

**SECTION 26 05 11**  
**REQUIREMENTS FOR ELECTRICAL INSTALLATIONS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section applies to all sections of Division 26.
- B. Furnish and install electrical wiring, systems, equipment and accessories in accordance with the specifications and drawings. Capacities and ratings of motors, transformers, cable, switchboards, switchgear, panelboards, motor control centers, generators, automatic transfer switches, and other items and arrangements for the specified items are shown on drawings.
- C. Wiring ampacities specified or shown on the drawings are based on copper conductors, with the conduit and raceways accordingly sized. Aluminum conductors are prohibited.

**1.2 MINIMUM REQUIREMENTS**

- A. References to the International Building Code (IBC), National Electrical Code (NEC), Underwriters Laboratories, Inc. (UL) and National Fire Protection Association (NFPA) are minimum installation requirement standards.
- B. Drawings and other specification sections shall govern in those instances where requirements are greater than those specified in the above standards.

**1.3 TEST STANDARDS**

- A. All materials and equipment shall be listed, labeled or certified by a nationally recognized testing laboratory to meet Underwriters Laboratories, Inc., standards where test standards have been established. Equipment and materials which are not covered by UL Standards will be accepted provided equipment and material is listed, labeled, certified or otherwise determined to meet safety requirements of a nationally recognized testing laboratory. Equipment of a class which no nationally recognized testing laboratory accepts, certifies, lists, labels, or determines to be safe, will be considered if inspected or tested in accordance with national industrial standards, such as NEMA, or ANSI. Evidence of compliance shall include certified test reports and definitive shop drawings.
- B. Definitions:

1. Listed; Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production or listed equipment or materials or periodic evaluation of services, and whose listing states that the equipment, material, or services either meets appropriate designated standards or has been tested and found suitable for a specified purpose.
2. Labeled; Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.
3. Certified; equipment or product which:
  - a. Has been tested and found by a nationally recognized testing laboratory to meet nationally recognized standards or to be safe for use in a specified manner.
  - b. Production of equipment or product is periodically inspected by a nationally recognized testing laboratory.
  - c. Bears a label, tag, or other record of certification.
4. Nationally recognized testing laboratory; laboratory which is approved, in accordance with OSHA regulations, by the Secretary of Labor.

#### **1.4 QUALIFICATIONS (PRODUCTS AND SERVICES)**

- A. Manufacturers Qualifications: The manufacturer shall regularly and presently produce, as one of the manufacturer's principal products, the equipment and material specified for this project, and shall have manufactured the item for at least three years.
- B. Product Qualification:
  1. Manufacturer's product shall have been in satisfactory operation, on three installations of similar size and type as this project, for approximately three years.
  2. The Government reserves the right to require the Contractor to submit a list of installations where the products have been in operation before approval.

- C. Service Qualifications: There shall be a permanent service organization maintained or trained by the manufacturer which will render satisfactory service to this installation within eight hours of receipt of notification that service is needed. Submit name and address of service organizations.

#### **1.5 APPLICABLE PUBLICATIONS**

- A. Applicable publications listed in all Sections of Division are the latest issue, unless otherwise noted.

#### **1.6 MANUFACTURED PRODUCTS**

- A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts shall be available.
- B. When more than one unit of the same class or type of equipment is required, such units shall be the product of a single manufacturer.
- C. Equipment Assemblies and Components:
1. Components of an assembled unit need not be products of the same manufacturer.
  2. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.
  3. Components shall be compatible with each other and with the total assembly for the intended service.
  4. Constituent parts which are similar shall be the product of a single manufacturer.
- D. Factory wiring shall be identified on the equipment being furnished and on all wiring diagrams.
- E. When Factory Testing Is Specified:
1. The Government shall have the option of witnessing factory tests. The contractor shall notify the VA through the Project Engineer a minimum of 15 working days prior to the manufacturers making the factory tests.
  2. Two copies of certified test reports containing all test data shall be furnished to the Project Engineer prior to final inspection and not more than 90 days after completion of the tests.
  3. When equipment fails to meet factory test and re-inspection is required, the contractor shall be liable for all additional expenses, including expenses of the Government.

**1.7 EQUIPMENT REQUIREMENTS**

- A. Where variations from the contract requirements are requested in accordance with Section 00 72 00, GENERAL CONDITIONS and Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, the connecting work and related components shall include, but not be limited to additions or changes to branch circuits, circuit protective devices, conduits, wire, feeders, controls, panels and installation methods.

**1.8 EQUIPMENT PROTECTION**

- A. Equipment and materials shall be protected during shipment and storage against physical damage, vermin, dirt, corrosive substances, fumes, moisture, cold and rain.
1. Store equipment indoors in clean dry space with uniform temperature to prevent condensation. Equipment shall include but not be limited to switchgear, switchboards, panelboards, transformers, motor control centers, motor controllers, uninterruptible power systems, enclosures, controllers, circuit protective devices, cables, wire, light fixtures, electronic equipment, and accessories.
  2. During installation, equipment shall be protected against entry of foreign matter; and be vacuum-cleaned both inside and outside before testing and operating. Compressed air shall not be used to clean equipment. Remove loose packing and flammable materials from inside equipment.
  3. Damaged equipment shall be, as determined by the Project Engineer, placed in first class operating condition or be returned to the source of supply for repair or replacement.
  4. Painted surfaces shall be protected with factory installed removable heavy kraft paper, sheet vinyl or equal.
  5. Damaged paint on equipment and materials shall be refinished with the same quality of paint and workmanship as used by the manufacturer so repaired areas are not obvious.

**1.9 WORK PERFORMANCE**

- A. All electrical work must comply with the requirements of NFPA 70 (NEC), NFPA 70B, NFPA 70E, OSHA Part 1910 subpart J, OSHA Part 1910 subpart S and OSHA Part 1910 subpart K in addition to other references required by contract.
- B. Job site safety and worker safety is the responsibility of the contractor.

- C. Electrical work shall be accomplished with all affected circuits or equipment de-energized.
- D. For work on existing stations, arrange, phase and perform work to assure electrical service for other buildings at all times. E. New work shall be installed and connected to existing work neatly, safely and professionally. Disturbed or damaged work shall be replaced or repaired to its prior conditions, as required by Section 01 00 00, GENERAL REQUIREMENTS.
- F. Coordinate location of equipment and conduit with other trades to minimize interferences.

#### **1.10 EQUIPMENT INSTALLATION AND REQUIREMENTS**

- A. Equipment location shall be as close as practical to locations shown on the drawings.
- B. Working spaces shall not be less than specified in the NEC for all voltages specified.
- C. Inaccessible Equipment:
  - 1. Where the Government determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, the equipment shall be removed and reinstalled as directed at no additional cost to the Government.
  - 2. "Conveniently accessible" is defined as being capable of being reached quickly for operation, maintenance, or inspections without the use of ladders, or without climbing or crawling under or over obstacles such as, but not limited to, motors, pumps, belt guards, transformers, piping, ductwork, conduit and raceways.

#### **1.11 EQUIPMENT IDENTIFICATION**

- A. In addition to the requirements of the NEC, install an identification sign which clearly indicates information required for use and maintenance of items such as switchboards and switchgear, panelboards, cabinets, motor controllers (starters), fused and unfused safety switches, automatic transfer switches, separately enclosed circuit breakers, individual breakers and controllers in switchboards, switchgear and motor control assemblies, control devices and other significant equipment.
- B. Nameplates for Normal Power System equipment shall be laminated black phenolic resin with a white core with engraved lettering. Nameplates for Essential Electrical System (EES) equipment, as defined in the NEC, shall be laminated red phenolic resin with a white core with engraved

lettering. Lettering shall be a minimum of 1/2 inch [12mm] high. Nameplates shall indicate equipment designation, rated bus amperage, voltage, number of phases, number of wires, and type of EES power branch as applicable. Secure nameplates with screws.

- C. Install adhesive arc flash warning labels on all equipment as required by NFPA 70E. Label shall indicate the arc hazard boundary (inches), working distance (inches), arc flash incident energy at the working distance (calories/), required PPE category and description including the glove rating, voltage rating of the equipment, limited approach distance (inches), restricted approach distance (inches), prohibited approach distance (inches), equipment/bus name, date prepared, and manufacturer name and address.

#### **1.12 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. The Government's approval shall be obtained for all equipment and material before delivery to the job site. Delivery, storage or installation of equipment or material which has not had prior approval will not be permitted at the job site.
- C. All submittals shall include adequate descriptive literature, catalog cuts, shop drawings and other data necessary for the Government to ascertain that the proposed equipment and materials comply with specification requirements. Catalog cuts submitted for approval shall be legible and clearly identify equipment being submitted.
- D. Submittals for individual systems and equipment assemblies which consist of more than one item or component shall be made for the system or assembly as a whole. Partial submittals will not be considered for approval.
  - 1. Mark the submittals, "SUBMITTED UNDER SECTION\_\_\_\_\_".
  - 2. Submittals shall be marked to show specification reference including the section and paragraph numbers.
  - 3. Submit each section separately.
- E. The submittals shall include the following:
  - 1. Information that confirms compliance with contract requirements. Include the manufacturer's name, model or catalog numbers, catalog information, technical data sheets, shop drawings, pictures, nameplate data, VA contract number, VA project number, VA project

title, specification number and applicable paragraphs, and test reports as required.

2. Elementary and interconnection wiring diagrams for communication and signal systems, control systems and equipment assemblies. All terminal points and wiring shall be identified on wiring diagrams.
3. Parts list which shall include those replacement parts recommended by the equipment manufacturer.

F. Manuals: Submit in accordance with Section 01 00 00, GENERAL REQUIREMENTS.

1. Maintenance and Operation Manuals: Submit as required for systems and equipment specified in the technical sections. Furnish two copies, electronic pdf format and bound in hardback binders, (manufacturer's standard binders) or an approved equivalent. 2.

Inscribe the following identification on the cover: the words "MAINTENANCE AND OPERATION MANUAL," the name and location of the system, equipment, building, name of Contractor, VA contract number, VA project number, VA project title, specification number and applicable paragraphs. Include in the manual the names, addresses, and telephone numbers of each subcontractor installing the system or equipment and the local representatives for the system or equipment.

3. Provide a "Table of Contents" and assemble the manual to conform to the table of contents, with tab sheets placed before instructions covering the subject. The instructions shall be legible and easily read, with large sheets of drawings folded in.
4. The manuals shall include:
  - a. Internal and interconnecting wiring and control diagrams with data to explain detailed operation and control of the equipment.
  - b. A control sequence describing start-up, operation, and shutdown.
  - c. Description of the function of each principal item of equipment.
  - d. Installation instructions.
  - e. Safety precautions for operation and maintenance.
  - f. Diagrams and illustrations.
  - g. Periodic maintenance and testing procedures and frequencies, including replacement parts numbers and replacement frequencies.
  - h. Performance data.
  - i. Pictorial "exploded" parts list with part numbers. Emphasis shall be placed on the use of special tools and instruments. The list

shall indicate sources of supply, recommended spare parts, and name of servicing organization.

- j. List of factory approved or qualified permanent servicing organizations for equipment repair and periodic testing and maintenance, including addresses and factory certification qualifications.

G. Approvals will be based on complete submission of manuals together with shop drawings.

#### **1.13 SINGULAR NUMBER**

- A. Where any device or part of equipment is referred to in these specifications in the singular number (e.g., "the switch"), this reference shall be deemed to apply to as many such devices as are required to complete the installation as shown on the drawings.

#### **1.15 ACCEPTANCE CHECKS AND TESTS**

- A. The contractor shall furnish the instruments, materials and labor for field tests.

#### **1.16 TRAINING**

- A. Training shall be provided in accordance with Article 1.25, INSTRUCTIONS, of Section 01 00 00, GENERAL REQUIREMENTS.
- B. Training shall be provided for the particular equipment or system as required in each associated specification.
- C. A training schedule shall be developed and submitted by the contractor and approved by the Project Engineer at least 30 days prior to the planned training.

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**SECTION 26 05 12**  
**ELECTRICAL DEMOLITION**

**PART 1 GENERAL**

**1.1 SECTION INCLUDES**

- A. Electrical demolition.
- B. Construction Phasing

**PART 2 PRODUCTS**

**2.1 MATERIALS AND EQUIPMENT**

- A. Materials and equipment for patching and extending work: As specified in individual sections.

**PART 3 EXECUTION**

**3.1 EXAMINATION**

- A. Verify field measurements and circuiting arrangements are as shown on the drawings.
- B. Verify that abandoned wiring and equipment serve only abandoned facilities.
- C. Demolition drawings are based on casual field observation and existing record documents.
- D. Report discrepancies to Project Engineer before disturbing existing installation.
- E. Beginning of demolition means installer accepts existing conditions.

**3.2 PREPARATION**

- A. Disconnect electrical systems in walls, floors, and ceilings to be removed.
- B. Provide temporary wiring and connections to maintain existing systems in service during construction.
- C. Existing Switchgear, Electrical Panels and Equipment: Disable system only to make switchovers and connections. Minimize outage duration.
  - 1. Obtain permission from Owner at least 2 weeks before partially or completely disabling panels and equipment.
  - 2. Make temporary connections to maintain service in areas adjacent to work area.
  - 3. Coordinate all switching operations on the 5 kV and 25 kV distribution systems with the VA Project Engineer. Any required switching shall be done by VA staff and shall be scheduled 2 weeks in advance if it will result in any kind of power outage.

**3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK**

- A. Remove, relocate, and extend existing installations to accommodate new construction.

- B. Remove abandoned wiring to source of supply.
- C. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
- D. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlet boxes which are not removed.
- E. Disconnect and remove abandoned panelboards and distribution equipment.
- F. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
- G. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.
- H. Repair adjacent construction and finishes damaged during demolition and extension work.
- I. Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.
- J. Install junction boxes in walls, ceilings or floors if required to continue circuiting.
- K. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

#### **3.4 CONSTRUCTION PHASING**

- A. All work shall be phased to create minimal electrical service disruption to the daily operations of the hospital. Provide temporary connections to branch circuit devices, light fixtures, panelboards, motor starters, MCC's, etc. during switchover operations to keep downtime to any piece of equipment or areas of the building to a minimum.
- B. Switchover work may need to be completed outside of normal work hours to keep disruption to hospital operations minimized.
- C. Phasing schedules are to be submitted to VA Project Engineer at least two weeks prior to any power outages for approval. Outages are to be scheduled at least two weeks prior to the outage date with the VA Project Engineer.
- D. The work to replace the Building 1 switchgear, generator and transfer switches shall be done in phases as indicated on the drawings. Submit a final phasing plan for this work to the VA Project Engineer 2 weeks prior to the first outage for approval. The following is a general outline of the suggested phasing plan for the work. The contractor shall determine the final phasing plan with approval from the VA Project Engineer.
  - 1. Install the new critical branch transfer switch and switchboard and

provide a temporary normal power connection from the existing main switchboard to the new CR ATS.

2. Temporary the existing loads connected to the EB Switchboard to the new CR switchboard and connect the new CR ATS to the existing feeder from the generator that was used or the EB ATS.
  3. Replace the EB ATS and EB switchboard while the loads are temporarily connected to the CR switchboard. Once the EB equipment is installed reconnect the EB loads to this switchboard.
  4. Use the CR switchboard to temporary the LS branch loads and replace the LS equipment similar to the EB equipment procedure.
  5. Install the new switchboard SWBD SB2.
  6. Provide a temporary exterior generator to power each of the ATS's.
  7. Replace the existing generator and generator switchboard.
  8. Provide temporary connections from the existing transformer T1-E and T1-W to the LS, CR, and EB transfer switches and to switchboard SWBD-SB2. Provide any required temporary disconnect switches, etc. to provide overcurrent protection for the equipment.
  9. Temporary the existing loads in the main switchboard to the new LS, EB, SWBD SB2 and CR switchboards. If there is not adequate space to accommodate all of the required connections, provide an additional temporary panel in the main electrical room or interconnect some of the panels on the upper floors to minimize the amount of temporary needed.
  10. Replace the existing main switchboard after all loads have been temporaried.
- E. The modifications to the 25 kV and 5 kV distribution systems shall be done in such a manner as to have no significant power outages to the remainder of the hospital.
1. The 25 kV system shall be switched such that the power is being routed from the north utility service so that the chiller farm is powered at all times.
  2. The 5 kV system shall be switched within buildings 1, 9 and 46 to the other 5kV feeder so there is a minimal outage within the hospital. The time to remove the existing splices and install the new splices shall be minimized to avoid disruption of power to other buildings on that feeder. The existing conductors shall be re-spliced after removal of T38 to allow the feeder to be re-energized until the new T1-Shops is ready to be re-installed and energized.

- F. The existing surgery chiller relocation shall be coordinated with the mechanical contractor to minimize downtime on the chiller. The time of year the unit is relocated, downtime, etc., shall be coordinated with the VA Project Engineer.

### **3.5 CLEANING AND REPAIR**

- A. Clean and repair existing materials and equipment which remain or are to be reused.
- B. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.

### **3.6 MATERIAL DISPOSAL**

- A. Material and equipment deemed salvageable by the Owner shall remain the property of Owner. Contractor shall dismantle these items to manageable size and deliver to designated storage area on site. The Owner shall have first right of refusal on all material and equipment.
- B. All other materials and equipment shall become property of Contractor and must be removed from site and disposed of by approved method.

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**SECTION 26 05 13  
MEDIUM VOLTAGE CABLES**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the furnishing, installation, and connection of medium voltage cables, splices, and terminations.

**1.2 RELATED WORK**

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirement and items that are common to more than one section of Division 26.
- B. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.
- C. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits for medium voltage cables.
- D. Section 26 05 41, UNDERGROUND ELECTRICAL CONSTRUCTION: Manholes and ducts for medium voltage cables.

**1.3 QUALITY ASSURANCE**

- A. Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

**1.4 FACTORY TESTS**

- A. Medium voltage cables shall be thoroughly tested at the factory per NEMA WC 74 to ensure that there are no electrical defects. Factory tests shall be certified.

**1.5 SUBMITTALS**

- A. In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:
- B. Shop Drawings:
  - 1. Clearly present sufficient information to determine compliance with drawings and specifications.
  - 2. Include product and installation information for cables, splices, terminations, and fireproofing tape.
- C. Certifications:
  - 1. Factory Test Reports: Prior to installation of the cables, deliver two copies of the manufacturers certified NEMA WC 71 or WC 74 standard factory test reports to the Project Engineer. Certified copies of test data shall show conformance with the referenced standards and shall be approved prior to delivery of cable.

1. Employees who install splices and terminations and test the cables shall have not fewer than five years of experience splicing and terminating cables equivalent to those being spliced and terminated, including experience with the materials in the kits.
2. Furnish satisfactory proof of such experience for each employee who splices or terminates the cables.

A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only:

- 386-95 (R2001).....Separable Insulated Connector Systems for Power  
Distribution Systems above 600 V

- 400-01.....Guide for Field Testing and Evaluation of the  
Insulation of Shielded Power Cable Systems
- 400.2-05.....Guide for Field Testing of Shielded Power Cable  
Systems Using Very Low Frequency (VLF)
- 400.3-06.....Guide for Partial Discharge Testing of Shielded  
Power Cable Systems in a Field Environment
- 404-00.....Extruded and Laminated Dielectric Shielded  
Cable Joints Rated 2500-500,000 Volts
- C. National Electrical Manufacturers Association (NEMA):
  - WC 71-99.....Standard for Non-Shielded Cables Rated 2001-  
5000 Volts for Use in the Distribution of  
Electrical Energy (ICEA S-96-659)
  - WC 74-06.....5-46 KV Shielded Power Cable for Use in the  
Transmission and Distribution of Electrical  
Energy (ICEA S-93-969)
- D. National Fire Protection Association (NFPA):
  - 70-08.....National Electrical Code (NEC)
- E. Underwriters Laboratories (UL):
  - 1072-06 ..... Medium-Voltage Power Cables

## **1.7 SHIPMENT AND STORAGE**

- A. Cable shall be shipped on reels such that it is protected from  
mechanical injury. Each end of each length of cable shall be  
hermetically sealed with manufacturer's end caps and securely attached  
to the reel.
- B. Cable stored and/or cut on site shall have the ends turned down, and  
sealed with cable manufacturer's standard cable end seals, or field-  
installed heat-shrink cable end seals.

## **PART 2 - PRODUCTS**

### **2.1 MEDIUM VOLTAGE CABLE**

- A. Medium voltage cable shall be in accordance with the NEC and NEMA WC  
71, WC 74, and UL 1072.
- B. Single conductor stranded copper conforming to ASTM B3.
- C. Voltage Rating:
  - 1. 15,000 V cable shall be used on 4,160 V distribution systems.
  - 2. 25,000 V cable shall be used on 25,000 V distribution systems.
- D. Insulation:
  - 1. Insulation level shall be 133%.
  - 2. Types of insulation:

- a. Cable type abbreviation, EPR: Ethylene propylene rubber insulation shall be thermosetting, light and heat stabilized.
  - b. In wet locations, anti-tree CCLP or EPR shall be used.
- E. Conductors and insulation shall be wrapped separately with semi-conducting tape.
- F. Insulation shall be wrapped with non-magnetic, metallic shielding tape, helically-applied over semi-conducting insulation shield.
- G. Heavy duty, overall protective jacket of chlorosulphonated polyethylene or polyvinyl chloride shall enclose every cable. The manufacturer's name, cable type and size, and other pertinent information shall be marked or molded clearly on the overall protective jacket.
- H. Cable temperature ratings for continuous operation, emergency overload operation, and short circuit operation shall be not less than the NEC, NEMA WC 71, or NEMA WC 74 standard for the respective cable.

## **2.2 SPLICES AND TERMINATIONS**

- A. The materials shall be compatible with the cables.
- B. In locations where moisture might be present, the splices shall be watertight. In manholes and handholes, the splices shall be submersible.
- C. Where the Government determines that unsatisfactory splices and terminations have been installed, the contractor shall replace the unsatisfactory splices and terminations with approved material at no additional cost to the Government.
- D. Splices and Terminations:
  - 1. Materials shall be designed for the cables being spliced and terminated, and shall be suitable for the prevailing environmental conditions.
  - 2. Splices:
    - a. Shall comply with IEEE 404. Include all components required for complete splice, with detailed instructions.
    - b. Cold-shrink splice: Premolded, cold-shrink-rubber, in-line splicing kit.
  - 3. Terminations:
    - a. Shall comply with IEEE 48. Include shield ground strap for shielded cable terminations.
    - b. Class 3 terminations for outdoor use: Kit with stress cone and compression-type connector.



- c. Load-break terminations for indoor and outdoor use: Elbow-type unit with test point and 200-A load make/break and continuous-current rating.

### **2.3 FIREPROOFING TAPE**

- A. Fireproofing tape shall be flexible, non-corrosive, self-extinguishing, arcproof, and fireproof intumescent elastomer. Securing tape shall be glass cloth electrical tape not less than 7 mils [0.18 mm] thick, and 0.75 in [19 mm] wide.

## **PART 3 - EXECUTION**

### **3.1 GENERAL**

- A. Installation shall be in accordance with the NEC, as shown on the drawings, and per cable manufacturer's instructions.
- B. Cable shall be installed in conduit above grade and duct bank below grade. All cables of a feeder shall be pulled simultaneously.
- C. Splice the cables only in manholes and accessible pullboxes.
- D. Ground shields in accordance with Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.
- E. Cable maximum pull length, maximum pulling tension, and minimum bend radius shall conform with the recommendations of the cable manufacturer.
- F. Use suitable lubricating compounds on the cables to prevent pulling damage. Provide compounds that are not injurious to the cable jacket and do not harden or become adhesive.
- G. Seal the cable ends prior to pulling, to prevent the entry of moisture or lubricant.

### **3.2 PROTECTION DURING SPLICING OPERATIONS**

- A. Blowers shall be provided to force fresh air into manholes where free movement or circulation of air is obstructed. Waterproof protective coverings shall be available on the work site to provide protection against moisture while a splice is being made. Pumps shall be used to keep manholes dry during splicing operations. Under no conditions shall a splice or termination be made that exposes the interior of a cable to moisture. A manhole ring at least 6 in [150 mm] above ground shall be used around the manhole entrance to keep surface water from entering the manhole. Unused ducts shall be plugged and water seepage through ducts in use shall be stopped before splicing.

### **3.3 PULLING CABLES IN DUCTS AND MANHOLES**

- A. Cables shall be pulled into ducts with equipment designed for this purpose, including power-driven winches, cable-feeding flexible tube guides, cable grips, pulling eyes, and lubricants. A sufficient number of trained personnel and equipment shall be employed to ensure the careful and proper installation of the cable.
- B. Cable reels shall be set up at the side of the manhole opening and above the duct or hatch level, allowing cables to enter through the opening without reverse bending. Flexible tube guides shall be installed through the opening in a manner that will prevent cables from rubbing on the edges of any structural member.
- C. Cable shall be unreeled from the top of the reel. Pay-out shall be carefully controlled. Cables to be pulled shall be attached through a swivel to the main pulling wire by means of a suitable cable grip and pulling eye.
- D. Woven-wire cable grips shall be used to grip the cable end when pulling small cables and short straight lengths of heavier cables.
- E. Pulling eyes shall be attached to the cable conductors to prevent damage to the cable structure.
- F. Cables shall be liberally coated with a suitable lubricant as they enter the tube guide or duct. Rollers, sheaves, or tube guides around which the cable is pulled shall conform to the minimum bending radius of the cable.
- G. Cables shall be pulled into ducts at a reasonable speed. Cable pulling using a vehicle shall not be permitted. Pulling operations shall be stopped immediately at any indication of binding or obstruction, and shall not be resumed until the potential for damage to the cable is corrected. Sufficient slack shall be provided for free movement of cable due to expansion or contraction.
- H. Splices in manholes shall be firmly supported on cable racks. No splices shall be pulled in ducts. Cable ends shall overlap at the ends of a section to provide sufficient undamaged cable for splicing.
- I. Cables cut in the field shall have the cut ends immediately sealed to prevent entrance of moisture.

### **3.4 SPLICES AND TERMINATIONS**

- A. Install the materials as recommended by the manufacturer, including precautions pertaining to air temperature and humidity during installation.

- B. Installation shall be accomplished by qualified personnel trained to accomplish medium voltage equipment installations. All manufacturer's instructions shall be followed precisely.
- C. Splices in manholes shall be located midway between cable racks on walls of manholes, and supported with cable arms at approximately the same elevation as the enclosing duct.

### **3.5 FIREPROOFING**

- A. Cover all cable segments exposed in manholes with fireproofing tape.
- B. Apply the tape in a single layer, wrapped in a half-lap manner, or as recommended by the manufacturer. Extend the tape not less than 1 in [25 mm] into each duct.
- C. At each end of a taped cable section, secure the fireproof tape in place with glass cloth tape.

### **3.6 CIRCUIT IDENTIFICATION OF FEEDERS**

- A. In each manhole and pullbox, install permanent tags on each circuit's cables to clearly designate the circuit identification and voltage. The tags shall be the embossed brass type, 1.5 in [40 mm] in diameter and 40 mils thick. Attach tags with plastic ties. Position the tags so they will be easy to read after the fireproofing tape is installed.

### **3.7 ACCEPTANCE CHECKS AND TESTS**

- A. Perform tests in accordance with the manufacturer's recommendations. Include the following visual and electrical inspections.
- B. Test equipment and labor and technical personnel shall be provided as necessary to perform the acceptance tests. Arrangements shall be made to have tests witnessed by the Project Engineer.
- C. Visual Inspection:
  - 1. Inspect exposed sections of cables for physical damage.
  - 2. Inspect shield grounding, cable supports, splices, and terminations.
  - 3. Verify that visible cable bends meet manufacturer's minimum published bending radius.
  - 4. Verify installation of fireproofing tape and identification tags.
- D. Electrical Tests:
  - 1. Acceptance tests shall be performed on new and service-aged cables as specified herein.
  - 2. Test new cable after installation, splices, and terminations have been made, but before connection to equipment and existing cable.
- E. Service-Aged Cable Tests:

1. Maintenance tests shall be performed on service-aged cable interconnected to new cable.
  2. After new cable test and connection to an existing cable, test the interconnected cable. Disconnect cable from all equipment that could be damaged by the test.
- F. Insulation-Resistance Test: Test all new and service-aged cables with respect to ground and adjacent conductors.
1. Test data shall include megohm readings and leakage current readings. Cable shall not be energized until insulation-resistance test results have been approved by the Project Engineer. Test voltages and minimum acceptable resistance values shall be:
 

Voltage Class	Test Voltage	Min. Insulation Resistance
5kV	2,500 VDC	1,000 megohms
15kV	2,500 VDC	5,000 megohms
25kV	5,000 VDC	20,000 megohms
35kV	15,000 VDC	100,000 megohms
  2. Provide a comprehensive report that describes the identification and location of cables tested, the test equipment used, and the date tests were performed; identifies the persons who performed the tests; and identifies the insulation resistance and leakage current results for each cable section tested. The report shall provide conclusions and recommendations for corrective action.
- G. Online Partial Discharge Test: Comply with IEEE 400 and 400.3. Test all new and service-aged cables. Perform tests after cables have passed the insulation-resistance test, and after successful energization.
1. Testing shall use a time or frequency domain detection process, incorporating radio frequency current transformer sensors with a partial discharge detection range of 10 kHz to 300 MHz.
  2. Provide a comprehensive report that describes the identification and location of cables tested, the test equipment used, and the date tests were performed; identifies the persons who performed the tests; and numerically and graphically identifies the magnitude of partial discharge detected for each cable section tested. The report shall provide conclusions and recommendations for corrective action.
- H. Final Acceptance: Final acceptance shall depend upon the satisfactory performance of the cables under test. No cable shall be energized until recorded test data have been approved by the Project Engineer. Final test reports shall be provided to the Project Engineer.

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**SECTION 26 05 21**  
**LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW)**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the furnishing, installation, and connection of low voltage and power wiring.

**1.2 RELATED WORK**

- A. Section 07 84 00, FIRESTOPPING: Sealing around penetrations to maintain the integrity of fire-rated construction.
- B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements that are common to more than one section.
- C. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.
- D. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits for cables and wiring.
- E. Section 26 05 41, UNDERGROUND ELECTRICAL CONSTRUCTION: Installation of low-voltage conductors and cables in manholes and ducts.

**1.3 QUALITY ASSURANCE**

- A. Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

**1.4 FACTORY TESTS**

- A. Power and low voltage cables shall be thoroughly tested at the factory per NEMA WC-70 to ensure that there are no electrical defects. Factory tests shall be certified.

**1.5 APPLICABLE PUBLICATIONS**

- A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are reference in the text by designation only.
- B. American Society of Testing Material (ASTM):  
D2301-04.....Standard Specification for Vinyl Chloride  
Plastic Pressure-Sensitive Electrical  
Insulating Tape
- C. National Fire Protection Association (NFPA):  
70-08.....National Electrical Code (NEC)
- D. National Electrical Manufacturers Association (NEMA):

WC 70-09.....Power Cables Rated 2000 Volts or Less for the  
Distribution of Electrical Energy

E. Underwriters Laboratories, Inc. (UL):

44-05.....Thermoset-Insulated Wires and Cables  
83-08.....Thermoplastic-Insulated Wires and Cables  
467-071.....Electrical Grounding and Bonding Equipment  
486A-486B-03.....Wire Connectors  
486C-04.....Splicing Wire Connectors  
486D-05.....Sealed Wire Connector Systems  
486E-94.....Equipment Wiring Terminals for Use with  
Aluminum and/or Copper Conductors  
493-07.....Thermoplastic-Insulated Underground Feeder and  
Branch Circuit Cable  
514B-04.....Conduit, Tubing, and Cable Fittings  
1479-03.....Fire Tests of Through-Penetration Fire Stops

**PART 2 - PRODUCTS**

**2.1 CONDUCTORS AND CABLES**

- A. Conductors and cables shall be in accordance with NEMA WC-70 and as specified herein.
- B. Single Conductor:
1. Shall be annealed copper.
  2. Shall be stranded for sizes No. 8 AWG and larger, solid for sizes No. 10 AWG and smaller.
  3. Shall be minimum size No. 12 AWG, except where smaller sizes are allowed herein.
- C. Insulation:
1. THHN-THWN shall be in accordance with NEMA WC-70, UL 44, and UL 83.
- D. Color Code:
1. Secondary service feeder and branch circuit conductors shall be color-coded as follows:

208/120 volt	Phase	480/277 volt
Black	A	Brown
Red	B	Orange
Blue	C	Yellow
White	Neutral	Gray *
* or white with colored (other than green) tracer.		

- a. Lighting circuit "switch legs" and 3-way switch "traveling wires" shall have color coding that is unique and distinct (e.g., pink and purple) from the color coding indicated above. The unique color codes shall be solid and in accordance with the NEC.  
Coordinate color coding in the field with the Project Engineer.
- 2. Use solid color insulation or solid color coating for No. 12 AWG and No. 10 AWG branch circuit phase, neutral, and ground conductors.
- 3. Conductors No. 8 AWG and larger shall be color-coded using one of the following methods:
  - a. Solid color insulation or solid color coating.
  - b. Stripes, bands, or hash marks of color specified above.
  - c. Color as specified using 0.75 in [19 mm] wide tape. Apply tape in half-overlapping turns for a minimum of 3 in [75 mm] for terminal points, and in junction boxes, pull-boxes, troughs, and manholes. Apply the last two laps of tape with no tension to prevent possible unwinding. Where cable markings are covered by tape, apply tags to cable, stating size and insulation type.
- 4. For modifications and additions to existing wiring systems, color coding shall conform to the existing wiring system.

## 2.2 SPLICES AND JOINTS

- A. In accordance with UL 486A, C, D, E, and NEC.
- B. Aboveground Circuits (No. 10 AWG and smaller):
  - 1. Connectors: Solderless, screw-on, reusable pressure cable type, rated 600 V, 220° F [105° C], with integral insulation, approved for copper and aluminum conductors.
  - 2. The integral insulator shall have a skirt to completely cover the stripped wires.
  - 3. The number, size, and combination of conductors, as listed on the manufacturer's packaging, shall be strictly followed.
- C. Aboveground Circuits (No. 8 AWG and larger):
  - 1. Connectors shall be indent, hex screw, or bolt clamp-type of high conductivity and corrosion-resistant material, listed for use with copper and aluminum conductors.
  - 2. Field-installed compression connectors for cable sizes 250 kcmil and larger shall have not fewer than two clamping elements or compression indents per wire.
  - 3. Insulate splices and joints with materials approved for the particular use, location, voltage, and temperature. Splice and joint



insulation level shall be not less than the insulation level of the conductors being joined.

4. Plastic electrical insulating tape: Per ASTM D2304, flame-retardant, cold and weather resistant.

### **2.3 CONTROL WIRING**

- A. Unless otherwise specified elsewhere in these specifications, control wiring shall be as specified for power and lighting wiring, except that the minimum size shall be not less than No. 22 AWG. Low voltage control wiring (48 volts and lower) may also utilize cables that include twisted pairs of conductors within an overall jacket.
- B. Control wiring shall be large enough such that the voltage drop under in-rush conditions does not adversely affect operation of the controls.

### **2.4 WIRE LUBRICATING COMPOUND**

- A. Lubricating compound shall be suitable for the wire insulation and conduit, and shall not harden or become adhesive.

## **PART 3 - EXECUTION**

### **3.1 GENERAL**

- A. Install in accordance with the NEC, and as specified.
- B. Install all wiring in raceway systems.
- C. Splice cables and wires only in outlet boxes, junction boxes, and pull-boxes.
- D. Wires of different systems (e.g., 120 V, 277 V) shall not be installed in the same conduit or junction box system.
- E. Install cable supports for all vertical feeders in accordance with the NEC. Provide split wedge type which firmly clamps each individual cable and tightens due to cable weight.
- F. For panel boards, cabinets, wireways, switches, and equipment assemblies, neatly form, train, and tie the cables in individual circuits.
- G. Wire Pulling:
  1. Provide installation equipment that will prevent the cutting or abrasion of insulation during pulling of cables. Use lubricants approved for the cable.
  2. Use nonmetallic ropes for pulling feeders.
  3. Attach pulling lines for feeders by means of either woven basket grips or pulling eyes attached directly to the conductors, as approved by the Project Engineer.
  4. All cables in a single conduit shall be pulled simultaneously.

5. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

H. No more than three single-phase branch circuits shall be installed in any one conduit.

### **3.2 INSTALLATION IN MANHOLES**

A. Install and support cables in manholes on the steel racks with porcelain or equivalent insulators. Train the cables around the manhole walls, but do not bend to a radius less than six times the overall cable diameter.

B. Fireproofing:

1. Install fireproofing on low-voltage cables where the low-voltage cables are installed in the same manholes with medium-voltage cables; also cover the low-voltage cables with arcproof and fireproof tape.

2. Use tape of the same type used for the medium-voltage cables, and apply the tape in a single layer, half-lapped, or as recommended by the manufacturer. Install the tape with the coated side towards the cable and extend it not less than 1 in [25 mm] into each duct.

