



**Black Hills  
Health Care System**  
Department of Veterans Affairs

## **Fort Meade Surgical Tower Addition**

### **FOR CONSTRUCTION Specifications Vol. 3**



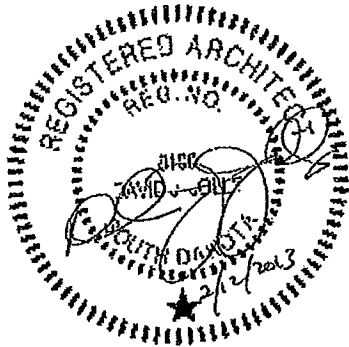
**February 12, 2013**



BLACK HILLS HEALTH CARE SYSTEM  
DEPARTMENT OF VETERANS AFFAIRS  
FORT MEADE, SD

FORT MEADE SURGICAL TOWER ADDITION  
VA PROJECT #568-001

February 12, 2013

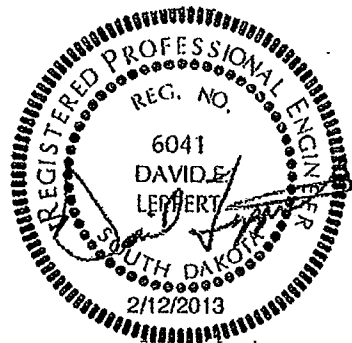


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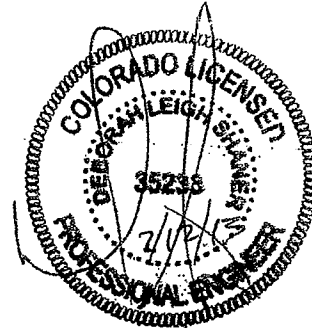
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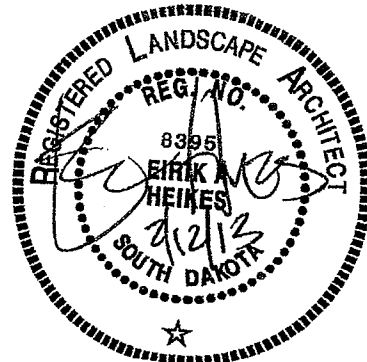
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**SECTION 26 05 11**  
**REQUIREMENTS FOR ELECTRICAL INSTALLATIONS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section applies to all sections of Division 26. All work shall be performed per the requirements of the NEC, VA, and NFPA codes and requirements. Division 0 and 1 project specifications shall equally apply to the work and all requirements of those specifications, shall be adhered to. Should there be a conflict, the most stringent or costly requirement shall be applied.
- B. The drawings and specifications shall work together to form one scope. The contractor shall provide work required or specified as required for a complete installation even though not every incidental item will be shown on the drawings. Likewise, the contractor shall provide work shown on the drawings even if it is not fully specified to provide a complete installation. Should the contractor or vendor see an item during bidding that is extremely expensive; the contractor is encouraged to identify the item in writing and provide a recommended alternative during the bidding process.
- C. 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.
- D. Electrical service entrance equipment and arrangements for temporary and permanent connections to the utility's system shall conform to the utility's requirements. Coordinate fuses, circuit breakers and relays with the utility's system, and obtain utility approval for sizes and settings of these devices.
- E. 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 SUMMARY OF WORK**

- A. The project scope installs an addition to existing Building 113 on the Department of Veteran Affairs campus - Ft. Meade, SD. Existing campus primary power, fire alarm, data/telecommunications, public address and other special systems will be tied into to feed Building 113.
- B. Existing power and signal ductbank found on the site will be intercepted and utilized for the Building 113 as shown on the electrical site plan.

- C. The contractor is required to submit all local and state applications and permits for construction as applicable to this project including, but not limited to, general construction permits, transportation permits, and all South Dakota Department of Environment and Natural Resources permit applications (Air Quality, Engine-Generator Installation, etc) as applicable to this project. Some applications shall be submitted on behalf of the VAMC Ft. Meade. The DENR submittals forms and requirements can be found at <http://denr.sd.gov/des/aq/airpermits.aspx> and shall be prepared in accordance with the VA and the State of SD requirements. Any and all DENR forms required to be submitted by the VAMC to the State shall be prepared, to the extent possible, by the contractor for submittal by the VAMC.

### 1.3 PHASING OF WORK

- A. The project shall be performed in phases in order to maintain the operation of all campus buildings and services.
- B. All medical facility must remain operational at all times.
- C. Construct all new underground power and signal ductbanks before interrupting the existing underground power and signal ductbanks.
- D. In as much as possible, each system/circuit is to be kept operational at all times. Any work that affects existing electrical or building utility systems shall be coordinated with and approved by the VA COTR prior to commencing work. All existing electrical system interruptions shall be kept to an absolute minimum.
- E. A maximum of a 4 hour major service interruption will be allowable for primary power to existing Buildings. Schedule all service interruption work a minimum of 1 week in advance with the VA COTR. This work may be required to be accomplished outside normal working hours.
- F. The existing campus Fire Alarm system is a Life Safety system and must maintain full operation at all times. If for any reason, the campus Fire Alarm system would need to be temporarily interrupted this service interruption work shall be scheduled a minimum of 2 weeks in advance with the VA COTR. This work may be required to be accomplished outside normal working hours. The contractor shall furnish manned fire watches on every floor of every building which undergoes a temporary fire alarm interruption.
- G. Remove and salvage all abandoned equipment to VA, unless specifically noted otherwise. Remove equipment/materials from the site when not desired to be salvaged by the VA.
- H. The generalized outline above provides recommendation to guide/supplement the 260512 Work Method of Procedure (MOP). All work

must be proposed on an MOP and approved by the Architect/Engineer and COTR prior to the work commencing. The contractor provided MOP shall detail every aspect, step by step, for completion of the work required on this project. If a MOP cannot be followed, the contractor shall immediately provide an updated MOP and gain approval by the COTR prior to commencing work. Review by the COTR does not relieve the contractor of the responsibility for a thoroughly thought out and detailed MOP that considers:

1. Complying with all safety, NEC, NFPA, VA and other code requirements.
2. Any legal liabilities for violating of aforementioned, damages occurred, cost overruns, etc in the execution of an inaccurate or poorly planned MOP.
3. Complying with all contract documents requiring, but not limited to, commissioning, completion dates, warranties, drawings, specifications, materials, and/or required project quantities.

#### **1.4 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.
- C. The construction, (including but not limited to, pre-bid, pre-construction, etc.), commissioning, associated construction administration, etc, shall be in accordance with the contract documents (including, but not limited to, drawings, specifications, selection criteria, performance requirements, etc) and with the most recent version of all applicable codes (including, but not limited to, NFPA, NEC, JCAHO, OSHA, ASHRAE, SD DENR, EPA, etc), the Energy Independence and Security Act, SD State Historical Preservation Office (SHPO), and VA Publications, including, but not limited to, VA Construction Procedures (PG-18-3), VA Energy Reduction Manual, VA Construction Standards, VA Commissioning Manual, etc.
- D. All work shall conform to the minimum requirements of the Department of Veteran Affairs (VA).
- E. In the unlikely event of a conflict among the aforementioned requirements (code, manuals, etc), in general, the more stringent or restrictive (more efficient, safer, etc) requirement shall take precedence and the installation, etc shall comply with that requirement. The contractor shall advise the A/E, Commissioning Agent (CxA), and COTR



of any and all conflicts. Resolution options shall be developed in coordination with A/E and CxA and shall consider all technical aspects including, but not limited to, VA requirements/standards, efficiency, safety, cost, and potential impact to the facility operations. The contractor shall make a proposal with a minimum of three (3) recommended resolutions to rectify the conflict as outlined below:

1. Recommended resolutions shall avoid contract constructive changes (financial adjustments) to the project.
  2. Small daily problems, conflicts, coordination, etc (daily/routine items with no financial adjustments) shall, in the interest of project efficiency, be first resolved at the lowest level (CxA, A/E, Contractor, and if required, COTR). Contractor shall notify the VA COTR of problems, etc and the associated resolution options.
  3. Larger problems, conflicts, deficiencies, etc (issues in which financial adjustments are likely required) with design, construction, administration, commissioning, phasing, etc shall be concisely defined and presented to the A/E, VA Contracting Officer (CO) and the VA COTR. The proposed resolution shall be coordinated with the Architect/Engineer (A/E) and the Commissioning Agent (CxA) and agreed upon prior to resolution presentation to the CO and the COTR. All three recommended resolution options and the preferred resolution shall be presented to the COTR with all technical aspects (including but not limited to, VA requirements/standards, efficiency, safety, cost, and potential impact to the facility operations) to be considered and outlined.
  4. The CO and COTR shall provide final direction.
- F. In the unlikely event of a problems, conflicts, deficiencies, etc, with design, construction, commissioning, etc, the Contractor shall notify the CO and COTR of the aforementioned problems, conflicts, deficiencies, etc and the Contractor shall provide a minimum of three (3) resolution recommendations. Resolution recommendations shall be coordinated with A/E and CxA. Resolution recommendations shall consider all technical aspects including, but not limited to, VA requirements/standards, efficiency, safety, cost, and potential impact to the facility operations. In addition:
1. Recommended resolutions shall avoid contract constructive changes to the project.
  2. Small daily problems, conflicts, coordination, etc (daily/routine items with anticipated financial adjustments) shall, in the interest of project efficiency, be first resolved at the lowest level (CxA,

