be capable of self adjustment to compensate for the accumulation of contaminants that would change the detector sensitivity in either a more or less sensitive direction. This adjustment shall keep the

relationship between the sensing chamber voltage and the programmed alarm threshold voltage constant to prevent false indications or failure to alarm in the presence of smoke.

- E. The system shall annunciate a trouble condition when any smoke detector approaches 80% of its alarm threshold due to gradual contamination, signaling the need for service and eliminating unwanted alarms.
 - 1. The trouble report shall annunciate the specific location of the smoke detector requiring service. All analog smoke detectors installed in the system shall include this feature.
- F. Any intelligent analog smoke detector or conventional smoke detector zone shall include a selectable alarm verification capability. This feature shall provide automatic verification of smoke detector alarms as described by NFPA 72.
- G. All external circuits shall be listed as power limited circuits per article 760 of the National Electric Code.
 - 1. Power limitation shall be provided using on board self restoring solid state thermal devices. Units using fuses for this purpose and requiring board replacement or exchange are not acceptable.
- H. The system shall perform time based control functions including automatic changes of specified smoke detector sensitivity settings.
 - 1. Time based functions shall be controlled by specifying time periods or actual dates. It also shall provide the ability to control these functions on an exception basis using a holiday schedule.
- I. The system shall provide a one person walk test of either the complete system or a specified area, maintaining full function of areas not under test.
 - 1. Field test shall be usable in a silent or audible mode. When in the audible mode, the signals shall audibly annunciate alarms, troubles and device types.
 - 2. All field test activity shall be logged to the system printer and historical memory.
- J. The system shall be provided with a minimum four (4) levels of password protection, with level four (4) being the highest level. Level one (1) shall not require a password.
- K. The system shall be programmed in the field via a laptop computer. All programmed information shall be stored in nonvolatile memory after downloading into the control panel. No special programming terminal or prom burning shall be required and the system shall continue in service during reprogramming. Systems requiring on line programming or not capable of mass uploading of software for offsite documentation

- or editing will not be acceptable.
- L.** The system shall support the use of multiple CRTs for the display of information in a format equal to that of the system logging printer.
- M.** The system as installed shall be expandable to its predetermined maximum capacity of initiating devices and/or combined zones of audible and visual devices.
- N.** The system shall support a UL listed supervised printer, as supplied by the system manufacturer. Multiple unsupervised ancillary printers also shall be supported as approved or required by the authority having jurisdiction.
- O.** System Alarm and Acknowledgment:
 - 1.** Should an abnormal condition be detected (alarm, supervisory, or trouble), the appropriate LED lamps shall flash. The panel audible signal shall pulse for alarm conditions and sound steadily for trouble or supervisory conditions. Acknowledgment of the alarm by operation of the Acknowledge button shall silence the audible alarm and cause the alarm LED lamps to glow steadily. Receipt of subsequent alarms shall cause the appropriate LED lamps to flash and the panel audible signal to resound.
 - 2.** After all the points have been acknowledged, the LEDs shall glow steadily and the panel audible signal will be silenced. The total number of alarms, supervisory, and trouble conditions shall be displayed along with a prompt to review each list chronologically. The end of the list shall be indicated by an end of list message.
- P.** Alarm Silencing:
 - 1.** Should the Alarm Silence button be pressed, all alarm signals shall cease operation.
 - 2.** Signals shall not be silenced during alarm silence inhibit mode.
- Q.** System Reset:
 - 1.** The System Reset button shall be used to return the system to its normal state after an alarm condition has been remedied. The LCD display shall step the user through the reset process with simple English language messages.
 - 2.** Should an alarm condition continue to exist, a message shall be displayed, system reset shall be aborted, and the system shall remain in the abnormal state. System control relays shall not reset. The panel audible signal and the Alarm LED shall be on. The display will indicate the total number of alarms and troubles present in the system along with a prompt to use the Acknowledge buttons to review the points. These points will not require acknowledgment if they were previously acknowledged.
 - 3.** Should the Alarm Silence Inhibit function be active, the System Reset key press will be ignored. A message shall be displayed for a short time to indicate the action was not taken. As feedback to the operator, a message

- indicating system reset no longer inhibited shall be displayed when the inhibit function times out.
- R. The printer or alphanumeric shall be capable of listing, upon request:
1. Alarms with time, date and location.
 2. Troubles with time, date and location.
 3. Status of output functions, "on" or "off".
 4. Sensitivity of intelligent/analog smoke detectors.
 5. Detection device number, type and location.
 6. Status of remote relays, "on" or "off".
 7. Acknowledgment time and date.
 8. Signal silence time and date.
 9. Reset time and date.
 10. Battery voltage, AC voltage and battery charge current.
- S. The system shall be capable of:
1. Counting the number of intelligent/analog detectors within a "zone" which are in alarm.
 2. Counting "zones" which are in alarm.
 3. Counting the number of intelligent/analog detectors which are in alarm on the system.
 4. Differentiating among types of devices, such as smoke detectors, manual stations, water-flow switches, thermal detectors, cross-zoning.
- T. Automatic response functions shall be accomplished by the first zone initiated. Alarm functions resulting from initiation by first zone shall not be altered by subsequent alarms. An alarm signal shall be the highest priority. A pre-alarm signal shall have second priority and supervisory or trouble signals shall have third or fourth level priority. Signals of a higher level priority shall 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.
- U. All signals shall be sent to a UL listed central station service.
- V. The manual or automatic operation of any alarm or supervisory initiating device shall be annunciated both on the FACP and on the graphic annunciator. The annunciator shall indicate the location and type of device.
- W. Each independent smoke detection system and elevator detection system shall be monitored both for normal operation and for trouble. Elevator smoke detectors shall annunciate at the FACP by floor.
- X. The building evacuation system shall be by voice communication. The requirement for the audibility of the system shall be 15dB above ambient. The measurement shall be taken 5 feet off of the floor. The amount of speakers required shall be dependant

upon this requirement. Final testing will determine if placement of speakers is acceptable.

- Y.** Each automatic sprinkler control valve and sprinkler service entrance valve, whether supplied under this contract or existing, shall be monitored to ensure its proper position.
- Z.** Provide strobe synchronization.

1.8 SYSTEM ARCHITECTURE AND WIRING STYLES

- A.** The system shall consist of a central architecture using a single centrally located control unit. The system also shall be operable in a distributed multiplex architecture using a centrally located control unit with interconnection to remote transponder panels containing any combination of plug in intelligent analog signaling circuits, plug in conventional initiating device circuits and plug in relays.
 - 1.** All remote transponder panels shall provide a power supply, microprocessor controlled battery charger and communication link to the main fire control panel CPU through a Style 7 signaling line circuit riser.
 - 2.** Provide Style 4 addressable loop signaling line circuits on a per floor basis, with loop isolation at each floor level.
 - 3.** Provide Style Y notification appliance circuits, including fireman's telephone circuits.
 - 4.** Provide Style B initiating device circuits.
 - 5.** Provide Style 7 signaling line circuits for all annunciator panels.