3. Secure the tape in place by a random wrap of glass cloth tape.

### **3.3 SPLICE INSTALLATION**

A. Splices and terminations shall be mechanically and electrically secure.

B. Tighten electrical connectors and terminals according to manufacturer's published torque values.

C. Where the Government determines that unsatisfactory splices or terminations have been installed, remove the devices and install approved devices at no additional cost to the Government.

### **3.4 FEEDER IDENTIFICATION**

A. In each interior pull-box and junction box, install metal tags on all circuit cables and wires to clearly designate their circuit identification and voltage. The tags shall be the embossed brass type, 1.5 in [40 mm] in diameter and 40 mils thick. Attach tags with plastic ties.

B. In each manhole and handhole, provide tags of the embossed brass type, showing the circuit identification and voltage. The tags shall be the embossed brass type, 1.5 in [40 mm] in diameter and 40 mils thick. Attach tags with plastic ties.

**3.5 EXISTING WIRING**

- A. Unless specifically indicated on the plans, existing wiring shall not be reused for a new installation.

**3.6 CONTROL AND SIGNAL WIRING INSTALLATION**

- A. Unless otherwise specified in other sections, install wiring and connect to equipment/devices to perform the required functions as shown and specified.
- B. Except where otherwise required, install a separate power supply circuit for each system so that malfunctions in any system will not affect other systems.
- C. Where separate power supply circuits are not shown, connect the systems to the nearest panel boards of suitable voltages, which are intended to supply such systems and have suitable spare circuit breakers or space for installation.

**3.5 CONTROL AND SIGNAL SYSTEM WIRING IDENTIFICATION**

- A. Install a permanent wire marker on each wire at each termination.
- B. Identifying numbers and letters on the wire markers shall correspond to those on the wiring diagrams used for installing the systems.
- C. Wire markers shall retain their markings after cleaning.

**3.6 ACCEPTANCE CHECKS AND TESTS**

- A. Feeders and branch circuits shall have their insulation tested after installation and before connection to utilization devices, such as fixtures, motors, or appliances. Test each conductor with respect to adjacent conductors and to ground. Existing conductors to be reused shall also be tested.
- B. Applied voltage shall be 500VDC for 300-volt rated cable, and 1000VDC for 600-volt rated cable. Apply test for one minute or until reading is constant for 15 seconds, whichever is longer. Minimum insulation resistance values shall not be less than 25 megohms for 300-volt rated cable and 100 megohms for 600-volt rated cable.
- C. Perform phase rotation test on all three-phase circuits.
- D. The contractor shall furnish the instruments, materials, and labor for all tests.

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**SECTION 26 05 26**  
**GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the general grounding and bonding requirements for electrical equipment and operations to provide a low impedance path for possible ground fault currents.
- B. "Grounding electrode system" refers to all electrodes required by NEC, as well as made, supplementary, and lightning protection system grounding electrodes.
- C. The terms "connect" and "bond" are used interchangeably in this specification and have the same meaning.

**1.2 RELATED WORK**

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.
- B. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Low Voltage power and lighting wiring.
- C. Section 26 24 11, DISTRIBUTION SWITCHBOARDS: Low voltage distribution switchboards.
- D. Section 26 24 16, PANELBOARDS: Low voltage panelboards.
- E. Section 26 32 13, ENGINE-GENERATORS: Engine-generators.
- F. Section 26 36 23, AUTOMATIC TRANSFER SWITCHES: Automatic transfer switches.

**1.3 QUALITY ASSURANCE**

- A. Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

**1.4 SUBMITTALS**

- A. Submit in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. Shop Drawings:
  - 1. Clearly present enough information to determine compliance with drawings and specifications.
  - 2. Include the location of system grounding electrode connections and the routing of aboveground and underground grounding electrode conductors.
- C. Test Reports: Provide certified test reports of ground resistance.

D. Certifications: Two weeks prior to final inspection, submit four copies of the following to the Project Engineer:

1. Certification that the materials and installation are in accordance with the drawings and specifications.
2. Certification by the contractor that the complete installation has been properly installed and tested.

### 1.5 APPLICABLE PUBLICATIONS

Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.

A. American Society for Testing and Materials (ASTM):

B1-07.....Standard Specification for Hard-Drawn Copper Wire

B3-07.....Standard Specification for Soft or Annealed Copper Wire

B8-04.....Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

B. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

81-1983.....IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System

C2-07.....National Electrical Safety Code

C. National Fire Protection Association (NFPA):

70-08.....National Electrical Code (NEC)

99-2005.....Health Care Facilities

D. Underwriters Laboratories, Inc. (UL):

44-05 .....Thermoset-Insulated Wires and Cables

83-08 .....Thermoplastic-Insulated Wires and Cables

467-07 .....Grounding and Bonding Equipment

486A-486B-03 .....Wire Connectors

## PART 2 - PRODUCTS

### 2.1 GROUNDING AND BONDING CONDUCTORS

A. Equipment grounding conductors shall be UL 44 or UL 83 insulated stranded copper, except that sizes No. 10 AWG [6 mm<sup>2</sup>] and smaller shall be solid copper. Insulation color shall be continuous green for all

equipment grounding conductors, except that wire sizes No. 4 AWG [25 mm<sup>2</sup>] and larger shall be identified per NEC.

- B. Bonding conductors shall be ASTM B8 bare stranded copper, except that sizes No. 10 AWG [6 mm<sup>2</sup>] and smaller shall be ASTM B1 solid bare copper wire.
- C. Conductor sizes shall not be less than shown on the drawings, or not less than required by the NEC, whichever is greater.

## **2.2 GROUND RODS**

- A. Steel or copper clad steel, 0.75 in [19 mm] diameter by 10 ft [30 M] long, conforming to UL 467.
- B. Quantity of rods shall be as required to obtain the specified ground resistance, as shown on the drawings.

## **2.3 CONCRETE ENCASED ELECTRODE**

- A. Concrete encased electrode shall be No. 4 AWG bare copper wire, installed per NEC.

## **2.4 MEDIUM VOLTAGE SPLICES AND TERMINATIONS**

- A. Components shall meet or exceed UL 467 and be clearly marked with the manufacturer, catalog number, and permitted conductor size(s).

## **2.5 GROUND CONNECTIONS**

- A. Below Grade: Exothermic-welded type connectors.
- B. Above Grade:
  - 1. Bonding Jumpers: Compression-type connectors, using zinc-plated fasteners and external tooth lockwashers.
  - 2. Connection to Building Steel: Exothermic-welded type connectors.
  - 3. Ground Busbars: Two-hole compression type lugs, using tin-plated copper or copper alloy bolts and nuts.
  - 4. Rack and Cabinet Ground Bars: One-hole compression-type lugs, using zinc-plated or copper alloy fasteners.

## **2.6 EQUIPMENT RACK AND CABINET GROUND BARS**

- A. Provide solid copper ground bars designed for mounting on the framework of open or cabinet-enclosed equipment racks with minimum dimensions of 0.375 in [4 mm] thick x 0.75 in [19 mm] wide.

## **2.7 GROUND TERMINAL BLOCKS**

- A. At any equipment mounting location (e.g., backboards and hinged cover enclosures) where rack-type ground bars cannot be mounted, provide screw lug-type terminal blocks.

## **2.8 GROUNDING BUS**

- A. Pre-drilled rectangular copper bar with stand-off insulators, minimum 0.25 in [6.3 mm] thick x 4 in [100 mm] high in cross-section, length as shown on drawings, with 0.281 in [7.1 mm] holes spaced 1.125 in [28 mm] apart.

## **PART 3 - EXECUTION**

### **3.1 GENERAL**

- A. Ground in accordance with the NEC, as shown on drawings, and as specified herein. Provide all required grounding electrode connections to the new electrical service switchboards in building 1 and the shops area to meet NEC requirements. All new and existing electrodes and bonding connections shall be made.
- B. System Grounding:
  - 1. Secondary service neutrals: Ground at the supply side of the secondary disconnecting means and at the related transformers.
  - 2. Separately derived systems (transformers downstream from the service entrance): Ground the secondary neutral.
- C. Equipment Grounding: Metallic structures, including ductwork and building steel, enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits, shall be bonded and grounded.
- D. Special Grounding: For patient care area electrical power system grounding, conform to NFPA 99 and NEC.

### **3.2 INACCESSIBLE GROUNDING CONNECTIONS**

- A. Make grounding connections, which are normally buried or otherwise inaccessible (except connections for which access for periodic testing is required), by exothermic weld.

### **3.3 MEDIUM VOLTAGE EQUIPMENT AND CIRCUITS**

- A. Duct Banks and Manholes: Provide an insulated equipment grounding conductor in each duct containing medium voltage conductors, sized per NEC except that minimum size shall be 2 AWG [25 mm<sup>2</sup>]. Bond the equipment grounding conductors to the switchgear ground bus, to all manhole hardware and ground rods, to the cable shielding grounding provisions of medium-voltage cable splices and terminations, and to equipment enclosures.
- B. Pad-Mounted Transformers:
  - 1. Provide a driven ground rod and bond with a grounding electrode conductor to the transformer grounding pad.

2. Ground the secondary neutral.

D. Lightning Arresters: Connect lightning arresters to the equipment ground bus or ground rods as applicable.

### **3.4 SECONDARY VOLTAGE EQUIPMENT AND CIRCUITS**

A. Main Bonding Jumper: Bond the secondary service neutral to the ground bus in the service equipment.

B. Metallic Piping, Building Steel, and Supplemental Electrode(s):

1. Provide a grounding electrode conductor sized per NEC between the service equipment ground bus and all metallic water pipe systems, building steel, and supplemental or made electrodes. Provide jumper insulating joints in the metallic piping. All connections to electrodes shall be made with fittings that conform to UL 467.
2. Provide a supplemental ground electrode and bond to the grounding electrode system.

D. Switchboards, Panelboards, Engine-Generators, and Automatic Transfer Switches:

1. Connect the various feeder equipment grounding conductors to the ground bus in the enclosure with suitable pressure connectors.
2. For service entrance equipment, connect the grounding electrode conductor to the ground bus.
3. Provide ground bars, bolted to the housing, with sufficient lugs to terminate the equipment grounding conductors.
4. Connect metallic conduits that terminate without mechanical connection to the housing, by grounding bushings and grounding conductor to the equipment ground bus.

### **3.5 RACEWAY**

A. Conduit Systems:

1. Ground all metallic conduit systems. All metallic conduit systems shall contain an equipment grounding conductor.
2. Non-metallic conduit systems, except non-metallic feeder conduits that carry a grounded conductor from exterior transformers to interior or building-mounted service entrance equipment, shall contain an equipment grounding conductor.
3. Conduit that only contains a grounding conductor, and is provided for its mechanical protection, shall be bonded to that conductor at the entrance and exit from the conduit.
4. Metallic conduits which terminate without mechanical connection to an electrical equipment housing by means of locknut and bushings or



- adapters, shall be provided with grounding bushings. Connect bushings with a bare grounding conductor to the equipment ground bus.
- B. Feeders and Branch Circuits: Install equipment grounding conductors with all feeders and power and lighting branch circuits.
- C. Boxes, Cabinets, Enclosures, and Panelboards:
1. Bond the equipment grounding conductor to each pullbox, junction box, outlet box, device box, cabinets, and other enclosures through which the conductor passes (except for special grounding systems for intensive care units and other critical units shown).
  2. Provide lugs in each box and enclosure for equipment grounding conductor termination.
- D. Wireway Systems:
1. Bond the metallic structures of wireway to provide 100% electrical continuity throughout the wireway system, by connecting a No. 6 AWG [16 mm<sup>2</sup>] bonding jumper at all intermediate metallic enclosures and across all section junctions.
  2. Install insulated No. 6 AWG [16 mm<sup>2</sup>] bonding jumpers between the wireway system, bonded as required above, and the closest building ground at each end and approximately every 50 ft [16 M].
  3. Use insulated No. 6 AWG [16 mm<sup>2</sup>] bonding jumpers to ground or bond metallic wireway at each end for all intermediate metallic enclosures and across all section junctions.
  4. Use insulated No. 6 AWG [16 mm<sup>2</sup>] bonding jumpers to ground cable tray to column-mounted building ground plates (pads) at each end and approximately every 49 ft [15 M].
- E. Receptacles shall not be grounded through their mounting screws. Ground receptacles with a jumper from the receptacle green ground terminal to the device box ground screw and a jumper to the branch circuit equipment grounding conductor.
- F. Ground lighting fixtures to the equipment grounding conductor of the wiring system when the green ground is provided; otherwise, ground the fixtures through the conduit systems. Fixtures connected with flexible conduit shall have a green ground wire included with the power wires from the fixture through the flexible conduit to the first outlet box.
- G. Fixed electrical appliances and equipment shall be provided with a ground lug for termination of the equipment grounding conductor.

- H. Panelboard Bonding in Patient Care Areas: The equipment grounding terminal buses of the normal and essential branch circuit panel boards serving the same individual patient vicinity shall be bonded together with an insulated continuous copper conductor not less than No. 10 AWG [16 mm<sup>2</sup>]. These conductors shall be installed in rigid metal conduit.

### **3.6 CORROSION INHIBITORS**

- A. When making ground and ground bonding connections, apply a corrosion inhibitor to all contact surfaces. Use corrosion inhibitor appropriate for protecting a connection between the metals used.

### **3.7 CONDUCTIVE PIPING**

- A. Bond all conductive piping systems, interior and exterior, to the grounding electrode system. Bonding connections shall be made as close as practical to the equipment ground bus.

### **3.8 ELECTRICAL AND IRM ROOM GROUNDING**

- A. Building Earth Ground Busbars: Provide ground busbar and mounting hardware at each electrical room and IRM room and connect to pigtail extensions of the building grounding ring. Provide a #3/0 copper bonding conductor from the main ground busbar in the new electrical room in building 1 shops area to each of the new IRM rooms and terminate on a ground bus bar in each IRM room. Provide a #6 grounding conductor from each ground bus bar to each data rack, telephone terminal board and TV splitter board in each IRM room.

### **3.9 EXTERIOR LIGHT POLES**

- A. Provide 20 ft [6.1 M] of No. 4 bare copper coiled at bottom of pole base excavation prior to pour, plus ground rod in each base as shown on the drawings and additional unsplined length in and above foundation as required to reach pole ground stud.

### **3.10 GROUND RESISTANCE**

- A. Grounding system resistance to ground shall not exceed 5 ohms. Make any modifications or additions to the grounding electrode system necessary for compliance without additional cost to the Government. Final tests shall ensure that this requirement is met.
- B. Resistance of the grounding electrode system shall be measured using a four-terminal fall-of-potential method as defined in IEEE 81. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not fewer than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made

before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.

- C. Below-grade connections shall be visually inspected by the Project Engineer prior to backfilling. The contractor shall notify the Project Engineer 24 hours before the connections are ready for inspection.

### **3.11 GROUND ROD INSTALLATION**

- A. For outdoor installations, drive each rod vertically in the earth, until top of rod is 24 in [609 mm] below final grade.
- B. For indoor installations, leave 4 in [100 mm] of rod exposed.
- C. Where permanently concealed ground connections are required, make the connections by the exothermic process, to form solid metal joints. Make accessible ground connections with mechanical pressure-type ground connectors.
- D. Where rock prevents the driving of vertical ground rods, install angled ground rods or grounding electrodes in horizontal trenches to achieve the specified resistance.

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**SECTION 26 05 33**  
**RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the furnishing, installation, and connection of conduit, fittings, and boxes, to form complete, coordinated, grounded raceway systems. Raceways are required for all wiring unless shown or specified otherwise.
- B. Definitions: The term conduit, as used in this specification, shall mean any or all of the raceway types specified.

**1.2 RELATED WORK**

- A. Section 07 84 00, FIRESTOPPING: Sealing around penetrations to maintain the integrity of fire rated construction.
- B. Section 07 92 00, JOINT SEALANTS: Sealing around conduit penetrations through the building envelope to prevent moisture migration into the building.
- C. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.
- D. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.
- E. Section 26 05 41, UNDERGROUND ELECTRICAL CONSTRUCTION: Underground conduits.

**1.3 QUALITY ASSURANCE**

- A. Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

**1.4 SUBMITTALS**

In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:

- A. Shop Drawings:
  - 1. Layout of required conduit penetrations through structural elements.

**1.5 APPLICABLE PUBLICATIONS**

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.

- B. American National Standards Institute (ANSI):
  - C80.1-05.....Electrical Rigid Steel Conduit
  - C80.3-05.....Steel Electrical Metal Tubing
  - C80.6-05.....Electrical Intermediate Metal Conduit
- C. National Fire Protection Association (NFPA):
  - 70-08.....National Electrical Code (NEC)
- D. Underwriters Laboratories, Inc. (UL):
  - 1-05.....Flexible Metal Conduit
  - 5-04.....Surface Metal Raceway and Fittings
  - 6-07.....Electrical Rigid Metal Conduit - Steel
  - 50-95.....Enclosures for Electrical Equipment
  - 360-093.....Liquid-Tight Flexible Steel Conduit
  - 467-07.....Grounding and Bonding Equipment
  - 514A-04.....Metallic Outlet Boxes
  - 514B-04.....Conduit, Tubing, and Cable Fittings
  - 514C-96.....Nonmetallic Outlet Boxes, Flush-Device Boxes  
and Covers
  - 651-05.....Schedule 40 and 80 Rigid PVC Conduit and  
Fittings
  - 651A-00.....Type EB and A Rigid PVC Conduit and HDPE  
Conduit
  - 797-07.....Electrical Metallic Tubing
  - 1242-06.....Electrical Intermediate Metal Conduit - Steel
- E. National Electrical Manufacturers Association (NEMA):
  - TC-2-03.....Electrical Polyvinyl Chloride (PVC) Tubing and  
Conduit
  - TC-3-04.....PVC Fittings for Use with Rigid PVC Conduit and  
Tubing
  - FB1-07.....Fittings, Cast Metal Boxes and Conduit Bodies  
for Conduit, Electrical Metallic Tubing and  
Cable

## **PART 2 - PRODUCTS**

### **2.1 MATERIAL**

- A. Conduit Size: In accordance with the NEC, but not less than 3/4 inch unless otherwise shown. Where permitted by the NEC, 1/2 inch [13 mm] flexible conduit may be used for tap connections to recessed lighting fixtures.
- B. Conduit:

1. Rigid steel: Shall conform to UL 6 and ANSI C80.1.
2. Electrical metallic tubing (EMT): Shall conform to UL 797 and ANSI C80.3. Maximum size not to exceed 4 in [105 mm] and shall be permitted only with cable rated 600 V or less.
3. Flexible galvanized steel conduit: Shall conform to UL 1.
4. Liquid-tight flexible metal conduit: Shall conform to UL 360.
7. Direct burial plastic conduit: Shall conform to UL 651 and UL 651A, heavy wall PVC or high density polyethylene (PE).

C. Conduit Fittings:

1. Rigid steel fittings:
  - a. Fittings shall meet the requirements of UL 514B and NEMA FB1.
  - b. Standard threaded couplings, locknuts, bushings, conduit bodies, and elbows: Only steel or malleable iron materials are acceptable. Integral retractable type IMC couplings are also acceptable.
  - c. Locknuts: Bonding type with sharp edges for digging into the metal wall of an enclosure.
  - d. Bushings: Metallic insulating type, consisting of an insulating insert, molded or locked into the metallic body of the fitting. Bushings made entirely of metal or nonmetallic material are not permitted.
  - e. Erickson (union-type) and set screw type couplings: Approved for use in concrete are permitted for use to complete a conduit run where conduit is installed in concrete. Use set screws of case-hardened steel with hex head and cup point to firmly seat in conduit wall for positive ground. Tightening of set screws with pliers is prohibited.
  - f. Sealing fittings: Threaded cast iron type. Use continuous drain-type sealing fittings to prevent passage of water vapor. In concealed work, install fittings in flush steel boxes with blank cover plates having the same finishes as that of other electrical plates in the room.
2. Electrical metallic tubing fittings:
  - a. Fittings and conduit bodies shall meet the requirements of UL 514B, ANSI C80.3, and NEMA FB1.
  - b. Only steel materials are acceptable.

- c. Set screw couplings and connectors: Use setscrews of case-hardened steel with hex head and cup point, to firmly seat in wall of conduit for positive grounding.
  - d. Indent-type connectors or couplings are prohibited.
  - e. Die-cast or pressure-cast zinc-alloy fittings or fittings made of "pot metal" are prohibited.
3. Flexible steel conduit fittings:
- a. Conform to UL 514B. Only steel materials are acceptable.
  - b. Clamp-type, with insulated throat.
4. Liquid-tight flexible metal conduit fittings:
- a. Fittings shall meet the requirements of UL 514B and NEMA FB1.
  - b. Only steel or malleable iron materials are acceptable.
  - c. Fittings must incorporate a threaded grounding cone, a steel or plastic compression ring, and a gland for tightening. Connectors shall have insulated throats.
5. Direct burial plastic conduit fittings:
- Fittings shall meet the requirements of UL 514C and NEMA TC3.
6. Expansion and deflection couplings:
- a. Conform to UL 467 and UL 514B.
  - b. Accommodate a 0.75 in [19 mm] deflection, expansion, or contraction in any direction, and allow 30 degree angular deflections.
  - c. Include internal flexible metal braid, sized to guarantee conduit ground continuity and a low-impedance path for fault currents, in accordance with UL 467 and the NEC tables for equipment grounding conductors.
  - d. Jacket: Flexible, corrosion-resistant, watertight, moisture and heat-resistant molded rubber material with stainless steel jacket clamps.
- D. Conduit Supports:
- 1. Parts and hardware: Zinc-coat or provide equivalent corrosion protection.
  - 2. Individual Conduit Hangers: Designed for the purpose, having a pre-assembled closure bolt and nut, and provisions for receiving a hanger rod.
  - 3. Multiple conduit (trapeze) hangers: Not less than 1.5 x 1.5 in [38 mm x 38 mm], 12-gauge steel, cold-formed, lipped channels; with not less than 0.375 in [9 mm] diameter steel hanger rods.

4. Solid Masonry and Concrete Anchors: Self-drilling expansion shields, or machine bolt expansion.

E. Outlet, Junction, and Pull Boxes:

1. UL-50 and UL-514A.
2. Cast metal where required by the NEC or shown, and equipped with rustproof boxes.
3. Sheet metal boxes: Galvanized steel, except where otherwise shown.
4. Flush-mounted wall or ceiling boxes shall be installed with raised covers so that the front face of raised cover is flush with the wall. Surface-mounted wall or ceiling boxes shall be installed with surface-style flat or raised covers.

- F. Wireways: Equip with hinged covers, except where removable covers are shown. Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for a complete system.

**PART 3 - EXECUTION**

**3.1 PENETRATIONS**

A. Cutting or Holes:

1. Cutting or drilling through structural elements such as beams or columns shall not be allowed.
2. Cut holes through concrete and masonry in new and existing structures with a diamond core drill or concrete saw. Pneumatic hammers, impact electric, hand, or manual hammer-type drills are not allowed, except where permitted by the Project Engineer.

- B. Firestopping: Where conduits, wireways, and other electrical raceways pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke and gases as specified in Section 07 84 00, FIRESTOPPING.

- C. Waterproofing: At floor, exterior wall, and roof conduit penetrations, completely seal clearances around the conduit and make watertight, as specified in Section 07 92 00, JOINT SEALANTS.

**3.2 INSTALLATION, GENERAL**

- A. In accordance with UL, NEC, as shown, and as specified herein.
- B. Essential (Emergency) raceway systems shall be entirely independent of other raceway systems, except where shown on drawings.
- C. Install conduit as follows:



1. In complete mechanically and electrically continuous runs before pulling in cables or wires.
  2. Unless otherwise indicated on the drawings or specified herein, installation of all conduits shall be concealed within finished walls, floors, and ceilings.
  3. Flattened, dented, or deformed conduit is not permitted. Remove and replace the damaged conduits with new undamaged material.
  4. Assure conduit installation does not encroach into the ceiling height head room, walkways, or doorways.
  5. Cut square, ream, remove burrs, and draw up tight.
  6. Independently support conduit at 8 ft [2.4 M] on centers. Do not use other supports, i.e., suspended ceilings, suspended ceiling supporting members, lighting fixtures, conduits, mechanical piping, or mechanical ducts.
  7. Support within 12 in [300 mm] of changes of direction, and within 12 in [300 mm] of each enclosure to which connected.
  8. Close ends of empty conduit with plugs or caps at the rough-in stage until wires are pulled in, to prevent entry of debris.
  9. Conduit installations under fume and vent hoods are prohibited.
  10. Secure conduits to cabinets, junction boxes, pull-boxes, and outlet boxes with bonding type locknuts. For rigid and IMC conduit installations, provide a locknut on the inside of the enclosure, made up wrench tight. Do not make conduit connections to junction box covers.
  11. Flashing of penetrations of the roof membrane is specified in Section 07 60 00, FLASHING AND SHEET METAL.
  12. Conduit bodies shall only be used for changes in direction, and shall not contain splices.
- D. Conduit Bends:
1. Make bends with standard conduit bending machines.
  2. Conduit hickey may be used for slight offsets and for straightening stubbed out conduits.
  3. Bending of conduits with a pipe tee or vise is prohibited.
- E. Layout and Homeruns:
1. Install conduit with wiring, including homeruns, as shown on drawings.

2. Deviations: Make only where necessary to avoid interferences and only after drawings showing the proposed deviations have been submitted approved by the Project Engineer.

### **3.3 CONCEALED WORK INSTALLATION**

- A. Above Furred or Suspended Ceilings and in Walls:
  1. Conduit for conductors 600 V and below: Rigid steel or EMT. Mixing different types of conduits indiscriminately in the same system is prohibited.
  2. Align and run conduit parallel or perpendicular to the building lines.
  3. Connect recessed lighting fixtures to conduit runs with maximum 6 ft [1.8 M] of flexible metal conduit extending from a junction box to the fixture.
  4. Tightening setscrews with pliers is prohibited.
  5. Route all conduit above ceilings in finished spaces.
  6. Flexible metal conduit may only be used as indicated in paragraph 3 and within existing walls to serve devices that are required to be cut into the surface. VA Project Engineer shall approve the use of flexible metal conduit for this application prior to the installation.

### **3.4 EXPOSED WORK INSTALLATION**

- A. Unless otherwise indicated on the drawings, exposed conduit is only permitted in mechanical and electrical rooms.
- B. Conduit for Conductors 600 V and Below: Rigid steel or EMT. Mixing different types of conduits indiscriminately in the system is prohibited.
- C. Align and run conduit parallel or perpendicular to the building lines.
- D. Install horizontal runs close to the ceiling or beams and secure with conduit straps.
- E. Support horizontal or vertical runs at not over 8 ft [2.4 M] intervals.
- F. If conduit is routed through areas without ceilings, it shall be routed as high as possible and in no case lower than any other utilities.  
Exact route and location shall be approved in advance by the VA Project Engineer.
- G. Painting:
  1. Paint exposed conduit as specified in Section 09 91 00, PAINTING.

### **3.5 DIRECT BURIAL INSTALLATION**

- A. Refer to Section 26 05 41, UNDERGROUND ELECTRICAL CONSTRUCTION.

### **3.5 WET OR DAMP LOCATIONS**

- A. Unless otherwise shown, use conduits of rigid steel or IMC.
- B. Provide sealing fittings to prevent passage of water vapor where conduits pass from warm to cold locations, i.e., refrigerated spaces, constant-temperature rooms, air-conditioned spaces, building exterior walls, roofs, or similar spaces.

### **3.6 MOTORS AND VIBRATING EQUIPMENT**

- A. Use flexible metal conduit for connections to motors and other electrical equipment subject to movement, vibration, misalignment, cramped quarters, or noise transmission.
- B. Use liquid-tight flexible metal conduit for installation in exterior locations, moisture or humidity laden atmosphere, corrosive atmosphere, water or spray wash-down operations, inside airstream of HVAC units, and locations subject to seepage or dripping of oil, grease, or water. Provide a green equipment grounding conductor with flexible metal conduit.

### **3.7 EXPANSION JOINTS**

- A. Conduits 3 in [75 mm] and larger that are secured to the building structure on opposite sides of a building expansion joint require expansion and deflection couplings. Install the couplings in accordance with the manufacturer's recommendations.
- B. Provide conduits smaller than 3 in [75 mm] with junction boxes on both sides of the expansion joint. Connect conduits to junction boxes with sufficient slack of flexible conduit to produce 5 in [125 mm] vertical drop midway between the ends. Flexible conduit shall have a bonding jumper installed. In lieu of this flexible conduit, expansion and deflection couplings as specified above for conduits 15 in [375 mm] and larger are acceptable.
- C. Install expansion and deflection couplings where shown.

### **3.8 CONDUIT SUPPORTS, INSTALLATION**

- A. Safe working load shall not exceed one-quarter of proof test load of fastening devices.
- B. Use pipe straps or individual conduit hangers for supporting individual conduits. Maximum distance between supports is 2.5 m (8 foot) on center and within 1 foot of all boxes and bends.
- C. Support multiple conduit runs with trapeze hangers. Use trapeze hangers that are designed to support a load equal to or greater than the sum of

the weights of the conduits, wires, hanger itself, and 200 lbs [90 kg]. Attach each conduit with U-bolts or other approved fasteners.

- D. Support conduit independently of junction boxes, pull-boxes, fixtures, suspended ceiling T-bars, angle supports, and similar items.
- E. Fasteners and Supports in Solid Masonry and Concrete:
  - 1. New Construction: Use steel or malleable iron concrete inserts set in place prior to placing the concrete.
  - 2. Existing Construction:
    - a. Steel expansion anchors not less than 0.25 in [6 mm] bolt size and not less than 1.125 in [28 mm] embedment.
    - b. Power set fasteners not less than 0.25 in [6 mm] diameter with depth of penetration not less than 3 in [75 mm].
    - c. Use vibration and shock-resistant anchors and fasteners for attaching to concrete ceilings.
- E. Hollow Masonry: Toggle bolts.
- F. Bolts supported only by plaster or gypsum wallboard are not acceptable.
- G. Metal Structures: Use machine screw fasteners or other devices specifically designed and approved for the application.
- H. Attachment by wood plugs, rawl plug, plastic, lead or soft metal anchors, or wood blocking and bolts supported only by plaster is prohibited.
- I. Chain, wire, or perforated strap shall not be used to support or fasten conduit.
- J. Spring steel type supports or fasteners are prohibited for all uses except horizontal and vertical supports/fasteners within walls.
- K. Vertical Supports: Vertical conduit runs shall have riser clamps and supports in accordance with the NEC and as shown. Provide supports for cable and wire with fittings that include internal wedges and retaining collars.

### **3.9 BOX INSTALLATION**

- A. Boxes for Concealed Conduits:
  - 1. Flush-mounted.
  - 2. Provide raised covers for boxes to suit the wall or ceiling, construction, and finish.
- B. In addition to boxes shown, install additional boxes where needed to prevent damage to cables and wires during pulling-in operations.

- C. Remove only knockouts as required and plug unused openings. Use threaded plugs for cast metal boxes and snap-in metal covers for sheet metal boxes.
- D. Outlet boxes mounted back-to-back in the same wall are prohibited. A minimum 24 in [600 mm] center-to-center lateral spacing shall be maintained between boxes.
- E. Minimum size of outlet boxes for ground fault interrupter (GFI) receptacles is 4 in [100 mm] square x 2.125 in [55 mm] deep, with device covers for the wall material and thickness involved.
- F. Stencil or install phenolic nameplates on covers of the boxes for control wiring; for example "SIG-FA JB No. 1" or "Nurse Call." All control wiring shall be stenciled as to the type of system installed within. In addition, the covers on all temperature controls related junction boxes shall be painted blue.
- G. On all branch circuit junction box covers, identify the circuits with black marker. Provide stenciled labels where junction boxes are installed in exposed finished areas.
- H. Provide support for all outlet boxes installed within steel studs on both sides of the outlet box, not just on the stud side of the box.

- - - E N D - - -

**SECTION 26 05 36**  
**CABLE TRAYS FOR ELECTRICAL SYSTEMS**

**PART 1 GENERAL**

**1.1 SECTION INCLUDES**

- A. Cable trays and accessories.
- B. Firestopping cable trays.

**1.2 RELATED REQUIREMENTS**

- A. Section 07 84 00 - Firestopping: Firestopping around cable trays.
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

**1.3 REFERENCES**

- A. ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2002.
- B. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2007.
- C. NEMA VE 1 - Metallic Cable Tray Systems; National Electrical Manufacturers Association; 2002.
- D. NFPA 70 - National Electrical Code; National Fire Protection Association; 2008.

**1.4 SUBMITTALS**

- A. See Section 01 33 23 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data for fittings and accessories.
- C. Shop Drawings: Indicate tray type, dimensions, support points, and finishes.
- D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Quality Assurance. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- E. Project Record Documents: Record actual routing of cable tray and locations of supports.

**1.5 QUALITY ASSURANCE**

- A. Conform to requirements of NFPA 70.
- B. Products: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

**PART 2 PRODUCTS**

**2.1 MANUFACTURERS**

- A. CABLOFIL - EZ Tray.

- B. B-line.
- C. Flextray.
- D. Chalfant.
- E. Or Equal.

## **2.2 WIRE BASKET TYPE CABLE TRAY**

- A. Description: Wire Basket Runway Cable Tray NEMA VE1.
- B. Material: Steel.
- C. Finish: ASTM A 510, electro zinc finish.
- D. Inside Width: 12 inches unless shown otherwise on the drawings.
- E. Inside Depth: 4 inches
- F. Straight Section Mesh Spacing: 4 inches on center, 2 inches in width.
- G. Provide manufacturers standard clamps, hangers, brackets, splice plates, reducer plates, blind ends, barrier strips, connectors, and grounding straps.
- H. Provide support brackets to mount tray to wall or structure.
- I. Provide bending radius clips.

## **2.3 GROUNDING**

- A. Provide grounding lug and bond all sections to building grounding system.

## **PART 3 EXECUTION**

### **3.1 EXAMINATION**

- A. Verify that field measurements are as on shop drawings.

### **3.2 INSTALLATION**

- A. Install metallic cable tray in accordance with NEMA VE 1.
- B. Support trays in accordance with Section 26 05 29. Provide supports at each connection point, at the end of each run, and at other points to maintain spacing between supports of 8 ft maximum.
- C. Use expansion connectors where required.
- D. Provide firestopping under provisions of Section 07 84 00 and 26 05 33 to sustain ratings when passing cable tray through fire-rated elements.
- E. Properly seal around cable tray passing through partitions to prevent passage of smoke and flame. Provide fireproofing which preserves the fire resistant rating of the partition and can be removed and replaced for future cable routing requirements.
- F. Provide fireproofing pillows where cable tray passes through partitions. See Specification Section 07 84 00 and 27 10 05 and 26 05 33.
- G. Ground and bond cable tray under provisions of Section 26 05 26.
  - 1. Provide continuity between tray components.
  - 2. Provide 2 AWG bare copper equipment grounding conductor to bond each

section of tray; bond to each component.

3. Connections to tray may be made using mechanical or exothermic connectors.

- - - END - - -



**SECTION 26 05 41**  
**UNDERGROUND ELECTRICAL CONSTRUCTION**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the furnishing, installation, and connection of precast manholes and pullboxes with ducts to form a complete underground raceway system.
- B. "Duct" and "conduit," and "rigid metal conduit" and "rigid steel conduit" are used interchangeably in this specification.

**1.2 RELATED WORK**

- A. Section 07 92 00, JOINT SEALANTS: Sealing of conduit penetrations.
- B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.
- C. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.
- D. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits, fittings and boxes for raceway systems.
- E. Section 31 20 00, EARTH MOVING: Trenching, backfill and compaction.

**1.3 QUALITY ASSURANCE**

- A. Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. Coordinate layout and installation of ducts, manholes, pullboxes, and pull-boxes with final arrangement of other utilities, site grading, and surface features, as determined in the field.

**1.4 SUBMITTALS**

- A. Submit in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. Shop Drawings:
  - 1. Clearly present sufficient information to determine compliance with drawings and specifications.
  - 2. Include manholes, pullboxes, duct materials, and hardware. Submit plan and elevation drawings, showing openings, pulling irons, cable supports, cover, ladder, sump, and other accessories and details.
  - 3. Proposed deviations from details on the drawings shall be clearly marked on the submittals. If it is necessary to locate manholes or pullboxes at locations other than shown on the drawings, show the

proposed locations accurately on scaled site drawings, and submit four copies to the Project Engineer for approval prior to construction.