- A/E, Contractor, and if required, COTR). Contractor shall notify the VA COTR of problems, etc and the associated resolution options.
3. Larger problems, conflicts, deficiencies, etc (issues in which financial adjustments are likely required) with design, construction, administration, commissioning, phasing, etc shall be concisely defined and presented to the A/E, VA Contracting Officer (CO) and the VA COTR. The proposed resolution shall be coordinated with the Architect/Engineer (A/E) and the Commissioning Agent (CxA) and agreed upon prior to resolution presentation to the CO and the COTR. All three recommended resolution options and the preferred resolution shall be presented to the COTR with all technical aspects (including but not limited to, VA requirements/standards, efficiency, safety, cost, and potential impact to the facility operations) considered and outlined.
  4. The CO and COTR shall provide final direction.
- G. All requirements and associated direction from the CO and COTR shall be complied with.
  - H. The final installation shall provide for a complete system with all incidental work provided.

#### **1.5 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. Equipment proposed for the project shall be the latest approved design of the equipment as manufactured by a nationally recognized manufacturer to be in conformity with the latest applicable standards, UL listings, NFPA requirements, and NEMA standards. This shall apply to all equipment, from devices to engine-generators.
- C. 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.

#### **1.6 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 six hours of receipt of notification that service is needed. Submit name and address of service organizations.

### 1.7 APPLICABLE PUBLICATIONS

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

### 1.8 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 COTR a minimum of 15 working days prior to the manufacturers making the factory tests.
  - 2. Four copies of certified test reports containing all test data shall be furnished to the COTR 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.
- F. Where a specific manufacturer/product is specified by drawings or specifications, it shall carry the same meaning as "specified project or approved equal" and shall represent the general quality. Information for equivalent products from other manufacturers may be submitted as a product substitution for engineering approval not less than 20 days (minimum) prior to the bid date. Substitutions shall conform to the following:
  - 1. Submittal of an alternative product or system indicates that the contractor has verified and guarantees that the quantities, capacities, functionality, performance, and code/VA requirement

compliance of the proposed substitutions are at least equivalent, to the specified product or system.

2. The engineer and the VA reserve the right to deny acceptability of a proposed product or system for any reason and shall notify all bidders of the equal product by addendum.
3. Any proposed substitution shall consider and maintain required code and working clearances.
4. Any proposed substitution for material, product, or systems shall include adequate drawings and engineering analysis to accurately delineate the proposed change, including, but not limited to load calculations, space and working clearances analysis, etc. Submittal shall clearly indicate any construction, material and/or performance differences between that specified and that being proposed.
  - a. Submittals with incomplete information shall not be considered.
  - b. Submittals demonstrating inferior product or quantities shall not be considered.
5. Should the substituted product consequently require increased space, revised systems, building redesign, building construction modification, revision to the structure, finish, ducting, piping, electrical or relocation of other equipment or systems, consequential project design revisions, revised engineering design and design reviews, the contractor shall bear the sole responsibility of the required changes and any direct or indirect cost associated with the revision(s), including re-design cost.
6. See drawings and Sections 1.2, 1.14 and division sections for additional information and items/documents to be submitted.

#### **1.9 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.

#### **1.10 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 COTR, 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.

#### **1.11 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. Work shall be performed by a licensed and bonded contractor utilizing licensed tradesmen skilled in the art and in accordance with acceptable VA practices.
- C. Job site safety and worker safety is the responsibility of the contractor.
  - 1. Due to potentially mentally impaired building occupants, the contractor shall, at all times, keep tools in personal possession or locked for safekeeping and to protect the building occupants from access to any tools or potentially dangerous materials.
- D. Contractor is responsible for coordinating, providing and installing all electrical systems in conformance with the contract documents (drawings, specifications, etc), NEC, NFPA, ANSI/ASME, and all VA applicable codes and ordinances. Where contract documents are more stringent than code, the contract documents shall take precedence and shall be followed. In addition, direction from the AHJ shall be complied with. See drawings and Section 1.4 herein for additional requirements. The contractor shall provide and install all lighting, power, special systems (fire alarm, data/telecomm, etc), associated distribution and all incidental items required for complete system of work whether or not specifically mentioned or indicated in specifications or drawings. Changes in the location of conduits, outlets, luminaires, switches, panelboards,

equipment, etc, if necessary due to obstacles or work of other trades, shall be made by the contractor at no additional cost. All deviations from drawings and specifications requested by the contractor, due to unknown site factors or any other, shall be submitted in writing to the VA COTR and A/E. COTR and A/E retain right to deny deviation approval. Deviation request shall meet aforementioned requirements and codes, make for an equal or better job. Authorization or non-authorization of deviation request does not relieve the contractor of responsibility for:

1. Complying with all safety, security, and all code requirements.
2. Any legal liabilities for violation of aforementioned, damages occurred, cost overruns, etc, in the execution of deviation.
3. Complying with contract document requirements including, but not limited to completion dates, warranties, drawings, specifications, acceptable material use and associated number and locations, etc.

E. Electrical work shall be accomplished with all affected circuits or equipment de-energized. When an electrical outage cannot be accomplished in this manner for the required work, the following requirements are mandatory:

1. Electricians must use full protective equipment (i.e., certified and tested insulating material to cover exposed energized electrical components, certified and tested insulated tools, etc.) while working on energized systems in accordance with NFPA 70E.
2. Electricians must wear personal protective equipment while working on energized systems in accordance with NFPA 70E.
3. Before initiating any work, a job specific work plan must be developed by the contractor with a peer review conducted and documented by the COTR and Medical Center staff. The work plan must include procedures to be used on and near the live electrical equipment, barriers to be installed, safety equipment to be used and exit pathways.
4. Work on energized circuits or equipment cannot begin until prior written approval is obtained from the COTR.

F. Prior to the start of drilling or excavation work, the contractor shall have coordinated and checked the anticipated work with the VA, local municipality and/or utility companies and have obtained the necessary utility locates in the vicinity of work. The contractor shall perform all work in a manner that no holes are left open or unprotected at the end of each day(s) operation.

G. For work on existing stations, arrange, phase and perform work to assure electrical service for other buildings at all times. Refer to Article

OPERATIONS AND STORAGE AREAS under Section 01 00 00, GENERAL REQUIREMENTS.

- H. 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.
- I. Coordinate location of equipment and conduit with other trades to minimize interferences.

#### **1.12 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.
- D. **ALL EQUIPMENT SHALL BE INSTALLED IN THE LOCATIONS AND OF QUANTITY PER THE DRAWINGS AND QUALITY PER THE EQUIPMENT SPECIFICATION SECTION, THE NEC, THE MANUFACTURER'S RECOMMENDATIONS, AND AS MAY BE REQUIRED BY THE SELECTED EQUIPMENT, DOCES, STANDARDS OR REGULATIONS, EVEN IF NOT SHOWN ON THE PLAN.**

#### **1.13 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/cm<sup>2</sup>), 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.
- D. Reference individual specification sections and plans for additional requirements.

#### **1.14 SUBMITTALS**

- A. Within 30 days after contract award, the electrical contractor shall submit in brochure form shop drawings on electrical equipment used on this project. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES. Submittals (shop drawings and brochure of equipment) shall be marked with arrow to show exact features provided. Submit to VA COTR and A/E for review, certified print manufacturer's literature on electrical materials used on the project. Submittal shall include, but is not limited to engine-generator, automatic transfer switches, switchgear, panelboards, breakers, wiring devices, luminaires, disconnects, motor starters, fire alarm equipment, etc. Contractor shall sign all copies attesting to the correctness and compliance of the submittal. Tab dividers shall be used to separate the literature for equipment. Submittals marked "revise and resubmit" shall be changed and resubmitted for review. See contract documents for additional requirements
- 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.
4. Reference individual specification sections and plans for additional requirements.

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 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.
4. Reference individual specification sections and plans for additional requirements.