1.9 SYSTEM ZONING

- A.** Each intelligent addressable device or conventional zone on the system shall be displayed at the fire alarm control panel by a unique alpha numeric label identifying its location.

1.10 SYSTEM ALARM SEQUENCE

- A.** Activation of any fire alarm initiating device shall cause the following actions and indications:
 - 1.** Display a custom message describing the device originating the alarm condition, at the fire alarm control panel LCD alpha numeric display. Remote LCD annunciators shall display the alarm condition via unique messages as required by the system owner. LED type annunciator displays, conventional and graphic style shall indicate alarm zoning as specified.
 - 2.** Sound the audible signals, and activate the visual signals on the floor of alarm, the floor below and the floor above.
 - a.** Audible signals shall be silencable from the fire alarm control panel

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the event, the time of occurrence and the device initiating the event.

- F. Receipt of a trouble report (primary power loss, open or grounded initiating or signaling circuit wiring, open, grounded or shorted indication system wiring, device communication failure, battery disconnect, etc.) at the fire alarm control panel shall cause the following actions and indications:
 - 1. Display at the alarm control panel alphanumeric LCD display, the origin of the trouble condition report.
 - 2. Activate trouble audible and visual signals at the control panel.
 - a. Audible signals shall be silencable from the fire alarm control panel by a trouble acknowledge switch. The trouble indication shall be transferred to a visual indicator on the control panel and the trouble signals shall resound for a subsequent trouble condition reported by a different device.
 - 3. Furnish an alarm system closure for connection to an off site reporting device as contracted for by the system user.
 - a. Offsite trouble reports for primary system power failure shall be automatically delayed for a period of time equal to 25% of the system standby battery capacity to eliminate spurious reports as a result of power fluctuations.
 - 4. Record within the non-volatile system historical memory the occurrence of the event, the time of occurrence and the device initiating the event.
- G. Central Station Notification: All alarm, trouble and/or supervisory signals shall be transmitted to the Owner's Central Station monitoring service. Provide all required digital alarm communicator transmitters (DACT) and interface wiring.

1.11 SYSTEM MONITORING

- A. Valves: Each valve affecting the proper operation of a fire protection system, including automatic sprinkler control valves, standpipe control valves, sprinkler service entrance valves, valves at fire pumps, and valves at backflow preventers, whether supplied under this contract or existing, shall be monitored to ensure its proper position. Each tamper switch shall be provided with a separate address.
- B. Smoke Detection: Each existing independent smoke detection sub-system, and kitchen fire extinguishing system shall be monitored both for the presence of an alarm condition and for a trouble condition. Each monitored condition shall be provided with a separate address.

1.12 VOICE ALARM

- A. Provide a voice alarm system complete with all necessary microphones, pre-

amplifiers, back-up amplifiers and tone generators. The system shall meet the requirements of NFPA 72. The system shall be an integrated, UL listed, life safety, and emergency communication system. The voice alarm system shall contain two (2) channels to permit the simultaneous transmission of different voice evacuation announcements to specific areas via the central control microphone. All announcements shall be made over dedicated, supervised communication lines. The system shall provide a manual override that has the capability of addressing both a single floor or the entire building. Message shall meet all Local Authorities Having Jurisdiction requirements.

B. For any alarm condition:

1. Fire Floor, Floor Above, and Floor Below shall receive a message to evacuate the building:

[Alert Tone]

FEMALE VOICE: May I have your attention please. May I have your attention please.

MALE VOICE: There has been a fire reported in your area of the building. While this report is being verified, the building manager would like you to proceed to exit the building. Please do not use the elevators, as they may be needed. Please do not use the elevators, but proceed to the exits.

C. All other floors of the building shall receive a message advising them of the alarm and instructing them to remain where they are and await further instructions:

[Alert Tone]

FEMALE VOICE: May I have your attention please. May I have your attention please.

MALE VOICE: There has been a fire reported in another portion of the building. Please remain where you are and await further instructions. You are safe in your area.

PART 2 - SYSTEM PRODUCTS

2.1 FIRE ALARM CONTROL PANEL

A. Fire alarm control panel shall be designed for wall mounting as indicated on the drawings.

B. The control panel shall be modular in construction and shall include, but not be limited to; the hardware, software and firmware required to perform the following major system functions:

1. Surface mounted steel cabinet with indicator viewing window, hinged door and cylinder lock, factory finished in baked enamel.
2. System power supplies, including necessary transformers rectifiers, regulators, filters and surge protection required for system operation, with the

capacity to power the system in a worst case condition with all devices in alarm and all local indicating appliances active without exceeding the listed ratings. The system devices shall display normal and alarm conditions consistently whether operating from normal power or reserve (standby) power.

3. System 16 bit core processor, with internal operating system processing incoming alarm signals and issuing output commands required as a result of the alarm reception by system programming or manual commands. Total system response time shall not exceed 2.5 seconds on a system configured to the maximum capacity. All system processors shall be supervised by watchdog circuitry furnishing automatic restart after loss of activity.
4. Style 7 system riser digital communication capabilities required for the control panel to communicate with remote transponder panels, annunciators, and displays. All communications shall be conducted in a digital format. Systems processing signals using pulse width or voltage level techniques are not considered acceptable.
5. Style 4 analog signaling line circuitry required to communicate with, and receive alarms from 127 points, any combination of monitor and control.
6. Style Y indicating appliance circuits as required to supervise and operate all connected indicating appliances.
7. Style B initiating device circuitry as required to supervise and operate all connected initiating devices.
8. For control of air handling units and elevators there shall be provided a controllable relay module. The module shall be system interconnected by a card edge connector and shall be operable by the control unit. It shall contain a minimum of four independent relays, fitted with form "C" contacts, rated at 2 amps 28VDC/120 VAC resistance. All relays shall be supervised for coil open or shorted conditions.
9. The integrated voice system shall be configured for two-channel operation, permitting the simultaneous transmission of announcements to different areas of the building.
10. The voice system amplifiers shall be capable of operating either 25vrms or 70vrms speakers. It shall transfer to battery when commercial power is lost.
11. The Audio Control Module is the master control module for all voice related functions. This module shall have a supervised tone generator capable of providing a variety of tones for use in the system. The module shall also include microphone preamplifier for use with the microphone master module. The pre-amplifier shall use an automatic gain control circuit to assure distortion free live voice announcements. A back-up-pre-amplifier shall be provided with automatic transfer if primary pre-amplifier fails.
12. The master Microphone Module shall provide firefighters with the means of sending voice messages to specific audio zones or all zones. The microphone and the press-to-talk switch shall be supervised. This module shall have a locking door (provide keys) and shall contain a local speaker with volume