#### 1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. American Concrete Institute (ACI):
  - Building Code Requirements for Structural Concrete
  - 318/318M-05.....Building Code Requirements for Structural Concrete & Commentary
  - SP-66-04.....ACI Detailing Manual
- C. American National Standards Institute (ANSI):
  - 77-07.....Underground Enclosure Integrity
- D. American Society for Testing and Materials (ASTM):
  - C478-09.....Standard Specification for Precast Reinforced Concrete Manhole Sections
  - C858-09.....Underground Precast Concrete Utility Structures
  - C990-09.....Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants.
- E. Institute of Electrical and Electronic Engineers (IEEE):
  - C2-07 .....National Electrical Safety Code
- F. National Electrical Manufacturers Association (NEMA):
  - TC 2-03.....Electrical Polyvinyl Chloride (PVC) Tubing And Conduit
  - TC 3-2004.....PVC Fittings for Use With Rigid PVC Conduit And Tubing
  - TC 6 & 8 2003.....PVC Plastic Utilities Duct For Underground Installations
  - TC 9-2004.....Fittings For PVC Plastic Utilities Duct For Underground Installation
- G. National Fire Protection Association (NFPA):
  - 70-08.....National Electrical Code (NEC)
- H. Underwriters Laboratories, Inc. (UL):
  - 6-07.....Electrical Rigid Metal Conduit-Steel
  - 467-07.....Grounding and Bonding Equipment

651-05.....Schedule 40 and 80 Rigid PVC Conduit and  
Fittings

651A-00.....Type EB and A Rigid PVC Conduit and HDPE  
Conduit

651B-07.....Continuous Length HDPE Conduit

I. U.S. General Services Administration (GSA):

A-A-60005-1998.....Frames, Covers, Gratings, Steps, Sump and Catch  
Basin, Manhole

## 1.6 STORAGE

Lift and support pre-cast concrete structures only at designated  
lifting or supporting points.

## PART 2 - PRODUCTS

### 2.2 PULLBOXES

- A. General: Size as indicated on drawings. Provide pullboxes with weatherproof, non-skid covers with recessed hook eyes, secured with corrosion- and tamper-resistant hardware. Cover material shall be identical to pullbox material. Covers shall have molded lettering, ELECTRIC or SIGNAL as applicable. Pullboxes shall comply with the requirements of ANSI/SCTE 77 Tier 8 loading. Provide pulling irons, 0.875 in [22 mm] diameter galvanized steel bar with exposed triangular-shaped opening.
- B. Polymer Concrete Pullboxes: Shall be molded of sand, aggregate, and polymer resin, and reinforced with steel, fiberglass, or both. Pullbox shall have open bottom. See detail on the drawings for information.

### 2.3. DUCTS

- A. Number and sizes shall be as shown on drawings.
- B. Ducts (concrete-encased):
  - 1. Plastic Duct:
    - a. NEMA TC6 & 8 and TC9 plastic utilities duct UL 651 and 651A Schedule 40 PVC.
    - b. Duct shall be suitable for use with 194° F [90° C] rated conductors.
  - 2. Conduit Spacers: Prefabricated plastic.
- C. Ducts (direct-burial):
  - 1. Plastic duct:
    - a. NEMA TC2 and TC3
    - b. UL 651, 651A, and 651B, Schedule 40 PVC.

c. Duct shall be suitable for use with 167° F [75° C] rated conductors.

2. Rigid metal conduit: UL6 and NEMA RN1 galvanized rigid steel, threaded type, half-lapped with 10 mil PVC tape.

#### **2.4 GROUNDING**

A. Rods: Per Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.

B. Ground Wire: Stranded bare copper 6 AWG [16 mm<sup>2</sup>] minimum.

#### **2.5 WARNING TAPE**

A. Standard 4-mil polyethylene 3 in [76 mm] wide detectable tape, red with black letters, imprinted with "CAUTION - BURIED ELECTRIC CABLE BELOW" or similar.

#### **2.6 PULL ROPE FOR SPARE DUCTS**

A. Plastic with 200 lb [890 N] minimum tensile strength.

### **PART 3 - EXECUTION**

#### **3.1 PULLBOX INSTALLATION**

A. Assembly and installation shall follow the printed instructions and recommendations of the manufacturer. Install pullboxes level and plumb.

1. Units shall be installed on a 12 in [300 mm] level bed of 90% compacted granular fill, well-graded from the 1 in [25 mm] sieve to the No. 4 sieve. Granular fill shall be compacted with a minimum of four passes with a plate compactor.

2. Seal duct terminations so they are watertight.

B. Access: Ensure the top of frames and covers are flush with finished grade.

C. Grounding in Existing Manholes:

1. Install a No. 3/0 AWG [95 mm<sup>2</sup>] bare copper ring grounding conductor around the inside perimeter of the manhole and anchor to the walls with metallic cable clips.

2. Connect the ring grounding conductor to the ground rod by an exothermic welding process.

3. Bond the ring grounding conductor to the duct bank equipment grounding conductors, the exposed non-current carrying metal parts of racks, sump covers, and like items in the manholes with a minimum No. 6 AWG [16 mm<sup>2</sup>] bare copper jumper.

#### **3.2 TRENCHING**

A. Refer to Section 31 20 00, EARTH MOVING for trenching, backfilling, and compaction.

- B. Before performing trenching work at existing facilities, the Ground Penetrating Radar Survey shall be carefully performed by certified technician to reveal all existing underground ducts, conduits, cables, and other utility systems.
- C. Work with extreme care near existing ducts, conduits, cables, and other utilities to avoid damaging them.
- D. Cut the trenches neatly and uniformly.
- E. For Concrete-Encased Ducts:
  - 1. After excavation of the trench, stakes shall be driven in the bottom of the trench at 4 ft [1.2 M] intervals to establish the grade and route of the duct bank.
  - 2. Pitch the trenches uniformly toward manholes or both ways from high points between manholes for the required duct line drainage. Avoid pitching the ducts toward buildings wherever possible.
  - 3. The walls of the trench may be used to form the side walls of the duct bank, provided that the soil is self-supporting and that concrete envelope can be poured without soil inclusions. Forms are required where the soil is not self-supporting.
  - 4. After the concrete-encased duct has sufficiently cured, the trench shall be backfilled to grade with earth, and appropriate warning tape installed.
- F. Conduits to be installed under existing paved areas and roads that cannot be disturbed shall be jacked into place. Conduits shall be heavy wall rigid steel.

### **3.3 DUCT INSTALLATION**

- A. General Requirements:
  - 1. Ducts shall be in accordance with the NEC and IEEE C2, as shown on the drawings, and as specified.
  - 2. Slope ducts to drain towards manholes and pullboxes, and away from building and equipment entrances. Pitch not less than 4 in [100 mm] in 100 ft [30 M].
  - 3. Underground conduit stub-ups and sweeps to equipment inside of buildings shall be taped galvanized rigid steel, and shall extend a minimum of 5 ft [1.5 M] outside the building foundation. Tops of conduits below building slab shall be minimum 24 in [610 mm] below bottom of slab.

4. Stub-ups, sweeps, and risers to equipment mounted on outdoor concrete slabs shall be taped galvanized rigid steel, and shall extend a minimum of 5 ft [1.5 M] away from the edge of slab.
  5. Install insulated grounding bushings on the terminations.
  6. Radius for turns of direction shall be sufficient to accomplish pulls without damage. Minimum radius shall be six times conduit diameter. Use manufactured long sweep bends.
  7. Additional burial depth shall be required in order to accomplish NEC-required minimum bend radius of ducts.
  8. All multiple conduit runs shall have conduit spacers. Spacers shall securely support and maintain uniform spacing of the duct assembly a minimum of 3 in [75 mm] above the bottom of the trench during the concrete pour. Spacer spacing shall not exceed 5 ft [1.5 M]. Secure spacers to ducts and earth to prevent floating during concrete pour. Provide nonferrous tie wires to prevent displacement of the ducts during pouring of concrete. Tie wires shall not act as substitute for spacers.
  9. Duct lines shall be installed no less than 12 in [300 mm] from other utility systems, such as water, sewer, and chilled water.
  10. Clearances between individual ducts:
    - a. For like services, not less than 3 in [75 mm].
    - b. For power and signal services, not less than 6 in [150 mm].
  11. Duct lines shall terminate at window openings in manhole walls as shown on the drawings. All ducts shall be fitted with end bells.
  12. Couple the ducts with proper couplings. Stagger couplings in rows and layers to ensure maximum strength and rigidity of the duct bank.
  13. Keep ducts clean of earth, sand, or gravel, and seal with tapered plugs upon completion of each portion of the work.
  14. Seal conduits, including spare conduits, at building entrances and at outdoor equipment terminations with a suitable compound to prevent entrance of moisture and gases.
- B. Concrete-Encased Ducts and Conduits:
1. Install concrete-encased ducts for medium-voltage systems, low-voltage systems, and signal systems, unless otherwise shown on the drawings.
  2. Duct lines shall consist of single or multiple duct assemblies encased in concrete. Ducts shall be uniform in size and material throughout the installation.

3. Tops of concrete-encased ducts shall be:
    - a. Not less than 24 in [600 mm] and not less than shown on the drawings, below finished grade.
    - b. Not less than 30 in [750 mm] and not less than shown on the drawings, below roads and other paved surfaces.
    - c. Conduits crossing under grade slab construction joints shall be installed a minimum of 4 ft [1.2 M] below slab.
  4. Extend the concrete envelope encasing the ducts not less than 3 in [75 mm] beyond the outside walls of the outer ducts and conduits.
  5. Within 10 ft [3 M] of building manhole and pullbox wall penetrations, install reinforcing steel bars at the top and bottom of each concrete envelope to provide protection against vertical shearing.
  6. Install reinforcing steel bars at the top and bottom of each concrete envelope of all ducts underneath roadways and parking areas.
  7. Where new ducts, conduits, and concrete envelopes are to be joined to existing manholes, pullboxes, ducts, conduits, and concrete envelopes, make the joints with the proper fittings and fabricate the concrete envelopes to ensure smooth durable transitions.
  8. Conduit joints in concrete may be placed side by side horizontally, but shall be staggered at least 6 in [150 mm] vertically.
  9. Pour each run of concrete envelope between manholes or other terminations in one continuous pour. If more than one pour is necessary, terminate each pour in a vertical plane and install 0.75 in [19 mm] reinforcing rod dowels extending 18 in [450 mm] into concrete on both sides of joint near corners of envelope.
  10. Pour concrete so that open spaces are uniformly filled. Do not agitate with power equipment unless approved by Project Engineer.
- B. Direct-Burial Duct and Conduits:
1. Install direct-burial ducts and conduits only where shown on the drawings. Provide direct-burial ducts only for low-voltage systems.
  2. Join and terminate ducts and conduits with fittings recommended by the conduit manufacturer.
  3. Tops of ducts and conduits shall be:
    - a. Not less than 24 in [600 mm] and not less than shown on the drawings, below finished grade.

- b. Not less than 30 in [750 mm] and not less than shown on the drawings, below roads and other paved surfaces.
- 4. Do not kink the ducts or conduits. Compaction shall not deform the ducts.
- D. Concrete-Encased and Direct-Burial Duct and Conduit Identification: Place continuous strip of warning tape approximately 12 in [300 mm] above ducts or conduits before backfilling trenches. Warning tape shall be preprinted with proper identification.
- E. Spare Ducts and Conduits: Where spare ducts are shown, they shall have a nylon pull rope installed. They shall be capped at each end and labeled as to location of the other end.
- F. Duct and Conduit Cleaning:
  - 1. Upon completion of the duct installation, a standard flexible mandrel shall be pulled through each duct to loosen particles of earth, sand, or foreign material left in the duct. The mandrel shall be not less than 12 in [3600 mm] long, and shall have a diameter not less than 0.5 in [13 mm] less than the inside diameter of the duct. A brush with stiff bristles shall then be pulled through each duct to remove the loosened particles. The diameter of the brush shall be the same as, or slightly larger than, the diameter of the duct.
  - 2. Mandrel pulls shall be witnessed by the Project Engineer.
- G. Duct and Conduit Sealing: Seal the ducts and conduits at building entrances, and at outdoor terminations for equipment, with a suitable non-hardening compound to prevent the entrance of moisture and gases.
- H. Connections to Existing Manholes: For duct connections to existing manholes, break the structure wall out to the dimensions required and preserve the steel in the structure wall. Cut steel and extend into the duct bank envelope. Chip the perimeter surface of the duct bank opening to form a key or flared surface, providing a positive connection with the duct bank envelope.
- I. Partially-Completed Duct Banks: During construction, wherever a construction joint is necessary in a duct bank, prevent debris such as mud and dirt from entering ducts by providing suitable conduit plugs. Fit concrete envelope of a partially completed duct bank with reinforcing steel extending a minimum of 2 ft [0.6 M] back into the envelope and a minimum of 2 ft [0.6 M] beyond the end of the envelope. Provide one No. 4 bar in each corner, 3 in [75 mm] from the edge of the envelope. Secure corner bars with two No. 3 ties, spaced approximately



12 in [300 mm] apart. Restrain reinforcing assembly from moving during pouring of concrete.

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**SECTION 26 24 11**  
**DISTRIBUTION SWITCHBOARDS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the furnishing, installation, and connection of the distribution switchboards.

**1.2 RELATED WORK**

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.
- B. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Cables and wiring.
- C. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for Personnel Safety and to provide a low impedance path for possible fault currents.
- D. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduit and outlet boxes.
- E. Section 26 43 13, TRANSIENT-VOLTAGE SURGE SUPPRESSION: TVSS equipment for distribution switchboards.

**1.3 QUALITY ASSURANCE**

- A. Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

**1.4 FACTORY TESTS**

- A. Distribution switchboards shall be thoroughly tested at the factory to assure that there are no electrical or mechanical defects. Tests shall be conducted as per NEMA PB 2 and UL 891. Factory tests shall be certified.
- B. The following additional tests shall be performed:
1. Verify that circuit breaker sizes and types correspond to drawings and coordination study.
  2. Verify tightness of bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
  3. Confirm correct operation and sequencing of electrical and mechanical interlock systems by attempting closure on locked-open devices, and attempting to open locked-closed devices, and making key exchange with devices operated in off-normal positions.
  4. Exercise all active components.

5. Perform a dielectric withstand voltage test on each bus section, each phase-to-ground with phases not under test grounded, in accordance with manufacturer's published data.
  6. Perform insulation-resistance tests on control wiring with respect to ground. Applied potential shall be 500 volts dc for 300-volt rated cable and 1000 volts dc for 600-volt rated cable, or as required if solid-state components or control devices cannot tolerate the applied voltage.
  7. If applicable, verify correct function of control transfer relays located in the switchboard with multiple control power sources.
  8. Perform phasing checks on double-ended or dual-source switchboards to insure correct bus phasing from each source.
- C. Furnish four (4) copies of certified manufacturer's factory test reports to the Project Engineer prior to shipment of the switchboards to ensure that the switchboards have been successfully tested as specified.

#### **1.5 SUBMITTALS**

Submit in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS:

##### **A. Shop Drawings:**

1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
2. Include electrical ratings, dimensions, mounting details, materials, required clearances, terminations, weight, temperature rise, wiring and connection diagrams, plan, front, side, and rear elevations, sectional views, bus work, circuit breaker frame sizes, trip and short-circuit rating, long-time, short-time, instantaneous and ground fault settings, coordinated breaker and fuse curves, accessories, and device nameplate data.
3. Show the size, ampere-rating, number of bars per phase and neutral in each bus run (horizontal and vertical), bus spacing, equipment ground bus, and bus material.

##### **B. Manuals:**

1. Submit, simultaneously with the shop drawings, companion copies of complete maintenance and operating manuals including technical data sheets, wiring diagrams, and information for ordering replacement parts.

- a. Wiring diagrams shall have their terminals identified to facilitate installation, maintenance, and operation.
  - b. Wiring diagrams shall indicate internal wiring for each item of equipment and the interconnection between the items of equipment.
  - c. Provide a clear and concise description of operation, which gives, in detail, the information required to properly operate the equipment.
  - d. Approvals will be based on complete submissions of manuals together with shop drawings.
2. Two weeks prior to final inspection, deliver four copies of the final updated maintenance and operating manuals to the Resident Engineer.
- a. The manuals shall be updated to include any information necessitated by shop drawing approval.
  - b. Complete "As Installed" wiring and schematic diagrams shall be included which show all items of equipment and their interconnecting wiring.
  - c. Show all terminal identification.
  - d. Include information for testing, repair, trouble shooting, assembly, disassembly, and recommended maintenance intervals.
  - e. Provide a replacement parts list with current prices. Include a list of recommended spare parts, tools, and instruments for testing and maintenance purposes.
  - f. Furnish manuals in loose-leaf binder or manufacturer's standard binder.
- C. Certifications:
- 1. Two weeks prior to final inspection, submit four copies of the following to the Resident Engineer:
    - a. Certification by the Contractor that the assemblies have been properly installed, adjusted and tested, including circuit breakers settings.
    - b. Certified copies of all of the factory design and production tests, field test data sheets and reports for the assemblies.

#### **1.6 APPLICABLE PUBLICATIONS**

Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by basic designation only.

- A. Institute of Engineering and Electronic Engineers (IEEE):
  - C37.13.....Low Voltage AC Power Circuit Breakers Used in Enclosures
  - C57.13.....Instrument Transformers
  - C62.41.....Surge Voltage in Low Voltage AC Power Circuits
  - C62.45.....Surge Testing for Equipment connected to Low-Voltage AC Power Circuits
- B. National Electrical Manufacturer's Association (NEMA):
  - PB-2.....Dead-Front Distribution Switchboards.
  - PB-2.1.....Instructions for Proper Handling, Installation, Operation, and Maintenance of Switchboards
  - AB-1.....Molded Case Circuit Breakers, Molded Case Switches and Circuit Breaker Enclosures
- C. National Fire Protection Association (NFPA):
  - 70.....National Electrical Code (NEC)
- D. Underwriters Laboratories, Inc. (UL):
  - 67.....Panelboards
  - 489.....Molded Case Circuit Breakers and Circuit Breakers Enclosures
  - 891.....Dead-Front Switchboards
  - 1283.....Electromagnetic Interference Filters
  - 1449.....Transient Voltage Surge Suppressors

## **PART 2 - PRODUCTS**

### **2.1 GENERAL**

- A. Switchboards shall be in accordance with UL, NEMA, NEC, IEEE, and as shown on the drawings.
- B. Switchboards shall be provided complete, ready for operation including, but not limited to housing, buses, circuit breakers, instruments and related transformers, fuses, and wiring.
- C. Switchboard dimensions shall not exceed the dimensions shown on the drawings.
- D. Manufacturer's nameplate shall include complete ratings of switchboard in addition to the date of manufacture.

### **2.2 BASIC ARRANGEMENT**

- A. Type I: Switchboard shall be front accessible with the following features:
  - 1. Device mounting:
    - a. Main breaker: Individually mounted and draw-out construction.

- b. Feeder breakers: Group fixed mounted.
- 2. Section alignment: As shown on the drawings.
- 3. Accessibility:
  - a. Main section line and load terminals: Front and side.
  - b. Distribution section line and load terminals: Front.
  - c. Through bus connections: Front and end.
- 4. Bolted line and load connections.
- 5. Full height wiring gutter covers for access to wiring terminals.
- 6. Short Circuit Current Rating: 65,000 amperes rms symmetrical, minimum, or as shown on the drawings, whichever is higher.

### **2.3 HOUSING**

- A. Provide a completely enclosed, free standing, steel enclosure not less than the gage required by the ANSI and UL standards. The enclosure is to consist of the required number of vertical sections bolted together to form one metal enclosed rigid switchboard. The sides, top and rear shall be covered with removable screw on sheet steel plates.
- B. Provide ventilating louvers where required to limit the temperature rise of current carrying parts. All openings shall be protected against entrance of falling dirt, water, or foreign matter.
- C. Enclosure shall be thoroughly cleaned, phosphate treated, and primed with rust-inhibiting paint. Final finish coat to be the manufacturers standard gray. Provide a quart of finish paint for touch-up purposes.

### **2.4 BUSES**

- A. General: Buses shall be arranged for 3 phase, 4 wire distribution. Main phase buses (through bus), full size neutral bus, and ground bus shall be full capacity the entire length of the switchboard. Provide for future extensions by means of bolt holes or other approved method. Brace the bus to withstand the available short circuit current at the particular location and as shown on the drawings. No magnetic material shall be used between buses to form a magnetic loop.
- B. Material and Size: Buses and connections shall be hard drawn copper of 98 percent conductivity. Bus temperature rise shall not exceed 65 degrees C (149 degrees F). Section busing shall be sized based on UL and NEMA Switchboard Standards.
- C. Bus Connections: All contact surfaces shall be copper. Provide a minimum of two plated bolts per splice. Where physical bus size permits only one bolt, provide a means other than friction to prevent turning,

twisting or bending. Torque bolts to the manufacturer's recommended values.

- D. Neutral Bus: Provide bare or plated bus and mount on insulated bus supports. Provide neutral disconnect link to permit isolation of neutral bus from the common ground bus and service entrance conductors.
- E. Ground Bus: Provide an uninsulated 6 mm by 50 mm (1/4 inch by 2 inch) copper equipment ground bus bar sized per UL 891 the length of the switchboard and secure at each section.
- F. Main Bonding Jumper: Connect an uninsulated 1/4 inch by 2 inch (6mm by 50 mm) copper bus between the neutral and ground buses to establish the system common ground point.

## **2.5 TRANSIENT VOLTAGE SURGE SUPPRESSION**

- A. Refer to Section 26 43 13, TRANSIENT-VOLTAGE SURGE SUPPRESSION.

## **2.6 NAMEPLATES AND MIMIC BUS**

- A. Nameplates: For Normal Power system, provide laminated black phenolic resin with white core with 1/2 inch [12mm] engraved lettered nameplates next to each circuit breaker. For Essential Electrical System, provide laminated red phenolic resin with white core with 1/2 inch [12mm] engraved lettered nameplates next to each circuit breaker. Nameplates shall indicate equipment served, spaces, or spares in accordance with one line diagram shown on drawings. Nameplates shall be mounted with plated screws on front of breakers or on equipment enclosure next to breakers. Mounting nameplates only with adhesive is not acceptable.

## **2.7 PROVISION FOR FUTURE**

- A. Where "provision for", "future", or "space" is noted on drawings, the space shall be equipped with bus connections to the future overcurrent device with suitable insulation and bracing to maintain proper short circuit rating and physical clearance. Provide buses for the ampere rating as shown for the future device.

## **2.8 BREAKER REMOVAL EQUIPMENT**

- A. Where draw out circuit breakers are provided, furnish a portable elevating carriage or switchboard permanent top mounted device for installation and removal of the breakers.

## **2.9 CONTROL WIRING**

- A. Control wiring shall be 600 volt class B stranded SIS. Install all control wiring complete at the factory adequately bundled and protected. Wiring across hinges and between shipping units shall be

Class C stranded. Size in accordance with NEC. Provide control circuit fuses.

## **2.10 MAIN CIRCUIT BREAKERS**

- A. Type I Switchboard: Provide UL listed and labeled insulated case, stored energy, drawout circuit breakers in accordance with NEC and as shown on the drawings. Circuit breakers shall be the solid state adjustable trip type.
  - 1. Trip units shall have field adjustable tripping characteristics as follows:
    - a. Ampere setting (continuous).
    - b. Long time band, both adjustable delay and trip settings.
    - c. Short time trip point.
    - d. Short time delay.
    - e. Instantaneous trip point.
  - 2. Trip settings shall be as indicated on the drawings. Final settings shall be as instructed by the Project Engineer.
  - 3. Breakers, which have same rating, shall be interchangeable with each other.
  - 4. Padlocking: Include provisions for padlocking the breaker in the open position.
  - 5. The tie breaker in the main switchboard shall be stationary mount. The main breaker within the generator switchboard may be stationary mount.
  - 6. Circuit breakers shall be selectively coordinated with all downstream breakers associated with the equipment branches, critical branch and life safety branch to meet NEC article 517 requirements. Shop drawings shall indicate the breakers are selectively coordinated based on the manufacturer tables. List the string of breakers by use of a spreadsheet that are coordinated and highlight in the tables how they meet the requirements. It shall be clear in the shop drawings that the breakers are coordinated.

## **2.11 FEEDER CIRCUIT BREAKERS**

- A. Provide UL listed and labeled molded case circuit breakers, in accordance with the NEC, as shown on the drawings, and as herein specified.
- B. Non-adjustable Trip Molded Case Circuit Breakers:
  - 1. Molded case circuit breakers shall have automatic, trip free, non-adjustable, inverse time, and instantaneous magnetic trips for 100



ampere frame size or less. Magnetic trip shall be adjustable from 3X to 10X for breakers with 600 ampere frame size and higher. Factory setting shall be LOW unless otherwise noted.

2. Breaker features shall be as follows:

- a. A rugged, integral housing of molded insulating material.
- b. Silver alloy contacts.
- c. Arc quenchers and phase barriers for each pole.
- d. Quick-make, quick-break, operating mechanisms.
- e. A trip element for each pole, thermal magnetic type with long time delay and instantaneous characteristics, a common trip bar for all poles and a single operator.
- f. Electrically and mechanically trip free.
- g. An operating handle which indicates ON, TRIPPED and OFF positions.
- h. Line and load connections shall be bolted.
- i. Interrupting rating shall not be less than the maximum short circuit current available at the line.
- j. An overload on one pole of a multipole breaker shall automatically cause all the poles of the breaker to open.

C. Adjustable Trip Molded Case Circuit Breakers:

- 1. Provide molded case, solid state adjustable trip type circuit breakers where shown on the drawings.
- 2. Trip units shall have field adjustable tripping characteristics as follows:
  - a. Ampere setting (continuous).
  - b. Long time band, both adjustable delay and trip settings.
  - c. Short time trip point.
  - d. Short time delay.
  - e. Instantaneous trip point.
- 3. Trip settings shall be as indicated on the drawings. Final settings shall be shown on the electrical system protective device study.
- 4. Breakers, which have same rating, shall be interchangeable with each other.
- 5. Circuit breakers shall be selectively coordinated with all downstream breakers associated with the equipment branches, critical branch and life safety branch to meet NEC article 517 requirements. Shop drawings shall indicate the breakers are selectively coordinated based on the manufacturer tables. List the string of

breakers by use of a spreadsheet that are coordinated and highlight in the tables how they meet the requirements. It shall be clear in the shop drawings that the breakers are coordinated.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Install the switchboard in accordance with the NEC, as shown on the drawings, and as recommended by the manufacturer.
- B. Anchor switchboard to the slab with plated 1/2 inch [12.5mm] minimum anchor bolts, or as recommended by the manufacturer.
- C. Interior Location. Mount switchboard on concrete slab. Unless otherwise indicated, the slab shall be at least 4 inches [100mm] thick. The top of the concrete slab shall be approximately 4 inches [100mm] above finished floor. Edges above floor shall have 1/2 inch [12.5mm] chamfer. The slab shall be of adequate size to project at least 8 inches [200mm] beyond the equipment. Provide conduit turnups and cable entrance space required by the equipment to be mounted. Seal voids around conduit openings in slab with water- and oil-resistant caulking or sealant. Cut off and bush conduits 3 inches [75mm] above slab surface. Concrete work shall be as specified in Section 03 30 00, CAST-IN-PLACE CONCRETE.

#### **3.2 ACCEPTANCE CHECKS AND TESTS**

- A. Perform in accordance with the manufacturer's recommendations. Include the following visual and mechanical inspections and electrical tests:
  - 1. Visual and Mechanical Inspection
    - a. Compare equipment nameplate data with specifications and approved shop drawings.
    - b. Inspect physical, electrical, and mechanical condition.
    - c. Confirm correct application of manufacturer's recommended lubricants.
    - d. Verify appropriate anchorage, required area clearances, and correct alignment.
    - e. Verify that circuit breaker sizes and types correspond to approved shop drawings.
    - f. Verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey after energization.
    - g. Confirm correct operation and sequencing of electrical and mechanical interlock systems.

- h. Clean switchboard.
  - i. Inspect insulators for evidence of physical damage or contaminated surfaces.
  - j. Verify correct shutter installation and operation.
  - k. Exercise all active components.
  - l. Verify the correct operation of all sensing devices, alarms, and indicating devices.
  - m. If applicable, verify that vents are clear.
  - n. If applicable, inspect control power transformers.
2. Electrical Tests
- a. Perform insulation-resistance tests on each bus section.
  - b. Perform overpotential tests.
  - c. Perform insulation-resistance test on control wiring; do not perform this test on wiring connected to solid-state components.
  - d. Perform phasing check on double-ended switchboard to ensure correct bus phasing from each source.

### **3.3 FOLLOW-UP VERIFICATION**

- A. Upon completion of acceptance checks, settings, and tests, the Contractor shall show by demonstration in service that the switchboard is in good operating condition and properly performing the intended function. Circuit breakers shall be tripped by operation of each protective device.

### **3.4 INSTRUCTION**

- A. Furnish the services of a factory certified instructor for one 4 hour period for instructing personnel in the operation and maintenance of the switchboard and related equipment on the date requested by the Project Engineer.

### **3.5 ARC FLASH LABELS**

- A. Provide ARC flash identification per NFPA 70E and the existing labeling system at the VAMC Fargo. Exact orientation and information required on the labels will be provided to the contractor. Coordinate exact label requirements with the Project Engineer prior to printing the labels.

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**SECTION 26 24 16**  
**PANELBOARDS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the furnishing, installation, and connection of panelboards.

**1.2 RELATED WORK**

- A. Section 09 91 00, PAINTING: Identification and painting of panelboards.
- B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one Section of Division 26.
- C. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Cables and wiring.
- D. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.
- E. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits and outlet boxes.

**1.3 QUALITY ASSURANCE**

- A. Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

**1.4 SUBMITTALS**

- A. Submit in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. Shop Drawings:
  - 1. Sufficient information, shall be clearly presented to determine compliance with drawings and specifications.
  - 2. Include electrical ratings, dimensions, mounting details, materials, wiring diagrams, accessories, and weights of equipment. Complete nameplate data, including manufacturer's name and catalog number.
- C. Manuals:
  - 1. When submitting the shop drawings, submit companion copies of complete maintenance and operating manuals, including technical data sheets and wiring diagrams.
  - 2. If changes have been made to the maintenance and operating manuals that were originally submitted, then submit four copies of updated maintenance and operating manuals to the Project Engineer two weeks prior to final inspection.

## 1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. National Electrical Manufacturers Association (NEMA):
  - PB-1-06.....Panelboards
  - 250-08.....Enclosures for Electrical Equipment (1000V Maximum)
- C. National Fire Protection Association (NFPA):
  - 70-2005 .....National Electrical Code (NEC)
  - 70E-2004.....Standard for Electrical Life Safety in the Workplace
- D. Underwriters Laboratories, Inc. (UL):
  - 50-95.....Enclosures for Electrical Equipment
  - 67-09.....Panelboards
  - 489-09.....Molded Case Circuit Breakers and Circuit Breaker Enclosures

## PART 2 - PRODUCTS

### 2.1 PANELBOARDS

- A. Panelboards shall be in accordance with UL, NEMA, NEC, and as shown on the drawings.
- B. Panelboards shall be standard manufactured products.
- C. All panelboards shall be hinged "door in door" type with:
  - 1. Interior hinged door with hand-operated latch or latches, as required to provide access only to circuit breaker operating handles, not to energized parts.
  - 2. Outer hinged door shall be securely mounted to the panelboard box with factory bolts, screws, clips, or other fasteners, requiring a tool for entry. Hand-operated latches are not acceptable.
  - 3. Push inner and outer doors shall open left to right.
- D. All panelboards shall be completely factory-assembled with molded case circuit breakers and integral accessories as scheduled on the drawings or specified herein. Include one-piece removable, inner dead front cover, independent of the panelboard cover.
- E. Panelboards shall have main breaker or main lugs, bus size, voltage, phase, top or bottom feed, and flush or surface mounting as scheduled on the drawings.

F. Panelboards shall conform to NEMA PB-1, NEMA AB-1, and UL 67 and have the following features:

1. Non-reduced size copper bus bars with current ratings as shown on the panel schedules, rigidly supported on molded insulators.
2. Bus bar connections to the branch circuit breakers shall be the "distributed phase" or "phase sequence" type.
3. Mechanical lugs furnished with panelboards shall be cast, stamped, or machined metal alloys of sizes suitable for the conductors to which they will be connected.
4. Neutral bus shall be 100% rated, mounted on insulated supports.
5. Grounding bus bar shall be equipped with screws or lugs for the connection of grounding wires.
6. Buses shall be braced for the available short-circuit current. Bracing shall not be less than 10,000 A symmetrical for 120/208 V and 120/240 V panelboards, and 14,000 A symmetrical for 277/480 V panelboards.
7. Branch circuit panelboards shall have buses fabricated for bolt-on type circuit breakers.
8. Protective devices shall be designed so that they can easily be replaced.
9. Where designated on panel schedule "spaces," include all necessary bussing, device support, and connections. Provide blank cover for each space.
10. In two section panelboards, the main bus in each section shall be full size. The first section shall be furnished with subfeed lugs on the line side of main lugs only, or through-feed lugs for main breaker type panelboards, and have cable connections to the second section. Panelboard sections with tapped bus or crossover bus are not acceptable.
11. Series-rated panelboards are not permitted.

## **2.2 CABINETS AND TRIMS**

Cabinets:

1. Provide galvanized steel cabinets to house panelboards. Cabinets for outdoor panelboards shall be factory primed and suitably treated with a corrosion-resisting paint finish meeting UL 50 and UL 67.
2. Cabinet enclosure shall not have ventilating openings.

3. Cabinets for panelboards may be of one-piece formed steel or of formed sheet steel with end and side panels welded, riveted, or bolted as required.
4. Keyed to match existing panelboards within the facility. Key shall be a Square D NSR251 only.

### **2.3 MOLDED CASE CIRCUIT BREAKERS FOR PANELBOARDS**

- A. Circuit breakers shall be per UL 489, in accordance with the NEC, as shown on the drawings, and as specified.
- B. Circuit breakers in panelboards shall be bolt-on type.
- C. Molded case circuit breakers shall have minimum interrupting rating as required to withstand the available fault current, but not less than:
  1. 120/208 V Panelboard: 10,000 A symmetrical.
  2. 120/240 V Panelboard: 10,000 A symmetrical.
  3. 277/480 V Panelboard: 14,000 A symmetrical.
- D. Molded case circuit breakers shall have automatic, trip free, non-adjustable, inverse time, and instantaneous magnetic trips for 100 A frame or lower. Magnetic trip shall be adjustable from 3x to 10x for breakers with 600 A frames and higher. Factory setting shall be HI, unless otherwise noted.
- E. Breaker features shall be as follows:
  1. A rugged, integral housing of molded insulating material.
  2. Silver alloy contacts.
  3. Arc quenchers and phase barriers for each pole.
  4. Quick-make, quick-break, operating mechanisms.
  5. A trip element for each pole, thermal magnetic type with long time delay and instantaneous characteristics, a common trip bar for all poles and a single operator.
  6. Electrically and mechanically trip free.
  7. An operating handle which indicates ON, TRIPPED, and OFF positions.
  8. An overload on one pole of a multipole breaker shall automatically cause all the poles of the breaker to open.
  9. Ground fault current interrupting breakers, shunt trip breakers, lighting control breakers (including accessories to switch line currents), or other accessory devices or functions shall be provided where indicated.
  10. For circuit breakers being added to existing panelboards, coordinate the breaker type with existing panelboards. Provide a new typed panel directory.

11. Circuit breakers shall be selectively coordinated with all upstream and downstream breakers associated with the equipment branch, critical branch and life safety branch to meet NEC article 517 requirements. Shop drawings shall indicate the breakers are selectively coordinated through use of a spreadsheet and manufacturer tables.

#### **2.4 SEPARATELY ENCLOSED MOLDED CASE CIRCUIT BREAKERS**

- A. Where separately enclosed molded case circuit breakers are shown on the drawings, provide circuit breakers in accordance with the applicable requirements of those specified for panelboards.
- B. Enclosures are to be of the NEMA types shown on the drawings. Where the types are not shown, they are to be the NEMA type most suitable for the environmental conditions where the circuit breakers are being installed.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Installation shall be in accordance with the manufacturer's instructions, the NEC, as shown on the drawings, and as specified.
- B. Locate panelboards so that the present and future conduits can be conveniently connected.
- C. Install a printed schedule of circuits in each panelboard after approval by the Project Engineer. Schedules shall be printed on the panelboard directory cards, installed in the appropriate panelboards, and incorporate all applicable contract changes. Information shall indicate outlets, lights, devices, or other equipment controlled by each circuit, and the final room numbers served by each circuit.
- D. Mount the fully-aligned panelboard such that the maximum height of the top circuit breaker above the finished floor shall not exceed 78 in [1980 mm]. Mount panelboards that are too high such that the bottom of the cabinets will not be less than 6 in [150 mm] above the finished floor.
- E. For panelboards located in areas accessible to the public, paint the exposed surfaces of the trims, doors, and boxes with finishes to match surrounding surfaces after the panelboards have been installed.
- F. Label each panelboard with the system voltage, and feeder sizes as shown on the riser diagram in 1/2 inch block lettering on the inside cover of the cabinet door. Include the words "LIFE SAFETY BRANCH", "CRITICAL BRANCH", or "EQUIPMENT SYSTEM" as applicable and the panel



designation in 1/2 inch block letters on the inside of the cabinet doors.