F. Substitutions

1. Materials/equipment are listed and specified as representative of general quality. Information for equivalent products from other manufacturers may be submitted prior to the bid for A/E review with the following conditions:
  - a. The determination by the Engineer and the VA shall be final.
  - b. Submittals of incomplete information will not be reviewed.
  - c. Submittals utilizing non-applicable information will not be reviewed.
  - d. Submittal of a product indicates that the contractor has verified and confirmed that the quality, capacities, functionality, performance, of the proposed items is not less than that of a specified item - it must not be considered. In addition, space restrictions must be acceptable.
  - e. If the installation of a substituted product requires increased space, revised systems, relocation of other systems, the cost of the changes required (as determined by the Architect/Engineer and VA) including design review and changes, shall be the responsibility of the contractor.

- f. See also requirements in Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.
  - g. Substitutions are subject to rejection if not in complete conformance with the contract documents when submitted.
  - h. See drawings and Section 1.4 herein for additional requirements.
- G. 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 four copies, bound in hardback binders, (manufacturer's standard binders) or an approved equivalent. Furnish one complete manual as specified in the technical section but in no case later than prior to performance of systems or equipment test, and furnish the remaining manuals prior to contract completion.
  - 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, and contract number. 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.

- H. Approvals will be based on complete submission of manuals together with shop drawings.
- I. After approval and prior to installation, furnish the COTR with one sample of each of the following:
  - 1. A 300 mm (12 inch) length of each type and size of wire and cable along with the tag from the coils of reels from which the samples were taken.
  - 2. Each type of conduit coupling, bushing and termination fitting.
  - 3. Conduit hangers, clamps and supports.
  - 4. Duct sealing compound.
  - 5. Each type of receptacle, toggle switch, occupancy sensor, outlet box, manual motor starter, device wall plate, engraved nameplate, wire and cable splicing and terminating material, and branch circuit single pole molded case circuit breaker.
- J. The contractor shall submit Work Method of Procedures in PDF form of work authorizations and Methods of Procedures (MOP).

#### **1.15 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.

#### **1.16 ACCEPTANCE CHECKS AND TESTS**

- A. The contractor shall furnish the instruments, materials and labor for field tests.
- B. The VA is contracting a third-party commissioning agent through the Architect/Engineer contract. See Section 26 08 00, COMMISSIONING OF ELECTRICAL.

#### **1.17 TRAINING**

- A. Training shall be provided in accordance with Article 1.25, INSTRUCTIONS, of Section 01 00 00, GENERAL REQUIREMENTS and as may be required by the Commissioning Agent (CxA).
- B. Training shall be provided for the particular equipment or system as required in each associated specification. Contractor shall instruct VA personnel (per VA's requested level) as to function, operation, maintenance, adjustment of equipment and systems installed. See contract documents for additional requirements.
- C. A training schedule and topic summary shall be developed and submitted by the contractor and approved by the COTR at least 30 days prior to the planned training.

- D. Training shall be based on and provided in concert with the approved Shop Drawings and Operation and Maintenance manuals.
- E. The trainer(s) shall instruct VA personnel such that the facility operation and maintenance personnel as to function, operation, maintenance, seasonal requirements, testing, and adjustment of equipment.

#### **1.18 PROJECT CONDITIONS**

- A. The electrical contractor should visit the site during the prebid conference to gain an understanding of the many site/building conditions.
- B. All work shall be within the base bid.
- C. Proposed equipment shall not encroach on working, service, or code-required clearances. The contractor shall verify all clearance prior to ordering of any equipment.
- D. The project is a sizable new construction project which impacts primary power service to building 86 and fire alarm system service to multiple buildings. As such, the contractor shall be responsible to fully understand the following:
  - 1. The electrical contractor shall provide schedules and planning according to the general conditions, to include the following:
    - a. The contractor shall prepare a full project schedule.
    - b. The electrical contractor shall participate in weekly project coordination meetings with the VA.
    - c. The electrical contractor shall prepare a two-week lookahead schedule each week for all work.
    - d. The contractor shall delineate any/all potential disturbances to campus operations during the coordination meeting.
    - e. The contractor shall submit the MOP a minimum of 48 hours prior to the coordination meeting.
  - 2. No work shall be performed while equipment is energized without verifying compliance with NFPA 70E and obtaining written permission from the VA COTR.
  - 3. The contractor shall submit and gain approval of an acceptable lock-out tag-out procedure prior to commencing any work.
  - 4. The work is drawn from site observation and existing drawings. The contractor shall be responsible to field verify all existing condition that may affect his bid and make any necessary associated allowances. Required construction deviations from the drawings and specifications shall be brought to the attention of the A/E prior to bid. All discovered conditions during bidding or construction shall be recorded on the site as-built drawings.

5. The campus buildings must remain fully operational to the extent possible. Any service interruptions must be kept to an absolute minimum. Recommended project phasing has been depicted by the drawings and specifications to minimize the service interruptions. Adjustments to the recommended phasing are allowed (and may be required) providing the adjustment results directly in reduction of service interruptions or is necessary to maintain codes and/or compliance with other requirements. NOT: the contractor shall provide a MOP for any normal or ESS system interruption.
  6. All life safety systems shall be fully operations during the evening. These system may NOT be left in any type of derangement over the evening that would prevent normal operation and/or protection of occupants. The contractor shall maintain the operation of the existing campus Fire Alarm system and all other life safety systems at all times.
  7. Any/all work which man affect the normal operation of campus and associated building systems shall be identified to the VA not less than two weeks in advance of the work and must be approved by the VA prior to commencement of that work. This includes any disruption to traffic systems including parking, drives, docks, etc.
  8. If any existing condition, equipment, or systems are concealed and are only discovered during the work and will require demolition, relocation, or reconnection this work shall be brought to the attention of the COTR immediately. Damage to any existing system shall remain the responsibility of the contractor.
  9. Penetrations of fire/smoke rated assemblies shall be repaired to match the assembly rating. All corridor walls shall be assumed fire resistive rated to a minimum of one hour. Seal work shall be considered incidental to the work. All fire/smoke seals shall be per Section 07 84 00 FIRESTOPPING.
  10. The contractor shall comply with all applicable VA regulations, policies and procedures, regarding fire, safety, lockdown, sanitation, environmental protection, security, courtesies, off-limits areas, possession of firearms, designated area visit escort rules, etc while working or visiting the VA facility. See also Section 10 00 00 GENERAL CONDITIONS for additional working environment requirements.
- E. Federal Holidays, Operations and Planning
1. The contractor shall coordinate all scheduling, CPM, and construction phasing plans, MOPS, etc with and to accommodate the following operational conditions: VA Medical Center operation hours are 7:30am

to 4:00pm MDT daily Monday through Friday, excluding federal holidays. Access to the VA Medical Center during other times must be requested in writing a minimum of three (3) weeks prior to the requested date and time period. Project schedules, shall take into account the limited access during these periods and Federal Holidays. Typically, permission to work outside standard business hours shall only be granted when work directly conflicts with VAMC Ft. Meade facility operations. The contractor shall not count on and may only work on Federal holidays, weekends, and outside operational hours when specifically approved or requested by the CO. The contractor cannot count on approval, however.

#### **1.19 ELECTRICAL DEMOLITION**

- A. The project shall require limited general materials demolition. However considerable ductbank and conductors is required to be demolished and shall be performed per the following:
  1. No work shall be performed while equipment is energized without written permission from the VA COTR and verified compliance with NEPA 70E. See 1.11 herein.
  2. All material indicated or inferred for demolition shall be removed in its entirety.
  3. The VA shall retain the right to any/all removed materials. However, if the VA not desire to retain removed materials, the contractor shall remove from the site and properly dispose of.
  4. Following current DEQ, Clean Water Act, Clean Air Act, Toxic Substances Control Act, OSHA, and VA Regulations, the contractor shall be responsible to identify, collect, package and store all material, but not limited to electrical-related hazardous materials. The contractor shall provide its employees with appropriate training, certifications, and shall provide for proper disposal of all materials, including hazardous materials and provide documentation of proper disposal to the VA. The contractor shall weigh all disposed material and provide updates at the weekly construction meetings and/or by separate report.
  5. Unless the system is scheduled for demolition, the contractor shall be responsible to understand and maintain the circuits, feeders, controls, etc for any systems/equipment within the area in which they are working. Damage (not scheduled for demolition) as a result of the contractor's work shall be repaired to VA satisfaction by the contractor at no additional cost to the VA.