- control to monitor selected audio channels. Install microphone module adjacent to fire alarm graphic annunciator.
13. Provide as required Speaker/Strobe Zone Cards. Each card shall provide Style Y (Class B) for two channel 25 vrms speakers or 24 VDC strobe light or combination of the two indicating type signals.
 14. The enclosure for the system shall provide complete dead front construction. Operator control modules shall be on a frame hinge mounted to provide easy access to wiring and system plug in cards.
 15. Non volatile memory for system data base, historical event log, logic, and operating system. The system shall require no manual input to initialize in the event of a complete power down condition. It shall return to an on line state as an operating system performing all programmed functions upon power restoration.
 16. System display consisting of an 80 character back lighted alphanumeric super twist LCD display readable at any angle. Forty character custom messages shall describe the location of the active device.
 17. LED display for "ALARM", "AUDIBLE SILENCE", "SUPERVISORY", "TROUBLE", and "POWER ON".
 18. Touch activated membrane switches for "ALARM ACKNOWLEDGE", "AUDIBLE SILENCE", "SUPERVISORY ACKNOWLEDGE", "TROUBLE ACKNOWLEDGE", "PRIORITY 2 ALARM ACKNOWLEDGE", "RESET", "DISPLAY HOLD" and "DISPLAY NEXT".
 19. Touch activated membrane switches, programmable to perform a minimum of five custom functions such as drill, disable, bypass automatic control commands or other special functions as required by the system user.
 20. Ten digit keypad for the passcode entry to perform programming and maintenance functions.
 21. Conventional zone modules as required in style B for the operation and supervision of a minimum of 30 compatible two wire detectors per zone.
 22. Programmable panel mounted relays to be software programmed to perform control functions required for system operation described in this specification and shown on the drawings.
 23. Software defined logic module as required for each alarm initiation point, capable of controlling any combination of the system output functions using as logic factors; counting, verification, time, day, holiday, type of device, "and", "or", "not", "timer", "all" or "any".
 24. Software logic modules and system database shall be programmed using a DOS compatible program on any IBM compatible computer. It shall be possible to program or edit the system database off site after downloading from the control panel.
 25. Selective event history, up to 600 events, shall be stored in flash memory and displayed, printed or downloaded by classification for selective event reports.
 - a. Software shall allow selection of events to be logged, including;

- inputs, as alarms, troubles, supervisorys, securities, status changes and device verification; outputs, as audible control and output activation; actions, as reset, set sensitivity, arm/disarm, override, password, set time and acknowledge.
- b. Audible and visual indications shall be generated when memory is 80% and 90% full to allow downloading of data. The system shall be programmable of circular logging, assuring that the last 500 events will always be stored in non-volatile memory.
26. Software driven logic for adjusting the alarm threshold windows on detectors to compensate for accumulating contamination and keep detector response sensitivity constant. The software shall compensate for either over-sensitized or de-sensitized units, raising a system flag when a detector approaches the allowable limits of adjustment, indicating a requirement for cleaning.
- a. Values shall be stored in non-volatile memory allowing activation of all tracking functions within 90 seconds of system initiation from a "cold boot". During the boot sequence, alarms from detectors programmed with the feature shall be suppressed. When the full data history is active all devices shall be checked and any active alarms displayed.
 - b. The control panel shall place each detector in the system in an alarm condition, transparent to the system user, every twenty four hours as a dynamic check of the accuracy of the alarm threshold setting. Upon reception of the alarm report, the system detector shall be restored to it's pretest state.
 - c. The system shall be capable of monitoring the state of detectors and displaying a message when a detector is approaching the limits of adjustment as a result of contaminates. A second message shall be displayed when the detector reaches the limits of adjustment due to these contaminates.
 - d. The system shall be capable of recognizing that a detector has been cleaned, initiating a series of tests to determine if the cleaning was successful and display a detector cleaned message, readjusting that detectors normal sensitivity setting reference.
27. Walk Test: The FACP shall have a walk test feature. When using this feature, operation of initiating devices shall result in limited system outputs, so that the notification appliances operate for only a few seconds and the event is indicated on the system printer, but no other outputs occur.

2.2 FIRE ALARM SYSTEM POWER SUPPLIES

- A. System Primary Power
 - 1. Primary power for the FACP and the secondary power battery chargers shall each be obtained from the power panel board. Circuit breakers shall be fitted with a suitable guard, requiring removal of a screw to open, and used only for

fire alarm. Each circuit used for fire alarm purposes shall be permanently labeled for function.

B. Secondary Power Supply

1. Provide sealed gelled electrolyte batteries as the secondary power supply for the fire alarm control panel and each system circuit interface panel. The battery supply shall be calculated to operate its load in a supervisory mode for twenty-four (24) hours with no primary power applied and after that time, operate its alarm mode for fifteen (15) minutes. Batteries shall be sized at no larger than 80% of the calculated size to compensate for deterioration and aging during the battery life cycle. Battery calculations shall be submitted to justify the battery size. Batteries shall be housed in a separate cabinet with hinged lockable door and adequate cell separation to prevent accidental discharge.
2. Provide battery charging circuitry for each standby battery bank in the system low voltage power supply or as a separate circuit. The charger shall be automatic in design, adjusting the charge rate to the condition of the batteries. Battery charge rate and terminal voltage shall be read using the fire alarm control panel LCD display in the service mode, indicating directly in volts and amps. Meters reading in percentage are not acceptable. Charger shall be housed in the main fire alarm control panel or the battery cabinet.

2.3 REMOTE TRANSPONDER PANELS

- A.** Remote transponder panels shall consist of an enclosure, power supplies as required, digital communications circuitry, and hardware, modules and circuitry described for inclusion in the fire alarm control panel as required to function as specified.
1. Circuit interface panels shall, when required, include conventional zones, intelligent addressable analog signaling circuits, indicating appliance circuits and output circuitry to perform actions and monitor alarms locally.
 2. Circuit interface panels shall support remote system displays, annunciators and printers.
 3. Walk Test: Each panel shall have a walk test feature. When using this feature, operation of initiating devices shall result in limited system outputs, so that the notification appliances operate for only a few seconds and the event is indicated on the system printer, but no other outputs occur.

2.4 NOTIFICATION APPLIANCE CIRCUIT EXTENDER PANELS (NAC)

- A.** Panel shall meet UL 864.
- B.** Panel shall have a minimum of 4 Style Y notification appliance circuits.
- C.** Panel shall be rated for a minimum of 6A @ 24 VDC.

- D. Input voltage shall be 115 volt.
- E. Panel shall have an internal power supply/battery charger with the following:
 - 1. Power on LED and trouble LED;
 - 2. Battery supervision circuitry; and
 - 3. Power loss and brownout voltage supervision.
- F. Provide strobe synchronization.