- G. Provide ARC flash identification per NFPA 70E and the existing labeling system at the VAMC Fargo. Exact orientation and information required on the labels will be provided to the contractor. Coordinate label requirements with the Project Engineer prior to printing labels.

### **3.2 ACCEPTANCE CHECKS AND TESTS**

Perform in accordance with the manufacturer's recommendations. Include the following visual and mechanical inspections and electrical tests:

#### **1. Visual and Mechanical Inspection**

- a. Compare equipment nameplate data with specifications and approved shop drawings.
- b. Inspect physical, electrical, and mechanical condition.
- c. Verify appropriate anchorage and required area clearances.
- d. Verify that circuit breaker sizes and types correspond to approved shop drawings.
- e. To verify tightness of accessible bolted electrical connections, use the calibrated torque-wrench method or perform thermographic survey after energization.
- f. Clean panelboard.

### **3.3 FOLLOW-UP VERIFICATION**

- A. Upon completion of acceptance checks, settings, and tests, the contractor shall demonstrate that the panelboards are in good operating condition and properly performing the intended function.

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**SECTION 26 27 26**  
**WIRING DEVICES**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the furnishing, installation and connection of wiring devices.

**1.2 RELATED WORK**

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements that are common to more than one section of Division 26.
- B. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits and outlets boxes.
- C. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Cables and wiring.
- D. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path to ground for possible ground fault currents.

**1.3 QUALITY ASSURANCE**

- A. Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

**1.4 SUBMITTALS**

- A. In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:
- B. Shop Drawings:
  - 1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
  - 2. Include electrical ratings, dimensions, mounting details, construction materials, grade and termination information.
- C. Manuals: Two weeks prior to final inspection, deliver two copies of the following to the Project Engineer: Technical data sheets and information for ordering replacement units in both bound hardcopy and electronic PDF versions.

**1.5 APPLICABLE PUBLICATIONS**

- A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by basic designation only.

- B. National Fire Protection Association (NFPA):
  - 70.....National Electrical Code (NEC)
- C. National Electrical Manufacturers Association (NEMA):
  - WD 1.....General Color Requirements for Wiring Devices
  - WD 6 .....Wiring Devices - Dimensional Requirements
- D. Underwriter's Laboratories, Inc. (UL):
  - 5.....Surface Metal Raceways and Fittings
  - 20.....General-Use Snap Switches
  - 231.....Power Outlets
  - 467.....Grounding and Bonding Equipment
  - 498.....Attachment Plugs and Receptacles
  - 943.....Ground-Fault Circuit-Interrupters

## **PART 2 - PRODUCTS**

### **2.1 RECEPTACLES**

- A. General: All receptacles shall be listed by Underwriters Laboratories, Inc., and conform to NEMA WD 6.
  - 1. Mounting straps shall be plated steel, with break-off plaster ears and shall include a self-grounding feature. Terminal screws shall be brass, brass plated or a copper alloy metal.
  - 2. Receptacles shall have provisions for back wiring with separate metal clamp type terminals (four min.) and side wiring from four captively held binding screws.
- B. Duplex Receptacles: Hospital-grade, single phase, 20 ampere, 120 volts, 2-pole, 3-wire, and conform to the NEMA 5-20R configuration in NEMA WD 6. The duplex type shall have break-off feature for two-circuit operation. The ungrounded pole of each receptacle shall be provided with a separate terminal.
  - 1. Bodies shall be ivory in color.
  - 2. Switched duplex receptacles shall be wired so that only the top receptacle is switched. The remaining receptacle shall be unswitched.
- 3. Duplex Receptacles on Emergency Circuit:
  - a. Bodies shall be red in color. Wall plates shall be red with the word "EMERGENCY" engraved in 6 mm, (1/4 inch) white letters.
  - b. All receptacles shall be labeled with the panel name and circuit number. Example: 12S1-5. The labels shall be self-adhesive type with clear background and black lettering, 3/16 inch high text.

4. Ground Fault Interrupter Duplex Receptacles: Shall be an integral unit, hospital-grade, suitable for mounting in a standard outlet box.
  - a. Ground fault interrupter shall be consist of a differential current transformer, solid state sensing circuitry and a circuit interrupter switch. Device shall have nominal sensitivity to ground leakage current of five milliamperes and shall function to interrupt the current supply for any value of ground leakage current above five milliamperes (+ or - 1 milliamp) on the load side of the device. Device shall have a minimum nominal tripping time of 1/30th of a second.
- C. Receptacles; 20, 30 and 50 ampere, 250 volts: Shall be complete with appropriate cord grip plug. Devices shall meet UL 231.
- D. Weatherproof Receptacles: Shall consist of a duplex receptacle, mounted in box with a gasketed, weatherproof, cast metal cover plate and cap over each receptacle opening. The cap shall be permanently attached to the cover plate by a spring-hinged flap. The weatherproof integrity shall not be affected when heavy duty specification or hospital grade attachment plug caps are inserted. Cover plates on outlet boxes mounted flush in the wall shall be gasketed to the wall in a watertight manner.

## **2.2 TOGGLE SWITCHES**

- A. Toggle Switches: Shall be totally enclosed tumbler type with bodies of phenolic compound. Toggle handles shall be ivory in color unless otherwise specified. The rocker type switch is not acceptable and will not be approved.
  1. Switches installed in hazardous areas shall be explosion proof type in accordance with the NEC and as shown on the drawings.
  2. Shall be single unit toggle, butt contact, quiet AC type, heavy-duty general-purpose use with an integral self grounding mounting strap with break-off plaster ears and provisions for back wiring with separate metal wiring clamps and side wiring with captively held binding screws.
  3. Ratings:
    - a. 120 volt circuits: 20 amperes at 120-277 volts AC.
    - b. 277 volt circuits: 20 amperes at 120-277 volts AC.

## **2.3 MANUAL DIMMING CONTROL**

- A. Slide dimmer with on/off control, single-pole or three-way as shown on plans. Faceplates shall be ivory in color unless otherwise specified.

- B. Manual dimming controls shall be fully compatible with electronic dimming ballasts and approved by the ballast manufacturer, shall operate over full specified dimming range, and shall not degrade the performance or rated life of the electronic dimming ballast and lamp.

#### **2.4 WALL PLATES**

- A. Wall plates for switches and receptacles shall be type 302 stainless steel. Oversize plates are not acceptable.
- B. Standard NEMA design, so that products of different manufacturers will be interchangeable. Dimensions for openings in wall plates shall be accordance with NEMA WD 6.
- C. For receptacles or switches mounted adjacent to each other, wall plates shall be common for each group of receptacles or switches.
- D. Wall plates for data, telephone or other communication outlets shall be as specified in the associated specification.
- E. Duplex Receptacles on Emergency Circuit:
  - 1. Bodies shall be red in color. Wall plates shall be red with the word "EMERGENCY" engraved in 6 mm, (1/4 inch) white letters.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Installation shall be in accordance with the NEC and as shown as on the drawings.
- B. Ground terminal of each receptacle shall be bonded to the outlet box with an approved green bonding jumper, and also connected to the green equipment grounding conductor.
- C. Outlet boxes for light and dimmer switches shall be mounted on the strike side of doors.
- D. Provide barriers in multigang outlet boxes to separate systems of different voltages, Normal Power and Emergency Power systems, and in compliance with the NEC.
- E. Coordinate with other work, including painting, electrical boxes and wiring installations, as necessary to interface installation of wiring devices with other work. Coordinate the electrical work with the work of other trades to ensure that wiring device flush outlets are positioned with box openings aligned with the face of the surrounding finish material. Pay special attention to installations in cabinet work, and in connection with laboratory equipment.
- F. Exact field locations of floors, walls, partitions, doors, windows, and equipment may vary from locations shown on the drawings. Prior to

locating sleeves, boxes and chases for roughing-in of conduit and equipment, the Contractor shall coordinate exact field location of the above items with other trades. In addition, check for exact direction of door swings so that local switches are properly located on the strike side.

- G. Install wall switches 48 inches [1200mm] above floor, OFF position down.
- H. Install wall dimmers 48 inches [1200mm] above floor; derate ganged dimmers as instructed by manufacturer; do not use common neutral.
- I. Install convenience receptacles 18 inches [450mm] above floor, and 6 inches [152mm] above counter backsplash or workbenches. Install specific-use receptacles at heights shown on the drawings.
- J. Label device plates with a permanent adhesive label listing panel and circuit feeding the wiring device.
- K. Test wiring devices for damaged conductors, high circuit resistance, poor connections, inadequate fault current path, defective devices, or similar problems using a portable receptacle tester. Correct circuit conditions, remove malfunctioning units and replace with new, and retest as specified above.
- L. Test GFCI devices for tripping values specified in UL 1436 and UL 943.
- M. Label all receptacles and switch plates with the panel name and circuit number serving it. Example: 10S1-5. Labels to be self adhesive type with clear background and black letters, 3/16 inch high letters.

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**SECTION 26 29 11**  
**MOTOR STARTERS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. All motor starters and variable speed motor controllers, including installation and connection (whether furnished with the equipment specified in other Divisions or otherwise), shall meet these specifications.

**1.2 RELATED WORK**

- A. Other sections which specify motor driven equipment, except elevator motor controllers.
- B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one Section of Division 26.
- C. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.

**1.3 QUALITY ASSURANCE**

- A. Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

**1.4 SUBMITTALS**

- A. Submit in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS:
- B. Shop Drawings:
  - 1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
  - 2. Include electrical ratings, dimensions, weights, mounting details, materials, running over current protection, size of enclosure, over current protection, wiring diagrams, starting characteristics, interlocking and accessories.
- C. Manuals:
  - 1. Submit, simultaneously with the shop drawings, companion copies of complete maintenance and operating manuals, including technical data sheets, wiring diagrams and information for ordering replacement parts.
    - a. Wiring diagrams shall have their terminals identified to facilitate installation, maintenance and operation.

- b. Wiring diagrams shall indicate internal wiring for each item of equipment and interconnections between the items of equipment.
  - c. Elementary schematic diagrams shall be provided for clarity of operation.
2. Two weeks prior to the project final inspection, submit four copies of the final updated maintenance and operating manual to the Project Engineer.

### 1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by basic designation only.
- B. Institute of Electrical and Electronic Engineers (IEEE):
  - 519.....Recommended Practices and Requirements for  
Harmonic Control in Electrical Power Systems
  - C37.90.1.....Standard Surge Withstand Capability (SWC) Tests  
for Protective Relays and Relay Systems
- C. National Electrical Manufacturers Association (NEMA):
  - ICS 1.....Industrial Control and Systems General  
Requirements
  - ICS 1.1.....Safety Guidelines for the Application,  
Installation and Maintenance of Solid State  
Control
  - ICS 2.....Industrial Control and Systems, Controllers,  
Contactors and Overload Relays Rated 600 Volts  
DC
  - ICS 6.....Industrial Control and Systems Enclosures
  - ICS 7.....Industrial Control and Systems Adjustable-Speed  
Drives
  - ICS 7.1.....Safety Standards for Construction and Guide for  
Selection, Installation and Operation of  
Adjustable-Speed Drive Systems
- D. National Fire Protection Association (NFPA):
  - 70.....National Electrical Code (NEC)
- E. Underwriters Laboratories Inc. (UL):
  - 508.....Industrial Control Equipment

### PART 2 - PRODUCTS



## 2.1 MOTOR STARTERS, GENERAL

- A. Shall be in accordance with the requirements of the IEEE, NEC, NEMA (ICS 1, ICS 1.1, ICS 2, ICS 6, ICS 7 and ICS 7.1) and UL.
- B. Shall have the following features:
  - 1. Separately enclosed unless part of another assembly.
  - 2. Circuit breakers and safety switches within the motor controller enclosures shall have external operating handles with lock-open padlocking provisions and shall indicate the ON and OFF positions.
  - 3. Motor control circuits:
    - a. Shall operate at not more than 120 volts.
    - b. Shall be grounded except as follows:
      - 1) Where isolated control circuits are shown.
      - 2) Where manufacturers of equipment assemblies recommend that the control circuits be isolated.
    - c. Incorporate a separate, heavy duty, control transformer within each motor controller enclosure to provide the control voltage for each motor operating over 120 volts.
    - d. Incorporate over current protection for both primary and secondary windings of the control power transformers in accordance with the NEC.
  - 4. Overload current protective devices:
    - a. Overload relay (solid state type).
    - c. One for each pole.
    - d. Manual reset on the door of each motor controller enclosure.
    - e. Correctly sized for the associated motor's rated full load current.
    - f. Check every motor controller after installation and verify that correct sizes of protective devices have been installed.
    - g. Deliver four copies of a summarized list to the Project Engineer, which indicates and adequately identifies every motor controller installed. Include the catalog numbers for the correct sizes of protective devices for the motor controllers.
  - 5. Hand-Off-Automatic (H-O-A) switch is required unless specifically stated on the drawings as not required for a particular starter. H-O-A switch is not required for manual motor starters.
  - 6. Incorporate into each control circuit a 120-volt, solid state time delay relay (ON delay), minimum adjustable range from 0.3 to 10

- minutes, with transient protection. Time delay relay is not required where H-O-A switch is not required.
7. Unless noted otherwise, equip with not less than two normally open and two normally closed auxiliary contacts. Provide green run pilot lights and H-O-A control devices as indicated, operable at front of enclosure without opening enclosure. Push buttons, selector switches, pilot lights, etc., shall be interchangeable.
  8. Enclosures:
    - a. Shall be the NEMA types shown on the drawings for the motor controllers and shall be the NEMA types which are the most suitable for the environmental conditions where the motor controllers are being installed.
    - b. Doors mechanically interlocked to prevent opening unless the breaker or switch within the enclosure is open. Provision for padlock must be provided.
    - c. Enclosures shall be primed and finish coated at the factory with the manufacturer's prime coat and standard finish.
  - C. Motor controllers incorporated with equipment assemblies shall also be designed for the specific requirements of the assemblies.
  - D. For motor controllers being installed in existing motor control centers or panelboards, coordinate with the existing centers or panelboards.
  - E. Additional requirements for specific motor controllers, as indicated in other sections, shall also apply.
  - F. Provide a disconnecting means or safety switch near and within sight of each motor. Provide all wiring and conduit required to facilitate a complete installation.

## **2.2 MANUAL MOTOR STARTERS**

- A. Shall be in accordance with applicable requirements of 2.1 above.
- B. Motor starting switches.
  1. Switches shall be general-purpose Class A, manually operated type with full voltage controller for fractional horsepower induction motors.
  2. Units shall include thermal overload protection, red pilot light and toggle operator.

## **2.3 MAGNETIC MOTOR STARTERS**

- A. Shall be in accordance with applicable requirements of 2.1 above.
- B. Starters shall be general-purpose, Class A magnetic controllers for induction motors rated in horsepower. Minimum size 0.

- C. Where combination motor starters are used, combine starter with protective or disconnect device in a common enclosure.
- D. Provide phase loss protection for each starter, with contacts to de-energize the starter upon loss of any phase.
- E. Unless otherwise indicated, provide full voltage non-reversing across-the-line mechanisms for motors less than 75 HP, closed by coil action and opened by gravity. For motors 75 HP and larger, provide reduced voltage starters. Equip starters with 120V AC coils and individual control transformer unless otherwise noted. Locate "reset" button to be accessible without opening the enclosure.

#### **2.4 VARIABLE SPEED MOTOR CONTROLLERS**

- A. Shall be in accordance with applicable portions of 2.1 above.
- B. Shall be solid state, micro processor-based with adjustable frequency and voltage, three phase output capable of driving standard NEMA B design, three phase alternating current induction motors at full rated speed. The drives shall utilize a full wave bridge design incorporating diode rectifier circuitry with pulse width modulation (PWM). Other control techniques are not acceptable. Silicon controlled rectifiers (SCR) shall not be used in the rectifying circuitry. The drives shall be designed to be used on variable torque loads and shall be capable of providing sufficient torque to allow the motor to break away from rest upon first application of power.
- C. Unit shall be capable of operating within voltage parameters of plus 10 to minus 10 percent of line voltage, and be suitably rated for the full load amps of the maximum watts (HP) within its class.
- D. Operating and Design Conditions:
  - Elevation: 1000feet AMSL
  - Temperatures: Maximum +90°F Minimum +40°F
  - Relative Humidity: 95%
  - Drive Location: Non-Air conditioned Building
- E. Controllers shall have the following features:
  - 1. Isolated power for control circuits.
  - 2. Manually re-settable motor overload protection for each phase.
  - 3. Adjustable current limiting circuitry to provide soft motor starting. Maximum starting current shall not exceed 200 percent of motor full load current.

4. Independent acceleration and deceleration time adjustment, manually adjustable from 2 to 30 seconds. (Set timers to the equipment manufacturer's recommended time in the above range.)
5. Provide 4 to 20 ma current follower circuitry for interface with mechanical sensor devices.
6. Automatic frequency adjustment from 20 Hz to 60 Hz.
7. Provide circuitry to initiate an orderly shutdown when any of the conditions listed below occur. The controller shall not be damaged by any of these electrical disturbances and shall automatically restart when the conditions are corrected. The drive shall be able to restart into a rotating motor operating in either the forward or reverse direction and matching that frequency.
  - a. Incorrect phase sequence.
  - b. Single phasing.
  - c. Over voltage in excess of 10 percent.
  - d. Under voltage in excess of 10 percent.
  - e. Running over current above 110 percent (shall not automatically reset for this condition.)
  - f. Instantaneous overcurrent above 150 percent (shall not automatically reset for this condition).
  - g. Surge voltage in excess of 1000 volts.
  - h. Short duration power outages of 12 cycles or less (i.e., distribution line switching, generator testing, and automatic transfer switch operations.)
8. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.
9. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.
- F. Minimum efficiency shall be 95 percent at 100 percent speed and 85percent at 50 percent speed.
- G. The displacement power factor of the controller shall not be less than 95 percent under any speed or load condition.
- H. Controllers shall include a door interlocked fused safety disconnect switch or door interlocked circuit breaker switch which will disconnect all input power.

- I. Controller shall include a 3% line reactor, and RFI/EMI filter.
- J. The following accessories are to be door mounted:
  - 1. AC Power on light.
  - 2. Ammeter (RMS motor current).
  - 3. HAND-OFF-AUTOMATIC switch.
  - 4. Manual speed control in HAND mode.
  - 5. System protection lights indicating that the system has shutdown and will not automatically restart.
  - 6. System protection light indicating that the system has shutdown but will restart when conditions return to normal.
  - 7. Manual variable speed controller by-pass switch.
  - 8. Diagnostic shutdown indicator lights for each shutdown condition.
  - 9. Provide two N.O. and two N.C. dry contacts rated 120 volts, 10 amperes, 60 HZ for remote indication of the following:
    - a. System shutdown with auto restart.
    - b. System shutdown without auto restart.
    - c. System running.
  - 10. Incorporate into each control circuit a 120-volt, time delay relay (ON delay), adjustable from 0.3-10 minutes, with transient protection. Provide transformer/s for the control circuit/s.
  - 11. Controller shall not add any current or voltage transients to the input AC power distribution system nor shall transients from other devices on the AC power distribution system affect the controller. Controllers shall be protected to comply with IEEE C37.90.1 and UL-508. Line noise and harmonic voltage distortion shall not exceed the values allowed by IEEE 519.
- K. Hardware and software to enable the BAS to monitor, control, and display controller status and alarms.
- L. Network Communications Ports: Ethernet.
- M. Embedded BAS Protocols for Network Communications: As specified in Division 22.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Install motor control equipment in accordance with manufacturer's recommendations, the NEC, NEMA and as shown on the drawings.
- B. Furnish and install heater elements in motor starters and to match the installed motor characteristics. Submit a list of all motors listing motor nameplate rating and heater element installed.

- D. Motor Data: Provide neatly-typed label inside each motor starter enclosure door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, voltage/phase rating and heater element installed.
- E. Connect hand-off auto selector switches so that automatic control only is by-passed in "manual" position and any safety controls are not by-passed.
- F. Install manual motor starters in flush enclosures in finished areas.
- G. Examine control diagrams indicated before ordering motor controllers. Should conflicting data exist in specifications, drawings and diagrams, request corrected data prior to placing orders.

### **3.2 ADJUSTING**

- A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
- B. Adjust overload-relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.
- C. Adjust trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust at six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cooldown between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Resident Engineer before increasing settings.

### **3.3 ACCEPTANCE CHECKS AND TESTS**

- A. Perform in accordance with the manufacturer's recommendations. Include the following visual and mechanical inspections and electrical tests:
  - 1. Visual and Mechanical Inspection
    - a. Compare equipment nameplate data with specifications and approved shop drawings.
    - b. Inspect physical, electrical, and mechanical condition.
    - c. Inspect contactors.
    - d. Clean motor starters and variable speed motor controllers.
    - e. Verify overload element ratings are correct for their applications.
    - f. If motor-running protection is provided by fuses, verify correct fuse rating.

- g. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
- 2. Variable speed motor controllers:
  - a. Final programming and connections to variable speed motor controllers shall be by a factory-trained technician. Set all programmable functions of the variable speed motor controllers to meet the requirements and conditions of use.
  - b. Test all control and safety features of the variable frequency drive.

#### **3.4 FOLLOW-UP VERIFICATION**

- A. Upon completion of acceptance checks, settings, and tests, the Contractor shall show by demonstration in service that the motor starters and variable speed motor controllers are in good operating condition and properly performing the intended functions.

#### **3.5 SPARE PARTS**

- A. Two weeks prior to the final inspection, provide one complete set of spare fuses (including heater elements) for each starter/controller installed on this project.

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**SECTION 26 29 21  
DISCONNECT SWITCHES**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the furnishing, installation, and connection of low voltage disconnect switches.

**1.2 RELATED WORK**

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.
- B. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES 600 VOLTS AND BELOW: Cables and wiring.
- C. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground faults.
- D. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits for cables and wiring.
- E. Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS: Motor rated toggle switches.

**1.3 QUALITY ASSURANCE**

Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

**1.4 SUBMITTALS**

- A. Submit in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. Shop Drawings:
  - 1. Clearly present sufficient information to determine compliance with drawings and specifications.
  - 2. Include electrical ratings, dimensions, mounting details, materials, enclosure types, and fuse types and classes.
  - 3. Show the specific switch and fuse proposed for each specific piece of equipment or circuit.
- C. Manuals:
  - 1. Provide complete maintenance and operating manuals for disconnect switches, including technical data sheets, wiring diagrams, and information for ordering replacement parts. Deliver four copies to the Project Engineer two weeks prior to final inspection.



2. Terminals on wiring diagrams shall be identified to facilitate maintenance and operation.
3. Wiring diagrams shall indicate internal wiring and any interlocking.

#### **1.5 APPLICABLE PUBLICATIONS**

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. National Electrical Manufacturers Association (NEMA):
  - FU 1-07.....Low Voltage Cartridge Fuses
  - KS 1-06.....Enclosed and Miscellaneous Distribution  
Equipment Switches (600 Volts Maximum)
- C. National Fire Protection Association (NFPA):
  - 70-08.....National Electrical Code (NEC)
- D. Underwriters Laboratories, Inc. (UL):
  - 98-04.....Enclosed and Dead-Front Switches
  - 248-00.....Low Voltage Fuses
  - 977-94.....Fused Power-Circuit Devices

### **PART 2 - PRODUCTS**

#### **2.1 LOW VOLTAGE FUSIBLE SWITCHES**

- A. In accordance with UL 98, NEMA KS1, and NEC.
- B. Shall have NEMA classification Heavy Duty (HD).
- C. Shall be HP rated.
- D. Shall have the following features:
  1. Switch mechanism shall be the quick-make, quick-break type.
  2. Copper blades, visible in the OFF position.
  3. An arc chute for each pole.
  4. External operating handle shall indicate ON and OFF position and have lock-open padlocking provisions.
  5. Mechanical interlock shall permit opening of the door only when the switch is in the OFF position, defeatable to permit inspection.
  6. Fuse holders for the sizes and types of fuses specified.
  7. Solid neutral for each switch being installed in a circuit which includes a neutral conductor.
  8. Ground lugs for each ground conductor.
  9. Enclosures:
    - a. Shall be the NEMA types shown on the drawings for the switches.

- b. Where the types of switch enclosures are not shown, they shall be the NEMA types most suitable for the ambient environmental conditions. Unless otherwise indicated on the plans, all outdoor switches shall be NEMA 3R.
- c. Shall be finished with manufacturer's standard gray baked enamel paint over pretreated steel (for the type of enclosure required).

## **2.2 LOW VOLTAGE UNFUSED SWITCHES**

- A. Shall be the same as Low Voltage Fusible, but without provisions for fuses.

## **2.3 MOTOR RATED TOGGLE SWITCHES**

- A. Refer to Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS.

## **2.4 LOW VOLTAGE CARTRIDGE FUSES**

- A. In accordance with NEMA FU1.
- B. Feeders: Class RK1, time delay.
- D. Motor Branch Circuits: Class RK1, time delay.
- E. Other Branch Circuits: Class RK1, time delay.
- F. Control Circuits: Class CC, time delay.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install disconnect switches in accordance with the NEC and as shown on the drawings.
- B. Fusible disconnect switches shall be furnished complete with fuses. Arrange fuses such that rating information is readable without removing the fuse.

- - - E N D - - -

**SECTION 26 32 13  
ENGINE-GENERATORS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the furnishing, installation, and testing of the low-voltage engine-generator system. This includes, but is not limited to: air filtration, starting system, generator controls, instrumentation, lubrication, fuel system, cooling system, and exhaust system.
- B. The engine-generator system shall be fully automatic and shall constitute a unified and coordinated system ready for operation.

**1.2 RELATED WORK**

- A. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT: Requirements for pipe and equipment support and noise control.
- B. Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION: Requirements for hot piping and equipment insulation.
- C. Section 23 10 00, FACILITY FUEL SYSTEMS: Fuel supply and storage requirements.
- D. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items common to more than one section of Division 26.
- E. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Low voltage conductors.
- F. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.
- G. Section 26 24 11, DISTRIBUTION SWITCHBOARDS: Requirements for secondary distribution switchboards.
- H. Section 26 36 23, AUTOMATIC TRANSFER SWITCHES: Requirements for automatic transfer switches for use with engine-generators.

**1.3 QUALITY ASSURANCE**

- A. Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

**1.4 QUALITY ASSURANCE**

- A. The supplier of the engine-generator shall be responsible for satisfactory total operation of the system and its certification. This supplier shall have had experience with three or more installations of

systems of comparable size and complexity. Each of these installations shall have been in successful operation for three or more years. Prior to review of submittals, the Government reserves the right to:

1. Have the manufacturer submit a list of locations with similar installations.
  2. Inspect any of these installations and question the user concerning the installations without the presence of the supplier.
- B. A factory-authorized representative shall be capable of providing emergency maintenance and repairs at the project site within 1 hour maximum of notification.

#### **1.5 SUBMITTALS**

- A. In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:
- B. Shop Drawings:  
Scaled drawings, showing plan views, side views, elevations, and cross-sections.
- C. Diagrams:  
Control system diagrams, elementary diagrams, control sequence diagrams or tables, wiring diagrams, interconnections diagrams (between local control cubicles, remote annunciator panels, remote derangement panels, remote monitoring panels, remote exercising panel, automatic transfer switches, paralleling switchgear, and fuel storage tanks, as applicable), illustrative diagrams, flow diagrams, and other like items.
- D. Technical Data:
1. Published ratings, catalog cuts, pictures, and manufacturers' specifications for engine-generator, governor, voltage regulator, radiator, muffler, dampers, day tank, pumps, fuel tank, batteries and charger, jacket heaters, torsional vibration, and control and supervisory equipment.
  2. Description of operation.
  3. Short-circuit current capacity and subtransient reactance.
  4. Sound power level data.
- E. Calculations:
1. Detailed engineering calculations with all equations, graphs, assumptions, and approximations shown and data sources referenced. Include any calculated performance derations appropriate to installed environment.

F. Manuals:

1. When submitting the shop drawings, submit complete maintenance and operating manuals of the engine-generator and auxiliaries, including technical data sheets, wiring diagrams, and information for ordering replacement parts.
2. Two weeks prior to the final inspection, submit four copies of the updated maintenance and operating manual to the Project Engineer:
  - a. Include complete "As Installed" diagrams, which indicate all items of equipment and their interconnecting wiring.
  - b. Include complete diagrams of the internal wiring for each of the pieces of equipment, including "As Installed" revisions of the diagrams.
  - c. The wiring diagrams shall identify the terminals to facilitate installation, maintenance, operation, and testing.
  - d. Include complete lists of spare parts and special tools recommended for two years of normal operation of the complete system.

G. Certifications:

1. Prior to fabrication of the engine-generator, submit the following to the Project Engineer for approval:
  - a. A certification in writing that an engine-generator of the same model and configuration, with the same bore, stroke, number of cylinders, and equal or higher kW/kVA ratings as the proposed engine-generator, has been operating satisfactorily with connected loads of not less than 75% of the specified kW/kVA rating, for not fewer than 2,000 hours without any failure of a crankshaft, camshaft, piston, valve, injector, or governor system.
  - b. A certification in writing that devices and circuits will be incorporated to protect the voltage regulator and other components of the engine-generator during operation at speeds other than the rated RPM while performing maintenance. Submit thorough descriptions of any precautions necessary to protect the voltage regulator and other components of the system during operation of the engine-generator at speeds other than the rated RPM.
  - c. A certification from the engine manufacturer stating that the engine exhaust emissions meet the federal, state, and local

regulations and restrictions specified. At a minimum, this certification shall include emission factors for criteria pollutants including nitrogen oxides, carbon monoxide, particulate matter, sulfur dioxide, non-methane hydrocarbon, and hazardous air pollutants (HPAs).

2. Prior to installation of the engine-generator at the job site, submit four copies of certified factory test data to the Project Engineer.
3. Two weeks prior to the final inspection, submit four copies of the following to the Project Engineer:
  - a. Certification by the engine-generator manufacturer that the equipment conforms to the requirements of the drawings and specifications.
  - b. A certified report of field tests from the contractor that the engine-generator has been properly installed, adjusted, and tested.

#### **1.6 STORAGE AND HANDLING**

- A. Equipment shall withstand shipping and handling stresses in addition to the electrical and mechanical stresses which occur during operation of the system. Protect radiator core with wood sheet.
- B. Store the equipment in a location approved by the Project Engineer.

#### **1.7 JOB CONDITIONS**

- A. Shall conform to the arrangements and details shown on the drawings. The dimensions, enclosures, and arrangements of the engine-generator system shall permit the operating personnel to safely and conveniently operate and maintain the system in the space designated for installation.

#### **1.8 APPLICABLE PUBLICATIONS**

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. American National Standards Institute (ANSI):
  - C37.50-00.....Low-Voltage AC Power Circuit Breakers Used In Enclosures-Test Procedures
  - C39.1-81 (R1992) .....Requirements for Electrical Analog Indicating Instruments
- C. American Society of Testing Materials (ASTM):

- A53/A53M-07.....Standard Specification for Pipe, Steel, Black,  
and Hot-Dipped, Zinc Coated Welded and  
Seamless.
- B88-03.....Specification for Seamless Copper Water Tube
- B88M-03.....Specification for Seamless Copper water Tube  
(Metric)
- D975-09b.....Diesel Fuel Oils
- D. Institute of Electrical and Electronic Engineers (IEEE):
- C37.13-08.....Low Voltage AC Power Circuit Breakers Used In  
Enclosures
- C37.90.1-02.....Surge Withstand Capability (SWC) Tests for  
Relays and Relay Systems Associated with  
Electric Power Apparatus
- E. National Electrical Manufacturers Association (NEMA):
- ICS 6-06.....Enclosures
- ICS 4-05.....Terminal Blocks
- MG 1-07.....Motor and Generators
- MG 2-01.....Safety Standard and Guide for Selection,  
Installation and Use of Electric Motors and  
Generators
- PB 2-06.....Dead-Front Distribution Switchboards
- 250-08.....Enclosures for Electrical Equipment (1000 Volts  
Maximum)
- F. National Fire Protection Association (NFPA):
- 30-08.....Flammable and Combustible Liquids Code
- 37-06.....Installations and Use of Stationary Combustion  
Engine and Gas Turbines
- 70-08.....National Electrical Code (NEC)
- 99-05.....Health Care Facilities
- 110-10.....Standard for Emergency and Standby Power  
Systems
- G. Underwriters Laboratories, Inc. (UL):
- 50-95.....Enclosures for Electrical Equipment
- 142-06.....Steel Aboveground Tanks for Flammable and  
Combustible Liquids
- 2085-97.....Insulated Aboveground Tanks for Flammable and  
Combustible Liquids
- 2200-98.....Stationary Engine Generator Assemblies

1236-06.....	Battery Chargers for Charging Engine-Starter Batteries
467-07.....	Grounding and Bonding Equipment
489-09.....	Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
508-99.....	Industrial Control Equipment
891-05.....	Switchboards

## **PART 2 - PRODUCTS**

### **2.1 ENGINE-GENERATOR**

- A. The engine-generator system shall be in accordance with NFPA, UL, NEMA and ANSI, and as specified herein. All information required by these specifications shall shown on the drawings.
- B. Provide a factory-assembled, wired (except for field connections), complete, fully automatic engine-generator system.
- C. Engine-Generator Parameter Schedule:
  - Power Rating: Emergency Standby
  - Voltage: 120/208V, 3 phase, 4 wire.
  - Service Load: 400 KW standby rated.
  - Motor Starting kVA (Max.): 240 kVA
  - Power Factor: 0.8 lagging
  - Engine-Generator Application: stand-alone
  - Fuel: diesel
  - Maximum Speed: 1800 RPM
  - Frequency Bandwidth (steady state): + 0.25 %
  - Voltage Regulation: + 2% (maximum) (No Load to Full Load) (standalone applications)
  - Voltage Bandwidth: + 0.5 % (steady state)
  - Frequency: 60 Hz
  - Phases: 3 Phase, Wye
  - Max Time to Start and be Ready to Assume Load: 10 seconds
  - Max Summer Indoor Temp (Prior to Engine-Generator Operation): 95 degrees F.
  - Min Winter Indoor Temp (Prior to Engine-Generator Operation): 45 degrees F.
  - Max Summer Outdoor Temp (Ambient): 95 ° F
  - Min Winter Outdoor Temp (Ambient): -30 ° F
  - Installation Elevation: 1000 feet above sea level



- D. Assemble, connect, and wire the equipment at the factory so that only the external connections need to be made at the construction site.
- E. Unit shall be factory-painted with manufacturer's primer and standard finishes.
- F. Connections between components of the system shall conform to the recommendations of the manufacturer.
- G. Couplings, shafts, and other moving parts shall be enclosed and guarded. Guards shall be metal, ruggedly constructed, rigidly fastened, and readily removable for convenient servicing of the equipment without disassembling any pipes and fittings.
- H. Engine-generator shall have the following features:
  - 1. Factory-mounted on a common, rigid, welded, structural steel base.
  - 2. Engine-generator shall be statically and dynamically balanced so that the maximum vibration in the horizontal, vertical, and axial directions shall be limited to 0.0059 in [0.15 mm], with an overall velocity limit of 0.866 in/sec [24 mm/sec] RMS, for all speeds.
  - 3. The isolators shall be constrained with restraints capable of withstanding static forces in any direction equal to twice the weight of the supported equipment.
  - 4. Shall be capable of operating satisfactorily as specified for not fewer than 10,000 hours between major overhauls.

## 2.2 ENGINE

- A. Coupled directly to a generator.
- B. Minimum four cylinders.
- C. The engine shall be able to start in a 40° F [4.5° C] ( ) ambient temperature while using No. 2 diesel fuel oil without the use of starting aids such as glow plugs and ether injections.
- D. Fuel oil consumption of the engine rate shall not exceed the following values:

Size Range Net kW	% of Rated Output <b>capacity</b>	Fuel Usage kg/kWH (lbs/kWH)
100 -299	75 and 100	0.272 (0.600)
	50	0.292 (0.643)
300 -999	75 and 100	0.261 (0.575)
	50	0.272 (0.600)
1000 -2500	75 and 100	0.243 (0.536)
	50	0.260 (0.573)

E. Equipped with electric heater for maintaining the coolant temperature between 90-100° F [32-38° C]), or as recommended by the manufacturer.

1. Install thermostatic controls, contactors, and circuit breaker-protected circuits for the heaters.
2. The heaters shall operate continuously except while the engine is operating or the water temperature is at the predetermined level.

### **2.3 GOVERNOR**

- A. Isochronous, electronic type.
- B. Steady-state speed band at 60 Hz shall not exceed plus or minus one-third of 1%.
- C. While the engine is running, manual speed adjustments may be made.

### **2.4 LUBRICATION OIL SYSTEM**

- A. Pressurized type.
- B. Positive-displacement pump driven by engine crankshaft.
- C. Full-flow strainer and full-flow or by-pass filters.
- D. Filters shall be cleanable or replaceable type and shall remove particles as small as 3 microns without removing the additives in the oil. For by-pass filters, flow shall be diverted without flow interruption.
- E. Extend lube oil sump drain line out through the skid base and terminate it with a drain valve and plug.