**1.20 ELECTRICAL SITEWORK**

- A. The underground work may only be performed after all underground utilities in the vicinity of the work have been located and a locates report has been provided to the VA COTR.
- B. Prior to the start of the drilling or excavation work, the contractor shall have coordinated and checked the anticipated work the VA, local municipality and/or utility companies and have obtained the necessary utility locates in the vicinity of the work.
- C. No underground work may be performed until the method and route has been approved by the VA COTR and the Architect/Engineer. The installation shall be planned to minimize damage to existing finished surfaces, and to existing or planned vegetation. Final location of transformer pad, manholes, luminaires, etc shall be set as approved by the VA. Trenching shall only take place with prior approval of the VA.
- D. All work shall be performed under traffic conditions. Provide continuous access to all adjacent VA and business establishments at the existing driveways and approaches at all times.
- E. Locations, sizes, and quantities of junction boxes are approximate and shall be verified for the required installation. The contractor shall field verify condition, adjust junction box sizes and quantities and bid accordingly. Final locations of junction boxes, equipment, etc shall be coordinated with the VA and approved by the VA prior to the start of the work.
- F. If electrical ductbanks are installed over/under other site systems, a minimum of 12" clearance shall be maintained.
- G. Continuous traffic access shall be maintained on all drives and approaches.
- H. Underground work may not be performed without protective measures when the weather is unfavorable for proper restoration. The Architect and/or VA shall be consulted for that determination.
- I. Exterior surfaces shall be left in a safe condition. The contractor shall perform all work in a manner that no holes are left open or unprotected at the end of each day(s) operation.
- J. Contractor shall avoid damaging all existing landscape vegetation, etc.

**1.21 ELECTRICAL WARRANTY**

- A. The contractor guarantees that all work will be free from defects of materials and workmanship for a period of at least one (1) year from the date of final acceptance. The warranty shall include labor, materials, and all other costs associated with the defective work. Contractor further agrees that he will replace or repair, to VA and Architect/Engineer satisfaction all defective or damaged equipment and



installation that becomes defective or damaged during the term of the warranty. Any replaced work will again be subject to a one (1) year warranty from the date of its installation.

- - - E N D - - -

**SECTION 26 05 12**  
**METHODS OF PROCEDURE**

**PART 1 -GENERAL**

**1.1 SUMMARY**

- A. The purpose of this Section of the Specifications is for the Contractor to establish a step by step plan for the completion of the work required in this project. This plan is necessary to avoid any interruption to the normal operation of the VAMC Ft. Meade and associated remote community base outpatient clinics (CBOC, etc.) facilities.
- B. The Contractor (including subcontractors, where applicable: general, electrical, fire alarm, fire sprinkler, elevator, mechanical, etc.) shall provide copy (in PDF format) of work authorization and Methods Of Procedure (MOP) forms included herein. These forms must be complete and approved by VA (COTR, etc.) prior to commencing work on this project. A brief description of the MOP has been provided here as a guide to help the Contractor prepare the MOP. This description is not intended to cover every detail of the work to be performed. It is the Contractor's responsibility to provide a complete detailed step by step plan for the completion of the work required for this project. If for any reason the MOP cannot be followed after it has been approved. The Contractor shall notify the VA of the problem and new MOP shall be submitted by the Contractor for approval.
- C. The Building B113 facility and all other VAMC Ft. Meade campus buildings, etc., must be able to remain operational throughout the construction period and a detailed sequence of work and construction phasing plan shall be provided by the Contractor to minimize impact of the construction on building, facility, etc., operations.
- D. Project Management Software (MS Projects): All Contractor submittals shall include critical path schedules, and critical chain and schedules shall indicate all deliverables in a time scaled bar graph format. Programming shall have detailed progress scheduling. In addition, the horizontal axis shall be scaled for time beginning with the Notice to Proceed and concluding with contract completion. All schedule items shall show start and completion dates, specific tasks, labor man-hours and cost for each schedule item, submittals, mobilization, demolition method and sequencing, procurement and installation of equipment,

electrical, controls, test, final inspection, etc., and all other steps, etc., as indicated herein.

VA authorization of MOP does not relieve Contractor of responsibility for:

1. Complying with all safety, security, VA and code requirements.
2. Complying with contract documents requirements including, but not limited to, completion dates, warranties, drawings/plans, specification, acceptable material use and associated number and locations, etc. Complying with all safety, security, VA and code requirements.
3. Any legal liabilities for violating of aforementioned, damages occurred, cost overruns, etc., in the execution of MOP.

## **PART 2 -DOCUMENTS**

### **2.1 METHODS OF PROCEDURE FORMS**

- A. The Contractor shall complete the work authorization and Methods of Procedure Form (MOP) included in this Section. These forms must be complete and approved by VA prior to commencing work on this project.
- B. A brief description of the Methods of Procedure has been provided on the plans as a guide to help the Contractor prepare the MOP. This description is not intended to cover every detail of the work to be performed. It is the Contractor's responsibility to provide a complete detailed step by step plan for the completion of the work required for this project.

## **PART 3 -EXECUTION**

### **3.1 INSTALLATION**

- A. If for any reason the MOP cannot be followed after it has been approved. The Contractor shall notify the Hospital Representative of the problem and new MOP shall be submitted by the Contractor for approval. No work shall resume until the new MOP has been approved.

## **PART 4 -FORM TO BE COMPLETED BY CONTRACTOR**

## **METHODS OF PROCEDURE INSTRUCTIONS**

### **A METHOD OF PROCEDURE IS MANDATORY FOR ALL WORK WHICH AFFECTS THE ENVIRONMENT OF CRITICAL EQUIPMENT OR CRITICAL FUNCTIONS.**

Each work activity needs to be evaluated to determine its potential impact on the availability of continued service.

Three risk categories are used to evaluate work operations. These activities are High, Medium, and Low and are defined as follows:

1. HIGH: Activities that could directly or indirectly affect the safety of facilities, patients and/or personnel. The effect could consist of interruption or fluctuation of power and other electrical services in the facility. High risk activities must have prior review and approval by the VA. These activities shall be developed in a format called Method of Procedure (MOP). The MOP MUST be developed and approved by the organization performing the work (the Contractor) and then reviewed and approved by the VA.
  - High risk activities consist of, but are not limited to, modification or expansion work on the following equipment or systems:
    - o Fire Alarm System in the building or for the campus.
    - o Any work on Normal and Emergency Power System Distribution including Essential Electrical Systems and NON-Essential Electrical Systems and associated equipment (Panelboards, Switchboards, Transfer Switches, Generators, etc.)
    - o Engine-Generators and related switchgear.
    - o Paralleling/interconnection of two power sources.
    - o Any work activity on Primary Electrical Systems (Lighting, Nurse Call, Phone/data, Paging, building management systems, etc.) that are directly supporting facility operation.
    - o This applies if there is backup or redundant systems.
2. Medium: Activities that pose no risk to the normal facility operation, but can affect the operation if normal conditions are changed or can affect the coordination and /or construction of facility. It includes activities around the HIGH risk systems and equipment. The effect could cause interruption or fluctuation of the power and other electrical systems in the facility. These activities must have prior review and approval by the VA. MOP's shall be developed and approved by the organization performing the work (Contractor) and then reviewed and approved by the VA.
  - Medium risk activities consist of, but are not limited to, work around the following equipment or systems:

- o Electrical equipment and system, not included on High risk activities list.
- o Any work in electrical equipment rooms/closets, mechanical rooms, telephone/data rooms/closets or areas with electrical equipment
- o Testing and maintenance of spare switches, circuit breakers, or other devices.
- o Any other work or activity not specifically indicated in High or Low risk activities.

3. Low: Activities that pose no risk to the facility operation at any time. The assignment of an activity to the 'LOW' category should be a result of prior careful evaluation by the individual responsible for the work activity. Low risk activities should have no direct or indirect effect from interruption or fluctuation of power or other electrical systems in the facility. MOP forms are not necessary for performing this work.

- Low risk activities consist of, but are not limited to, work on the following equipment or systems:
  - o Cleaning in locations other than the electronic equipment rooms and electrical / mechanical equipment rooms that directly support the electronic equipment.

The work risk level needs to be evaluated at the local level due to site specific differences. These differences include redundancy of equipment, time of day the work is performed, and type of electronic equipment affected by the procedure.



## **MOP STEPS**

All activities that are HIGH or MEDIUM risk activity must be submitted to and approved by the VA.

The Contractor and individual who is responsible for overseeing the construction/remodel work at the site (Contractor) is responsible for initiating the process and seeing that the MOP is produced, approved and completed, with the assistance of the subcontractor organization performing the work.

The Contractor and organization performing the work is responsible for completing:

- 1) Methods of Procedure Authorizations.
- 2) Methods of Procedure Approval Signature Pages.
- 3) Methods of Procedure Transmittals.
- 4) Methods of Procedure Checklist of Pertinent Items.
- 5) Methods of Procedure Step-by-Step forms.

After the MOP is completed, it shall be discussed, shared and agreed upon by the VA.

After the MOP is approved, copies shall be distributed and discussed with every person working on site who is involved with electrical systems including, but not limited to, those items listed in HIGH activities, MEDIUM activities, Fire Alarm, Nurse Call, Phone/Data, Paging, Essential and Non-essential Power, etc. Workers shall be familiar with or shall be made aware, through Contractor provided training, of the critical nature of the equipment being worked on and the facility in general. Worker must again be familiar with all systems involved with the MOP or Contractor shall provide training. If utility companies are involved, make sure they have scheduled people to assist if necessary.