2.5 SMOKE DETECTORS, INTELLIGENT IONIZATION

- A. Furnish and install where indicated on the drawings, intelligent analog smoke detectors with features and characteristics as follows:
 - 1. The detector shall be dual chamber and self-compensating for ambient temperature and humidity.
 - 2. The detector readout shall yield a discreet percent of obscuration value for status tracking and logging for determining maintenance and cleaning requirements. The control panel shall provide a sensitivity readout from the detector without removal from the pluggable base. Detectors not specifically listed for sensitivity testing from the control panel are not acceptable due to the expense involved with manual testing as required by NFPA 72.
 - 3. The detector shall be suitable for two-wire operation and two-way communications on the intelligent analog signaling circuit. The detector shall display a steady LED when in the alarm state when the system is operating from normal or standby power.
 - 4. Sensitivity shall be programmed electronically. The detectors shall be assigned a sensitivity level based on environment, time of day or any programmable function as required by the system user.
 - a. Detectors shall be supplied with feature enabling the detector to maintain a constant programmed sensitivity within the environment installed, regardless of contaminant accumulation. This feature shall compensate by increasing or decreasing the alarm threshold, dependent on the ambient detector chamber voltage, eliminating both failure to detect at the desired level and unwanted alarms at lower levels.
 - 5. The detectors furnished shall be listed for use in environments as covered by Factory Mutual, UL and shall be installed according to the requirements of NFPA 72 for open area coverage.
 - 6. Detectors furnished shall be available in the following separate configurations to serve all possible environmental requirements:
 - a. Listed for installation in high air velocities and inside air ducts, between 35 and 2000 FPM.
 - b. Listed for installation in air duct sampling housings for the detection

- of smoke in HVAC system ducts.
7. Provide remote indicator lights for detectors installed above ceilings, below raised floors or other similar concealed locations.

2.6 SMOKE DETECTORS, INTELLIGENT PHOTOELECTRIC

- A. Furnish and install where indicated intelligent photoelectric smoke detectors with features and characteristics as follows:
 1. The detector shall be self-compensating for ambient temperature and humidity.
 2. The detector readout shall yield a discreet percent of obscuration value for status tracking and logging for determining maintenance and cleaning requirements. The control panel shall provide a sensitivity readout from the detector without removal from the pluggable base. Detectors not specifically listed for sensitivity testing from the control panel are not acceptable due to the expense involved with manual testing as required by NFPA 72.
 3. The detector shall be suitable for two-wire operation and two-way communications on the intelligent analog signaling circuit. The detector shall display a steady LED when in the alarm state when the system is operating from normal or standby power.
 4. Sensitivity assignments shall be set electronically. The detectors shall be assigned a sensitivity level based on environment, time of day or any programmable function as required by the system user.
 5. Detectors shall be supplied with the feature enabling the detector to maintain a constant programmed sensitivity within the environment installed, regardless of contaminant accumulation. This feature shall compensate by increasing or decreasing the alarm threshold, dependent on the ambient detector chamber voltage, eliminating both failure to detect at the desired level and unwanted alarms at lower levels.
 6. The detectors furnished shall be listed for use in environments as covered by Factory Mutual, UL and shall be installed according to the requirements of NFPA 72 for open area coverage.
 7. Detectors furnished shall be available in the following separate configurations to serve all possible environmental requirements:
 - a. Listed for installation in high air velocities and inside air ducts, between 0-2000 FPM, in addition to open area coverage.
 - b. Listed for installation in air duct sampling housings for the detection of smoke in HVAC system ducts.
 8. Provide remote indicator lights for detectors installed above ceilings, below raised floors or other similar concealed locations.

2.7 HEAT DETECTORS, INTELLIGENT RATE COMPENSATED

- A. Furnish and install where indicated in the drawings heat detectors with features and

characteristics as follows:

1. Detectors shall be of the intelligent, rate compensated type rated at 135 or 160 degrees, as required. Detectors shall be constructed to compensate for the thermal inertia inherent in conventional type detectors due to the thermal mass, and alarm at the set point of 135 or 160 degrees Fahrenheit, as required.
2. The detector shall be suitable for two-wire operation and two-way communications on the intelligent analog signaling circuit. The detector shall display a steady LED when in the alarm state when the system is operating from normal or standby power.
3. Detectors shall incorporate triple technology microprocessor chips including analog, digital and EEROM technologies on the single device.
4. The detectors furnished shall have a listed spacing for coverage up to 2,500 square feet for use in environments as covered by Factory Mutual and UL and shall be installed according to the requirements of NFPA 72 for open area coverage.

2.8 FIRE DETECTOR BASES, UNIVERSAL

- A. Detector bases shall be low profile twist lock type with screw clamp terminals and self wiping contacts. Bases shall be installed on an industry standard, 4" square or octagonal electrical outlet box.
 1. Where selective localized control of electrical devices is required for system operation, furnish and install detector base with software programmed addressable relay integral to the base. The relay shall switch electrical loads, as indicated on the drawings.
 2. Where indicated on the drawings, furnish detector base with integral approved audible evacuation alarm signal having an output of 85db. The audible signal shall be software programmed for operation.
 3. Furnish a concealed security lock, preventing unauthorized removal, installed in the base in those areas requiring tamper resistant installation as indicated on the drawings.
 4. The detector bases shall be compatible with, and allow the installation of, detectors operating on the flame, ionization, photoelectric or rate compensated heat principles of detection.

2.9 MANUAL STATIONS, ADDRESSABLE

- A. Provide double action intelligent manual stations where shown on the drawings, to be flush or surface mounted as required.
- B. Station shall be equipped with terminal strip and pressure style screw terminals for the connection of field wiring.

- C. The manual stations shall be addressable and identifiable by the master fire alarm control panel.
- D. Surface mounted stations where indicated on the drawings shall be mounted using a manufacturer's prescribed matching baked red enamel outlet box.
- E. Stations requiring the breaking of a glass panel are not acceptable. Stations which require the breaking of a concealed glass rod may be provided. Furnish stations which require the use of a key or wrench to reset. Station switches should be rated for the voltage and current at which they shall operate. Contacts shall be double pole, double throw.

2.10 EVACUATION SIGNALS, GENERAL

- A. Compression type terminals shall be provided for the connection of field wiring up to #12 AWG. Terminals shall be provided for each output tones and strobe.
- B. 24VDC supervised operation from approved signal indication modules with a maximum current draw per audible signal of 25MA at the low output selection and 50MA at high output selection.
- C. Solid state design to limit transient generation, current inrush and inductive kick, allowing maximum signal capacity on each circuit and raceway sharing with microprocessor multiplex communication circuitry.
- D. Signals shall be available in the following configurations to satisfy the requirements of this specification:
 - 1. Flush mounting or semi-flush mounting.
 - 2. Surface mounting using baked enamel, factory finished boxes available for interior finish mounting or exterior weatherproof mounting.
- E. Signals shall be available for installation in audible only, audible/visual, and visual only in all combinations as described below.
- F. All visual strobe devices, including wall mounted combination audible/strobe devices shall be white with red letters.
- G. All horn devices shall be white with red letters.
- H. All speaker baffles shall be white.