### **2.5 FUEL SYSTEM**

- A. Shall comply with NFPA 37 and NFPA 30, and have the following features:
  1. Injection pump(s) and nozzles.
  2. Plungers shall be carefully lapped for precision fit and shall not require any packing.
  3. Filters or screens that require periodic cleaning or replacement shall not be permitted in the injection system assemblies.
  4. Return surplus oil from the injectors to the main storage tank by gravity or a pump.
  5. Filter System:
    - a. Dual primary filters shall be located between the main fuel oil storage and day tank.
    - b. Secondary filters (engine-mounted) shall be located such that the oil will be thoroughly filtered before it reaches the injection system assemblies.

- c. Filters shall be cleanable or replaceable type and shall entrap and remove water from oil as recommended by the engine manufacturer.

B. Day Tank (Existing):

1. Each engine-generator shall be provided with a welded steel integral day tank.
2. Each day tank shall have capacity to supply fuel to the engine for a 4-hour period at 100% rated load without being refilled, including fuel that is returned to the main fuel storage tank. The calculation of the capacity of each day tank shall incorporate the requirement to stop the supply of fuel into the day tank at 90% of the ultimate volume of the tank.
3. Secure, pipe, and connect the tank adequately for maximum protection from fire hazards, including oil leaks.
4. Incorporate a vent, drain cock, shutoff cocks, and gauge glass. Terminate the vent piping outdoors with mushroom vent cap.
5. Incorporate a float switch on the day tank to control the fuel oil transfer pump and to actuate an alarm in the engine-generator control cubicle when the oil level in the tank drops below the level at which the transfer pump should start to refill the tank.
  - a. The float switch contacts controlling the fuel oil transfer pump shall be set to energize the pump when the liquid level in the tank reaches one-third of the total volume of the tank.
  - b. The float switch contacts that actuate the low fuel oil day tank alarm device shall be set to alarm and energize the second fuel transfer pump when the liquid level in the tank reaches one-quarter of the total volume of the tank.
6. Day tank and engine supply line elevations shall be below the elevation of the injector return outlet on the engine.
7. Provide new connections as required to the existing system so it is operational as specified above.

D. Fuel Transfer Pump (Existing) - Main Storage Tank to Day Tank(s):

1. Electric motor-driven, duplex arrangement, close-coupled, single-stage, positive-displacement type with built-in pressure relief valves. When the fuel is used for cooling components of the fuel injection system, the engine's fuel return line shall be returned to the main storage tank, rather than the day tank.

2. Include a heavy-duty automatic alternator and H-O-A switch to alternate sequence of pumps. Pumps shall be controlled with the float switch on the day tank and H-O-A selector switch such that the day tank will be refilled automatically when the oil level lowers to the low limit for the float switch. The H-O-A selector switches shall enable the pumps to be operated manually at any time.
  3. For all engines, the related transfer pump and its electrical and plumbing connections shall be sized to provide a flow rate of at least four times the engine's fuel pumping rate.
  4. Provide a manually-operated, rotary-type transfer pump connected in parallel with the electric motor-driven transfer pumps so that oil can be pumped to the day tank while the electric motor-driven pumps are inoperative.
  5. Provide new connections as required to the existing system so it is operational as specified above.
- E. Piping System: Black steel standard weight ASTM A-53 pipe and necessary valves and pressure gauges between:
1. The engine and the day tank as shown on the drawings.
  2. The day tank and the supply and return connections at the underground storage tank as shown on the drawings. Connections at the engine shall be made with flexible piping suitable for the fuel furnished. Connections will be completed by the mechanical contractor, provide flexible fuel lines for installation by the mechanical contractor.

## 2.6 COOLING SYSTEM

- A. Liquid-cooled, closed loop, with fin-tube radiator mounted on the engine-generator, and integral engine driven circulating pump.
- B. Cooling capacity shall not be less than the cooling requirements of the engine-generator and its lubricating oil while operating continuously at 110% of its specified rating.
- C. Water circulating pumps shall be the centrifugal type driven by engine. Incorporate pressure relief devices where required to prevent excessive pressure increase after the engine stops.
- D. Coolant shall be extended-life antifreeze solution, 50% ethylene glycol and 50% soft water, with corrosion inhibitor additive as recommended by the manufacturer.
- E. Fan shall be driven by multiple belts from engine shaft a totally enclosed electric motor.

- F. Coolant hoses shall be flexible, per manufacturer's recommendation.
- G. Self-contained thermostatic-control valve shall modulate coolant flow to maintain optimum constant coolant temperature, as recommended by the engine manufacturer.
- H. Existing Motor-Operated Dampers:
  - 1. Dampers shall open simultaneously with the starting of the diesel engine and shall close simultaneously with the stopping of the diesel engine. Provide new wiring as required.

## 2.7 AIR INTAKE AND EXHAUST SYSTEMS

- A. Air Intake:
  - 1. Provide an engine-mounted air cleaner with replaceable dry filter and dirty filter indicator.
- B. Exhaust System:
  - 1. Where turbo-charges are required, they shall be engine-mounted, driven by the engine gases, securely braced against vibration and adequately lubricated by the engine's filtered lubrication system.
  - 2. Exhaust Muffler:
 

Shall be critical grade type and capable of the following noise attenuation:

Octave Band Hertz (Mid Frequency)	Minimum db Attenuation (.0002 Microbar Reference)
31	5
63	10
125	27
500	37
1000	31
2000	26
4000	25
8000	26

- 3. Pressure drop in the complete exhaust system shall be small enough for satisfactory operation of the engine-generator while it is delivering 110% of its specified rating.
- 4. Exhaust pipe size from the engine to the muffler shall be as recommended by the engine manufacturer. Pipe size from muffler to air discharge shall be two pipe sizes larger than engine exhaust pipe.

5. Connections at the engine exhaust outlet shall be made with a flexible exhaust pipe. Provide bolted type pipe flanges welded to each end of the flexible section.
- C. Condensate drain at muffler shall be made with schedule 40 black steel pipe through a petcock.
- D. Exhaust Piping and Supports: Black steel pipe, ASTM A-53 standard weight with welded fittings. Spring type hangers, as specified in Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT, shall support the pipe.
- E. Insulation for Exhaust Pipe and Muffler:
  1. Calcium silicate minimum 3 in [75 mm] thick.
  2. Insulation shall be as specified in Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION.
  3. The installed insulation shall be covered with aluminum jacket 0.016 in [0.4 mm] thick. The jacket is to be held in place by bands of 0.015 in [0.38 mm] thick by 0.5 in [15 mm] wide aluminum.
  4. Insulation and jacket are not required on flexible exhaust sections.
- F. Roof Sleeves (By Mechanical): Pipe sleeves (thimble) shall be Schedule 40 standard weight steel pipe. Flash exhaust pipe thimble through roof with 16 oz soft sheet copper, flanged, and made watertight under built-up roofing and extended up around pipe thimble. The exhaust pipe shall be positioned within the thimble by four 6 in [150 mm] wide spiders welded to the exhaust pipe.
- G. Vertical exhaust piping shall be provided with a hinged, gravity-operated, self-closing rain cover by mechanical.

## **2.8 ENGINE STARTING SYSTEM**

- A. Shall start the engine at any position of the flywheel.
- B. Electric cranking motor:
  1. Shall be engine-mounted.
  2. Shall crank the engine via a gear drive.
  3. Rating shall be adequate for cranking the cold engine at the voltage provided by the battery system, and at the required RPM during five consecutive starting attempts of 10 seconds cranking each at 10-second intervals, for a total of 50 seconds of actual cranking without damage (the fifth starting attempt will be manually initiated upon failure of a complete engine cranking cycle).
- C. Batteries shall be lead-acid high discharge rate type.

1. Each battery cell shall have minimum and maximum electrolyte level indicators and a flip-top flame arrestor vent cap.
2. Batteries shall have connector covers for protection against external short circuits.
3. With the charger disconnected, the batteries shall have sufficient capacity so that the total system voltage does not fall below 85% of the nominal system voltage with the following demands:  
Five consecutive starting attempts of 10 seconds cranking at 10second intervals for a total of 50 seconds of actual cranking (the fifth starting attempt will be manually initiated upon failure of a complete engine cranking cycle).
4. Battery racks shall be metal with an alkali-resistant finish and thermal insulation, and secured to the floor.

D. Battery Charger:

1. A current-limiting battery charger, conforming to UL 1236, shall be provided and shall automatically recharge the batteries. The charger shall be capable of an equalize-charging rate for recharging fully depleted batteries within 24 hours and a floating charge rate for maintaining the batteries at fully charged condition.
2. An ammeter shall be provided to indicate charging rate. A voltmeter shall be provided to indicate charging voltage.

## **2.9 LUBRICATING OIL HEATERS**

- A. Provide a thermostatically-controlled electric heater to automatically maintain the oil temperature within plus or minus 3° F [1.7° C] of the control temperature.

## **2.10 JACKET COOLANT HEATERS**

- A. Provide a thermostatically-controlled electric heater mounted in the engine coolant jacketing to automatically maintain the coolant within plus or minus 3° F [1.7° C] of the temperature recommended by the engine manufacturer to meet the starting time specified at the minimum winter outdoor temperature.

## **2.11 GENERATOR**

- A. Synchronous, amortisseur windings, bracket-bearing, self-venting, rotating-field type connected directly to the engine.
- B. Lifting lugs designed for convenient connection to and removal from the engine.

- C. Integral poles and spider, or individual poles dove-tailed to the spider.
- D. Designed for sustained short-circuit currents in conformance with NEMA Standards.
- E. Designed for sustained operation at 125% of the RPM specified for the engine-generator without damage.
- F. Telephone influence factor shall conform to NEMA Standards.
- G. Furnished with brushless excitation system or static-exciter-regulator assembly.
- H. Nameplates attached to the generator and exciter shall show the manufacturer's name, equipment identification, serial number, voltage ratings, field current ratings, kW/kVA output ratings, power factor rating, time rating, temperature rise ratings, RPM ratings, full load current rating, number of phases and frequency, and date of manufacture.
- I. The grounded (neutral) conductor shall be electrically isolated from equipment ground and terminated in the same junction box as the phase conductors.

#### **2.12 GENERATOR OVERCURRENT AND FAULT PROTECTION**

- A. Generator circuit breaker shall be molded-case, electronic-trip type, and 100% rated, complying with UL 489. Tripping characteristics shall be adjustable long-time and short-time delay and instantaneous. Provide shunt trip-to-trip breaker when engine-generator is shut down by other protective devices.

#### **2.13 CONTROLS**

- A. Shall include Engine Generator Control Cubicle(s) Remote Annunciator Panel
- B. General:
  - 1. Control Equipment shall be in accordance with UL 508, NEMA ICS-4, ICS-6, and ANSI C37.90.1.
  - 2. Panels shall be in accordance with UL 50.
  - 3. Cubicles shall be in accordance with UL 891.
  - 4. Coordinate controls with the automatic transfer switches shown on the drawings so that the systems will operate as specified.
  - 5. Cubicles:
    - a. Code gauge steel: manufacturer's recommended heavy gauge steel with factory primer and light gray finish.



- b. Doors shall be gasketed, attached with concealed or semi-concealed hinges, and shall have a permanent means of latching in closed position.
    - c. Panels shall be wall-mounted or incorporated in other equipment as indicated on the drawings or as specified.
    - d. Door locks for panels and cubicles shall be keyed identically to operate from a single key.
  - 6. Wiring: Insulated, rated at 600 V.
    - a. Install the wiring in vertical and horizontal runs, neatly harnessed.
    - b. Terminate all external wiring at heavy duty, pressure-type, terminal blocks.
  - 7. The equipment, wiring terminals, and wires shall be clearly and permanently labelled.
  - 8. The appropriate wiring diagrams shall be laminated or mounted under plexiglass within the frame on the inside of the cubicles and panels.
  - 9. All indicating lamps and switches shall be accessible and mounted on the cubicle doors.
  - 10. Meters shall be digital type.
  - 11. The manufacturer shall coordinate the interfacing of the control systems with all related equipment supplied in accordance with other sections of the project specification.
- C. Engine-Generator Control Cubicle:
- 1. Starting and Stopping Controls:
    - a. A three-position, maintained-contact type selector switch with positions marked "AUTOMATIC," "OFF," and "MANUAL." Provide flashing amber light for OFF and MANUAL positions.
    - b. A momentary contact push-button switch with positions marked "MANUAL START" and "MANUAL STOP."
    - c. Selector switch in AUTOMATIC position shall cause the engine to start automatically when a single pole contact in a remote device closes. When the generator's output voltage increases to not less than 90% of its rated voltage, and its frequency increases to not less than 58 Hz, the remote devices shall transfer the load to the generator. An adjustable time delay relay, in the 0 to 15 minute range, shall cause the engine-generator to continue operating without any load after completion of the period of

operation with load. Upon completion of the additional 0 to 15 minute (adjustable) period, the engine-generator shall stop.

- d. Selector switch in OFF position shall prevent the engine from starting either automatically or manually. Selector switch in MANUAL position shall also cause the engine to start when the manual start push-button is depressed momentarily.
  - e. With selector switch is in MANUAL position, depressing the MANUAL STOP push-button momentarily shall stop the engine after a cool-down period.
  - f. A maintained-contact, red mushroom-head push-button switch marked "EMERGENCY STOP" will cause the engine to stop without a cool down period, independent of the position of the selector switch.
2. Engine Cranking Controls:
- a. The cranking cycles shall be controlled by a timer that will be independent of the battery voltage fluctuations.
  - b. The controls shall crank the engine through one complete cranking cycle, consisting of four starting attempts of 10 seconds each and 10 seconds between each attempt.
  - c. Total actual cranking time for the complete cranking cycle shall be 40 seconds during a 70-second interval.
  - d. Cranking shall terminate when the engine starts so that the starting system will not be damaged. Termination of the cranking shall be controlled by self-contained, speed-sensitive switch. The switch shall prevent re-cranking of the engine until after the engine stops.
  - e. After the engine has stopped, the cranking control shall reset.
3. Supervisory Controls:
- a. Overcrank:
    - 1) When the cranking control system completes one cranking cycle (four starting attempts), without starting the engine, the OVERCRANK signal light and the audible alarm shall be energized.
    - 2) The cranking control system shall lock-out, and shall require a manual reset.
  - b. Coolant Temperature:
    - 1) When the temperature rises to the predetermined first stage level, the HIGH COOLANT TEMPERATURE - FIRST STAGE signal light and the audible alarm shall be energized.

- 2) When the temperature rises to the predetermined second stage level, which shall be low enough to prevent any damage to the engine and high enough to avoid unnecessary engine shutdowns, the HIGH COOLANT TEMPERATURE - SECOND STAGE signal light and the audible alarm shall be energized and the engine shall stop.
  - 3) The difference between the first and second stage temperature settings shall be approximately 10° F [-12° C].
  - 4) Permanently indicate the temperature settings near the associated signal light.
  - 5) When the coolant temperature drops to below 70° F [21° C], the "LOW COOLANT TEMPERATURE" signal light and the audible alarm shall be energized.
- c. Low Coolant Level: When the coolant level falls below the minimum level recommended by the manufacturer, the LOW COOLANT LEVEL signal light and audible alarm shall be energized.
- d. Lubricating Oil Pressure:
- 1) When the pressure falls to the predetermined first stage level, the OIL PRESSURE - FIRST STAGE signal light and the audible alarm shall be energized.
  - 2) When the pressure falls to the predetermined second stage level, which shall be high enough to prevent damage to the engine and low enough to avoid unnecessary engine shutdowns, the OIL PRESSURE - SECOND STAGE signal light and the audible alarm shall be energized and the engine shall stop.
  - 3) The difference between the first and second stage pressure settings shall be approximately 15% of the oil pressure.
  - 4) The pressure settings near the associated signal light shall be permanently displayed so that the running oil pressure can be compared to the target (setpoint) value.
- e. Overspeed:
- 1) When the engine RPM exceeds the maximum RPM recommended by the manufacturer of the engine, the engine shall stop.
  - 2) Simultaneously, the OVERSPEED signal light and the audible alarm shall be energized.
- f. Low Fuel - Day Tank:
- When the fuel oil level in the day tank decreases to less than the level at which the fuel oil transfer pump should start to

refill the tank, the LOW FUEL DAY TANK light and the audible alarm shall be energized.

g. Low Fuel - Main Storage Tank:

When the fuel oil level in the storage tank decreases to less than one-third of total tank capacity, the LOW FUEL-MAIN STORAGE TANK signal light and audible alarm shall be energized.

h. Reset Alarms and Signals:

Overcrank, Coolant Temperature, Coolant Level, Oil Pressure, Overspeed, and Low Fuel signal lights and the associated audible alarms shall require manual reset. A momentary-contact silencing switch and push-button shall silence the audible alarm by using relays of solid state devices to seal in the audible alarm in the de-energized condition. Elimination of the alarm condition shall automatically release the sealed-in circuit for the audible so that it will be automatically energized again when the next alarm condition occurs. The signal lights shall require manual reset after elimination of the condition which caused them to be energized. Install the audible alarm just outside the generator room in a location as directed by the Project Engineer. The audible alarm shall be rated for 85 dB at 10 ft [3 M].

i. Generator Breaker Signal Light:

- 1) A flashing green light shall be energized when the generator circuit breaker is in the OPEN or TRIPPED position.
- 2) Simultaneously, the audible alarm shall be energized.

4. Monitoring Devices:

- a. Electric type gauges for the cooling water temperatures and lubricating oil pressures. These gauges may be engine mounted with proper vibration isolation.
- b. A running time indicator, totalizing not fewer than 9,999 hours, and an electric type tachometer.
- c. A voltmeter, ammeter, frequency meter, kilowatt meter, manual adjusting knob for the output voltage, and the other items shown on the drawings shall be mounted on the front of the generator control panels.
- d. Install potential and current transformers as required.
- e. Individual signal lights:
  - 1) OVER-CRANK
  - 2) HIGH COOLANT TEMPERATURE - FIRST STAGE

- 3) HIGH COOLANT TEMPERATURE - SECOND STAGE
- 4) LOW COOLANT TEMPERATURE
- 5) OIL PRESSURE - FIRST STAGE
- 6) OIL PRESSURE - SECOND STAGE
- 7) LOW COOLANT LEVEL
- 8) GENERATOR BREAKER
- 9) OVERSPEED
- 10) LOW FUEL - DAY TANK
- 11) LOW FUEL - MAIN STORAGE TANK

f. Lamp Test: The LAMP TEST momentary contact switch shall momentarily actuate the alarm buzzer and all the indicating lamps.

5. Automatic Voltage Regulator:

- a. Shall correct voltage fluctuations rapidly and restore the output voltage to the predetermined level with a minimum amount of hunting.
- b. Shall include voltage level rheostat located inside the control cubicle.
- c. Provide a 3-phase automatic voltage regulator immune to waveform distortion.

**2.14 REMOTE ANNUNCIATOR PANEL**

- A. A remote annunciator panel shall be installed to replace the existing at the main hospital operator. Coordinate installation location with the VA Project Engineer.
- B. The annunciator shall indicate alarm conditions of the engine-generator as follows:
  - 1. Individual visual signals shall indicate generator run.
  - 2. Individual visual signals plus a common audible alarm shall warn of the following:
    - a. LOW LUBRICATING OIL PRESSURE
    - b. LOW COOLANT
    - c. HIGH COOLANT TEMPERATURE
    - d. LOW FUEL - DAY TANK
    - e. LOW FUEL - MAIN TANK
    - f. FAILURE TO START
    - g. OVERSPEED

- C. The annunciator shall also have the following features:
  - 1. Lamp test momentary contact switch which will momentarily actuate the alarm buzzer and all indicating lamps.
  - 2. Audible Alarm: There shall be an audible alarm, rated for 85 dB at 10 feet, which shall become actuated whenever an alarm condition occurs. A momentary-contact acknowledge push-button shall silence the audible alarm, but not clear the alarm lamp. Elimination of the alarm condition shall automatically release the seal-in circuit for the audible alarm and extinguish the alarm lamp.
- D. Include control wiring between the remote annunciator panel and the engine-generator. Wiring shall be as required by the manufacturer. Install remote annunciator at central operator office location as directed by the VA Project Engineer. Remove the existing annunciator and install new wiring and the new annunciator.

## **2.15 SPARE PARTS**

- A. For each engine generator:
  - 1. Six lubricating oil filters.
  - 2. Six primary fuel oil filters.
  - 3. Six secondary fuel oil filters.
  - 4. Six intake air filters.
- B. For each battery charger:
  - Three complete sets of fuses.
- C. For each control panel:
  - Three complete sets of fuses.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install concrete bases of dimensions shown on the drawings.
- B. Installation of the engine-generator shall comply with manufacturer's written instructions and with NFPA 110.
- C. Mounting:
  - 1. Support the base of engine-generator on vibration isolators, each isolator bolted to the floor (pad), and the generator base bolted to isolator.
  - 2. Install sufficient isolators so that the floor (pad) bearing pressure under each isolator is within the floor (pad) loading specification.
  - 3. Install equal number of isolators on each side of the engine-generator's base.

4. Locate isolators for approximately equal load distribution and deflection per isolator. The base of the engine-generator shall be drilled at the factory for the isolator bolts.
5. Isolators shall be shipped loose with the engine-generator.
6. All connections between the engine-generator and exterior systems, such as fuel lines, electrical connections, and engine exhaust system and air exhaust shroud, shall be flexible.

D. Balance:

The vibration velocity in the horizontal, vertical, and axial directions shall not exceed 0.65 in [16.25 mm] per second peak at any specific frequency. These limits apply to main structural components such as the engine block and the generator frame at the bearings.

E. Connect all components of the generator system so that they will continue to be energized during failure of the normal electrical power supply system.

F. Install piping between engine-generator and remote components of cooling, fuel, and exhaust systems.

G. Flexible connection between radiator and exhaust shroud at the wall damper by mechanical:

1. Install noncombustible flexible connections made of 20-oz neoprene-coated fiberglass fabric approximately 6 in [150 mm] wide.
2. Crimp and fasten the fabric to the sheet metal with screws 2 in [50 mm] on center. The fabric shall not be stressed, except by the air pressure.

H. Exhaust System Insulation:

1. Adhesive and insulation materials shall be applied on clean, dry surfaces from which loose scale and construction debris has been removed by wire brushing.
2. Fill all cracks, voids, and joints of applied insulation material with high temperature 2000° F [1093° C] insulating cement before applying the outer covering.
3. The installation shall be clean and free of debris, thermally and structurally tight without sag, neatly finished at all hangers or other penetrations, and shall provide a smooth finish surface.
4. Insulation and jacket shall terminate hard and tight at all anchor points.
5. Insulate completely from engine exhaust flexible connection through roof or wall construction, including muffler.

### 3.2 ACCEPTANCE CHECKS AND TESTS

- A. Provide the services of a factory-authorized, factory-trained representative of the engine-generator manufacturer to inspect field-assembled components, and equipment installation and supervise the field tests.
- B. When the complete engine-generator system has been installed and prior to the final inspection, test all components of the system in the presence of the Project Engineer for proper operation of the individual components and the complete system and to eliminate electrical and mechanical defects.
- C. Furnish fuel oil, lubricating oil, anti-freeze liquid, water treatment, and rust-inhibitor and load bank for testing of the engine-generator.
- D. Visual Inspection: Visually verify proper installation of engine-generator and all components per manufacturer's pre-start installation checklist.
- E. Field Tests:
  - 1. Perform manufacturer's after-starting checks and inspections.
  - 2. Test the engine-generator for eight hours of continuous operation as follows:
    - a. First six hours while the engine-generator is delivering 100% of its specified kW rating.
    - b. Last two hours while the engine-generator is delivering 110% of its specified kW rating.
    - c. If during the 8-hour continuous test, a failure occurs, either the diesel engine shuts down or the full kW rating of the load bank is not achieved, the test is null and void. The test(s) shall be repeated at no additional cost to the Government until satisfactory results are attained.
  - 3. Record the following test data at 30-minute intervals:
    - a. Time of day, as well as reading of running time indicator.
    - b. kW.
    - c. Voltage on each phase.
    - d. Amperes on each phase.
    - e. Engine RPM.
    - f. Frequency.
    - g. Engine water temperature.
    - h. Fuel pressure.
    - i. Oil pressure.



- j. Outdoor temperature.
  - k. Average ambient temperature in the vicinity of the engine-generator.
4. Demonstrate that the engine-generator will attain proper voltage, frequency, and will accept the specified block load within the specified time limit from a cold start after the closing of a single contact.
  5. Furnish a resistance-type load for the testing of the engine-generator. Test loads shall always include adequate resistance to assure stability of the loads and equipment during all of the testing operations. The test load kW rating shall not be less than 110% of the specified kW rating of the engine-generator.
- F. Starting System Test:
1. Demonstrate that the batteries and cranking motor are capable of five starting attempts of 10 seconds cranking each at 10-second intervals with the battery charger turned off.
- G. Remote Annunciator Panel Tests:
- Simulate conditions to verify proper operation of each indicating lamp, alarm device, meter, interconnecting hardware and software, and reset button.
- H. Fuel systems shall be flushed and tested per Section 23 10 00, FACILITY FUEL SYSTEMS: Fuel supply and storage requirements.
- I. Automatic Operation Tests:
- Test the engine-generator to demonstrate automatic starting, loading and unloading. The load for this test shall utilize both load banks and actual loads to be served. Initiate loss of normal source and verify the specified sequence of operation. Restore the normal power source and verify the specified sequence of operation. Verify resetting of controls to normal.
- J. At the completion of the field tests, fill the main storage tank and day tank with fuel of grade and quality as recommended by the manufacturer of the engine. Fill all engine fluids to levels as recommended by manufacturer.
- K. When any defects are detected during the tests, correct all the deficiencies and repeat all or part of the 8-hour continuous test as requested by the Project Engineer, at no additional cost to the Government.
- L. Provide test and inspection results in writing to the Project Engineer.

**3.3 FOLLOW-UP VERIFICATION**

Upon completion of acceptance checks, settings, and tests, the contractor shall demonstrate that the engine-generator(s) and control and annunciation components are in good operating condition and properly performing the intended function.

**3.4 INSTRUCTIONS AND FINAL INSPECTIONS**

- A. Laminate or mount under acrylic resin a set of operating instructions for the system and install instructions within a frame mounted on the wall near the engine-generator at a location per the Project Engineer.
- B. Furnish the services of a competent, factory-trained technician for three 4-hour periods for instructions to VA personnel in operation and maintenance of the equipment, on the dates requested by the Project Engineer.

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**SECTION 26 36 23**  
**AUTOMATIC TRANSFER SWITCHES**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the furnishing, installation, connection, and testing of open-transition automatic transfer.

**1.2 RELATED WORK**

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section in Division 26.
- B. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Cables and wiring.
- C. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personal safety and to provide a low impedance path for possible ground fault currents.
- D. Section 26 05 33, RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS: Raceways for power and control wiring.
- E. Section 26 32 13, ENGINE-GENERATORS: Requirements for normal and emergency power generation.

**1.3 QUALITY ASSURANCE**

- A. Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. A factory-authorized representative shall maintain a service center capable of providing emergency maintenance and repair services at the project site within a 4 hour maximum response time.
- C. Automatic transfer switch, bypass/isolation switch, and annunciation control panels shall be products of same manufacturer.
- D. Comply with OSHA - 29 CFR 1910.7 for the qualifications of the testing agency.

**1.4 FACTORY TESTS**

- A. Automatic transfer switches shall be thoroughly tested at the factory to ensure that there are no electrical or mechanical defects. Tests shall be conducted per UL standards. Factory tests shall be certified. The following factory tests shall be performed:
  - 1. Visual inspection to verify that each ATS is as specified.
  - 2. Mechanical test to verify that ATS sections are free of mechanical hindrances.
  - 3. Insulation resistance test to ensure integrity and continuity of entire system.

4. Main switch contact resistance test.
5. Electrical tests to verify complete system electrical operation and to set up time delays and voltage sensing settings.

#### 1.5 SUBMITTALS

A. Submit in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

B. Shop Drawings:

1. Clearly present sufficient information to determine compliance with drawings and specifications.
2. Include electrical ratings (including withstand), dimensions, weights, mounting details, conduit entry provisions front view, side view, equipment and device arrangement, elementary and interconnection wiring diagrams, factory relay settings, and accessories.
3. For automatic transfer switches that are networked together to a common means of annunciation and/or control, submit interconnection diagrams and site and building plans, showing connections for normal and emergency sources of power, load, control and annunciation components, and interconnecting communications paths. Equipment locations on the diagrams and plans shall match the site, building, and room designations on the construction drawings.
4. Complete nameplate data, including manufacturer's name and catalog number.
5. A copy of the markings that are to appear on the transfer switches when installed.

C. Manuals:

1. When submitting the shop drawings, submit companion copies of complete maintenance and operating and maintenance manuals, including technical data sheets, wiring diagrams and information, such as telephone number, fax number and web sites, for ordering replacement parts.
2. Two weeks prior to final inspection, submit four copies of a final updated maintenance and operating manual to the Project Engineer.
  - a. Include complete "As Installed" diagrams that indicate all pieces of equipment and their interconnecting wiring.
  - b. Include complete diagrams of the internal wiring for each piece of equipment, including "As Installed" revisions of the diagrams.
  - c. The wiring diagrams shall identify the terminals to facilitate installation, maintenance, operation, and testing.

D. Certifications:

1. When submitting the shop drawings, submit a certified test report from a recognized independent testing laboratory that a representative sample has passed UL 1008 prototype testing.
2. Two weeks prior to final inspection, submit four copies of the following to the Project Engineer:
  - a. Certification that no design changes have been made to the switch or its components since last certified by UL or tested by an independent laboratory.
  - b. Certification by the manufacturer that the equipment conforms to the requirements of the drawings and specifications.
  - c. Certification that the withstand current rating has been coordinated with upstream protective devices.
  - d. Certification by the contractor that the equipment has been properly installed, adjusted, and tested.
  - e. A certified test report from an independent laboratory that a representative sample has passed the ANSI surges withstand test for transfer switches which incorporate solid-state components.

**1.6 APPLICABLE PUBLICATIONS**

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only:
- B. Institute of Electrical and Electronic Engineers (IEEE):
  - 446-95.....Recommended Practice for Design and Maintenance  
of Emergency and Standby Power Systems
  - C37.90.1-02.....Surge Withstand Capability (SWC) Tests for  
Relays and Relay Systems Associated with  
Electric Power Apparatus
  - C62.41.1-02.....Guide on the Surges Environment in Low-Voltage  
(1000 V and Less) AC Power Circuits
  - C62.41.2.....Recommended Practice on Characterization of  
Surges in Low-Voltage (1000 V and Less) AC  
Power Circuits
- C. National Electrical Manufacturers Association (NEMA):
  - 250-03.....Enclosure for Electrical Equipment (1000 Volts  
Maximum)
  - ICS 6-06.....Enclosures
  - IC3 4-05.....Industrial Control and Systems: Terminal Blocks

- MG 1-07.....Motors and Generators
- D. National Fire Protection Association (NFPA):
  - 70-08.....National Electrical Code (NEC)
  - 99-05.....Health Care Facilities
  - 110-10.....Emergency and Standby Power Systems
- E. Underwriters Laboratories, Inc. (UL):
  - 50-95.....Enclosures for Electrical Equipment
  - 508-99.....Industrial Control Equipment
  - 891-05.....Dead-Front Switchboards
  - 1008-96.....Transfer Switch Equipment

## **PART 2 - PRODUCTS**

### **2.1 OPEN-TRANSITION AUTOMATIC TRANSFER SWITCH**

- A. General:
  1. Comply with UL, NEMA, NEC, ANSI, IEEE, and NFPA.
  2. Automatic transfer switches are to be 4-pole construction, electrically operated, mechanically held open contact type, without integral overcurrent protection. Automatic transfer switches utilizing automatic or non-automatic molded case circuit breakers, insulated case circuit breakers, or power circuit breakers as switching mechanisms are not acceptable.
  3. Automatic transfer switches shall be completely factory-assembled and wired such that only external circuit connections are required in the field.
  4. Ratings:
    - a. Phases, voltage, ampere rating, poles, and withstand current rating shall be as shown on the drawings.
    - b. Transfer switches are to be rated for continuous duty at specified continuous current rating on 60Hz systems.
    - c. Maximum automatic transfer switch rating: 800 A.
    - d. Shall be rated for 42,000 AIC when used with upstream electronic trip circuit breaker.
  5. Markings:
    - a. Markings shall be in accordance with UL 1008.
    - b. Markings for the additional withstand test specified below shall be included in the nameplate data.
  6. Tests:
 

Automatic transfer switches shall be tested in accordance with UL 1008. The contacts of the transfer switch shall not weld during the

performance of withstand and closing tests when used with the upstream overcurrent device and available fault current specified.

7. Surge Withstand Test:

Transfer switches utilizing solid-state devices in sensing, relaying, operating, or communication equipment or circuits shall comply with IEEE C37.90.1.

8. Housing:

- a. Enclose automatic transfer switches in wall- or floor-mounted steel cabinets, with metal gauge not less than No. 14, in accordance with UL 508, or in a switchboard assembly in accordance with UL 891, as shown on the drawings.
- b. Enclosure shall be constructed so that personnel are protected from energized bypass-isolation components during automatic transfer switch maintenance.
- c. Automatic transfer switch components shall be removable without disconnecting external source or load power conductors.
- d. Finish: Cabinets shall be given a phosphate treatment, painted with rust-inhibiting primer, and finish-painted with the manufacturer's standard enamel or lacquer finish.
- e. Viewing Ports: Provide viewing ports so that contacts may be inspected without disassembly.

B. Automatic transfer switches shall include the following features:

1. Operating Mechanism:

- a. Actuated by an electrical operator.
- b. Electrically and mechanically interlocked so that the main contact cannot be closed simultaneously in either normal and emergency position.
- c. Normal and emergency main contacts shall be mechanically locked in position by the operating linkage upon completion of transfer. Release of the locking mechanism shall be possible only by normal operating action.
- d. Contact transfer time shall not exceed six cycles.
- e. Operating mechanism components and mechanical interlocks shall be insulated or grounded.

2. Contacts:

- a. Main contacts: Silver alloy.
- b. Neutral contacts: Silver alloy, with same current rating as phase contacts.

- c. Current carrying capacity of arcing contacts shall not be used in the determination of the automatic transfer switch rating, and shall be separate from the main contacts.
  - d. Main and arcing contacts shall be visible for inspection with cabinet door open and barrier covers removed.
- 3. Manual Operator:
  - a. Capable of operation by one person in either direction under no load.
- 4. Replaceable Parts:
  - a. Include the main and arcing contact individually or as units, relays, and control devices.
  - b. Switch contacts and accessories shall be replaceable from the front without removing the switch from the cabinet and without removing main conductors.
- 5. Sensing Relays:
  - a. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100% of nominal, and dropout voltage is adjustable from 75 to 98% of pickup value. Factory set for pickup at 90% and dropout at 85%.
  - b. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
  - c. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100% of nominal. Factory set for pickup at 90%. Pickup frequency shall be adjustable from 90 to 100% of nominal. Factory set for pickup at 95%.
  - d. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
  - e. Test Switch: Simulate normal-source failure.
  - f. Switch-Position Pilot Lights: Indicate source to which load is connected.
  - g. Source-Available Indicating Lights: Supervise sources via transfer switch normal- and emergency-source sensing circuits.
  - h. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."



- i. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
  - j. Transfer Override Switch: Overrides automatic retransfer control so that automatic transfer switch shall remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
  - k. Engine Starting Contacts: One isolated and normally closed and one isolated and normally open; rated 10 A at 32-V dc minimum.
  - l. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
  - m. Engine-Generator Exerciser: Programmable exerciser starts engine-generator(s) and transfers load to them from normal source for a preset time, then retransfers and shuts down engine-generator(s) after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings shall be for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period.
6. Controls:
- a. Control module shall provide indication of switch status and be equipped with alarm diagnostics.
  - b. Control module shall control operation of the automatic transfer switches.
7. Factory Wiring: Train and bundle factory wiring and label either by color-code or by numbered/lettered wire markers. Labels shall match those on the shop drawings.
8. Auxiliary Contacts:
- a. Provide contacts as necessary to accomplish the functions shown on the drawings, as specified herein, and as designated in other sections of these specifications, as well as one spare normally open contact and one normally closed contact.
  - b. Provide remote contact to bypass retransfer time delay to normal source.
9. In-Phase Monitor: Factory-wired, internal relay controls transfer, so that it occurs only when the two sources are synchronized in phase. The relay compares phase relationship and frequency difference between normal and emergency sources and initiates

transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer is initiated only if both sources are within 2 Hz of nominal frequency and 70% or more of nominal voltage.