If this work is of an emergency nature and must be performed within 120 hours, The Contractor and the organization performing the work will need to get special approval. Once the VA has approved the MOP, the Contractor, who is responsible for overseeing the construction/remodel, shall notify individuals performing work to start preparation of the work according to the MOP Instructions and Steps.

Before starting the MOP the Contractor shall verify the availability of spare fuses, other parts, and equipment. Contact the VA, Fire Department, Police, etc., or as directed by VA.

Check operation of associated monitoring and alarms.

During the MOP, follow each item on the MOP Step-by-Step process and mark items as completed.

During the MOP the VA will need to be kept informed of the status of the work.

After the MOP is completed, call VA, Fire Department, Police, etc. (those who were informed originally as the MOP started) to let them know everything is back in operation. Check all alarms, equipment, etc., and verify that they are in operation.

An authorized MOP will be considered unauthorized if any steps are added or removed without the VA's approval



**METHOD OF PROCEDURE AUTHORIZATION**

MOP # {number, rev}

(DRAFT, FINAL)

DATE\_\_\_\_/\_\_\_\_/\_\_\_\_

THIS MOP HAS A (HIGH, MEDIUM, LOW) RISK RATING !!!

(Author Name/Title)

(Company Name/Phone)

(Company Address)

**GENERAL DESCRIPTION OF WORK TO BE PERFORMED:**

**SYSTEMS AFFECTED:**

WORK START DATE: (Day/Date)  
TIME (24 hr)

WORK COMPLETED DATE (Day/Date)  
TIME (24 hr)

Requirements for all work on electrical systems which directly or indirectly affect VA equipment and property):

1. Work activities rated with a HIGH or MEDIUM risk must be scheduled and approved by VA.
2. Methods of Procedure statements must be completed by Contractor (general and all applicable subcontractors) and submitted to VA for review and approval.
3. Work cannot start prior to an approved MOP signed by VA.

Contractor Guaranties that MOP:

1. Complies with all safety, security, VA and code requirements.
2. Complies with contract documents requirements including, but not limited to, budget, completion dates, warranties, drawings/plans, specification, acceptable material use and associated number and locations, etc.
3. Does not relive Contractor of any legal liabilities for violating of aforementioned, damages occurred, cost overruns, etc., in the execution of MOP.



## MOP APPROVAL SIGNATURE PAGE

VA Commissioning Agent

(Cell/Pager)

Project Manager  
(Name)

\_\_\_\_\_  
(Fax) \_\_\_\_\_ Signature  
Date \_\_/\_\_/\_\_

General Contractor

(Cell/Pager)

Site Super  
(Name)

\_\_\_\_\_  
(Fax) \_\_\_\_\_ Signature  
Date \_\_/\_\_/\_\_

General Contractors  
Commissioning Manager

(Cell/Pager)

Project Manager  
(Name)

\_\_\_\_\_  
(Fax) \_\_\_\_\_ Signature  
Date \_\_/\_\_/\_\_

Sub Contractor #1

(Cell/Pager)

Site Super (where applicable)  
(Name)

\_\_\_\_\_  
(Fax) \_\_\_\_\_ Signature  
Date \_\_/\_\_/\_\_

Sub Contractor #2

(Cell/Pager)

Site Super (where applicable)  
(Name)

\_\_\_\_\_  
(Fax) \_\_\_\_\_ Signature  
Date \_\_/\_\_/\_\_

Sub Contractor #3

(Cell/Pager)

Site Super (where applicable)  
(Name)

\_\_\_\_\_  
(Fax) \_\_\_\_\_ Signature  
Date \_\_/\_\_/\_\_

Contractor Guaranties that MOP:

1. Complies with all safety, security, VA and code requirements.
2. Complies with contract documents requirements including, but not limited to, budget, completion dates, warranties, drawings/plans, specification, acceptable material use and associated number and locations, etc.

3. Does not relive Contractor of any legal liabilities for violating of  
aforementioned, damages occurred, cost overruns, etc., in the execution of  
MOP.

**METHOD OF PROCEDURE TRANSMITTAL**

{Facility Name}

{Facility Address}

Date: \_\_\_\_\_ Company \_\_\_\_\_

Prepared by: \_\_\_\_\_ Cell/Pager No. \_\_\_\_\_

Tasks to be performed:

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Contractor-provided equipment involved:

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Existing VA equipment to be operated:

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Existing VA equipment affected:

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Inadvertent accidental possibility for operational interruptions:

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Procedure to be followed:

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Risk to on-line equipment:

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Duration time of work:

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Recommended date and time:

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General Contractor (Cell/Pager)

Site Super (Name) (Pg) (Fax) \_\_\_\_\_ Signature Date \_\_/\_\_/\_\_

Sub Contractor #1 (Cell/Pager)

Site Super (where applicable) (Pg) (Fax) \_\_\_\_\_ Signature Date \_\_/\_\_/\_\_  
( )

Contractor Guaranties that MOP:

1. Complies with all safety, security, VA and code requirements.
2. Complies with contract documents requirements including, but not limited to, budget, completion dates, warranties, drawings/plans, specification, acceptable material use and associated number and locations, etc.
3. Does not relive Contractor of any legal liabilities for violating of aforementioned, damages occurred, cost overruns, etc., in the execution of MOP.

## METHOD OF PROCEDURE CHECKLIST OF PERTINENT ITEMS

{Facility Name}

{Facility Address}

This work will not start until all items on this checklist have been evaluated for applicability to the MOP and included in MOP. Methods of Procedure statements must be completed, approved and signed by Contractor (general and all applicable subcontractors). Also, the MOP must be approved/signed by VA Project COTR, VA affected User/Department Manager and as directed by COTR. Contractor responsible for obtaining VA approval.

**The following important items, at minimum, must be specifically addressed and included, when applicable, as steps in the MOP:**

- ( ) 1. Storage of tools and materials
- ( ) 2. Specify fire and life safety precautions required.
- ( ) 3. Insulated and/or special tools required.
- ( ) 4. Detailed description of specific work to be done.
- ( ) 5. Check operation of associated monitoring/alarms prior to start of job.
- ( ) 6. The requested and restricted hours (period) that specific portions of work may be done.
- ( ) 7. Length of time required for specific portions of work.
- ( ) 8. Equipment and/or software programming to be installed or removed.
- ( ) 9. Compatibility of the proposed equipment/software with existing equipment/software and existing space.
- ( ) 10. Existing equipment to be operated and/or software to be manipulated.
- ( ) 11. Existing equipment directly affected and how (i.e., switching effects or interruption of service required).
- ( ) 12. Existing operating software to be directly or indirectly affected.
- ( ) 13. Electrical equipment to be removed, tagged and verified and by whom.
- ( ) 14. Locations of select High activity and Medium activity critical circuits.
- ( ) 15. Proximity of workers to power sources and distributing systems to computer rooms and critical building equipment (i.e., building power systems (EES and NON-EES, Fire Alarm system, Nurse Call system, Phone/data system, etc.).
- ( ) 16. Existing equipment/software that could be accidentally or indirectly affected.
- ( ) 17. Risk - what happens if equipment/software fails, or operator error occurs?
- ( ) 18. Protection required for equipment, floors, walls, personnel, etc.
- ( ) 19. Location of spare fuses and/or other material that may fail or become damaged.
- ( ) 20. Steps requiring the presence of VA.
- ( ) 21. Alarms that might be affected and automatic controls that may occur as a result of alarms that may be triggered knowingly or unknowingly.
- ( ) 22. Alarms to be disconnected and when.
- ( ) 23. Service restoration procedure and responsibilities in the event of an interruption or injury.
- ( ) 24. Electrical service releases required - when and by whom released?
- ( ) 25. Electrical service restoration required - when and by whom released?
- ( ) 26. Records and drawings to be corrected
- ( ) 27. Other pertinent factors.

List of documents (O&M Manuals, operations manuals, project specifications and drawings, National Electric Code, etc.) which outline general requirements, practices, precautions and procedures to be used by the Contractor during the installation period.

( ) Current NEC (National Electric Code)

( ) Operation and Maintenance Manuals

( ) Other

General Contractor (Cell/Pager)

Site Super (Name) \_\_\_\_\_ Signature  
(Fax) \_\_\_\_\_ Date \_\_/\_\_/\_\_

Sub Contractor #1 (Cell/Pager)

Site Super (where applicable) \_\_\_\_\_ Signature  
(Name) (Fax) \_\_\_\_\_ Date \_\_/\_\_/\_\_

Contractor Guaranties that MOP:

1. Complies with all safety, security, VA and code requirements.
2. Complies with contract documents requirements including, but not limited to, budget, completion dates, warranties, drawings/plans, specification, acceptable material use and associated number and locations, etc.
3. Does not relive Contractor of any legal liabilities for violating of aforementioned, damages occurred, cost overruns, etc., in the execution of MOP.