2.11 EVACUATION SIGNALS, VOICE REPRODUCING SPEAKERS

- A. Furnish and install where shown on the drawings, voice reproducing speakers with

the following characteristics and capacities:

1. Field selectable power taps at 3db increments between .25 and 2 watts and driven at 25vrms.
 2. Sound output rating of 90db at full power tap.
- B.** Where applicable, speaker grilles shall match color, finish and size of public address system ceiling speakers. Contractor shall coordinate between system vendors. Submit sample to Architect for approval.
- C.** The speakers shall have a frequency response from 400 to 5000 Hz.

2.12 EVACUATION SIGNALS, VISUAL STROBES

- A.** Strobe lights shall meet the requirements of the ADA, UL Standard 1971 and shall meet the following criteria:
1. Xenon strobe with a minimum repetition rate of 1 HZ, not exceeding 3 HZ and a maximum duty cycle of 40% with a pulse duration of 0.2 seconds.
 2. Strobe intensity shall meet the requirements of UL 1971.
 3. The flash rate shall meet the requirements of UL 1971.
 4. Provide strobe candela ratings as indicated on drawings.
 5. Visual strobes shall be mounted at a height of 80 inches above the finished floor, or six inches below the ceiling, whichever is lower.
 6. Provide strobe synchronization.

2.13 REMOTE CONVENTIONAL ZONE MODULE

- A.** Provide, for integration of compatible two-wire and shorting style contact devices into the analog signaling circuit, intelligent analog signaling circuit interface module with the following capabilities:
1. Communication interaction with the analog signaling circuit having the capability of reporting alarm or trouble conditions from the devices monitored.
 2. Compatibility with ionization and photoelectric and linear beam style smoke detectors, flame detectors, heat detectors and all listed contact type devices. The system manufacturer shall have specifically listed heat, smoke, ionization, linear beam and flame detectors for use with the remote conventional zone module.
 3. Module shall be equipped with terminal strip and pressure style screw terminals for the connection of the device and systems communications field wiring.
 4. The module shall be addressable and identifiable by the master fire alarm control panel.
 5. Modules shall be installed where indicated on the drawings using industry standard electrical outlet boxes; flush, surface, weatherproof or explosion

proof, as required for the area indicated.

2.14 INTELLIGENT SYSTEM INTERFACE MODULE

- A.** Furnish and install, for the monitoring of contact type initiation devices and for the control of electrical devices where required, intelligent analog signaling circuit interface module. Modules shall be supplied to meet the project requirements as follows:
 - 1.** A single circuit intelligent signaling circuit interface module for monitoring alarm, trouble, supervisory security or status contact type devices.
 - 2.** Unit as above with form C software programmable control contacts for the management of specified electrical loads as required by this specification.
 - 3.** Dual circuit units as described in paragraph A.01 above.
- B.** The module shall be suitable for two wire, two way communications on the intelligent analog signaling circuit.
- C.** Modules shall incorporate triple technology microprocessor chips including analog, digital and EEROM technologies on the single device.

2.15 INTELLIGENT SUPERVISED CONTROL MODULE

- A.** Furnish and install for the control of supervised relays, contactors, audible signal circuits, visual signal circuits, distributed speaker circuits and two way fire fighters communication circuits, intelligent supervisory and control modules including features as follows:
 - 1.** The modules shall be suitable for two-wire operation and communications on intelligent analog alarm detection loops.
 - 2.** The module shall be suitable for semi-flush or surface mounting in a standard electrical outlet box.
- B.** Modules shall be available to supervise reverse polarity supervised indicating circuits utilizing 24VDC, two-way supervised fireman's communication circuits or audio circuits utilizing 25VRMS or 70VRMS. It shall be possible to configure the module for supervised control of motor contactors and AC voltages to 115VAC.
 - 1.** All connected field wiring shall be supervised for opens, short circuits and grounded circuits.
 - 2.** Signal outputs shall be supported in style Y configuration.
 - 3.** The module shall report a trouble condition in the event of loss of the 24VDC signal operating supply voltage.

2.16 GRAPHIC ANNUNCIATOR

- A.** Provide a UL listed Graphic Annunciator Panel which shall have a plan view of all

unique floors shown in the proper perspective as shown on the drawings. Floor, device type and zone LED's shall be provided for each fire alarm and supervisory zone. A lamp test push button shall be mounted on the face plate. Operation of the lamp test push button shall light all LED's and sound a Sonalert. A fire alarm control panel trouble actuated LED with Sonalert and a supervisory actuated LED with Sonalert, and, momentary key operated silencing switches shall be provided. Provide a "Power On" LED for the fire alarm control panel on the face of this annunciator panel. Provide normal power and emergency power indicating lights. Annunciators shall be as detailed on the contract drawings.

- B. Provide two graphic annunciator panels. One shall be located in the building entrance vestibule, one shall be located in the fire control room.
- C. Materials: Construct the graphic annunciator faceplate of smoked plexi-glass. The LED's shall be backlit. All control equipment and wiring shall be housed in a flush mounted backbox. The frame and exposed portions of the backbox shall be satin stainless steel.
- D. Submit proposed Graphic Annunciator Panel for review and approval by Local Authorities Having Jurisdiction prior to fabrication.

2.17 LOAD CONTROL RELAYS

- A. Furnish and install for the control of air handler contactors and elevator recall circuits, control relays as follows:
 - 1. Rated for use with circuits up to 240VAC at 7A inductive. Relays shall be of the sealed pluggable type, and terminations shall be made to pressure type screw terminals.
 - 2. Relays shall be mounted in a NEMA style enclosure, with identification on the exterior as a fire alarm control device.
 - 3. All relays shall be supervised as required by NFPA 101 and mounted within three feet of the device controlled.

2.18 PRINTER

- A. Provide a system printer to record all alarm, supervisory, and trouble events without loss of any signal or signals. Printout shall be by zone, device, and function as provided in the FACP. Printer shall operate on a 120 VAC, 60 Hz power supply.
- B. The printer shall have at least 80 characters per line and have a 96 ASCII character set. The printer shall have a microprocessor-controlled, bi-directional, logic seeking head capable of printing 120 characters per second utilizing a 9 x 7 dot matrix print head. Printer shall not contain internal software that is essential for proper operation.