## 2.2 SEQUENCE OF OPERATION

- A. The specified voltage decrease in one or more phases of the normal power source shall initiate the transfer sequence. The automatic transfer switch shall start the engine-generator(s) after a specified time delay to permit override of momentary dips in the normal power source.
- B. The automatic transfer switch shall transfer the load from normal to emergency source when the frequency and voltage of the engine-generator(s) have attained the specified percent of rated value.
- C. Engine Start: A voltage decrease, at any automatic transfer switch, in one or more phases of the normal power source to less than the specified value of normal shall start the engine-generator(s) after a specified time delay.
- D. Transfer to Emergency System Loads: Automatic transfer switches for Emergency System loads shall transfer their loads from normal to emergency source when frequency and voltage of the engine-generator(s) have attained the specified percent of rated value. Only those switches with deficient normal source voltage shall transfer.
- E. Transfer to Equipment Branch Loads: Automatic transfer switches for Equipment Branch loads shall transfer their loads to the generator on a time-delayed, staggered basis, after the Emergency System switches have transferred. Only those switches with deficient normal source voltage shall transfer.
- F. Retransfer to Normal (All Loads): Automatic transfer switches shall retransfer the load from emergency to normal source upon restoration of normal supply in all phases to the specified percent or more of normal voltage, and after a specified time delay. Should the emergency source fail during this time, the automatic transfer switches shall immediately transfer to the normal source whenever it becomes available. After restoring to normal source, the engine-generator(s) shall continue to run unloaded for a specified interval before shut-down.
- G. Exercise Mode: Transfer to emergency power source shall be accomplished by remote manual test switches on a selective basis.

## 2.3 SPARE PARTS

Provide six control fuses for each automatic transfer switch with a different rating.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install the automatic transfer switch in accordance with the NEC, as shown on the drawings, and as recommended by the manufacturer.
- B. Anchor control and annunciator panel to wall.
- C. Anchor automatic transfer switch to the slab with plated 0.5 in [12.5 mm] minimum anchor bolts, or as recommended by the manufacturer.
- D. Mount automatic transfer switch on concrete slab. Unless otherwise indicated, the slab shall be at least 4 in [100 mm] thick. The top of the concrete slab shall be approximately 4 in [100 mm] above finished floor. Edges above floor shall have 0.5 in [12.5 mm] chamfer. The slab shall be of adequate size to project at least 8 in [200 mm] beyond the equipment. Provide conduit turnups and adequate cable entrance space required for the equipment to be mounted. Seal voids around conduit openings in slab with water- and oil-resistant caulking or sealant. Cut off and bush conduits 3 in [75 mm] above the slab surface. Concrete work shall be as specified in Section 03 30 00, CAST-IN-PLACE CONCRETE.
- E. Set field-adjustable intervals and delays, relays, and engine exerciser.

### 3.2 ACCEPTANCE CHECKS AND TESTS

A factory-authorized service representative is required to inspect components, assemblies, and equipment installation, including connections, and to assist in testing.

1. Following completion of automatic transfer switch installation and after making proper adjustments and settings, site tests shall be performed by the manufacturer's representative in accordance with manufacturer's written instructions to demonstrate that each automatic transfer switch functions satisfactorily and as specified. Advise Project Engineer of the site testing within five days prior to its scheduled date, and provide certified field test reports within 14 days following successful completion of the site tests. Test reports shall describe adjustments and settings made and site tests performed. Minimum operational tests shall include the following:
  - a. Insulation resistance shall be tested, both phase-to-phase and phase-to-ground.

- b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
  - c. Verify that manual transfer warnings are properly placed.
  - d. Perform manual transfer operation.
2. After energizing circuits, demonstrate the interlocking sequence and operational function for each automatic transfer switch at least three times.
- a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
  - b. Simulate loss of phase-to-ground voltage for each phase of normal source.
  - c. Verify time-delay settings.
  - d. Verify pickup and dropout voltages by data readout or inspection of control settings.
  - e. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, re-transfer time delay on restoration of normal power, and engine cool-down and shut-down.

### **3.3 DEMONSTRATION**

- A. At the final inspection in the presence of Project Engineer, demonstrate that the complete auxiliary electrical power system operates properly in every respect. Coordinate this demonstration with the demonstration of the engine-generator(s).

### **3.4 TRAINING**

- A. Furnish the services of a competent, factory-trained engineer or technician for one 4-hour period to instruct VA personnel in the operation and maintenance of the equipment, including review of the operation and maintenance manual, on a date requested by the Project Engineer/. Coordinate this training with that of the generator training.

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**SECTION 26 43 13**  
**TRANSIENT-VOLTAGE SURGE SUPPRESSION**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Section includes transient voltage surge suppression equipment for low-voltage power distribution and control equipment.

**1.2 RELATED WORK**

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General requirements that are common to more than one section of Division 26.

**1.3 QUALITY ASSURANCE**

- A. Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

**1.4 SUBMITTALS**

- A. Include rated capacities, operating weights, electrical characteristics, furnished specialties, and accessories.
- B. Operation and Maintenance Data: For TVSS devices to include in emergency, operation, and maintenance manuals.
- C. Warranties: Sample of special warranties.
- D. Certifications:
  - 1. Two weeks prior to final inspection, submit four copies of the following to the Resident Engineer:
    - a. Certification by the Contractor that the assemblies have been properly installed, adjusted and tested.
    - b. Certified copies of all of the factory design and production tests, field test data sheets and reports for the assemblies.

**1.5 APPLICABLE PUBLICATIONS**

Publications listed below (including amendments, addenda, revisions, supplement and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.

- A. Institute of Engineering and Electronic Engineers (IEEE):
  - IEEE C62.41.2.....Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits
  - IEEE C62.45.....Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits
- B. National Electrical Manufacturers Association (NEMA):

- NEMA LS 1.....Low Voltage Surge Protective Devices
- C. Underwriters Laboratories, Inc. (UL):
- UL 1283.....Electromagnetic Interference Filters
- UL 1449.....Surge Protective Devices
- D. National Fire Protection Association (NFPA):
- NFPA 70.....National Electrical Code (NEC)

## **PART 2 - PRODUCTS**

### **2.1 SWITCHGEAR/SWITCHBOARD SUPPRESSORS**

- A. Surge Protection Devices:
1. Comply with UL 1449.
  2. Modular design with field-replaceable modules.
  3. Fuses, rated at 200-kA interrupting capacity.
  4. Fabrication using bolted compression lugs for internal wiring.
  5. Integral disconnect switch.
  6. Redundant suppression circuits.
  7. Redundant replaceable modules.
  8. Arrangement with copper bus bars and for bolted connections to phase buses, neutral bus, and ground bus.
  9. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
  10. LED indicator lights for power and protection status.
  11. Audible alarm, with silencing switch, to indicate when protection has failed.
  12. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status.  
Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
  13. Four-digit transient-event counter set to totalize transient surges.
- B. Peak Single-Impulse Surge Current Rating: 240 kA per mode/480 kA per phase.
- C. Minimum single impulse current ratings, using 8-by-20-mic.sec waveform described in IEEE C62.41.2
1. Line to Neutral: 70,000 A.
  2. Line to Ground: 70,000 A.
  3. Neutral to Ground: 50,000 A.
- D. Protection modes and UL 1449 SVR for grounded wye circuits shall be as follows:

1. Line to Neutral: 800 V for 480Y/277 V, 400 V for 208Y/120 V.
  2. Line to Ground: 800 V for 480Y/277 V, 400 V for 208Y/120 V.
  3. Neutral to Ground: 800 V for 480Y/277 V, 400 V for 208Y/120 V.
- E. Protection modes and UL 1449 SVR for 240/120 V, single-phase, 3-wire circuits shall be as follows:
1. Line to Neutral: 400 V.
  2. Line to Ground: 400 V.
  3. Neutral to Ground: 400 V.
- F. Protection modes and UL 1449 SVR for 240/120-V, 3-phase, 4-wire circuits with high leg shall be as follows:
1. Line to Neutral: 400 V, 800 V from high leg.
  2. Line to Ground: 400 V.
  3. Neutral to Ground: 400 V.
- G. Protection modes and UL 1449 SVR for 240 V or 480 V, 3-phase, 3-wire, delta circuits shall be as follows:
1. Line to Line: 2000 V for 480 V, 1000 V for 240 V.
  2. Line to Ground: 2000 V for 480 V, 1000 V for 240 V.

### **2.3 ENCLOSURES**

- A. Indoor Enclosures: NEMA 250 Type 1.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install TVSS devices at switchboard, switchgear, or panelboard on load side, with ground lead bonded to service entrance ground.
- B. Install TVSS devices for panelboards and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.
1. Provide a circuit breaker, sized by manufacturer, as a dedicated disconnecting means for TVSS unless otherwise shown on drawings.

### **3.2 ACCEPTANCE CHECKS AND TESTS**

- A. Perform in accordance with the manufacturer's recommendations. Include the following visual and mechanical inspections and electrical tests:
1. Visual and Mechanical Inspection
    - a. Compare equipment nameplate data with specifications and approved shop drawings.
    - b. Inspect physical, electrical, and mechanical condition.
    - c. Verify that disconnecting means and feeder size and maximum to TVSS unit correspond to approved shop drawings.

- d. Verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method.
- e. Clean TVSS unit.
- f. Complete startup checks according to manufacturer's written instructions.
- g. Verify the correct operation of all sensing devices, alarms, and indicating devices.

### **3.3 STARTUP**

- A. Do not energize or connect switchgear, switchboards, or panelboards to their sources until TVSS devices are installed and connected.
- B. Do not perform insulation resistance tests of the distribution wiring equipment with the TVSS installed. Disconnect before conducting insulation resistance tests, and reconnect immediately after the testing is over.

### **3.4 SPARE PARTS**

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Replaceable Protection Modules: One of each size and type installed.

### **3.5 INSTRUCTION**

- A. Provide factory certified technician to train Government maintenance personnel to maintain TVSS devices. Training shall be provided for a total period of 4 hours of normal working time and shall start after the system is functionally complete but prior to final acceptance test. Training shall cover all essential items contained in the operation and maintenance manual.

-- -END OF SECTION - - -



**SECTION 26 51 00  
INTERIOR LIGHTING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION:**

- A. This section specifies the furnishing, installation and connection of the interior lighting systems.

**1.2 RELATED WORK**

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General requirements that are common to more than one section of Division 26.
- B. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Cables and wiring.
- C. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path to ground for possible ground fault currents.
- D. Section 26 27 26, WIRING DEVICES: Wiring devices used for control of the lighting systems.

**1.3 QUALITY ASSURANCE**

- A. Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

**1.4 SUBMITTALS**

- A. In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:
- B. Product Data: For each type of lighting fixture (luminaire) designated on the LIGHTING FIXTURE SCHEDULE, arranged in order of fixture designation, submit the following information.
  - 1. Material and construction details include information on housing, optics system and lens/diffuser.
  - 2. Physical dimensions and description.
  - 3. Wiring schematic and connection diagram.
  - 4. Installation details.
  - 5. Energy efficiency data.
  - 6. Photometric data based on laboratory tests complying with IESNA Lighting Measurements, testing and calculation guides.
  - 7. Lamp data including lumen output (initial and mean), color rendition index (CRI), rated life (hours) and color temperature (degrees Kelvin).

8. Ballast data including ballast type, starting method, ambient temperature, ballast factor, sound rating, system watts and total harmonic distortion (THD).

C. Manuals:

1. Submit, simultaneously with the shop drawings companion copies of complete maintenance and operating manuals including technical data sheets, and information for ordering replacement parts.
2. Two weeks prior to the final inspection, submit four copies of the final updated maintenance and operating manuals, including any changes, to the Project Engineer.

### 1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. Institute of Electrical and Electronic Engineers (IEEE):  
C62.41-91.....Guide on the Surge Environment in Low Voltage  
(1000V and less) AC Power Circuits
- C. National Fire Protection Association (NFPA):  
70.....National Electrical Code (NEC)  
101.....Life Safety Code
- D. National Electrical Manufacturer's Association (NEMA):  
C82.1-97.....Ballasts for Fluorescent Lamps - Specifications  
C82.2-02.....Method of Measurement of Fluorescent Lamp  
Ballasts  
C82.4-02.....Ballasts for High-Intensity-Discharge and Low-  
Pressure Sodium Lamps  
C82.11-02.....High Frequency Fluorescent Lamp Ballasts
- E. Underwriters Laboratories, Inc. (UL):  
496-96.....Edison-Base Lampholders  
542-99.....Lampholders, Starters, and Starter Holders for  
Fluorescent Lamps  
844-95.....Electric Lighting Fixtures for Use in Hazardous  
(Classified) Locations  
924-95.....Emergency Lighting and Power Equipment  
935-01.....Fluorescent-Lamp Ballasts  
1029-94.....High-Intensity-Discharge Lamp Ballasts

1029A-06.....	Ignitors and Related Auxiliaries for HID Lamp Ballasts
1598-00.....	Luminaires
1574-04.....	Standard for Track Lighting Systems
2108-04.....	Standard for Low-Voltage Lighting Systems
8750-08.....	Light Emitting Diode (LED) Light Sources for Use in Lighting Products

F. Federal Communications Commission (FCC):

Code of Federal Regulations (CFR), Title 47, Part 18

**PART 2 - PRODUCTS**

**2.1 LIGHTING FIXTURES (LUMINAIRES)**

- A. Shall be in accordance with NFPA 70 and UL 1598, as shown on drawings, and as specified.
- B. Sheet Metal:
  - 1. Shall be formed to prevent warping and sagging. Housing, trim and lens frame shall be true, straight (unless intentionally curved) and parallel to each other as designed.
  - 2. Wireways and fittings shall be free of burrs and sharp edges and shall accommodate internal and branch circuit wiring without damage to the wiring.
  - 3. When installed, any exposed fixture housing surface, trim frame, door frame and lens frame shall be free of light leaks; lens doors shall close in a light tight manner.
  - 4. Hinged door closure frames shall operate smoothly without binding when the fixture is in the installed position, latches shall function easily by finger action without the use of tools.
- C. Ballasts shall be serviceable while the fixture is in its normally installed position, and shall not be mounted to removable reflectors or wireway covers unless so specified.
- D. Lamp Sockets:
  - 1. Fluorescent: Lampholder contacts shall be the biting edge type or phosphorous-bronze with silver flash contact surface type and shall conform to the applicable requirements of UL 542. Lamp holders for bi-pin lamps shall be of the telescoping compression type, or of the single slot entry type requiring a one-quarter turn of the lamp after insertion.
  - 2. High Intensity Discharge (H.I.D.): Shall have porcelain enclosures.

- E. Recessed fixtures mounted in an insulated ceiling shall be listed for use in insulated ceilings.
- F. Mechanical Safety: Lighting fixture closures (lens doors, trim frame, hinged housings, etc.) shall be retained in a secure manner by captive screws, chains, captive hinges or fasteners such that they cannot be accidentally dislodged during normal operation or routine maintenance.
- G. Metal Finishes:
  - 1. The manufacturer shall apply standard finish (unless otherwise specified) over a corrosion resistant primer, after cleaning to free the metal surfaces of rust, grease, dirt and other deposits. Edges of pre-finished sheet metal exposed during forming, stamping or shearing processes shall be finished in a similar corrosion resistant manner to match the adjacent surface(s). Fixture finish shall be free of stains or evidence of rusting, blistering, or flaking, and shall be applied after fabrication.
  - 2. Interior light reflecting finishes shall be white with not less than 85 percent reflectances, except where otherwise shown on the drawing.
  - 3. Exterior finishes shall be as shown on the drawings.
- H. Lighting fixtures shall have a specific means for grounding metallic wireways and housings to an equipment grounding conductor.
- I. Light Transmitting Components for Fluorescent Fixtures:
  - 1. Shall be 100 percent virgin acrylic.
  - 2. Flat lens panels shall have not less than 1/8 inch [3.2mm] of average thickness. The average thickness shall be determined by adding the maximum thickness to the minimum unpenetrated thickness and dividing the sum by 2.
  - 3. Unless otherwise specified, lenses, diffusers and louvers shall be retained firmly in a metal frame by clips or clamping ring in such a manner as to allow expansion and contraction of the lens without distortion or cracking.
- J. Compact fluorescent fixtures shall be manufactured specifically for compact fluorescent lamps with ballast integral to the fixture. Assemblies designed to retrofit incandescent fixtures are prohibited except when specifically indicated for renovation of existing fixtures (not the lamp). Fixtures shall be designed for lamps as specified.

## 2.2 BALLASTS

- A. Linear Fluorescent Lamp Ballasts: Multi-voltage (120 - 277V) electronic instant-start or programmed-start type, complying with UL 935 and with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballasts shall be GE Ultramax with the capability to operate a low wattage 28 watt rated T8 lamp. Ballasts that are operated by occupancy sensors shall be provided with programmed start ballasts only. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated; including the following features:
1. Lamp end-of-life detection and shutdown circuit (T5 lamps only).
  2. Automatic lamp starting after lamp replacement.
  3. Sound Rating: Class A.
  4. Total Harmonic Distortion Rating: 10 percent or less.
  5. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
  6. Operating Frequency: 20 kHz or higher.
  7. Lamp Current Crest Factor: 1.7 or less.
  8. Ballast Factor: 0.87 or higher unless otherwise indicated.
  9. Power Factor: 0.98 or higher.
  10. Interference: Comply with 47 CFT 18, Ch.1, Subpart C, for limitations on electromagnetic and radio-frequency interference for non-consumer equipment.
  11. To facilitate multi-level lamp switching, lamps within fixture shall be wired with the outermost lamp at both sides of the fixture on the same ballast, the next inward pair on another ballast and so on to the innermost lamp (or pair of lamps). Within a given room, each switch shall uniformly control the same corresponding lamp (or lamp pairs) in all fixture units that are being controlled.
  12. Dimming ballasts shall be as per above, except dimmable from 100% to 5 of rated lamp lumens.
- B. Compact Fluorescent Lamp Ballasts: Multi-voltage (120 - 277V), 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; including the following features:
1. Lamp end-of-life detection and shutdown circuit.
  2. Automatic lamp starting after lamp replacement.

3. Sound Rating: Class A.
  4. Total Harmonic Distortion Rating: 10 percent or less.
  5. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
  6. Operating Frequency: 20 kHz or higher.
  7. Lamp Current Crest Factor: 1.7 or less.
  8. Ballast Factor: 0.95 or higher unless otherwise indicated.
  9. Power Factor: 0.98 or higher.
  10. Interference: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for non-consumer equipment.
  11. Dimming ballasts shall be as per above, except dimmable from 100% to 5 % of rated lamp lumens.
- C. Ballasts for high intensity discharge fixtures: Multi-tap voltage (120-480v) electromagnetic ballast for high intensity discharge lamps. Comply with ANSI C82.4 and UL 1029. Include the following features unless otherwise indicated:
1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
  2. Minimum Starting Temperature: Minus 22 deg F (Minus 30 deg C) for single-lamp ballasts.
  3. Rated Ambient Operating Temperature: 104 deg F (40 deg C).
  4. Open-circuit operation that will not reduce average life.
  5. Low-Noise Ballasts: Manufacturers' standard epoxy-encapsulated models designed to minimize audible fixture noise.

## 2.3 LAMPS

### A. Linear T5 and T8 Fluorescent Lamps:

1. Instant-start lamps shall comply with ANSI C78.3. Lamps shall be GE Ecolux Ultramax F28T8/XLSP41.
2. Chromacity of fluorescent lamps shall comply with ANSI C78.376.
3. Except as indicated below, lamps shall be low-mercury energy saving type, have a color temperature of 4100°K, a Color Rendering Index (CRI) of greater than 75, average rated life of 20,000 hours, and be suitable for use with dimming ballasts, unless otherwise indicated. Low mercury lamps shall have passed the EPA Toxicity Characteristic Leachate Procedure (TCLP) for mercury by using the lamp sample preparation procedure described in NEMA LL 1.

### B. Compact Fluorescent Lamps:

1. T4, CRI 80 (minimum), color temperature 4100 K, and suitable for use with dimming ballasts, unless otherwise indicated.

C. High Intensity Discharge Lamps:

1. High-Pressure Sodium Lamps: ANSI C78.42, CRI 21 (minimum), color temperature 1900°K, and average rated life of 24,000 hours, minimum.

## **2.4 EXIT LIGHT FIXTURES**

- A. Exit light fixtures shall meet applicable requirements of NFPA 101 and UL 924.

B. Housing and Canopy:

1. Shall be made of die-cast aluminum.

- C. Door frame shall be cast or extruded aluminum, and hinged with latch.

- D. Finish shall white aluminum.

- E. There shall be no radioactive material used in the fixtures.

F. Fixtures:

1. Maximum fixture wattage shall be 1 watt or less.
2. Inscription panels shall be cast or stamped aluminum a minimum of 0.090 inch [2.25mm] thick, stenciled with 6 inch [150mm] high letters, baked with red color stable plastic or fiberglass. Lamps shall be luminous Light Emitting Diodes (LED) mounted in center of letters on red color stable plastic or fiberglass. The LED shall be rated minimum 25 years life.
3. Double-Faced Fixtures: Provide double-faced fixtures where required or as shown on drawings.
4. Directional Arrows: Provide directional arrows as part of the inscription panel where required or as shown on drawings. Directional arrows shall be the "chevron-type" of similar size and width as the letters and meet the requirements of NFPA 101.

- G. Voltages: Refer to Lighting Fixture Schedule.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Installation shall be in accordance with the NEC, manufacturer's instructions and as shown on the drawings or specified.

- B. Align, mount and level the lighting fixtures uniformly.

- C. Fluorescent bed light fixtures shall be attached to the studs in the walls. Attachment to gypsum board only is not acceptable.

D. Lighting Fixture Supports:

1. Shall provide support for all of the fixtures. Supports may be anchored to channels of the ceiling construction, to the structural

slab or to structural members within a partition, or above a suspended ceiling.

2. Shall maintain the fixture positions after cleaning and relamping.
3. Shall support the lighting fixtures without causing the ceiling or partition to deflect.
4. Hardware for recessed fluorescent fixtures:
  - a. Where the suspended ceiling system is supported at the four corners of the fixture opening, hardware devices shall clamp the fixture to the ceiling system structural members, or plaster frame at not less than four points in such a manner as to resist spreading of the support members and safely lock the fixture into the ceiling system.
  - b. Where the suspended ceiling system is not supported at the four corners of the fixture opening, hardware devices shall independently support the fixture from the building structure at four points.
5. Surface mounted lighting fixtures:
  - a. Fixtures shall be bolted against the ceiling independent of the outlet box at four points spaced near the corners of each unit. The bolts (or stud-clips) shall be minimum 6 mm (1/4-20) bolt, secured to main ceiling runners and/or secured to cross runners. Non-turning studs may be attached to the main ceiling runners and cross runners with special non-friction clip devices designed for the purpose, provided they bolt through the runner, or are also secured to the building structure by 12 gauge safety hangers. Studs or bolts securing fixtures weighing in excess of 25 kg (56 pounds) shall be supported directly from the building structure.
  - b. Where ceiling cross runners are installed for support of lighting fixtures they must have a carrying capacity equal to that of the main ceiling runners and be rigidly secured to the main runners.
  - c. Fixtures less than 6.8 kg (15 pounds) in weight and occupying less than 600 mm x 600 mm (two square feet) of ceiling area may, (when designed for the purpose) be supported directly from the outlet box when all the following conditions are met.
    - 1) Screws attaching the fixture to the outlet box pass through round holes (not key-hole slots) in the fixture body.
    - 2) The outlet box is attached to a main ceiling runner (or cross runner) with approved hardware.



- 3) The outlet box is supported vertically from the building structure.
- d. Fixtures mounted in open construction shall be secured directly to the building structure with approved bolting and clamping devices.
- 6. Hardware for surface mounting fluorescent fixtures to suspended ceilings:
  - a. In addition to being secured to any required outlet box, fixtures shall be bolted to a grid ceiling system at four points spaced near the corners of each fixture. The bolts shall be not less than 1/4 inch [6mm] secured to channel members attached to and spanning the tops of the ceiling structural grid members. Non-turning studs may be attached to the ceiling structural grid members or spanning channels by special clips designed for the purpose, provided they lock into place and require simple tools for removal.
  - b. In addition to being secured to any required outlet box, fixtures shall be bolted to ceiling structural members at four points spaced near the corners of each fixture. Pre-positioned 1/4 inch [6mm] studs or threaded plaster inserts secured to ceiling structural members shall be used to bolt the fixtures to the ceiling. In lieu of the above, 1/4 inch [6mm] toggle bolts may be used on new or existing ceiling provided the plaster and lath can safely support the fixtures without sagging or cracking
- E. Furnish and install the specified lamps for all lighting fixtures installed and all existing lighting fixtures reinstalled under this project.
- F. Coordinate between the electrical and ceiling trades to ascertain that approved lighting fixtures are furnished in the proper sizes and installed with the proper devices (hangers, clips, trim frames, flanges), to match the ceiling system being installed.
- G. Bond lighting fixtures and metal accessories to the grounding system as specified in Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.
- H. Exercise electronic dimming ballasts over full range of dimming capability by operating the control devices(s) in the presence of the Resident Engineer. Observe for visually detectable flicker over full dimming range.

- I. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by Government. Burn-in period to be 40 hours minimum, unless a lesser period is specifically recommended by lamp manufacturer. Burn-in fluorescent and compact fluorescent lamps intended to be dimmed, for at least 100 hours at full voltage. Replace any lamps and ballasts which fail during burn-in.
- J. At completion of project, relamp/reballast fixtures which have failed lamps/ballasts. Clean fixtures, lenses, diffusers and louvers that have accumulated dust/dirt/fingerprints during construction. Replace damaged lenses, diffusers and louvers with new.

- - - E N D - - -

**SECTION 26 56 00  
EXTERIOR LIGHTING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the furnishing, installation, and connection of exterior luminaires, poles, and supports.

**1.2 RELATED WORK**

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.
- B. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Low voltage power and lighting wiring.
- C. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.
- D. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits, fittings, and boxes for raceway systems.
- E. Section 26 05 41, UNDERGROUND ELECTRICAL CONSTRUCTION: Underground handholes and conduits.

**1.3 QUALITY ASSURANCE**

- A. Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

**1.4 SUBMITTALS**

- A. Submit in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. Shop Drawings:
  - 1. Clearly present sufficient information to determine compliance with drawings and specifications.
  - 2. Include electrical ratings, dimensions, mounting, details, materials, required clearances, terminations, wiring and connection diagrams, photometric data, ballasts, poles, luminaires, lamps, and accessories.
- C. Manuals: Two weeks prior to final inspection, submit four copies of operating and maintenance manuals to the Project Engineer. Include technical data sheets, wiring and connection diagrams, and information for ordering replacement lamps, ballasts, and parts.

## 1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. Aluminum Association Inc. (AA):  
AAH35.1-06.....Alloy and Temper Designation Systems for  
Aluminum
- C. American Association of State Highway and Transportation Officials (AASHTO):  
LTS-5-09 .....Structural Supports for Highway Signs,  
Luminaires and Traffic Signals
- D. American Concrete Institute (ACI):  
318-05 .....Building Code Requirements for Structural  
Concrete
- E. American National Standards Institute (ANSI):  
C81.61-09 .....Electrical Lamp Bases - Specifications for  
Bases (Caps) for Electric Lamps
- F. American Society for Testing and Materials (ASTM):  
A123/A123M-09 .....Zinc (Hot-Dip Galvanized) Coatings on Iron and  
Steel Products  
A153/A153M-09.....Zinc Coating (Hot-Dip) on Iron and Steel  
Hardware  
B108-03a-08 .....Aluminum-Alloy Permanent Mold Castings  
C1089-06 .....Spun Cast Prestressed Concrete Poles
- G. Federal Aviation Administration (FAA):  
AC 70/7460-IK-07.....Obstruction Lighting and Marking  
AC 150/5345-43F-06.....Obstruction Lighting Equipment
- H. Illuminating Engineering Society of North America (IESNA)  
HB-9-00.....Lighting Handbook  
RP-8-05.....Roadway Lighting  
RP-20-98.....Lighting for Parking Facilities  
RP-33-99.....Lighting for Exterior Environments  
LM-5-96.....Photometric Measurements of Area and Sports  
Lighting Installations  
LM-50-99.....Photometric Measurements of Roadway Lighting  
Installations

- LM-52-99.....Photometric Measurements of Roadway Sign  
Installations
- LM-64-01.....Photometric Measurements of Parking Areas
- LM-72-97.....Directional Positioning of Photometric Data
- LM-79-08.....Approved Method for the Electrical and  
Photometric Measurements of Solid-State Lighting  
Products
- LM-80-08.....Approved Method for Measuring Lumen Maintenance  
of LED Light Sources
- I. National Electrical Manufacturers Association (NEMA):
- C78.41-06.....Electric Lamps - Guidelines for Low-Pressure  
Sodium Lamps
- C78.42-07 .....Electric Lamps - Guidelines for High-Pressure  
Sodium Lamps
- C78.43-07 .....Electric Lamps - Single-Ended Metal-Halide  
Lamps
- C78.1381-98.....Electric Lamps - 70-Watt M85 Double-Ended  
Metal-Halide Lamps
- C82.4-02 .....Ballasts for High-Intensity-Discharge and Low-  
Pressure Sodium Lamps (Multiple-Supply Type)
- C136.3-05 .....For Roadway and Area Lighting Equipment -  
Luminaire Attachments
- C136.17-05 .....Roadway and Area Lighting Equipment - Enclosed  
Side-Mounted Luminaires for Horizontal-Burning  
High-Intensity-Discharge Lamps - Mechanical  
Interchangeability of Refractors
- ICS 2-00 (R2005) .....Controllers, Contactors and Overload Relays  
Rated 600 Volts
- ICS 6-93 (R2006) .....Enclosures
- J. National Fire Protection Association (NFPA):
- 70-08 .....National Electrical Code (NEC)
- K. Underwriters Laboratories, Inc. (UL):
- 496-08 .....Lampholders
- 773-95.....Plug-In, Locking Type Photocontrols for Use  
with Area Lighting
- 773A-06 .....Nonindustrial Photoelectric Switches for  
Lighting Control
- 1029-94.....High-Intensity-Discharge Lamp Ballasts

1598-08 .....Luminaires

8750-08.....Light Emitting Diode (LED) Light Sources for  
Use in Lighting Products

## **1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Provide manufacturer's standard provisions for protecting pole finishes during transport, storage, and installation. Do not store poles on ground. Store poles so they are at least 12 in [305 mm] above ground level and growing vegetation. Do not remove factory-applied pole wrappings until just before installing pole.

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS AND EQUIPMENT**

- A. Materials and equipment shall be in accordance with NEC, UL, ANSI, and as shown on the drawings and specified.

### **2.2 POLES**

#### **A. General:**

1. Poles shall be as shown on the drawings, and as specified. Finish shall be as specified on the drawings.
2. The pole and arm assembly shall be designed for wind loading of 100 mph [161 km/hr], with an additional 30% gust factor, supporting luminaire(s) and accessories such as shields, banner arms, and banners that have the effective projected areas indicated. The effective projected area of the pole shall be applied at the height of the pole base, as shown on the drawings.
3. Poles shall be anchor-bolt type designed for use with underground supply conductors. Poles shall have handhole having a minimum clear opening of 2.5 x 5 in [65 x 125 mm]. Handhole covers shall be secured by stainless steel captive screws.
4. Provide a steel-grounding stud opposite handhole openings, designed to prevent electrolysis when used with copper wire.
5. Provide a base cover that matches the pole in material and color to conceal the mounting hardware pole-base welds and anchor bolts.
6. Hardware and Accessories: All necessary hardware and specified accessories shall be the product of the pole manufacturer.
7. Provide manufacturer's standard finish, as scheduled on the drawings.

#### **B. Types:**

1. Aluminum: Provide round aluminum poles manufactured of corrosion-resistant AA AAH35.1 aluminum alloys conforming to AASHTO LTS-4. Poles shall be seamless extruded or spun seamless type.

### **2.3 FOUNDATIONS FOR POLES**

- A. Foundations shall be cast-in-place concrete, having 3000 psi minimum 28-day compressive strength.
- B. Foundations shall support the effective projected area of the specified pole, arm(s), luminaire(s), and accessories, such as shields, banner arms, and banners, under wind conditions previously specified in this section.
- C. Place concrete in spirally-wrapped treated paper forms for round foundations, and construct forms for square foundations.
- D. Rub-finish and round all above-grade concrete edges to approximately 0.25 in [6 mm] radius.
- E. Anchor bolt assemblies and reinforcing of concrete foundations shall be as shown on the drawings. Anchor bolts shall be in a welded cage or properly positioned by the tie wire to stirrups.
- F. Prior to concrete pour, install electrode per Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.

### **2.4 LUMINAIRES**

- A. Per UL 1598 and NEMA C136.17. Luminaires shall be weatherproof, heavy duty, outdoor types designed for efficient light utilization, adequate dissipation of lamp and ballast heat, and safe cleaning and relamping.
- B. Light distribution pattern types shall be as shown on the drawings.
- C. Incorporate ballasts in the luminaire housing, except where otherwise shown on the drawings.
- D. Lenses shall be frame-mounted, heat-resistant, borosilicate glass, with prismatic refractors, unless otherwise shown on the drawings. Attach the frame to the luminaire housing by hinges or chain. Use heat and aging-resistant, resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- E. Lamp sockets for high intensity discharge (H.I.D) fixture shall have locking-type porcelain enclosures in conformance to the applicable requirements of ANSI C81.61 and UL 496.
- F. Pre-wire internal components to terminal strips at the factory.
- G. Bracket-mounted luminaires shall have leveling provisions and clamp-type adjustable slip-fitters with locking screws.

- H. Materials shall be rustproof. Latches and fittings shall be non-ferrous metal.
- I. Provide manufacturer's standard finish, as scheduled on the drawings. Where indicated on drawings, match finish process and color of pole or support materials.
- J. Luminaires shall carry factory labels, showing complete, specific lamp and ballast information.

## **2.5 LAMPS**

- A. Install the proper lamps in every luminaire installed and every existing luminaire relocated or reinstalled.
- B. Lamps shall be general-service, outdoor lighting types.
- C. High-Pressure Sodium (HPS) Lamps: NEMA C78.42, CRI 21 (minimum), wattage as indicated. Lamps shall have minimum average rated life of 24,000 hours.

## **2.6 HIGH INTENSITY DISCHARGE BALLASTS**

- A. Per NEMA C82.4 and UL 1029. Ballasts shall be encapsulated single-lamp, copper-wound, constant-wattage autotransformer type, designed to operate on the voltage system to which they are connected, and capable of open-circuit operation without reducing lamp life.
- B. Ballasts shall have individual overcurrent protection in each ungrounded supply conductor.
- C. Ballast shall have an allowable line voltage variations of  $\pm 10\%$ , with a maximum 20% lamp wattage regulation spread.
- D. Power factor shall be not less than 90%.
- E. Ballast shall have a minimum starting temperature of  $-22^{\circ}\text{ F } [-30^{\circ}\text{ C}]$ , and a normal ambient operating temperature of  $104^{\circ}\text{ F } [40^{\circ}\text{ C}]$ .
- F. Lamp current crest factor shall be 1.8 or less, in accordance with lamp manufacturer recommendations.

## **2.7 EXISTING LIGHTING SYSTEMS**

- A. For modifications or additions to existing lighting systems, the new components shall be compatible with the existing systems.
- B. New poles and luminaires shall have approximately the same configurations and dimensions as the existing poles and luminaires, except where otherwise shown on the drawings.

# **PART 3 - EXECUTION**

## **3.1 INSTALLATION**

- A. Install lighting in accordance with the NEC, as shown on the drawings, and in accordance with manufacturer's recommendations.



**B. Pole Foundations:**

1. Excavate only as necessary to provide sufficient working clearance for installation of forms and proper use of tamper to the full depth of the excavation. Prevent surface water from flowing into the excavation. Thoroughly compact backfill with compacting arranged to prevent pressure between conductor, jacket, or sheath, and the end of conduit.
2. Set anchor bolts according to anchor-bolt templates furnished by the pole manufacturer.
3. Install poles as necessary to provide a permanent vertical position with the bracket arm in proper position for luminaire location.
4. After the poles have been installed, shimmed, and plumbed, grout the spaces between the pole bases and the concrete base with non-shrink concrete grout material. Provide a plastic or copper tube, of not less than 0.375 in [9 mm] inside diameter through the grout, tight to the top of the concrete base to prevent moisture weeping from the interior of the pole.

C. Install lamps in each luminaire.

D. Adjust luminaires that require field adjustment or aiming.

**3.2 GROUNDING**

- A. Ground noncurrent-carrying parts of equipment, including metal poles, luminaires, mounting arms, brackets, and metallic enclosures, as specified in Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS. Where copper grounding conductor is connected to a metal other than copper, provide specially-treated or lined connectors suitable and listed for this purpose.

**3.3 ACCEPTANCE CHECKS AND TESTS**

- A. Verify operation after installing luminaires and energizing circuits.

- - - E N D - - -

**SECTION 27 10 05**  
**COMPUTER NETWORK AND TELEPHONE WIRING SYSTEM**

**PART 1 - GENERAL**

**1.1 SECTION INCLUDES**

This section includes the furnishing and installation of the following:

- A. Raceway distribution system.
- B. Computer and telephone wiring.
- C. Workstation communications outlets.
- D. Data rack and patch panels.
- E. Backbone telephone and fiber optic cable for in building wiring.
- F. Horizontal cabling patch panels.
- G. Premise testing.
- H. Equipment.