## METHOD OF PROCEDURE

### STEP-BY-STEP

{Facility Name}

{Facility Address}

In doing this job, the following steps must be followed in the order listed. Deviations from the procedure will not be made without the approval of the VA.

General information, precautions, notes, checklists, references to instructions/drawings/step-by-step procedure shall be included as appropriate. Each item must be completed before progressing to the next item.

If, after completing the pages proceeding this step-by-step MOP, VA agrees that a detailed step-by-step procedure is not required to prevent a service failure, an approved Method of Procedure Transmittal may be used in lieu of an MOP.

STEP NUMBER AND DESCRIPTION	Contractor RESPONSIBILITY			
	General	Sub #1	Sub #2	Sub #3
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
Etc.				

General Contractor (Cell/Pager)

Project Manager (Name) \_\_\_\_\_ Signature  
(Fax) \_\_\_\_\_ Date \_\_/\_\_/\_\_

Sub Contractor #1 (Cell/Pager)

Site Super (where applicable) (Name) \_\_\_\_\_ Signature  
(Fax) \_\_\_\_\_ Date \_\_/\_\_/\_\_

Contractor Guaranties that MOP:

1. Complies with all safety, security, VA and code requirements.
2. Complies with contract documents requirements including, but not limited to, budget, completion dates, warranties, drawings/plans, specification, acceptable material use and associated number and locations, etc.
3. Does not relive Contractor of any legal liabilities for violating of

aforementioned, damages occurred, cost overruns, etc., in the execution of MOP.

**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 the low voltage power and lighting 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. 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 SUBMITTALS**

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

1. Manufacturer's Literature and Data: Showing each cable type and rating.
2. Certifications: Three (3) weeks prior to the final inspection, submit four copies of the following certifications to the COTR:
  - a. Certification by the manufacturer that the materials conform to the requirements of the drawings and specifications.
  - b. Certification by the contractor that the materials have been properly installed, connected, and tested.

**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 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):
- 70-2011.....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 COTR.
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. Above ground 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. Above ground 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.

D. Underground Branch Circuits and Feeders:

1. Submersible connectors in accordance with UL 486D, rated 600 V, 190°F [90°C], with integral insulation.

### **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. 14 AWG.
- 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.

### **2.5 FIREPROOFING TAPE**

- A. The tape shall consist of a flexible, conformable fabric of organic composition coated one side with flame-retardant elastomer.
- B. The tape shall be self-extinguishing and shall not support combustion. It shall be arc proof and fireproof.
- C. The tape shall not deteriorate when subjected to water, gases, salt water, sewage, or fungus and shall be resistant to sunlight and ultraviolet light.
- D. The finished application shall withstand a 200A arc for not less than 30 seconds.
- E. Securing tape: Glass cloth electrical tape not less than 0.18 mm (7 mils) thick, and 19 mm (3/4 inch) wide.

### **2.6 WARNING TAPE**

- A. The tape shall be standard 76 mm (3 inch) wide, 4 mils polyethylene detectable type.
- B. The tape shall be red with black letters indicating "CAUTION BURIED ELECTRIC LINE BELOW."

**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, pull-boxes, manholes, or handholes.
- D. Wires of different systems (e.g., 120VAC, 277VAC) 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 panelboards, cabinets, wireways, switches, and equipment assemblies, neatly form, train, and tie the cables in individual circuits.
- G. Seal cable and wire entering a building from underground between the wire and conduit where the cable exits the conduit, with a non-hardening approved compound.
- H. 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 COTR.
  - 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.
- I. No more than three single-phase branch circuits shall be installed in any one conduit.
- J. Conductors shall be de-rated in accordance with NEC Article 310. Neutral conductors shall be considered current-carrying conductors and be sized accordingly.
- K. Voltage drop shall be limited to 3% on any new branch circuits. The drawings call out that #12AWG is the smallest allowed conductor. However, voltage drop on 20A circuits will require:
  - 1. #10AWG for any branch circuit exceeding 70 linear feet in length.
  - 2. #8AWG for any branch circuit exceeding 90 linear feet in length.
  - 3. #6AWG for any branch circuit exceeding 145 linear feet in length.
  - 4. At new receptacles or switches, wirenut a #12AWG "termination pigtail" onto the upsized supply conductor for final termination to

the device. This avoids unnecessary strain on the device. Upsize the backboxes if required due to splice.

5. Similar voltage drop conductor adjustments must be made by the contractor to any new branch circuits over 20A. The load shall be assumed at 80% of the overload protection rating.

### **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.

### **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.



**3.7 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.
- D. In each manhole and handhole, install embossed brass tags to identify the system served and function.

**3.8 EXISTING CONDUCTORS/CIRCUIT EXTENSIONS**

- A. Only conductors that conform to the specifications and applicable codes may be reused. If existing conductors do not meet the requirements, existing conductors may not be reused and new conductors must be installed. Utilization of existing conduit has similar restrictions, see Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS. Existing conduit/conductors not specifically indicated or inferred for reuse shall be removed.
- B. Existing conductors required to be removed shall not be reused for any new installation.
- C. If the existing conductors conform to these specifications, branch circuits being transferred/extended to new panelboards may be spliced at a practical/accessible (preferably above a ceiling) location for extension to the new panelboard/source. If possible, the contractor shall install the circuit extension from the splice location to the new panelboard/source prior to any service interruption to the circuit/equipment, thus limiting any service interruption to the time required to make up the conduit connections and conductor splices at the splice location.
- D. New conduit/conductors extending an existing circuit shall not be smaller than that required by the NEC and shall not be smaller than the existing circuit construction methods.

**3.9 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.
- D. The system shall have continuity of ground throughout the system. Raceway alone shall not be relied upon for the sole means of equipment grounding. All raceway shall have a continuous ground throughout, sized per the NEC.

**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 16, PANELBOARDS: Low voltage panelboards.
- D. Section 26 36 23, AUTOMATIC TRANSFER SWITCHES: Automatic transfer switches.
- E. Section 26 41 00, FACILITY LIGHTNING PROTECTION: Requirements for lightning protection.

**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: Three (3) Two weeks prior to final inspection, submit four copies of the following to the COTR:
  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):
  - 70-2011.....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.
- 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**

- C. 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.
- C. Service Disconnect (Separate Individual Enclosure): Provide a ground bar bolted to the enclosure with lugs for connecting the various grounding conductors.
- D. Switchgear, 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.
- E. Transformers:
1. Exterior: Exterior transformers supplying interior service equipment shall have the neutral grounded at the transformer secondary. Provide a grounding electrode at the transformer.
  2. Separately derived systems (transformers downstream from service equipment): Ground the secondary neutral at the transformer. Provide a grounding electrode conductor from the transformer to the ground bar at the service equipment.

### **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.

### **3.7 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.

### **3.8 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.
- B. In operating rooms and at intensive care and coronary care type beds, bond the gases and suction piping at the outlets directly to the room or patient ground bus.

### **3.9 LIGHTNING PROTECTION SYSTEM**

- A. Bond the lightning protection system to the electrical grounding electrode system.

### **3.10 ELECTRICAL ROOM GROUNDING**

- A. Building Earth Ground Busbars: Provide ground busbar and mounting hardware at each electrical room and connect to pigtail extensions of the building grounding ring.

### **3.11 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 additional unspliced length in and above foundation as required to reach pole ground stud.

### **3.12 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. Services at power company interface points shall comply with the power company ground resistance requirements.
- D. Below-grade connections shall be visually inspected by the COTR prior to backfilling. The contractor shall notify the COTR 72 hours before the connections are ready for inspection.

### **3.12 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 06 10 00, ROUGH CARPENTRY: Mounting board for telephone closets.
- B. Section 07 60 00, FLASHING AND SHEET METAL: Fabrications for the deflection of water away from the building envelope at penetrations.
- C. Section 07 84 00, FIRESTOPPING: Sealing around penetrations to maintain the integrity of fire rated construction.
- D. Section 07 92 00, JOINT SEALANTS: Sealing around conduit penetrations through the building envelope to prevent moisture migration into the building.
- E. Section 09 91 00, PAINTING: Identification and painting of conduit and other devices.
- F. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.
- G. 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.
- H. Section 26 05 41, UNDERGROUND ELECTRICAL CONSTRUCTION: Underground conduits.
- I. Section 31 20 11, EARTH MOVING (Short Form).

**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. Manufacturer's Literature and Data: Showing each cable type and rating. The specific item proposed and its area of application shall be identified on the catalog cuts.
- B. Shop Drawings:

1. Size and location of main feeders.
2. Size and location of panels and pull-boxes.
3. Layout of required conduit penetrations through structural elements.