- C. When the FACP receives a signal, the alarm supervisory, and trouble condition shall be printed. The printout shall include the type of signal, the circuit or device reporting, the date, and the time of the occurrence. The printer shall differentiate alarm signals from all other printed indications. When the system is reset this condition shall also be printed including the same information concerning device, location, date and time. Provide a means to automatically print a list of all existing alarm, supervisory, and trouble conditions in the system. In the event that a printer is off-line when an alarm is received, the system shall have a buffer to retain the data and it shall be printed when the printer is restored to service.

2.19 SPRINKLER AND STANDPIPE FLOW SWITCHES AND PRESSURE SWITCHES

- A. Sprinkler and standpipe system water flow switch and pressure switch devices shall be provided and installed by the sprinkler system subcontractor in accordance with design requirements. Connect each flow switch and pressure switch device to the fire alarm system for annunciation and alarm under Division 26 as part of fire alarm system. Provide a separate address for each flow switch and pressure switch device unless otherwise indicated.

2.20 SPRINKLER AND STANDPIPE VALVE TAMPER SWITCH

- A. Sprinkler and standpipe system valve tamper switch devices shall be provided and installed by the sprinkler system subcontractor in accordance with design requirements. Connect each tamper switch device to the fire alarm system for annunciation and alarm under Division 26 as part of fire alarm system. Provide a separate address for each tamper switch device unless otherwise indicated. Cover removal shall be supervised.

2.21 DOOR HOLDERS

- A. Magnetic door holders shall have an approximate holding force of 35 lbs. The door portion shall have a stainless steel pivotal mounted armature with shock absorbing nylon bearing. Unit shall be capable of being either surface, flush, semi-flush or floor mounted as required. Door holders shall be UL Listed for their intended purpose.
- B. Where magnetic hold open devices are indicated to be an integral part of the door hardware closure, coordinate such device requirements with Architect. Refer to door hardware schedule.
- C. The operation of any alarm or pre-alarm device in the fire alarm system shall cause the release of the magnetic fire door holding device permitting the door to be closed by the door closer. The magnetic holders shall be associated with two ionization type smoke detectors located on the ceiling with one on either side of the door

opening. The operation of either of these detectors shall also cause the magnetic holder to release the door.

2.22 FIREMAN PHONES

- A.** Provide Fireman Phone handsets as shown on the plans. Phone cabinets shall be flush mounted unless otherwise indicated.
- B.** Provide Fireman Phone handsets for installation in each elevator car by the elevator contractor. Required wiring from elevator controls to each elevator car shall be furnished and installed by the elevator contractor.

2.23 INSTRUCTION CARDS

- A.** Provide above each manual station, on center line, five-inch printed card sign. Sign shall provide instructions for turning in an alarm and shall be worded in accordance with Local Jurisdictional standards. Sign shall be installed in an anodized aluminum card frame with concealed mounting and covered with clear non-yellowing plastic. Minimum thickness of the aluminum frame: 0.05-inch.

PART 3 - EXECUTION

3.1 DESIGN AND INSTALLATION DRAWINGS

- A.** Show a general layout of the complete system including equipment arrangement. It shall be the responsibility of the fire alarm contractor to verify dimensions and assure compatibility of all other systems interfacing with the fire alarm system.
- B.** Identify on the drawings, conduit and conductor sizes and types with number of conductors in each conduit. Provide each conduit and device with a unique identification. For addressable alarm initiation devices, the system identifier shall be the system address for that device. Signals shall be sequentially numbered as the address of the controlling module.
- C.** Indicate on the point to point wiring diagrams, interconnecting wiring within the panel between modules, and connecting wiring to the field device terminals.
- D.** Provide mounting details of FACP and other boxes to building structure, showing fastener type, sizes, material and embedded depth where applicable.

3.2 WIRING METHOD

- A.** Perform work in accordance with the requirements of NEC, NFPA 70, NFPA 72.

- B.** Provide in accordance with manufacturer's instructions, all wiring, conduit, and outlet boxes required for erection of complete system. Wiring shall be installed in metal raceway in accordance with section ELECTRICAL BASIC MATERIAL AND METHOD. Use color codes throughout and tag wires at junction points and test free from grounds or crosses between conductors. Stencil or otherwise mark junction boxes "Fire Alarm Junction". Final connections between equipment and the wiring system shall be made under direct supervision of qualified technical representatives of manufacturer.
- C.** All wiring shall be installed in a completely separate metallic raceway system, or approved equivalent. Exposed plenum rated cabling shall not be permitted.
- D.** Conductors:
1. Each conductor shall be identified as shown on the drawings with wire markers at every splice and terminal point. Attach permanent wire markers within 2 inches of the wire termination. Marker legends shall be visible.
 2. All wiring shall be supplied and installed in compliance with the requirements of the National Electric Code, NFPA 70, Article 760.
 3. All splices shall be made using compression type terminal strips. All connectors shall be installed in conformance with the manufacturers recommendations.
 4. Crimp-on type spade lugs shall be used for terminations of stranded conductors to binder screw or stud type terminals. Spade lugs shall have upset legs and insulation sleeves sized for the conductors.
 5. Permanently label or mark each conductor at both ends with permanent alpha-numeric wire markers.
 6. A consistent color code for fire alarm system conductors shall be maintained throughout the installation. The installation contractor shall submit for approval prior to installation of wire, a proposed color code for system conductors to allow rapid identification of circuit types.
 7. Wiring within sub panels shall be arranged and routed to allow accessibility to equipment for adjustment and maintenance.
 8. Shielded wiring shall be used where recommended by the system manufacturer.
- E.** Devices
1. Where the fire alarm system is responsible for initiating an action in another emergency control device or system, such as an HVAC system, atrium exhaust system, smoke control system, elevator system, the addressable fire alarm relay module shall be within 3 feet of the emergency control device.
 2. Relays and other devices to be mounted in auxiliary panels are to be securely fastened to avoid false indications and failures due to shock or vibration.
 3. Wiring within subpanels shall be arranged and routed to allow accessibility to equipment for adjustment and maintenance.

4. All fire alarm initiating and indicating devices shall be installed in accordance with the manufacturer's direction, NFPA 72, local codes and ADA handicapped regulations.
- F. Splices And Cable Terminations
1. All splices shall be made using compression type terminal strips. All connectors shall be installed in conformance with the manufacturers recommendations.
 2. Crimp-on type spade lugs shall be used for terminations of stranded conductors to binder screw or stud type terminals. Spade lugs shall have upset legs and insulation sleeves sized for the conductors.
- G. Provide a minimum of two vertical cable risers to serve each fire alarm system. Each riser shall be enclosed within a minimum of two-hour fire rated construction so that the loss of one riser does not prevent the receipt or transmission of any signal from any floor or zone, in accordance with NFPA 72.