**1.2 RELATED SECTIONS**

- A. Section 26 05 11 - Requirements for Electrical Installations
- B. Section 26 05 33 - Raceway and Boxes for Electrical Systems
- C. Section 26 27 26 - Wiring Devices.

**1.3 REFERENCES**

- A. ANSI/TIA/EIA 568A - B.1, B.2, B3 Commercial Building Telecommunications Cabling Standard.
- B. ANSI/TIA/EIA 569A Commercial Building Standard Telecommunications Pathways and Spaces.
- C. ANSI/TIA/EIA 606 Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.
- D. NFPA 70 National Electrical Code.
- E. BICSI TDMM (Building Industry Consulting Service International, Telecommunications Distribution Methods Manual and Telecommunications Cabling Installation Manual).

**1.4 PROJECT RECORD DOCUMENTS**

- A. Submit record documents under provisions of Section 26 05 11.
- B. As-built record drawings to be provided to Owner/Engineer before final payment.

**1.5 SHOP DRAWINGS**

- A. Submit in accordance with Section 01 33 23.
- B. Submit conductors, jacks, racks, and patch panels.

**1.6 SYSTEM DESCRIPTION**

- A. Horizontal and workstation pathways conform to ANSI/EIA/TIA 569A, using raceway and patch panels as indicated.

- B. Premise Wiring: Horizontal and workstation complete from communication room to each outlet, using conductors and other equipment as specified.
- C. All premise wiring to be of one manufacturer.
- D. Backbone Cabling: Backbone cables shall be routed from the basement telephone and data rooms to the new IRM closets in the basement and on first floor. Cables shall be routed in existing cable tray and new vertical conduit sleeves.

#### **1.7 QUALITY ASSURANCE**

- A. Perform work in accordance with BICSI TDMM and ANSI/EIA/TIA standards.

#### **1.8 QUALIFICATIONS**

- A. Installer: Company specializing in installing data communications wiring with minimum of three years project experience and BICSI certified as an installer at start of installation.
- B. Installer: Must submit documentation of qualifications before start of installation.

#### **1.9 REGULATORY REQUIREMENTS**

- A. Conform to requirements of NFPA 70 and applicable building codes.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

#### **1.10 MAINTENANCE/WARRANTY**

- A. Manufacturer shall warranty and provide maintenance service for 15 years minimum on the network system and a lifetime for products used in the system.
- B. Submit documentation stating warranty at project closeout.

#### **1.11 COPPER AND FIBER OPTIC CONDUCTOR CABLE TESTING**

- A. Contractor shall perform and document all conductor tests. Return one copy of testing report to the Engineer and one copy to the Owner.
- B. All Category 6 Enhanced conductors, Category 3 backbone cables and fiber optic cables shall be tested and certified for ANSI/EIA/TIA, 568A, TSB-67 standards and ANSI/TIA/EIA-TSB-95.
- C. All copper station runs must be tested after final installation and termination. All data cable runs shall be documented with a hard copy printout of the test results. This printout shall be bound and delivered to the Owner prior to final payment.
- D. The Owner requires that the Scope/HP Wirescope 350 Level III, or approved equal tester be utilized for all copper data testing.
- E. The Owner requires that the company/individual testing the cable be manufacturer certified for products provided.

## **PART 2 - PRODUCTS**

### **2.1 CONDUIT AND OUTLETS**

- A. As specified in Section 26 05 33 - Conduit Systems.
- B. Conduit Size: Minimum 3/4 inch with larger sizes where noted on Drawings.
- C. Four-inch square box with single gang plaster ring.

### **2.2 OUTLET COVER PLATES**

- A. As specified in Section 26 27 26 - Wiring Devices.
- B. Cover Plate: Ivory.

### **2.3 WORKSTATION COMMUNICATIONS OUTLETS**

- A. Connector modules shall be equal to Panduit CJ6X88TGEI to match existing Fargo VAMC standard.
  - 1. ANSI/TIA/EIA-T568B wiring configuration.
  - 2. Category 6 Enhanced (500 MHz) power sum connector.  
Modular faceplates shall be Panduit Mini-Com Executive Series faceplates.
    - a. One, two, four and six-port single gang and 10-port double gang faceplates as required. Panduit part numbers CFPE1-IW, CFPE2-IW, CFPE4-IW, CFPE6-IW, and CFPE10IW-2G.
  - 3. Standard Color: Orange for data connectors, ivory for telephone connectors.
  - 4. See Drawings for quantity of connector modules and modular faceplates.
  - 5. Modular Furniture Faceplates: Provide Panduit CFFPL4BL four module space modular furniture snap-in faceplate with labels for installation in modular furniture where shown on the drawings.  
Faceplate to be compatible with the brand of modular furniture.

### **2.4 COPPER CONDUCTOR**

- A. Manufacturer: Equal to General Genspeed 6000E.
  - 1. Category 6 Enhanced.
  - 2. Four twisted pair non-shielded.
  - 3. 23 gauge solid copper conductors.
  - 4. U.L. listed MPP/CMP.
  - 5. Conductor Resistance: 9.38 ohms/100m nom. @ 20 degrees C.
  - 6. Impedance:
    - a. 100±15 ohms 1-100 MHz.
    - b. 100±22 ohms 101-250 MHz.
    - c. 100±32 ohms 250-500 MHz.

7. ACR based on Power Sum NEXT
  - a.  $\geq 15.8$  dB/100m @ 200 MHz.
  - b.  $\geq 10.7$  dB/100m @ 250 MHz.
8. Delay Skew  $\leq 35$  ns/100m.
9. NVP = 70% speed of light.
10. Plenum rated cable.

## **2.5 BACKBONE CABLES**

### **A. Fiber Optic Cables**

1. Manufacturer: Optical Cable Corporation (OCC) or equal.
  - a. Interior Cable: OCC DX series, distribution-style with 900um tight buffered fibers, Super/FDDI-grade, type OFNP nonconductive-plenum-rated cable, flame-retardant PVC jacket, plenum rated armor, armored jacket, provide plenum rated interlocked armored jacket with orange color, 12-fiber, multimode 62.5/125 um, complying with TIA-492AAAA; covered with orange cable jacket and complying with relevant portions of and addenda to latest edition of TIA/EIA-568.

### **B. Copper Backbone Cables**

1. Manufacturer: Superior Essex or equal.
  - a. Interior Cable: Superior Essex 18-799 series, TIA/EIA-568 Category 3 solid conductor unshielded twisted pair (UTP), 24 AWG, 100 ohm; 100 or 200 pairs formed into 25-pair binder groups; covered with gray thermoplastic jacket and complying with all relevant parts of and addenda to latest editions of TIA/EIA-568 and ICEA S-90-661, and UL 444. Provide NFPA 70 type CMP plenum-rated cable.

## **2.6 CROSS CONNECTION EQUIPMENT**

1. Connector Blocks for Category 3 Backbone Cabling: Type 110 insulation displacement connectors; capacity sufficient for cables to be terminated plus 25 percent spare. 110 blocks shall be used for terminating all copper telephone backbone cabling and all copper telephone horizontal cabling.
2. Patch Panels for Copper Data Cabling: Sized to fit EIA standard 19 inch wide equipment racks; 0.09 inch thick aluminum; cabling terminated on Type 110 insulation displacement connectors; printed circuit board interface.

- a. Panduit CPP48WBL 48-port all metal modular patch panel frames, populated with Panduit CJ6X88TGEI modular connectors (as listed in 2.3) Category 6 enhanced power sum connectors.
  - b. Capacity: Provide ports sufficient for cables to be terminated plus 25 percent spare.
  - c. Labels: Factory installed laminated plastic nameplates above each port, numbered consecutively; comply with TIA/EIA-606 using encoded identifiers.
  - d. Provide incoming cable strain relief and routing guides on back of panel.
  - e. Chatsworth 30530-719, HORZ MGR DBL UNIV 2U 19 IN, horizontal wire management panels shall be provided between pairs of CPP48 patch panel frames for front and rear patch cable management and as necessary above and/or below network electronics.
  - f. Panduit type WMPV22E, VTR CBL MGT 4X FRT/REAR 22RU vertical wire management panels shall be provided on the left and right sides of each rack.
2. Patch Panels for Fiber Optic Cabling: Sized to fit EIA standard 19 inch wide equipment racks; 0.09 inch thick aluminum.
- a. Panduit FRME24BL 24-port rack mount fiber panel with FAP-6W ST multimode ST adapter plate. Provide Panduit FWME8 series wall mount enclosures for wall mount applications.
  - b. Labels: Factory installed laminated plastic nameplates above each port, numbered consecutively; comply with TIA/EIA-606 using encoded identifiers.
  - c. Provide incoming cable strain relief and routing guides on back of panel.
  - d. Provide rear cable management tray at least 8 inches deep with removable cover.
  - e. Provide dust covers for unused adaptors.
  - f. Patch Cords: Provide one patch cord for each pair of patch panel ports.

## **2.7 ENCLOSURES**

- A. Equipment Racks and Cabinets: CEA-310 standard 19 inch wide component racks.

1. Floor Mounted Racks: 16 gage steel construction with corrosion resistant finish; vertical and horizontal cable management channels, top and bottom cable troughs, and grounding lug.
  - a. Manufacturer: Hoffman E4DR19FM38U open 4 post.
  - b. Description: Standard 19" rack meeting EIA-310-D standards. 84" high, aluminum construction, aluminum in color. 45 rack spaces minimum.
  - c. Mounting: Floor mount. Secure to floor and building structure above.
  - d. Wire Management: Provide matching horizontal and vertical wire management for rack and all installed components.
  - e. Provide UL listed horizontal power strip, 30 amp rated, (12) NEMA 5-20R outlets and an integral circuit breaker and 10 foot cord.
  - f. Cable Management: Provide "Cable Drop Out" or "Cable Exit" accessories for connecting the cable tray to the racks. Secure cable tray to each rack.
- B. Plywood Termination Board: ¾ inch thick, fire rated CDX plywood with smooth finish on one side, painted with gray intumescent paint. Provide plywood from 2'-6" to 6'-6" on all walls of the new IRM room.

## **2.8 FIRESTOP**

- A. Provide a firestop system with an "F" rating as determined by UL 1479 or ASTM E814 which is equal to the time rating of construction being penetrated.
  1. For penetrations by non-combustible items including steel pipe, copper pipe, rigid steel conduit, and electrical metallic tubing (EMT), the following are acceptable:
    - a. Hilti FS 601 elastomeric firestop sealant or Fs 605 HP firestop sealant.
    - b. 3M fire barrier CP25.
    - c. Nelson CLK firestop sealant.
  2. For fire-rated construction joints and other gaps, the following may be used:
    - a. Hilti FS 601.
    - b. 3M fire barrier CP25.
    - c. Nelson CLK firestop sealant.
  3. For penetrations by combustible items (penetrants consumed by high heat and flame) including insulated metal pipe, PVC

jacketed, flexible cable, or cable bundles, and plastic pipe (closed piping systems), the following are acceptable:

- a. Hilti FS 611A intumescent firestop sealant.
  - b. 3M fire barrier CP 25.
  - c. 3M fire barrier FS-195 wrap strip.
  - d. Nelson FSP firestop putty, PCS pipe choke system.
4. For large complex penetrations made to accommodate cable trays, multiple steel and copper pipes, electrical busways or raceways, the following are acceptable:
- a. Hilti FS 635, trowelable firestop compound.
  - b. 3M fire barrier CS-195 composite sheet.
  - c. Nelson CPS composite sheet, CMP firestop compound.

## **2.9 COMPUTER CABLE SUPPORT HANGERS**

- A. J-hooks shall be equal to Erico Caddy Fastener type CableCat.
1. Erico Caddy Fastener type CableCat Cat21 J-hook shall be used for up to 50 4-pair communication cables.
  2. Manufacturer guidelines shall be used for supporting/mounting CableCats.
  3. Cable shall be supported at no greater than four-foot intervals.
  4. Utilize cable hooks only to span across corridors or rooms to route cables to cable tray as shown on the plans.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Support raceways under the provisions of Section 26 05 11.
- B. Install cable from all computer and telephone outlets to rack or backboard.
- C. Install modular outlets at all locations shown on the Drawings. Terminate wiring at both ends.
- D. Provide cable supports as required in a neat workmanlike manner.
- E. Color coding of wiring is to be consistent between connector modules and connector blocks.
- F. All cabling shall consist of 4 pair, 1 cable per jack.
- G. Install cable in accordance with manufacturer's instructions and in accordance with ANSI/EIA/TIA 568A standards. Cable maximum bend radius shall not exceed four (4) times the outside cable diameter.
- H. Bridged taps/splices are not allowed as part of the horizontal wiring system.



- I. Each workstation jack shall be provided with its own UTP cable continuous (without splice) from jack to computer rack or telephone backboard.
- J. All penetrations through fire barrier walls or floors shall consist of a conduit sleeve and shall be sealed with an industry approved fire barrier caulk or compound reamed and bushed.
- K. All vertical/horizontal sleeves shall be sized according to station count passing through each. Sized for maximum 60 percent fill.
- L. Install cable support hooks a maximum of 4'-0" on center above ceiling.
- M. All vertical/horizontal raceways shall be sized according to station count passing through each. Sized for maximum 60 percent fill.
- N. Install a 3/4 inch conduit, minimum from each workstation outlet continuous to the nearest cable tray location in the corridor ceiling.
- O. Terminate all data cabling on data rack patch panels and all telephone cables on 110 blocks on the telephone backboard.
- P. Terminate all backbone cables in both the new IRM rooms and the existing basement telephone room and data room. The telephone backbone cables shall be terminated within a splice case in the existing telephone room to match the existing termination method. Coordinate termination requirement with the VA Project Engineer. The fiber optic backbone cables shall be terminate in new fiber optic patch panels. Coordinate the mounting location of the patch panels in the existing basement data room with the VA Project Engineer.

### **3.2 GANGING WORKSTATION JACKS**

- A. Where indicated, workstation jacks may be ganged under a common one gang wall plate. Where the plans show multiple outlets at one location they may be ganged into one wall plate.

### **3.3 LABELING**

- A. All horizontal cabling shall be labeled at both ends with permanent tag indication from which jack the cable originated.
- B. Machine labels shall be installed on each workstation jack faceplate and at the patch panels.
- C. All labels shall be a machine label in conformance with ANSI/EIA/TIA 606.
- D. Numbering of workstation jacks shall be consistent and match existing Veterans Administration standard.
- E. Labeling to be verified with Engineer and Owner.

### **3.4 CUTTING, PATCHING AND FINISHING**

- A. Perform all cutting, patching and finishing required for installation of electrical work. Restore surfaces to original condition.
- B. Cutting, patching and finishing work is subject to the direction and approval of the Engineer.

- - - E N D - - -

**SECTION 27 41 32**  
**TELEVISION WIRING SYSTEM**

**PART 1 GENERAL**

**1.1 SECTION INCLUDES**

- A. Television distribution equipment.
- B. Cable and accessories.

**1.2 RELATED REQUIREMENTS**

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- B. Section 26 05 33 - Raceway and Boxes for Electrical Systems.

**1.3 REFERENCE STANDARDS**

- A. NFPA 70 - National Electrical Code; National Fire Protection Association; 2008.

**1.4 SYSTEM DESCRIPTION**

- A. Premises wiring for broadband distribution of television signal, including individual outlets.
- B. Provide a broadband television distribution system as described herein. The system shall support the distribution of broadband signals from various sources including but not limited to programming from local cable provider, city offices, satellite receivers as well as programming generated locally.
- C. The contractor shall provide all necessary amplifiers, cables, connectors and hardware for a complete and functional broadband television distribution system.
- D. Signal at each outlet: 3 dBmV across 75 ohms, minimum, plus 5 dB, minus 0 dB.

**1.5 PERFORMANCE REQUIREMENTS**

- A. The broadband television distribution system shall be installed to meet the following requirements:
  - 1. Carrier to noise ratio must be greater than 55dB.
  - 2. Cross-modulation no less than -57dB.
  - 3. Operating band width on all passive devices shall be between 5 MHz and 1000 MHz.
  - 4. Composite second order distortion less than -60dB.
  - 5. Composite triple beat distortion less than -60dB.
  - 6. The amplitude difference between two adjacent channels shall be no greater than 2dB.
  - 7. The system shall be free of any signal leakage.
  - 8. The RF signal level at any outlet shall be no greater than +15dB and no less than +5dB.

9. Isolation between any two outlets shall be a minimum of +20dB for any frequencies between 5MHz and 1000 MHz.

#### **1.6 SUBMITTALS**

- A. See Section 01 33 23 - for submittal procedures.
- B. Shop Drawings: Indicate electrical characteristics and connection requirements. Show installation details, cable routing, and system configuration.
- C. Product Data: Provide showing electrical characteristics and connection requirements for each component.
- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- E. Project Record Documents: Record actual locations of outlets, devices, and cable routing.
- F. Maintenance Data: Basic trouble-shooting procedures.

#### **1.7 QUALITY ASSURANCE**

- A. Conform to requirements of NFPA 70 and cable television utility company.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience with service facilities within 100 miles of Project.
- C. Supplier Qualifications: Authorized distributor of specified manufacturer with minimum three years documented experience.
- D. Installer Qualifications: Authorized installer of specified manufacturer with service facilities within 100 miles of the project.
- E. Products: Furnish products listed and classified by Underwriters Laboratories Inc. as suitable for purpose specified and indicated.

#### **1.8 MAINTENANCE SERVICE**

- A. Furnish service and maintenance of television system for one year from Date of Substantial Completion.

### **PART 2 PRODUCTS**

#### **2.1 AMPLIFIERS AND CONVERTERS**

- A. Manufacturers:
  1. Blonder Tongue Laboratories, Inc: [www.blondertongue.com](http://www.blondertongue.com).
  2. VHF Amplifier: Provide broadband amplifier, wall mounted.
    - a. Impedance: 75 ohm.
    - b. 50 to 750 MHz Bandwidth.
    - c. 30 dB gain.

d. 120 volt input power.

## **2.2 ACCESSORIES**

### **A. Splitter:**

1. Blonder Tongue SXRS series.
2. Frequency Response: 5 - 1000 MHZ.
3. Isolation: 21 dB minimum.
4. Return Loss: 16 dB minimum.
5. Insertion Loss: 6.8 dB maximum.
6. RFI shielding: 120 dB minimum.
7. Quantity as required for Television locations as shown on Drawings.  
Provide a cable from each outlet to the IRM room as indicated on the drawings.

### **B. Receptacles:**

1. Manufacturer: Panduit CMFSR series.
2. Mini-com self-terminating F connector.
3. Provide with matching Panduit Mini-Com faceplate, color to match devices specified in Section 27 10 05.

### **C. Main Distribution Cable:**

1. Description: RG 11/F. Plenum rated.
2. Product: Comm/Scope or equal.

### **D. Branch Distribution Cable:**

1. Description: RG 6/F. Plenum rated.
2. Product: Comm/Scope or equal.

### **E. Conduit**

1. As specified in Section 26 05 33 - Raceway and Boxes.
2. Size: Minimum 3/4 inch with larger sizes where noted on Drawings.

### **F. Outlets**

1. As specified in Section 26 05 33 - Raceway and Boxes.
2. Four-inch square box with single gang plaster ring.

## **PART 3 EXECUTION**

### **3.1 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Provide proper grounding of television system components and wiring.
- D. Provide raceway system or utilize cable tray system for all cable.
- E. Provide cable continuous from the outlets to the IRM room splitter locations. Provide a trunk cable from the existing main trunk cable on first floor and in the basement to the new amplifier and splitters in the new IRM rooms. Install a new amplifier in each new IRM room and connect

to the new trunk cable on each floor.

- F. System connections will be made to provide the features described and specified herein.
- G. Additional connections and cabling may be required to provide a complete system.
- H. System connections will be made to provide the features described and specified herein. Additional connections and cabling may be required to provide a complete system.
- I. Cabling terminated at each piece of equipment shall be cut to length and terminated with the appropriate connector. The use of tie wraps is necessary to maintain the cabling in a neat manner.
- J. Equipment utilizing screw terminals shall have the conductors tinned prior to tightening into the terminals.
- K. Cable should be run in one piece without splices made. In the event a splice is absolutely necessary it shall be done to provide proper impedance. Video cable shall use a female to female BNC type barrel with crimped BNC connectors on each end. Splices must be accessible and not internal to conduit as per code regulations
- L. All National, State and Local Electrical, Fire and Building Codes apply to this project. The contractor must be aware of and adhere to these codes. The Owner shall not be liable for failure of the contractor in the following code. Any portion of the installation that does not meet code shall be removed and re-installed up to code shall be removed and re-installed up to code by the contractor at their own expense.
- M. All cables and T.V. outlet plates shall be labeled by number or origination and termination designation. Labels must be permanent and legible. Peel off numbers is not acceptable unless clear heat shrink is used over the numbers.

### **3.2 FIELD QUALITY CONTROL**

- A. Measure signal level at each outlet.

### **3.3 MANUFACTURER'S FIELD SERVICES**

- A. Provide services of manufacturer's technical representative to prepare and start systems and supervise final adjustments and tuning of system.

### **3.4 ADJUSTING**

- A. Adjust work under supervision of manufacturer's field service personnel.
- B. Adjust amplifier gain and make other system adjustments to achieve specified output levels at each outlet.

### **3.5 DEMONSTRATION**

- A. Conduct walking tour of Project and briefly describe function, operation, and maintenance of each component.
- B. Include demonstration of color television operation specified signal level at two outlets selected by Owner.

- - - END - - -

**SECTION 27 51 25**  
**PUBLIC ADDRESS SYSTEM**

**PART 1 GENERAL**

**1.1 DESCRIPTION OF WORK**

- A. Provide a complete and functional paging system as shown on the Drawings and Specifications. All material including installation material shall be provided in its entirety whether or not enumerated on the Drawings including relays, isolation transformers and termination materials.

**1.2 RELATED WORK**

- A. Section 26 05 33 - Raceway and Boxes for Electrical Systems.

**1.3 DESCRIPTION OF SYSTEM**

- A. The paging system is to provide audio reproduction of voice announcements via the telephone system. The new reproduction devices shown on the drawings shall be connected to the existing system as indicated on the drawings.

**1.4 SHOP DRAWINGS**

- A. Submit in accordance with Section 01 33 23.
- B. Clearly indicate dimensions, schematic diagrams, electrical characteristics, electrical connections, power requirements, cabling and conduit size requirements.
- C. Submit a detailed manufacturer's data sheet on all equipment and components to be provided.

**1.5 QUALITY ASSURANCE**

- A. U.L. listed components.
- B. All components and the system will conform to the minimum applicable standards issued by EIA. All work in conjunction with this installation will meet the provisions of the National Electrical Code and other applicable codes.

**1.6 DELIVERY, STORAGE AND HANDLING**

- A. Deliver to the job site in standard shipping containers. Leave labels intact.
- B. Store in dry area, protected from the weather. Maintain temperature above freezing.

**1.7 INSTALLATION**

- A. All system components and cables must be electronically balanced in nature.
- B. All cable must be arranged in a neat and orderly fashion using trimmed tie wraps and must be fasten securely to prevent them from physical damage and to minimize visibility.
- C. Speaker mounting hardware used should be installed as per the manufacturer's recommendations.



- D. The systems should be connected to the paging system and configured to allow paging override for massaging.
- E. Adjust the transformer taps on all new speakers to provide even sound pressure levels in all spaces indicated as having paging coverage.

## **PART 2 PRODUCTS**

### **2.1 PAGING SYSTEM COMPONENTS**

- A. Amplifier
  - 1. TOA model BG-060
  - 2. 60 watt rated amplifier with telephone interface input and microphone level input.
  - 3. 70 volt rated output
  - 4. 120 volt, 60 hz rated power supply.
  - 5. Provide wall mount bracket for installing in new electrical room in both the basement and first floor.
- B. Ceiling Mount Distributed Speaker - Recessed Mounted
  - 1. Manufacturer: Atlas Sound C803A or equal
    - a. 2-way coaxial mounted, 120 degree coverage, 8 inch LF driver with 3 inch HF driver, with 70 Volt, 16 watt multi-tap transformer. 70 Hz to 15 kHz frequency response. Sensitivity of 98 dB at 1 watt, 1 meter.
    - b. Back box - Atlas Sound 191-78-8 with 164-8 baffle or equal. Baffle to me white in color to match ceiling.
  - 2. Provide where shown on the drawings with required tile bridges and mounting hardware.

### **2.2 OUTLETS**

- A. As specified in Section 26 05 33 - Raceway and Boxes for Electrical Systems.
- B. 4-inch square box, 2 1/8 inch deep with single gang ring for mic/aux. jacks.

### **2.3 CABLE**

- A. Mic/Line Level Audio Cable: Balanced and unbalanced audio cable shall contain a 22 AWG twisted pair cable with 100% overall aluminum foil shield and drain wire. Cable shall be WestPenn 291 or equal. In plenum spaces use West Penn 25291 or equal.
- B. 70 Volt Distributed Speaker Cable: 18 AWG two conductor speaker cable with 100% overall aluminum shield and drain wire. Cable shall be equal to West Penn 293. In plenum spaces use West Penn 25293 or equal.

## **PART 3 EXECUTION**

### **3.1 GENERAL**

- A. All conductors will be installed in conduit, 3/4 inch minimum.

- B. Terminations will be made using screw type terminals, push-on terminal boards, multi-pin connectors or solder lugs with good, clean solder joints. Under no circumstances are any terminations to be taped.
- C. All incoming cables will be clearly marked as to origin with printed heat shrink tubing. All mic level cables to be labeled with white tubing and black print, line level cables with blue tubing and black print, and speaker level with yellow tubing and black print.
- D. Equalize sound system and adjust transformer taps for adequate paging coverage in all areas.
- E. All non-speaker level audio lines must be continuous, shielded cable. All termination of such lines must be made in accordance with manufacturer's specifications for the given electronic device. All terminations made at wall plates or cable connectors must be solder type.
- F. All equipment power and signal wiring shall conform to NEC and all state and local codes.
- G. Provide input connection to the amplifier to match the input in the other areas in the basement and first floor of the hospital. The existing paging signal in the basement and first floor areas of the hospital shall be extended to the new amplifier for the basement and first floor. Provide two new amplifiers, one for the new basement area and one for the new first floor area.

- - - END - - -

**SECTION 27 52 20**  
**PATIENT LIGHT ANNUNCIATION SYSTEM**

**PART 1 GENERAL**

**1.1 SECTION INCLUDES**

- A. Nurses station master control displays.
- B. Annunciation light panels and audible chimes.
- C. Conduit and outlet boxes.

**1.2 RELATED SECTIONS**

- A. Section 26 05 21 - Low Voltage Electric Power Conductors and Cables.
- B. Section 26 05 33 - Raceway and Boxes for Electrical Systems.

**1.3 REFERENCES**

- A. NFPA 70 - National Electrical Code; National Fire Protection Association; 2008.

**1.4 SYSTEM DESCRIPTION**

- A. Patient light annunciation system to accommodate the new outpatient treatment department functions. Work includes providing new master control displays, new annunciation light panels and new audible chimes.

**1.5 SUBMITTALS**

- A. See Section 01 33 23 for submittal procedures.
- B. Shop Drawings: Provide product data on the proposed cables and connectors to be used.
- C. Product Data: Provide electrical characteristics and connection requirements.
- D. Manufacturer's Installation Instructions: Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- E. Operation Data: Operating instructions.
- F. Maintenance Data: Maintenance and repair procedures.
- G. Submit O & M information in both card copies and in electronic PDF format on a CD/DVD-ROM.

**1.6 QUALITY ASSURANCE**

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience and with service facilities within 25 miles of Project.
- C. Products: Furnish products listed and classified by Underwriters Laboratories Inc. as suitable for purpose specified and indicated.

**1.7 MAINTENANCE SERVICE**

- A. Furnish service and maintenance of system for one year from Date of

Substantial Completion.

## **PART 2 PRODUCTS**

### **2.1 MANUFACTURERS**

#### **A. Patient Light Annunciation System**

1. Crestron to match the existing hospital system.

### **2.2 COMPONENTS**

#### **A. Master Control and Sub-Master Control Display Units**

1. Manufacturer
  - a. Crestron Touch Panel TPS 12.
2. New displays to indicate the new button colors and button labels as shown on the drawings.
3. Provide required associated system control unit to control display and the system annunciator light panels.

#### **B. Patient Annunciator Light Panels**

1. Provide new annunciator light panels to with the functions shown on the drawings. Light panels shall consist of black colored panel with IDEC AL6 series round LED pilot lights in the colors shown on the drawings.
2. Provide an audible chime at each ceiling mounted patient annunciator light panel. The chime shall announce when a light has been lit. The chime shall be a single chime only, not a repeating or continuous siren or horn.

#### **C. Accessories**

1. Cable
  - a. Provide plenum rated cable as recommended by the system manufacturer to interconnect the existing control unit to the new patient annunciation light panels.
    - 1) Route cable in either conduit or in the cable tray, 'free air' cable installation is not allowed.
2. Conduit and Outlet Boxes
  - a. Conduit - per section 26 05 33, provide 3/4 inch minimum.
  - b. Boxes - per section 26 05 33, provide 4 square box with ceiling ring for ceiling mount applications and 4 square box with single gang opening for wall mount applications.
3. Provide the required system power supply and control unit to provide a fully functional system.

## **PART 3 EXECUTION**

### **3.1 INSTALLATION**

- #### **A. Install in accordance with manufacturer's instructions.**

- B. Install all system wiring in conduit or in the cable tray system.
- C. Provide a 5 foot loop of cable at the master control unit location.
- D. Mark both ends of all cables to identify the cable location.
- E. Install light panels where shown on the drawings and make all power and communications connections for a complete and functional system. Install the master control unit in the new electrical room and provide a power connection as required.

### **3.2 MANUFACTURER'S FIELD SERVICES**

- A. Include services of technician to supervise installation, adjustments, final connections, system testing, and to train VAMC personnel.

### **3.3 DEMONSTRATION**

- A. Demonstrate modes of operation and how to operate the system.

- - - END - - -

**SECTION 27 52 23**  
**NURSE CALL AND CODE ONE SYSTEMS**

**PART 1 - GENERAL**

**1.1 SECTION SUMMARY**

- A. Work covered by this document includes design, engineering, labor, material, products, guaranty, training and services for, and incidental to, the extension of the existing National Fire Protection Association (NFPA) Listed Critical Service Nurse-Call and Life Safety Code Blue communication system as detailed herein.
- B. Work shall be complete, tested, labeled, certified and ready for operation.

**1.2 RELATED SECTIONS**

- A. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES
- B. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 Volts and Below).

**1.3 DEFINITIONS**

- A. Provide: Design, engineer, furnish, install, connect complete, test, certify and guarantee.
- B. Work: Materials furnished and completely installed.
- C. Review of contract drawings: A service by the engineer to reduce the possibility of materials being ordered which do not comply with contract documents. The engineer's review shall not relieve the Contractor of responsibility for dimensions or compliance with the contract documents. The reviewer's failure to detect an error does not constitute permission for the Contractor to proceed in error.
- D. Headquarters (aka VACO) Technical Review, for National and VA Communications and Security, Codes, Frequency Licensing Standards, Guidelines and Compliance:
  - Office of Telecommunications
  - Special Communications Team (0050P3B)
  - 1335 East West Highway - 3rd Floor
  - Silver Spring, Maryland 20910,
  - (O) 301-734-0350, (F) 301-734-0360
- E. Contractor: Systems Contractor; you; successful bidder.

#### 1.4 REFERENCES

A. The installation shall comply fully with all governing authorities, laws and ordinances, regulations, codes and standards, including, but not limited to:

1. United States Federal Law and Codes:

a. Departments of:

1) CFR, Title 15 - Department of Commerce, Under the Information Technology Management Reform Act (Public Law 104-106), the Secretary of Commerce approves standards and guidelines that are developed by the:

a) Chapter II, National Institute of Standards Technology (NIST - formerly the National Bureau of Standards). Under Section 5131 of the Information Technology Management Reform Act of 1996 and the Federal Information Security Management Act of 2002 (Public Law 107-347), NIST develops - Federal Information Processing Standards Publication (FIPS) 140-2-Security Requirements for Cryptographic Modules.

b) Chapter XXIII, National Telecommunications and Information Administration (NTIA - aka 'Red Book') Chapter 7.8/9 Federal communications Commission (FCC) Title 47 (CFR), Part 15, Radio Frequency Restriction of Use and Compliance in "Safety of Life" Functions and Locations.

2) CFR, Title 29, Department of Labor, Chapter XVII - Occupational Safety and Health Administration (OSHA), Part 1910 - Occupational Safety and Health Standard:

a) Subpart 7, Definition and requirements for a National Recognized Testing Laboratory (NRTL - 15 Laboratory's, for complete list, contact

[http://www.osha.gov/dts/otpca/nrtl/faq\\_nrtl.html](http://www.osha.gov/dts/otpca/nrtl/faq_nrtl.html))

(1) Underwriters Laboratories (UL):

65	Standard for Wired Cabinets.
468	Standard for Grounding and Bonding Equipment.
1449	Standard for Transient Voltage Surge Suppressors.
1069	Hospital Signaling and Nurse Call

	Equipment.
60950-1/2	Information Technology Equipment - Safety.

- (2) Canadian Standards Association (CSA): same tests as for UL.
- (3) Communications Certifications Laboratory (CCL): same tests as for UL.
- (4) Intertek Testing Services NA, Inc. (ITSNA formerly Edison Testing Laboratory [ETL]): same tests as for UL.
- b) Subpart 35, Compliance with NFPA 101 - Life Safety Code.
- c) Subpart 36, Design and construction requirements for exit routes.
- d) Subpart 268, Telecommunications.
- e) Subpart 305, Wiring methods, components, and equipment for general use.
- 3) Title 42, CFC, Department of Health, Chapter IV Health and Human Services, Subpart 1395(a)(b) Joint Commission on Accreditation of Healthcare Organizations (JCAHO) "a hospital that meets JCAHO accreditation is deemed to meet the Medicare conditions of Participation by meeting Federal Directives:" All guidelines for Life, Personal and Public Safety; and, Essential and Emergency Communications.
- 4) All guidelines for Life, Personal and Public Safety; and, Essential and Emergency Communications.
- 5) CFR, Title 47 - Telecommunications, FCC: Part 15 - Restrictions of use for Part 15 listed Radio Equipment in Safety of Life, Emergency Functions, Equipment and Locations (also see CFR, Title 15 - Department of Commerce, Chapter XXIII - NTIA).
- 6) Public Law No. 100-527, Department of Veterans Affairs:
  - a) Office of Telecommunications: Handbook 6100, Telecommunications.
  - b) Office of Cyber and Information Security (OCIS):
    - (1) Handbook 6500, Information Security Program.
    - (2) Wireless and Handheld Device Security Guideline Version 3.2, August 15, 2005.
  - c) Spectrum Management FCC and NTIA Radio Frequency Compliance and Licensing Program.



## 2. National Codes:

- a. American Institute of Architects (AIA): Guidelines for Healthcare Facilities.
- b. American National Standards Institute/Electronic Industries Association/Telecommunications Industry Association (ANSI/EIA/TIA):

568-B	Commercial Building Telecommunications Wiring Standards:
569	Commercial Building Standard for Telecommunications Pathways and Spaces.
606	Administration Standard for the Telecommunications Infrastructure of Communications Buildings.
607	Commercial Building Grounding and Bonding Requirements for Telecommunications.
REC 127-49	Power Supplies.
RS 27	Tools, Crimping, Solderless Wiring Devices, Recommended Procedures for User Certification.

- c. Institute of Electrical and Electronics Engineers (IEEE):

SO/TR 21730:2007	Use of mobile wireless communication and computing technology in healthcare facilities - Recommendations for electromagnetic compatibility (management of unintentional electromagnetic interference) with medical devices.
0739- 5175/08/\$25. 00©2008IEEE	Medical Grade - Mission Critical - Wireless Networks.
C62.41	Surge Voltages in Low-Voltage AC Power Circuits.

- d. NFPA

70	National Electrical Code (current date of issue) - Articles 517, 645 and 800.
75	Standard for Protection of Electronic Computer

	Data- Processing Equipment.
77	Recommended Practice on Static Electricity.
99	Healthcare Facilities.
101	Life Safety Code.

3. State Hospital Code(s).

4. Local Codes.

#### **1.5 QUALIFICATIONS**

A. The Contractor's Communications Technicians assigned to the system shall be fully trained, qualified, and certified by the OEM on the engineering, installation, operation, and testing of the system. The Contractor shall provide formal written evidence of current OEM certification(s) for the installer(s) as a part of the submittal or to the Resident Engineer before being allowed to commence work on the system.

B. Applicable national, state and local licenses.

#### **1.6 CODES AND PERMITS**

A. The Contractor is responsible to adhere to all codes described herein and associated contractual, state and local codes.