C. Certifications:

1. Three (3) weeks prior to the final inspection, submit four copies of the following certifications to the COTR:
  - a. Certification by the manufacturer that the material conforms to the requirements of the drawings and specifications.
  - b. Certification by the contractor that the material has been properly installed.

#### 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):
  - 70-2011.....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 in [19 mm] unless otherwise shown. Where permitted by the NEC, 1/2 in [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.
- C. Conduit Fittings:
  - 1. Rigid steel conduit 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.
    - 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.
  - aluminum conduit.//
  - 3. 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 or malleable iron materials are acceptable.
  - c. Compression couplings and connectors: Concrete-tight and rain-tight, with connectors having insulated throats.
  - 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.
4. Flexible steel conduit fittings:
- a. Conform to UL 514B. Only steel or malleable iron materials are acceptable.
  - b. Clamp-type, with insulated throat.
5. 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.
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. Cut holes in advance where they should be placed in the structural elements, such as ribs or beams. Obtain the approval of the Structural Engineer and COTR prior to drilling through structural elements.
  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 COTR as required by limited working space.
- B. Firestop: 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, with rock wool fiber or silicone foam sealant only. Completely fill and seal clearances between raceways and openings with the firestop material.
- 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 specifically "accepted" by NEC Article 517.

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 COTR.



### 3.3 CONCEALED WORK INSTALLATION

#### A. In Concrete:

1. Conduit: Rigid steel or EMT. Do not install EMT in concrete slabs that are in contact with soil, gravel, or vapor barriers.
2. Align and run conduit in direct lines.
3. Install conduit through concrete beams only:
  - a. Where shown on the structural drawings.
  - b. As approved by the COTR prior to construction, and after submittal of drawing showing location, size, and position of each penetration.
4. Installation of conduit in concrete that is less than 3 in [75 mm] thick is prohibited.
  - a. Conduit outside diameter larger than one-third of the slab thickness is prohibited.
  - b. Space between conduits in slabs: Approximately six conduit diameters apart, and one conduit diameter at conduit crossings.
  - c. Install conduits approximately in the center of the slab so that there will be a minimum of 0.75 in [19 mm] of concrete around the conduits.
5. Make couplings and connections watertight. Use thread compounds that are UL approved conductive type to ensure low resistance ground continuity through the conduits. Tightening setscrews with pliers is prohibited.

#### B. Above Furred or Suspended Ceilings and in Walls:

1. Conduit for conductors above 600 V: Rigid steel. Mixing different types of conduits indiscriminately in the same system is prohibited.
2. Conduit for conductors 600 V and below: Rigid steel or EMT. Mixing different types of conduits indiscriminately in the same system is prohibited.
3. Align and run conduit parallel or perpendicular to the building lines.
4. 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.
5. Tightening setscrews with pliers is prohibited.

### 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 above 600 V: Rigid steel. Mixing different types of conduits indiscriminately in the system is prohibited.

- C. Conduit for Conductors 600 V and Below: Rigid steel, or EMT. Mixing different types of conduits indiscriminately in the system is prohibited.
- D. Align and run conduit parallel or perpendicular to the building lines.
- E. Install horizontal runs close to the ceiling or beams and secure with conduit straps.
- F. Support horizontal or vertical runs at not over 8 ft [2.4 M] intervals.
- G. Surface metal raceways: Use only where shown.
- H. Painting:
  - 1. Paint exposed conduit as specified in Section 09 91 00, PAINTING.
  - 2. Paint all conduits containing cables rated over 600 V safety orange. Refer to Section 09 91 00, PAINTING for preparation, paint type, and exact color. In addition, paint legends, using 2 in [50 mm] high black numerals and letters, showing the cable voltage rating. Provide legends where conduits pass through walls and floors and at maximum 20 ft [6 M] intervals in between.

### **3.5 HAZARDOUS LOCATIONS**

- A. Use rigid steel conduit only, notwithstanding requirements otherwise specified in this or other sections of these specifications.
- B. Install UL approved sealing fittings that prevent passage of explosive vapors in hazardous areas equipped with explosion-proof lighting fixtures, switches, and receptacles, as required by the NEC.

### **3.6 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.
- C. Unless otherwise shown, use rigid steel or IMC conduit within 5 ft [1.5 m] of the exterior and below concrete building slabs in contact with soil, gravel, or vapor barriers. Conduit shall be half-lapped with 10 mil PVC tape before installation. After installation, completely recoat or retape any damaged areas of coating.

### **3.7 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.

### **3.8 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.

### **3.9 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.
- 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.

### **3.10 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 identified on riser diagrams; for example "SIG-FA JB No. 1."
- G. On all branch circuit junction box covers, identify the circuits with black marker.

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**SECTION 26 05 34**  
**CABLE TRAYS (WIRE BASKET)**

**PART 1 GENERAL**

**1.1 DESCRIPTION**

- A. This section includes the furnishing and installation of the cable trays and accessories.
- B. Cable tray shall only be used for data/telecomm and other limited voltage system and only when specifically allowed by VA Electrical Design Manual, drawings and specifications. All other electrical systems shall be in separate raceway systems.

**1.2 RELATED SECTIONS**

- A. Section 078400 - Firestopping.
- B. Section 260521 - Low Voltage Electrical Power Conductors and Cables (600 Volts and Below).
- C. Section 260533 - Raceway and Boxes for Electrical Systems.

**1.3 REFERENCES**

- A. ANSI/NFPA 70-2011 - National Electrical Code.
- B. ASTM A 123 - Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip.
- C. ASTM A 525 - General Requirements for Steel Sheet, Zinc-Coated Galvanized by the Hot-Dip Process.
- D. NEMA FG 1 - Fiberglass Cable Tray Systems.
- E. NEMA VE 1 - Metallic Cable Tray Systems.
- F. NECA - National Contractors Association.

**1.4 SUBMITTALS**

- A. Shop Drawings: Indicate tray type, dimensions, support points, and finishes.
- B. Product Data: Provide data for fittings and accessories.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

### **1.5 REGULATORY REQUIREMENTS**

- A. Conform to requirements of ANSI/NFPA 70 and Underwriters Laboratories (UL).

## **PART 2 PRODUCTS**

### **2.1 CABLE TRAY MANUFACTURERS**

- A. Cablofil Cable Tray or approved equal.
- B. Chalfant Wire Mesh Tray or approved equal.
- C. Cooper B-line/GS Metals Corp. Flextray or approved equal.
- D. MP Husky Techtray or approved equal.

### **2.2 CABLE TRAY STEEL CHANNEL SUPPORT**

- A. Manufacturer:
  - 1. B-Line Systems, Inc. or approved equal.
  - 2. Unistrut or approved equal.
- B. Description: Painted steel.

### **2.3 CABLE TRAY SUPPORT FASTENERS**

- A. Manufacturer: Equal to Caddy Fasteners.

### **2.4 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. Nominal Width: 12 inches minimum or as required by code if larger for number of cables, etc.
- E. Nominal Depth: 4 inches minimum or as required by code if larger for number of cables, etc.
- F. Straight Section Mesh Spacing: 4 inches on center, 2 inches in width.
- G. Wire mesh tray fittings are to be purchased precut from the manufacturer of the straight tray sections. Tray must be attached to a support by mechanical means (e.g nuts/bolts).
- H. Provide manufacturer's standard clamps, hangers, brackets, splice plates, reducer plates, blind ends, barrier strips, connectors, and grounding straps, etc necessary for complete and secure installation.
- I. Provide support brackets to mount tray to wall or structure.
- J. Provide bending radius clips for all inside corners and transitions.

- K. Provide cable tray drop outs above each rack and cabinet to support vertical cable drops from cable tray to terminations.
- L. Provide a cable tray divider where noted to separate nurse call wiring from all other low voltage cabling. Position the divider within the tray to allow widths proportionate to the quantities of cabling to be installed in each of two sections.
- M. Provide splices, clamps, reduction fittings, and all other ancillary components required for a complete system.

## **2.5 PRODUCT REQUIREMENTS - CABLE TRAY SUPPORTS, FASTENERS AND ANCHORS**

- A. Materials and Finishes: Provide adequate corrosion resistance.
- B. Provide materials, sizes, and types of anchors, fasteners and supports to carry the loads of equipment and conduit. Consider weight of wire in conduit when selecting products. As a minimum, select products based on load factor of two.

- C. Anchors and Fasteners:

All supports and anchors to be secured to steel studs, CMU walls, or structures. Securing to wall coverings (gyp board, etc) shall not be acceptable.

- 1. Concrete Structural Elements: Use expansion anchors and preset inserts.
- 2. Steel Structural Elements: Use beam clamps and welded fasteners.
- 3. Concrete Surfaces: Use self-drilling anchors and expansion anchors.
- 4. Solid Masonry Walls: Use expansion anchors and preset inserts.
- 5. Sheet Metal: Use sheet metal screws.
- 6. Wood Elements: Use wood screws.