3.3 FIRESTOPPING

- A. Firestop all holes for conduit, raceways, piping, or other penetrations which pass through floor slabs, fire rated walls, partitions with fire rated doors, corridor walls, vertical service shafts, or any fire-rated assembly. All materials used shall be UL listed for firestopping.

3.4 TESTING, GENERAL

- A. All intelligent analog devices shall be tested for correct address and sensitivity using test equipment specifically designed for that purpose. These devices and their bases shall be tagged with adhesive tags located in an area not visible when installed, showing the system address, initials of the installing technician and date.
- B. Wiring runs shall be tested for continuity, short circuits and grounds before system is energized. Resistance, current and voltage readings shall be made as work progresses.
1. A systematic record shall be maintained of all readings using schedules or charts of tests and measurements. Areas shall be provided on the logging form for readings, dates and witnesses.
 2. The acceptance inspector shall be notified before the start of the required tests. All items found at variance with the drawings or this specification during testing or inspection by the acceptance inspector, shall be corrected.
 3. Test reports shall be delivered to the acceptance inspector as completed.
- C. All test equipment, instruments, tools and labor required to conduct the system tests shall be made available by the installing contractor. The following equipment shall

be a minimum for conducting the tests:

1. Ladders and scaffolds as required to access all installed equipment.
 2. Multimeter for reading voltage, current and resistance.
 3. Intelligent device programmer/tester.
 4. Laptop computer with programming software for any required program revisions.
 5. Two way radios, flashlights, smoke generation devices and supplies.
 6. Spare printer paper.
 7. A manufacturer recommended device for measuring air flow through air duct smoke detector sampling assemblies.
 8. Decibel meter.
- D. In addition to the testing specified to be performed by the installing contractor, the installation shall be subject to test by the acceptance inspector.
- E. System wiring: Fire alarm circuits shall be tested for continuity, grounds, and short circuits.

3.5 ACCEPTANCE TESTING

- A. A program matrix shall be prepared by the installing contractor referencing each alarm input to every output function affected as a result of an alarm condition on that input. In the case of outputs programmed using more complex logic functions involving "any", "or", "not", "count", "time", and "timer" statements; the complete output equation shall be referenced in the matrix.
- B. A complete listing of all device labels for alpha-numeric annunciator displays and logging printers shall be prepared by the installing contractor prior to the acceptance test procedure.
- C. System wiring shall be tested to demonstrate correct system response and correct subsequent system operation in the event of:
1. Open, shorted and grounded intelligent analog signaling circuit.
 2. Open, shorted and grounded network signaling circuit.
 3. Open, shorted and grounded conventional zone circuits.
 4. Open, shorted and grounded indicating appliance circuits.
 5. Intelligent device removal.
 6. Primary power or battery disconnected.
 7. Incorrect device at address.
 8. Printer trouble, off line or out of paper.
- D. System evacuation alarm indicating appliances shall be demonstrated as follows:
1. All alarm indicating appliances actuate as programmed.
 2. Audibility and visibility at required levels.

- E. System indications shall be demonstrated as follows:
 - 1. Correct message display for each alarm input at the control panel, each remote alpha-numeric display and each CRT terminal.
 - 2. Correct annunciator light for each alarm input at each annunciator and color graphic terminal as shown on the drawings.
 - 3. Correct printer logging for all system activity.
- F. System off-site reporting functions shall be demonstrated as follows:
 - 1. Correct zone transmitted for each alarm input.
 - 2. Trouble signals received for disconnect.
- G. Secondary power capabilities shall be demonstrated as follows:
 - 1. System primary power shall be disconnected for a period of time as specified herein. At the end of that period, an alarm condition shall be created and the system shall perform as specified for a period as specified.
 - 2. System primary power shall be restored for forty eight hours and system charging current shall be normal trickle charge for a fully charged battery bank.
 - 3. System battery voltages and charging currents shall be checked at the fire alarm control panel using the test codes and displayed on the LCD display.
- H. In the event of system failure to perform as specified and programmed during the acceptance test procedure, at the discretion of the acceptance inspector, the test shall be terminated.
 - 1. The installing contractor shall retest the system, correcting all deficiencies and providing test documentation to the acceptance inspector.
 - 2. The acceptance inspector may elect to require the complete acceptance test procedure to be performed again if, in his opinion, modifications to the system hardware or software warrant complete retesting.
- I. A preliminary test must be conducted to ensure that installation is complete and fully operable. Once this has been certified, final acceptance testing shall occur.

3.6 DOCUMENTATION

- A. System documentation shall be furnished to the owner and shall include but not be limited to the following:
 - 1. System record drawings and wiring details including one set of reproducible masters and drawings in a DXF format suitable for use in a CAD drafting program.
 - 2. System operation, installation and maintenance manuals.
 - 3. Written documentation for all logic modules as programmed for system operation with a matrix showing interaction of all input signals with output

commands.

4. Documentation of system voltage, current and resistance readings taken during the installation, testing and acceptance test procedure phases of the system installation.

3.7 SERVICES

- A. The contractor shall warrant the entire system against mechanical and electrical defects for a period described in the contract general conditions. This period shall begin upon completed certification and test of the system or upon first beneficial use of the system, whichever is earlier.
- B. The fire alarm system subcontractor or manufacturer shall offer for the owner's consideration at the time of system submittal a priced inspection, maintenance, testing and repair contract in full compliance with the requirements of NFPA 72.
 1. The services offered under this contract shall be performed during the first year after system acceptance and the owner shall have the option of renewing for single or multiple years up to five years.
 2. The contractor performing the contract services shall be qualified and listed to maintain ongoing certification of the completed system to the UL for specific installed system listing.

3.8 MANUFACTURER'S REPRESENTATIVE

- A. Provide the services of a representative or technician from the manufacturer of the system, experienced in the installation and operation of the type of system provided. The representative shall be licensed in the State if required. The technician shall supervise installation, software documentation, adjustment, preliminary testing, final testing and certification of the system. The technician shall provide the required instruction to the owner's personnel in the system operation, maintenance and programming.
- B. The installation contractor shall furnish training as follows for a minimum of four employees of the system user:
 1. Training in the receipt, handling and acknowledgment of alarms.
 2. Training in the system operation including manual control of output functions from the system control panel.
 3. Training in the testing of the system including logging of detector sensitivity, field test of devices and response to common troubles.
 4. The total training requirement shall be a minimum of 18 hours, conducted on three successive days, but shall be sufficient to cover all items specified.