#### **1.7 REVIEW OF CONTRACT DRAWINGS AND EQUIPMENT DATA SUBMITTALS**

- A. Submit at one time within 10 days of contract awarding, drawings and product data on all proposed equipment and system. Check for compliance with contract documents and certify compliance with Contractor's "APPROVED" stamp and signature.
- B. Support all submittals with descriptive materials, i.e., catalog sheets, product data sheets, diagrams, and charts published by the manufacturer. These materials shall show conformance to specification and drawing requirements.
- C. Where multiple products are listed on a single cut-sheet, circle or highlight the one that you propose to use. Provide a complete and through equipment list of equipment expected to be installed in the system, with spares, as a part of the submittal. Special Communications (0050P3B - herein after referred to as 0050P3B) will not review any submittal that does not have this list.
- D. Provide floor plan drawings in ACAD format to indicate all device locations, all conduit routing, all wiring requirements and individual device wiring diagrams.

**1.8 PROJECT RECORD DOCUMENTS (AS BUILTS)**

- A. Throughout progress of the work, maintain an accurate record of changes in Contract Documents. Upon completion of Work, transfer recorded changes to a set of Project Record Documents.
- B. The floor plans shall be updated in ACAD format to include the following:
  - 1. All device locations with labels.
  - 2. Conduit locations.
  - 3. Head-end equipment and specific location.
  - 4. Wiring diagram.

**1.9 WARRANTIES AND GUARANTY**

- A. The Contractor shall warrant the installation to be free from defect in material and workmanship for a period of 1 year from the date of acceptance of the project by the owner. The Contractor shall agree to remedy covered defects within 8 hours of notification of major failures or within twenty-four (24) hours of notification for individual station related problems.
- B. Refer to Part 4 for applicable System Guarantee requirements.

**1.10 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft.
- B. Store products in original containers.
- C. Do not install damaged products. Remove damaged products from the site and replaced with new product at no cost to the Owner.

**PART 2 - PRODUCTS AND FUNCTIONAL REQUIREMENTS****2.1 GENERAL REQUIREMENTS FOR EQUIPMENT AND MATERIALS**

- A. Coordinate features and select components to form an integrated system. Match components and interconnections for optimum performance of specified functions.
- B. Equipment: Modular type using solid-state components, fully rated for continuous duty unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz.
- C. Weather-Resistant Equipment: Listed and labeled by an OSHA certified National Recognized Testing Laboratory (NRTL - i.e. UL) for duty outdoors or in damp locations.

**2.2 SYSTEM DESCRIPTION**

- A. System hardware shall consist of a nurse and patient communications network comprised of nurse consoles, control stations, staff and duty

stations, dome lights, pillow speakers and call cords, pull cord stations, emergency push button stations, wiring. All necessary equipment required to meet the intent of these specifications, whether or not enumerated within these specifications, shall be supplied and installed to provide a complete and operating nurse and patient communications network.

- B. The Nurse Call and Code One system shall be designed to provide continuous electrical supervision of the complete and entire system (i.e. dome light bulbs [each light will be considered supervised if they use any one or a combination of (UL) approved electrical supervision alternates, as identified in UL-1069, 1992 revision], wires, contact switch connections, circuit boards, data, audio, and communication busses, main and UPS power, etc.). All alarm initiating and signaling circuits shall be supervised for open circuits, short circuits, and system grounds. Main and UPS power circuits shall be supervised for a change in state (i.e. primary to backup, low battery, UPS on line, etc.). When an open, short or ground occurs in any system circuit, an audible and visual fault alarm signal shall be initiated at the nurse control station and all remote locations.

### **2.3 MANUFACTURERS**

- A. The products specified shall be UL 1069 Listed, and compatible with the ~~existing~~ system to be provided under the CLC project at the VAMC, Fargo.
- B. The following equipment items are the salient requirements of VA to provide an acceptable system described herein.

### **2.4 HEAD-END EQUIPMENT**

- A. Provide all additional required power supplies, communications hubs, network switches, intelligent controllers and other devices necessary to form a complete system with the new system components specified.

### **2.5 LIGHT AND TONE CALL INITIATION, ANNUNCIATION, AND RESPONSE**

- A. Calls may be initiated through:
  1. Patient station.
  2. Staff station.
  3. Code One station.
  4. Toilet Emergency Station pull cord.
  5. Shower Emergency Station pull cord.
  6. Bed Pillow speaker.
  7. Bed Push-button cordset.

- 8. Bed Integrated controls.
- B. Once a call is initiated, it must be annunciated at the following locations:
  - 1. The Corridor, Intersectional and Room dome light associated with the initiating device.
  - 2. A local master control station indicating the call location and priority.
  - 3. Any duty stations associated with the unit.
  - 4. Any staff stations associated with the unit.
- C. All calls must be displayed until they are cleared by the nursing staff only from the initiating device location.

## **2.6 VOICE CALL INITIATION, ANNUNCIATION, AND RESPONSE**

- A. Calls may be initiated through:
  - 1. Patient station.
  - 2. Staff station.
  - 3. Code One station.
  - 4. Toilet Emergency pull cord station.
  - 5. Shower Emergency pull cord station.
  - 6. Pillow speaker.
  - 7. Push-button cordset.
  - 8. Integrated bed controls.
- B. Once a call is initiated, it must be annunciated at the following locations:
  - 1. The Corridor, Intersectional and Room dome light associated with the initiating device.
  - 2. A master station indicating the call location and priority.
  - 3. Any duty stations associated with the unit.
- C. All calls must be displayed until they are cleared by the nursing staff from only the initiating device location.
- D. Provide two-way voice communication between a master station and patient, staff and duty stations.
- E. Failure of voice intercom portion of system shall not interfere with visual and audible signal systems.
- F. All calls must be displayed on the master station until they are cleared by the nursing staff at ONLY the originating station. If multiple calls are received at the master station within a short period of time, they shall be stacked based on priority and wait time. If there are more calls than the master station screen can display at one

time (four (4) minimum), the system must provide a simple scrolling feature. The nurse must be able to answer any call in any order at the master station. The nurse must also be able to forward calls to staff members

## **2.7 SYSTEM FUNCTIONAL STATIONS**

### **A. Master Control:**

#### **1. Simple Tone and Light:**

- a. A visual / aural (tone only) system shall be provided, protected and located in the main reception area. The system shall include a push-button emergency station (pull cord in Outpatient Exam area) with an associated corridor dome light in each toilet.
  - b. The visual / aural (tone only) system shall also include a power supply and a visual / aural (tone only) display panel in the respective OPC receptionist / secretary's office and as shown on the drawings. The visual / tone display panel shall generate audible and visual emergency signals to indicate the location of a placed call.
  - c. The visual / aural (tone only) system shall be installed according to the same Procedures, guidelines and standards outlined for a regular Nurse Call System for emergency NOT CODE BLUE OPERATION.
2. Provide quantity of master control units as shown on the drawings. The units shall be interconnected to all for transferring calls between master stations. Zone the master stations in accordance with the VA instructions. Coordinate zoning requirements with the VA Project Engineer during the shop drawing process.

### **B. Emergency:**

1. 'Push for Help' button and pull cord.
2. 'Cancel' button
3. Light to indicate when station has been activated.

### **C. Corridor Light:**

1. Light and Tone Only.
2. Provide 1 spare station for each 20 stations installed.

### **D. Duty Station**

1. Light and Tone Only.
2. Provide with Cancel button to acknowledge.

**2.8 SYSTEM CABLES**

- A. Provide all cabling required for the nurse-call system; typically standard 4-pair unshielded twisted pair cable.
- B. Conductors: Jacketed, twisted pair and twisted multipair, untinned solid copper.
- C. All cabling shall be plenum rated.

**2.9 SYSTEM CONDUIT**

- A. The nurse call and code blue system is NFPA listed as Emergency and Public Safety Communication System which requires the entire system to be installed in a separate conduit system. The conduit system shall utilize ¾ inch minimum conduit installed in accordance with section 26 05 33.

**2.10 DEVICE BACKBOXES**

- A. The electrical Contractor shall install the backboxes as well as the system conduit. Coordinate the delivery of the backboxes with the construction schedule.

**PART 3 - EXECUTION****3.1 INSTALLATION**

- A. General:
  - 1. Execute work in accordance with National, State and local codes, regulations and ordinances.
  - 2. Install work neatly, plumb and square and in a manner consistent with standard industry practice. Carefully protect work from dust, paint and moisture as dictated by site conditions. The Contractor will be fully responsible for protection of his work during the construction phase up until final acceptance by the Owner.
  - 3. Install equipment according to OEM's recommendations. Provide any hardware, adaptors, brackets, rack mount kits or other accessories recommended by OEM for correct assembly and installation.
  - 4. Secure equipment firmly in place, including receptacles, speakers, equipment racks, system cables, etc:
    - a. All supports, mounts, fasteners, attachments and attachment points shall support their loads with a safety factor of at least 5:1.
    - b. Do not impose the weight of equipment or fixtures on supports provided for other trades or systems.
    - c. Any suspended equipment or associated hardware must be certified by the OEM for overhead suspension.

- d. The Contractor is responsible for means and methods in the design, fabrication, installation and certification of any supports, mounts, fasteners and attachments.
- 5. Finishes for any exposed work such as plates, racks, panels, speakers, etc. shall be approved by the Architect and Owner.
- 6. Coordinate cover plates with field conditions. Size and install cover plates as necessary to hide joints between back boxes and surrounding wall. Where cover plates are not fitted with connectors, provide grommets holes in size and quantity required. Do not allow cable to leave or enter boxes without cover plates installed.
- B. Wiring Practice - the following additional practices shall be adhered to:
  - 1. Comply with requirements for raceways and boxes specified in Division 26, Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS.
  - 2. Execute all wiring in strict adherence to the National Electrical Code, applicable local building codes and standard industry practices.
  - 3. Where raceway is to be EMT (conduit), wiring of differing classifications shall be run in separate conduit. Where raceway is to be an enclosure (rack, tray, wire trough, utility box) wiring of differing classifications which share the same enclosure shall be mechanically partitioned and separated by at least 4 inches. Where Wiring of differing classifications must cross, they shall cross perpendicular to one another.
  - 4. Do not splice wiring anywhere along the entire length of the run. Make sure cables are fully insulated and shielded from each other and from the raceway for the entire length of the run.
  - 5. Do not pull wire through any enclosure where a change of raceway alignment or direction occurs. Do not bend wires to less than radius recommended by manufacturer.
  - 6. Replace the entire length of the run of any wire or cable that is damaged or abraded during installation. There are no acceptable methods of repairing damaged or abraded wiring.
  - 7. Use wire pulling lubricants and pulling tensions as recommended by the OEM.
  - 8. Use grommets around cut-outs and knock-outs where conduit or chase nipples are not installed.



9. Do not use tape-based or glue-based cable anchors.
10. Field wiring entering equipment racks shall be terminated as follows:
  - a. Provide ample service loops at harness break-outs and at plates, panels and equipment. Loops should be sufficient to allow plates, panels and equipment to be removed for service and inspection.
  - b. If specified terminal blocks are not designed for rack mounting, utilize 3/4" plywood or 1/8" thick aluminum plates and blank panels as a mounting surface. Do not mount on the bottom of the rack.
  - c. Employ permanent strain relief for any cable with an outside diameter of 1" or greater.

C. Labeling:

1. Clearly, consistently, logically and permanently mark switches, connectors, jacks, relays, receptacles and electronic and other equipment.
2. Engrave and paint fill all receptacle panels using 1/8" minimum high lettering and contrasting paint.
3. For rack-mounted equipment, use engraved Lamacoid labels with white 1/8" (minimum) high lettering on black background. Label the front and back of all rack-mounted equipment.
4. Where multiple pieces of equipment reside in the same rack group, clearly and logically label each indicating to which room, channel, receptacle location, etc. they correspond.
5. Permanently label cables at each end, including intra-rack connections. Labels shall be covered by the same, transparent heat-shrink tubing covering the end of the overall jacket. Alternatively, computer generated labels of the type which include a clear protective wrap may be used.
6. Provide printed labels at both ends of the cable.
7. Ensure each OEM supplied equipment has appropriate UL Labels and Marks for the service the equipment is performed permanently attached/marked. Equipment installed not bearing these UL marks will not be allowed to be part of the system. The Contractor shall bear all costs required to provide replacement equipment with approved UL marks.

## **PART 4 - TESTING, GUARANTY AND TRAINING**

### **4.1 SYSTEM CLASSIFICATION**

- A. The PAS System is NFPA listed as an "Emergency and Public Safety" Communications system. Where Code Blue signals are transmitted, that listing is elevated to "Life Support." Therefore, the following testing and guaranty provisions are the minimum to be performed and provided by the Contractor and OEM.

### **4.2 PROOF OF PERFORMANCE TESTING**

#### **A. Acceptance Test:**

1. The Contractor shall schedule an acceptance test date and give the Project Engineer 5 days written notice prior to the date the acceptance test is expected to begin. The system shall be tested in the presence of a Government Representative and an OEM certified representative. The system shall be tested utilizing the approved test equipment to certify proof of performance and Emergency and Public Safety compliance. The test shall verify that the total system meets all the requirements of this specification. The notification of the acceptance test shall include the expected length (in time) of the test.
2. The acceptance test shall be performed on a "go-no-go" basis. Only those operator adjustments required to show proof of performance shall be allowed. The test shall demonstrate and verify that the installed system does comply with all requirements of this specification under operating conditions. The system shall be rated as either acceptable or unacceptable at the conclusion of the test. Failure of any part of the system that precludes completion of system testing, and which cannot be repaired in 4 hours, shall be cause for terminating the acceptance test of the system. Repeated failures that result in a cumulative time of 8 hours to affect repairs shall cause the entire system to be declared unacceptable. Retesting of the entire system shall be rescheduled at the convenience of the Government.

#### **B. Acceptance Test Procedure:**

1. Physical and Mechanical Inspection:
  - a. The Government Representative will tour where the system is and are completely and properly installed to insure they are operationally ready for proof of performance testing. A system inventory including available spare parts will be taken at this

time. Each item of installed equipment shall be checked to ensure appropriate UL certification labels are affixed.

- b. The system diagrams, record drawings, equipment manuals, Auto CAD Disks, intermediate, and pretest results shall be formally inventoried and reviewed.
  - c. Failure of the system to meet the installation requirements of this specification shall be grounds for terminating all testing.
2. Test Conclusion:
- a. At the conclusion of the Acceptance Test, using the generated punch list (or discrepancy list) the VA and the Contractor shall jointly agree to the results of the test, and reschedule testing on deficiencies and shortages with the RE. Any retesting to comply with these specifications will be done at the Contractor's expense.
  - b. If the system is declared unacceptable without conditions, all rescheduled testing expenses will be born by the Contractor.

#### **4.3 SYSTEM GUARANTEE PERIOD OF SERVICE**

##### **A. Contractor's Responsibility:**

- 1. The Contractor shall guarantee that all provided material and equipment will be free from defects, workmanship and will remain so for a period of one year from date of final acceptance of the system by the VA. The Contractor shall provide OEM's equipment warranty documents, to the Project Engineer (or Facility Contracting Officer if the Facility has taken possession of the building), that certifies each item of equipment installed conforms to OEM published specifications.
- 2. The Contractor's maintenance personnel shall have the ability to contact the Contractor and OEM for emergency maintenance and logistic assistance, remote diagnostic testing, and assistance in resolving technical problems at any time. This contact capability shall be provided by the Contractor and OEM at no additional cost to the VA.
- 3. All Contractor maintenance and supervisor personnel shall be fully qualified by the OEM and must provide 2 copies of current and qualified OEM training certificates and OEM certification upon request.

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**SECTION 28 13 16**  
**ACCESS CONTROL AND SECURITY**

**PART 1 GENERAL**

**1.1 SECTION INCLUDES**

- A. Access control devices.
- B. Access control panel.

**1.2 RELATED REQUIREMENTS**

- A. Section 08 71 00 - Door Hardware.
- B. Section 26 05 21 - Low Voltage Electric Power Conductors and Cables.
- C. Section 26 05 33 - Raceway and Boxes for Electrical Systems.

**1.3 REFERENCES**

- A. NFPA 70 - National Electrical Code; National Fire Protection Association; 2008.

**1.4 SYSTEM DESCRIPTION**

- A. Extension of the existing door access control system to several doors as shown on the drawings. A new access control panel is added to accommodate the new card readers. All new system components shall be compatible with the existing facility access control system and system software.

**1.5 SUBMITTALS**

- A. See Section 01 33 23 for submittal procedures.
- B. Shop Drawings: Provide system wiring diagram showing each device and wiring connection required. Submit drawings in ACAD format showing all devices and wiring requirements.
- C. Product Data: Provide electrical characteristics and connection requirements.
- D. Manufacturer's Installation Instructions: Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- E. Project Record Documents: Record actual locations of all system components.
- F. Operation Data: Operating instructions.
- G. Maintenance Data: Maintenance and repair procedures.

**1.6 QUALITY ASSURANCE**

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience and with service facilities and an authorized installer within 100 miles of Project.
- C. Products: Furnish products listed and classified by Underwriters

Laboratories Inc. as suitable for purpose specified and indicated.

## **PART 2 PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Access Control and Security System:
  - 1. SimplexGrinnell or approved equal.

### **2.2 COMPONENTS**

- A. Access Control Panel:
  - 1. Product: Simplex Grinnell Software House i-Star Pro Controller or approved equal.
  - 2. Description: 16 card reader or 8 card reader capacity control panel with 64 MB of on board memory. Control panel shall accommodate 16 (or 8) card readers, door position monitoring inputs for 16 (or 8) doors and request to exit sensors for 16 (or 8) doors. Provide an 8 card reader capacity panel in the basement and an 8 card reader capacity panel on the first floor in the electrical room.
- B. Encoded Card Readers:
  - 1. Product: HID Proxpro II or approved equal.
  - 2. Description: Proximity card reader, indoor/outdoor rated, 5"x 5" square polycarbonate housing with approximately a 8" read range.
- C. Request to Exit Sensors:
  - 1. Product: Bosch DS160 or approved equal.
  - 2. Description: Surface mount with passive infrared sensor with a 8' by 10' coverage pattern. White plastic enclosure.
- D. Door Position Switches:
  - 1. Product: General Electric 1076D series or approved equal.
  - 2. Description: 1 inch diameter steel door contact with DPDT contacts, white in color.
- F. System Cable:
  - 1. Product: Communications Supply Corporation or equal.
  - 2. Plenum rated cable with aluminum foil shield , copper drain wire, yellow PVC jacket. Cable shall include integral #18-4/C unshielded, #22-3PR shielded, #22-2/C unshielded, and #22-4/C unshielded conductors for card reader, REX and door contact functions.

## **PART 3 EXECUTION**

### **3.1 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Use multi-conductor cable for connections to all of the access control components at each door. Install all wiring in conduit, ¾ inch minimum.

- C. Make conduit and wiring connections to door hardware devices furnished and installed under Section 08 71 00.

### **3.2 FIELD QUALITY CONTROL**

- A. Manufacturer Services: Furnish services of technician to supervise installation, adjustments, final connections, system testing, and to train Owner personnel.

### **3.3 CLOSEOUT ACTIVITIES**

- A. Demonstrate normal and abnormal modes of operation for both the access control and security systems, and required response to each.

### **3.4 MAINTENANCE**

- A. Furnish service and maintenance of access control and security system for one year from Date of Substantial Completion.

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**SECTION 28 31 00**  
**FIRE DETECTION AND ALARM**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section of the specifications includes the furnishing, installation, and connection of new fire alarm equipment to the existing fire alarm equipment to form a complete coordinated system ready for operation. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, and wiring as shown on the drawings and specified.
- B. Fire alarm systems shall comply with requirements of NFPA 72 unless variations to NFPA 72 are specifically identified within these contract documents by the following notation: "variation". The design, system layout, document submittal preparation, and supervision of installation and testing shall be provided by a technician that is certified NICET level III or a registered fire protection engineer. The NICET certified technician shall be on site for the supervision and testing of the system. Factory engineers from the equipment manufacturer, thoroughly familiar and knowledgeable with all equipment utilized, shall provide additional technical support at the site as required by the Contracting Officer or his authorized representative. Installers shall have a minimum of two years experience installing fire alarm systems.
- C. Alarm signals (by device), supervisory signals (by device) and system trouble signals (by device not reporting) shall be distinctly transmitted to the main fire alarm system control unit located in room 1174B.
- D. The main fire alarm control unit shall automatically transmit alarm signals to a listed central station using a digital alarm communicator transmitter in accordance with NFPA 72.

**1.2 SCOPE**

- A. All existing fire alarm equipment, wiring, devices and sub-systems that are not shown to be reused shall be removed. All existing fire alarm conduit not reused shall be removed.
- B. New fire alarm system components shall be designed and installed in accordance with the specifications and drawings. Device location and wiring runs shown on the drawings are for reference only unless specifically dimensioned. Actual locations shall be in accordance with NFPA 72 and this specification.
- C. Existing fire alarm speakers, door holders, may be reused only as specifically indicated on the drawings and provided the equipment:

1. Meets this specification section
  2. Is UL listed or FM approved
  3. Is compatible with new equipment being installed
  4. Is verified as operable through contractor testing and inspection
  5. Is warranted as new by the contractor.
- D. Existing reused equipment shall be covered as new equipment under the Warranty specified herein.
- E. Basic Performance:
1. Alarm and trouble signals from each building fire alarm control panel shall be digitally encoded by UL listed electronic devices onto a multiplexed communication system.
  2. Response time between alarm initiation (contact closure) and recording at the main fire alarm control unit (appearance on alphanumeric read out) shall not exceed five (5) seconds.
  3. The signaling line circuits (SLC) between building fire alarm control units shall be wired Style 7 in accordance with NFPA 72. Isolation shall be provided so that no more than one building can be lost due to a short circuit fault.
  4. Initiating device circuits (IDC) shall be wired Style C in accordance with NFPA 72.
  5. Signaling line circuits (SLC) within buildings shall be wired Style 4 in accordance with NFPA 72. Individual signaling line circuits shall be limited to covering 22,500 square feet of floor space or 3 floors whichever is less.
  6. Notification appliance circuits (NAC) shall be wired Style Y in accordance with NFPA 72.

### 1.3 RELATED WORK

- A. Section 01 00 00, GENERAL REQUIREMENTS: Restoration of existing surfaces.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES: Procedures for submittals.
- C. Section 07 84 00, FIRESTOPPING: Fire proofing wall penetrations.
- E. Section 09 91 00, PAINTING: Painting for equipment and existing surfaces.
- F. Section 21 10 00, WATER BASED FIRE-SUPPRESSION SYSTEMS.
- G. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements for items which are common to other Division 26 sections.
- H. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits and boxes for cables/wiring.



- I. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES  
(600 VOLTS AND BELOW: Cables/wiring.

#### **1.4 SUBMITTALS**

- A. General: Submit 4 copies and 1 reproducible in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, and Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. Drawings:
1. Prepare drawings using AutoCAD release compatible with the version in use at the VAMC in Fargo and include all contractors information. Layering shall be by VA criteria. The contractor shall be responsible for verifying all critical dimensions shown on the drawings provided by VA.
  2. Floor plans: Provide updated locations of all new devices (with device number at each addressable device corresponding to control unit programming), appliances, panels, equipment, junction/terminal cabinets/boxes, risers, electrical power connections, individual circuits and raceway routing, system zoning; number, size, and type of raceways and conductors in each raceway; conduit fill calculations with cross section area percent fill for each type and size of conductor and raceway. Only those devices connected and incorporated into the final system shall be on these floor plans. Do not show any removed devices on the floor plans. Show all interfaces for all fire safety functions.
  3. Riser diagrams: Provide, for the entire system, the number, size and type of riser raceways and conductors in each riser raceway and number of each type device per floor and zone. Show door holder interface, elevator control interface, HVAC shutdown interface, fire extinguishing system interface, and all other fire safety interfaces. Show wiring Styles on the riser diagram for all circuits. Provide diagrams both on a per building and campus wide basis.
  4. Detailed wiring diagrams: Provide for control panels, modules, power supplies, electrical power connections, auxiliary relays and annunciators showing termination identifications, size and type conductors, circuit boards, LED lamps, indicators, adjustable controls, switches, ribbon connectors, wiring harnesses, terminal strips and connectors, spare zones/circuits. Diagrams shall be drawn to a scale sufficient to show spatial relationships between components, enclosures and equipment configuration.
  5. Two weeks prior to final inspection, the Contractor shall deliver to the COTR one (1) set of reproducible, as-built drawings, two blue-line copies and one (1) set of the as-built drawing computer files

(using AutoCAD release compatible with that currently in use at the Fargo VA). As-built drawings (floor plans) shall show all new and existing conduit used for the fire alarm system. The as-builts shall be added to the overall fire alarm system as-builts for the facility and submitted as an update to the entire facility as-builts.

#### **1.5 APPLICABLE PUBLICATIONS**

- A. The publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. The publications are referenced in text by the basic designation only.
- B. National Fire Protection Association (NFPA):
  - 70-2005.....National Electrical Code (NEC).
  - 72-2002.....National Fire Alarm Code.
  - 90A-2002.....Installation of Air Conditioning and Ventilating Systems.
  - 101-2003.....Life Safety Code
- C. Underwriters Laboratories, Inc. (UL):
  - 2000-2000.....Fire Protection Equipment Directory
- D. Factory Mutual Research Corp (FM): Approval Guide, 2005 Edition
- E. American National Standards Institute (ANSI):
  - S3.41-1996.....Audible Emergency Evacuation Signal
- F. International Code Council, International Building Code (IBC) 2003 Edition

### **PART 2 - PRODUCTS**

#### **2.1 EQUIPMENT AND MATERIALS, GENERAL**

- A. Existing equipment may be reused only where indicated on the drawings.
- B. Except as indicated in paragraph A above, All equipment and components shall be new and the manufacturer's current model. All equipment shall be tested and listed by Underwriters Laboratories, Inc. or Factory Mutual Research Corporation for use as part of a fire alarm system. The authorized representative of the manufacturer of the major equipment shall certify that the installation complies with all manufacturer's requirements and that satisfactory total system operation has been achieved.

#### **2.2 CONDUIT, BOXES, AND WIRE**

- A. Conduit shall be in accordance with Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS and as follows:
  - 1. All new and reused conduit shall be installed in accordance with NFPA 70.

2. Conduit fill shall not exceed 40 percent of interior cross sectional area.
3. All new conduit shall be 19 mm (3/4 inch) minimum.

B. Wire:

1. All existing wiring shall be removed and new wiring installed in a conduit or raceway.
2. Wiring shall be in accordance with NEC article 760, Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW), and as recommended by the manufacturer of the fire alarm system. All wires shall be color coded. Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 18 AWG for initiating device circuits and 14 AWG for notification device circuits.
3. Addressable circuits and wiring used for the multiplex communication loop shall be twisted and shielded unless specifically excepted by the fire alarm equipment manufacturer in writing.
4. Any fire alarm system wiring that extends outside of a building shall have additional power surge protection to protect equipment from physical damage and false signals due to lightning, voltage and current induced transients. Protection devices shall be shown on the submittal drawings and shall be UL listed or in accordance with written manufacturer's requirements.
5. All wire or cable used in underground conduits including those in concrete shall be listed for wet locations.

C. Terminal Boxes, Junction Boxes, and Cabinets:

1. Shall be galvanized steel in accordance with UL requirements.
2. All new and reused boxes shall be sized and installed in accordance with NFPA 70.
3. New and existing covers shall be repainted red in accordance with Section 09 91 00, PAINTING and shall be identified with white markings as "FA" for junction boxes and as "FIRE ALARM SYSTEM" for cabinets and terminal boxes. Lettering shall be a minimum of 19 mm (3/4 inch) high.
4. Terminal boxes and cabinets shall have a volume 50 percent greater than required by the NFPA 70. Minimum sized wire shall be considered as 14 AWG for calculation purposes.
5. Terminal boxes and cabinets shall have identified pressure type terminal strips and shall be located at the base of each riser. Terminal strips shall be labeled as specified or as approved by the COTR.

### **2.3 VOICE COMMUNICATION SYSTEM (VCS)**

#### **A. General:**

1. The existing voice communication system shall be modified with the new zones and new zone names in the basement and first floor areas as shown on the drawings. Re-program the voice communication system based on the new zone naming shown in the drawings.

### **2.4 ALARM NOTIFICATION APPLIANCES**

#### **A. Speakers:**

1. Shall operate on either 25 VRMS or 70.7 VRMS with field selectable output taps from 0.5 to 2.0W and originally installed at the one-half watt tap. Speakers shall provide a minimum sound output of 80 dBA at ten feet with the one-half watt tap.
2. Frequency response shall be a minimum of 400 HZ to 4000 HZ.
3. 100 mm (4 inches) or 200 mm (8 inches) cone type speakers ceiling mounted with white colored baffles in areas with suspended ceilings and wall mounted in areas without ceilings.

#### **B. Strobes:**

1. Xenon flash tube type minimum 15 candela in toilet rooms and 75 candela in all other areas with a flash rate of 1 HZ. Strobes shall be synchronized where required by the National Fire Alarm Code (NFPA 72).
2. Backplate shall be red with 13 mm (1/2 inch) permanent red letters. Lettering to read "Fire", be oriented on the wall or ceiling properly, and be visible from all viewing directions.
3. Each strobe circuit shall have a minimum of twenty (20) percent spare capacity.
4. Strobes may be combined with the audible notification appliances specified herein.

### **2.5 ALARM INITIATING DEVICES**

#### **A. Manual Fire Alarm Stations:**

1. Shall be non-breakglass, address reporting type.
2. Station front shall be constructed of a durable material such as cast or extruded metal or high impact plastic. Stations shall be semi-flush type.
3. Stations shall be of single action pull down type with suitable operating instructions provided on front in raised or depressed letters, and clearly labeled "FIRE".
4. Operating handles shall be constructed of a durable material. On operation, the lever shall lock in alarm position and remain so until reset. A key shall be required to gain front access for resetting,

or conducting tests and drills. The key shall be a Simplex 'B' key to match existing keys.

5. Unless otherwise specified, all exposed parts shall be red in color and have a smooth, hard, durable finish.

B. Smoke Detectors:

1. Smoke detectors shall be UL listed for use with the fire alarm control unit being furnished.
2. Smoke detectors shall be addressable type complying with applicable UL Standards for system type detectors. Smoke detectors shall be installed in accordance with the manufacturer's recommendations and NFPA 72.
3. Detectors shall have an indication lamp to denote an alarm condition. Provide remote indicator lamps and identification plates where detectors are concealed from view. Locate the remote indicator lamps and identification plates flush mounted on walls so they can be observed from a normal standing position.
4. All spot type and duct type detectors installed shall be of the photoelectric type.
5. Photoelectric detectors shall be factory calibrated and readily field adjustable. The sensitivity of any photoelectric detector shall be factory set at 3.0 plus or minus 0.25 percent obscuration per foot.
6. Detectors shall provide a visual trouble indication if they drift out of sensitivity range or fail internal diagnostics. Detectors shall also provide visual indication of sensitivity level upon testing. Detectors, along with the fire alarm control units shall be UL listed for testing the sensitivity of the detectors.

C. Water Flow and Pressure Switches:

1. Wet pipe water flow switches and dry pipe alarm pressure switches for sprinkler systems shall be connected to the fire alarm system by way of an address reporting interface device.

## 2.6 SUPERVISORY DEVICES

A. Duct Smoke Detectors:

1. Duct smoke detectors shall be provided and connected by way of an address reporting interface device. Detectors shall be provided with an approved duct housing mounted exterior to the duct, and shall have perforated sampling tubes extending across the full width of the duct (wall to wall). Detector placement shall be such that there is uniform airflow in the cross section of the duct.
2. Interlocking with fans shall be provided in accordance with NFPA 90A and as specified hereinafter under Part 3.2, "TYPICAL OPERATION".

3. Provide remote indicator lamps, key test stations and identification nameplates (e.g. "DUCT SMOKE DETECTOR AHU-X") for all duct detectors. Locate key test stations in plain view on walls or ceilings so that they can be observed and operated from a normal standing position.

## **2.7 ADDRESS REPORTING INTERFACE DEVICE**

- A. Shall have unique addresses that reports directly to the building fire alarm panel.
- B. Shall be configurable to monitor normally open or normally closed devices for both alarm and trouble conditions.
- C. Shall have terminal designations clearly differentiating between the circuit to which they are reporting from and the device that they are monitoring.
- D. Shall be UL listed for fire alarm use and compatibility with the panel to which they are connected.
- E. Shall be mounted in weatherproof housings if mounted exterior to a building.

## **2.8 SMOKE BARRIER DOOR CONTROL**

- A. Electromagnetic Door Holders:
  1. New Door Holders shall be standard wall mounted electromagnetic type. In locations where doors do not come in contact with the wall when in the full open position, an extension post shall be added to the door bracket.
  2. Operation shall be by 24 volt DC supplied from a battery located at the fire alarm control unit. Door holders shall be coordinated as to voltage, ampere drain, and voltage drop with the battery, battery charger, wiring and fire alarm system for operation as specified.
- B. A maximum of twelve door holders shall be provided for each circuit. Door holders shall be wired to allow releasing doors by smoke zone.
- C. Door holder control circuits shall be electrically supervised.
- D. Smoke detectors shall not be incorporated as an integral part of door holders.
- E. Where combination holder-closer units are required to match existing, these devices are furnished and installed as per Section 08 71 00, DOOR HARDWARE. Connection and wiring shall be as herein specified.

## **2.9 UTILITY LOCKS AND KEYS:**

- A. All key operated test switches, control units, annunciator panels and lockable cabinets shall be provided with a single standardized utility lock and key to match the existing Simplex 'B' key currently in use.
- B. Key-operated manual fire alarm stations shall have a single standardized lock and key to match the existing keys presently in use at the facility.

C. All keys shall be delivered to the Project Engineer.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION:**

- A. Installation shall be in accordance with NFPA 70, 72, 90A, and 101 as shown on the drawings, and as recommended by the major equipment manufacturer. Fire alarm wiring shall be installed in conduit. All conduit and wire shall be installed in accordance with Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS , Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW), and all penetrations of smoke and fire barriers shall be protected as required by Section 07 84 00, FIRESTOPPING.
- B. All new conduits, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas. All existing accessible fire alarm conduit not reused shall be removed.
- C. All new or reused exposed conduit shall be painted in accordance with Section 09 91 00, PAINTING to match surrounding finished areas and red in unfinished areas. All junction box covers shall be painted red and stenciled with 'FA' to match existing junction boxes.
- D. Existing devices that are reused shall be properly mounted and installed. Where devices are installed on existing shallow backboxes, extension rings of the same material, color and texture of the new fire alarm devices shall be used. Mounting surfaces shall be cut and patched in accordance with Section 01 00 00, GENERAL REQUIREMENTS, Restoration, and be re-painted in accordance with Section 09 91 00, PAINTING as necessary to match existing.
- E. All fire detection and alarm system devices shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas. Exact locations to be approved by the Project Engineer.
- F. Speakers shall be ceiling mounted and fully recessed in areas with suspended ceilings. Speakers shall be wall mounted and recessed in finished areas without suspended ceilings. Speakers may be surface mounted in unfinished areas.
- G. Strobes shall be flush wall mounted 2,000 mm (80 inches) above the floor or 150 mm (6 inches) below ceiling, whichever is lower. Locate and mount to maintain a minimum 900 mm (36 inches) clearance from side obstructions.
- H. Manual pull stations shall be installed not less than 1050 mm (42 inches) or more than 1200 mm (48 inches) from finished floor to bottom of device and within 1500 mm (60 inches) of a stairway or an exit door.

**3.2 TESTS**

- A. Provide the service of a NICET level III, competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment to technically supervise and participate during all of the adjustments and tests for the system. Make all adjustments and tests in the presence of the Project Engineer.
- B. When the systems have been completed and prior to the scheduling of the final inspection, furnish testing equipment and perform the following tests in the presence of the Project Engineer. When any defects are detected, make repairs or install replacement components, and repeat the tests until such time that the complete fire alarm systems meets all contract requirements. After the system has passed the initial test and been approved by the Project Engineer, the contractor may request a final inspection.
  - 1. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.
  - 2. Test the insulation on all installed cable and wiring by standard methods as recommended by the equipment manufacturer.
  - 3. Run water through all flow switches. Check time delay on water flow switches. Submit a report listing all water flow switch operations and their retard time in seconds.
  - 4. Open each alarm initiating and notification circuit to see if trouble signal actuates.
  - 5. Ground each alarm initiation and notification circuit and verify response of trouble signals.

**3.3 FINAL INSPECTION AND ACCEPTANCE**

- A. At the final inspection a factory trained representative of the manufacturer of the major equipment shall repeat the tests in Article 3.3 TESTS and those required by NFPA 72. In addition the representative shall demonstrate that the systems function properly in every respect. The demonstration shall be made in the presence of a VA representative.

**PART 4 - SCHEDULES****4.1 DIGITIZED VOICE MESSAGES:**

- A. The existing voice communication system shall be modified with the new zones and new zone names in the basement and first floor areas as shown on the drawings. Re-program the voice communication system based on the new zone naming shown in the drawings.

- - - END - - -