SECTION 26 80 00

ELECTRICAL SYSTEMS COMMISSIONING

PART 1 - GENERAL

1.1 SUMMARY

- A. The purpose of this section is to specify the Division 26 Contractor's responsibilities and participation in the commissioning process.
- B. Developing and witnessing the Commissioning process is the responsibility of the Commissioning Authority. Performing the Commissioning is primarily the responsibility of the Division 26 Contractor, with support for start-up, testing, and commissioning testing the responsibility of the Division 26 Subcontractors. The commissioning process does not relieve this Contractor from participation in the process, or diminish the role and obligations to complete all portions of work in a satisfactory and fully operational manner.
- C. Work of Division 26 includes:
 - 1. Testing and start-up of the electrical equipment
 - 2. Providing qualified personnel to assist in commissioning tests, including seasonal testing required after the initial commissioning.
 - 3. Providing equipment, materials, and labor necessary to correct deficiencies found during the commissioning process which fulfill contract and warranty requirements.
 - 4. Completion and endorsement of pre-functional test checklists to assure that Division 26 equipment and systems are fully operational and ready for functional testing.
 - 5. Providing operation and maintenance information and as-built drawings to the Commissioning Authority for review and verification prior to distribution
 - 6. Providing training for the systems specified in this Division with coordination by the Commissioning Authority

PART 2 - RELATED WORK

- A. All testing and start-up procedures and documentation requirements specified within Division 01, 23, and 26, and related portions of this project.
- B. Commissioning procedures that require participation of Division 26 Contractors
- C. Allow sufficient time before final completion dates so mechanical systems start-up, testing and commissioning can be accomplished.

- D. For specified electrical systems and component testing by a third-party testing contractor, coordinate with the Commissioning Authority, the scope and schedule of that testing for observation by the Commissioning Authority during the actual testing.

PART 3 - PRODUCTS

3.1 TEST EQUIPMENT

- A. Division 26 shall provide standard and specialized test equipment as necessary to start-up and test the electrical systems.
 - 1. Proprietary test equipment required by the manufacturer, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturer shall provide the test equipment, demonstrate its use, and assist the Commissioning Authority in the commissioning process.

PART 4 - EXECUTION

4.1 WORK PRIOR TO COMMISSIONING

- A. Complete all phases of the work so the system can be energized, started, tested, and otherwise commissioned. Division 26 has primary start-up responsibilities with obligations to complete systems, including all sub-systems so they are functional. This includes the complete installation of all equipment, materials, raceways, wire terminations, controls, etc., per the Contract Documents and related directives, clarifications, change orders, etc.
- B. A commissioning plan will be developed by the Commissioning Authority. The commissioning plan will be developed prior to completion of the installation. This contractor shall review the commissioning plan and comply with the requirements.
- C. If system modifications or clarifications are incorporated to this and related sections of work, commissioning of this work will be made at no additional cost to the Owner. If Contractor-initiated system changes have been made that alter the commissioning process, the Commissioning Authority will notify the Architect, and the Contractor may be obligated to compensate the Commissioner to test the revised product, or confirm the suitability/unsuitability of the substitution or revision.
- D. Specific pre-commissioning responsibilities of Division 26 are as follows:
 - 1. Normal start-up services required to bring each system into a fully operational state. This includes motor rotational check, lug tightening,

control sequences of operation, etc. The Commissioning Authority will not begin the commissioning process until each system is complete, including normal contractor start-up and debugging.

2. The Contractor shall perform pre-functional tests on the specified equipment and systems. Contractor start-up forms may be substituted for the pre-functional test forms with prior approval by the Commissioning Authority.
3. Factory start-up services will be provided for key equipment and systems specified in Division 23 and Division 26. This Contractor shall coordinate this work with the manufacturer and the CA.
4. Commissioning is intended to begin upon completion of a system. Commissioning may proceed prior to the completion of systems and/or sub-systems, if expediting this work is in the best interests of the Owner. Commissioning activities and schedule will be coordinated with the Contractor. Start of commissioning before system completion will not relieve the Contractor from completing those systems as per the schedule.

4.2 PARTICIPATION IN COMMISSIONING

- A. Provide skilled technicians to start-up and debug all systems within the division of work. These same technicians shall be made available to assist the Commissioning Authority in completing the commissioning program as it relates to each system and their technical specialty. Work schedules, time required for testing, etc. will be requested by the Commissioning Authority and coordinated by the Contractor. Contractor will ensure the qualified technician(s) are available and present during the agreed-upon schedules and of sufficient duration to complete the necessary tests, adjustments, and/or problem resolutions.
- B. System problems and discrepancies may require additional technician time, Commissioning Authority time, redesign and/or reconstruction of systems, and system components. The additional technician time shall be made available for the subsequent commissioning periods until the required system performance is obtained.
- C. The Commissioning Authority reserves the right to judge the appropriateness and qualifications of the technicians relative to each item of equipment, system and/or sub-system. Qualifications of technicians include expert knowledge relative to the specific equipment involved, adequate documentation and tools to service/commission the equipment, and an attitude/willingness to work with the Commissioning Authority to get the job done. A liaison or intermediary between the Commissioning Authority and qualified factory representatives does not constitute the availability of a qualified technician for purposes of this work.

4.3 WORK TO RESOLVE DEFICIENCIES

- A.** In some systems, misadjustments, misapplied equipment, and/or deficient performance under varying loads will result in additional work being required to commission the systems. This work will be completed under the direction of the Architect, with input from the Contractor, equipment supplier, and Commissioning Authority. Whereas all members will have input and the opportunity to discuss, debate and work out problems, the Architect/Engineer of Record will have final jurisdiction on the necessary work to be done to achieve performance.
- B.** Corrective work shall be completed in a timely fashion to permit the timely completion of the commissioning process. Experimentation to render system performance will be permitted. If the Commissioning Authority deems the experimentation work to be ineffective or untimely as it relates to the commissioning process, the Commissioning Authority will notify the Architect/Engineer indicating the nature of the problem, expected steps to be taken, and the deadline for completion of activities. If the deadline(s) passes without resolution of the problem, the Owner reserves the right to obtain supplementary services and/or equipment to resolve the problem. Costs incurred to solve the problems in an expeditious manner will be the Contractor's responsibility.

4.4 TRAINING

- A.** This Contractor will be required to participate in the training of the Owner's engineering and maintenance staff for each electrical system and the related components. Training may be conducted in a classroom setting, with system and component documentation and suitable classroom training aids, or in the field with the specific equipment. The type of training will be per the Owner's option.
- B.** Training will be conducted jointly with the Commissioning Authority, the design engineers, the equipment vendors, and the Contractor. The Contractor will be responsible for the generic training, as well as instructing the Owner's staff on the system peculiarities specific to the project.

4.5 SYSTEMS DOCUMENTATION

- A.** In addition to the requirements of Division 01, update Contract Documents to incorporate field changes and revisions to system designs to account for actual constructed configurations.
- B.** In addition to the stated requirements for operation and maintenance data, provide one copy of equipment technical literature, operation and maintenance literature, and shop drawings to the Commissioning Authority as soon as they are available.

This requirement is for review of these documents prior to distribution of multiple copies for the Owner's final use.