## **2.6 WARNING SIGNS**

- A. Engraved Nameplates: 1/2 inch high black letters on yellow laminated plastic nameplate, engraved with the following wording:

WARNING! DO NOT USE CABLE TRAY AS WALKWAY, LADDER, OR SUPPORT.  
USE ONLY AS MECHANICAL SUPPORT FOR CABLES AND TUBING!

## **2.7 GROUNDING**

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

### **PART 3 EXECUTION**

#### **3.1 INSTALLATION - CABLE TRAY**

- A. Install in accordance with manufacturer's recommendations, NEC, VA standards, whichever is more stringent or restrictive (shorter support spacing, larger sizing, etc).
- B. Install basket type cable tray in accordance with NEMA VE 1.
- C. The cable tray shall be run parallel or perpendicular to the building walls structural members and building lines, following as close as possible to the route indicated on the drawings.
- D. The complete cabletray system shall be installed complete before associated conductors are installed.
- E. Tray to be mounted at a minimum of 6 to 12 inches above lay-in ceiling, unless otherwise approved by Architect/Engineer and VA RE.
- F. Tray shall be installed to allow installation of cabling. A minimum of 18 inches clear shall be maintained above cable tray.
- G. At each building expansion joint and in each straight uninterrupted run of cable tray, an appropriate expansion fitting shall be provided. The distance between fittings as installed shall not exceed manufacturer's recommendations or 200 linear feet.
- H. Connect sections of cable tray together with edges free from burrs and sharp projections.
- I. Install warning signs at 50 foot centers along cable tray, located to be visible.
- J. Properly seal around cable tray passing through smoke or fire barrier 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. Fireproofing materials and methods shall be approved by Engineer. See Specification Section 078400.

- K. Provide fireproofing pillows where cable tray passes through fire rated partitions. See Specification Section 078400.
- L. Exercise control and coordinate with the Mechanical contractor, Fire Sprinkler contractor and other trades on installing cable tray to realize maximum use of space and greatest clearance between tray and hot piping. Specifications and drawings are for assistance and guidance, but exact routing, locations, distance, and levels will be governed by actual field conditions. Contractor is directed to make field surveys as part of the work prior to submitting system layout drawings.

### **3.2 INSTALLATION - CABLE TRAY SUPPORTS, FASTENERS AND ANCHORS**

- A. Install and support cable tray in accordance with manufacturer's instructions and manufacturer's suggested load span criteria of minimum  $L/240$ . Provide supports at each connection point, at the end of each run, and at other points to maintain spacing between supports of 8 foot maximum using galvanized or corrosion-resistant threaded rod.
- B. Provide anchors, fasteners, and supports in accordance with NECA "Standard of Installation".
- C. Do not fasten supports to pipes, ducts, mechanical equipment, and conduit.
- D. Do not use spring steel clips and clamps.
- E. Do not use powder-actuated anchors.
- F. Obtain permission from Architect/Engineer before drilling or cutting structural members.
- G. Fabricate supports from structural steel or steel channel. Rigidly weld members or use hexagon head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts. Paint all surfaces.

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**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 11, EARTH MOVING (SHORT FORM): 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 COTR for approval prior to construction.
- C. Certifications: Three (3) weeks prior to the final inspection, submit four copies of the following certifications to the COTR:
1. Certification by the manufacturer that the materials conform to the requirements of the drawings and specifications.
  2. Certification by the contractor that the materials have been properly installed, connected, and tested.

#### **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):

70-2011.....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**

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

## **PART 2 - PRODUCTS**

### **2.1 PRE-CAST CONCRETE MANHOLES AND HARDWARE**

B. Cable Supports:

1. Cable stanchions shall be hot-rolled, heavy duty, hot-dipped  
galvanized "T" section steel, 2.25 in [56 mm] x 0.25 in [6 mm] in  
size, and punched with 14 holes on 1.5 in [38 mm] centers for  
attaching cable arms.
2. Cable arms shall be 0.1875 in [5 mm] gauge, hot-rolled, hot-dipped  
galvanized sheet steel, pressed to channel shape. Arms shall be  
approximately 2.5 in [63 mm] wide x 14 in [350 mm] long.
3. Insulators for cable supports shall be high-glazed, wet process  
porcelain, and shall completely encircle the cable.
4. Equip each cable stanchion with two spare cable arms and six spare  
insulators for future use.

D. Ground Rod Sleeve: Provide a 3 in [75 mm] PVC sleeve in manhole floors  
so that a driven ground rod may be installed.

E. Sump: Provide 12 in x 12 in [305 mm x 305 mm] covered sump frame and  
cover.

## 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 5 loading. Provide pulling irons, 0.875 in [22 mm] diameter galvanized steel bar with exposed triangular-shaped opening.
- B. Fiberglass Pullboxes: Shall be sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.

## 2.3. DUCTS

- A. Number and sizes shall be as shown on drawings and required by code.
- 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.
  - 3. All underground ductbanks on this project (power, signal, etc) are concrete encased.

## 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.

### **3.2 TRENCHING**

A. Refer to Section 31 20 11 EARTH MOVING (SHORT FORM) 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 COTR.
11. Duct Bank Markers:
  - a. Duct bank markers, where required and shown on plans, shall be located at the ends of duct banks except at manholes or pullboxes at approximately every 200 ft [60 m] along the duct run and at each change in direction of the duct run. Markers shall be placed 2 ft [0.6 m] to the right of the duct bank, facing the longitudinal axis of the run in the direction of the electrical load.
  - b. The letter "D" with two arrows shall be impressed or cast on top of the marker. One arrow shall be located below the letter and shall point toward the ducts. The second arrow shall be located adjacent to the letter and shall point in a direction parallel to the ducts. The letter and arrow adjacent to it shall each be approximately 2 in [75 mm] long. The letter and arrows shall be V-shaped, and shall have a width of stroke at least 0.75 in [6 mm] at the top and a depth of 0.25 in [6 mm].
  - c. In paved areas, the top of the duct markers shall be flush with the finished surface of the paving.
  - d. Where the duct bank changes direction, the arrow located adjacent to the letter shall be cast or impressed with an angle in the arrow equivalent to the angular change of the duct bank.//
- D. Concrete-Encased 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 COTR.

- 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.
- J. Connections to Existing Ducts: Where connections to existing duct banks are indicated, excavate around the duct banks as necessary. Cut off the ducts and remove loose concrete from inside before installing new ducts. Provide a reinforced-concrete collar, poured monolithically with the new ducts, to take the shear at the joint of the duct banks.
- K. 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.

- - - E N D - - -

**SECTION 26 05 53**  
**IDENTIFICATION AND LABELING**

**PART I - GENERAL**

**1.1 DESCRIPTION**

- A. This section includes labor, material, equipment, and related services necessary to furnish and install identification labels on electrical equipment and wiring as indicated on the drawings and as specified herein. All labeling, identification, and markings shall comply with equipment manufacturer requirements, ANSI C2, the latest versions of the NEC and OSHA standards, specific labeling requested by the authority having jurisdiction, NFPA, VA and applicable healthcare "Joint Commission" and State Department of Health requirements.
- B. This section provides VAMC required labeling and is in addition to all identification, labels and signs that are required by OSHA, ANSI, NFPA and other codes.
- C. See Division 26 specifications for additional miscellaneous equipment identifications and labeling requirements.

**1.2 SHOP DRAWINGS**

- A. Submit a complete list of identification labels for all panels, disconnect, and equipment. The list shall be updated and verified with the Engineer and/or VA prior to manufacture of these labels to reflect changes made during the construction of the project.

**1.3 QUALITY ASSURANCE**

- A. All work shall be performed in a neat workmanship manner.
- B. Comply with applicable ANSI, NFPA and other codes. Refer to NFPA 70 (NEC) for color-coding and utilize the same color coding throughout the project. Utilize color coding which is consistent with any existing facilities providing they comply with code requirements.
- C. Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

**1.4 SUBMITTALS**

- A. In accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES and Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, furnish the following:
  - 1. Manufacturer's Literature and Data: Showing listing and ratings of materials proposed.
  - 2. Submit a complete listing of proposed identification material and proposed nameplate and associated language. Labels provided shall include those required for all receptacles, starters, controls,

panels, etc. Prior to manufacture, equipment labels for the project shall be presented to the COTR representative in a line-by-line listing in EXCEL or another acceptable format to the COTR.

3. Certifications: Three weeks prior to the final inspection, submit four copies of the following certifications to the COTR:

a. Certification by the manufacturer that the materials conform to the requirements of the drawings and specifications.

## **PART II - PRODUCTS**

### **2.1 LAMINATED PLASTIC NAMEPLATES**

- A. Engraved Plastic Nameplates and Signs: Engraving stock shall be 1/16" thick for signs up to 20 square inches and 1/8" thick for larger signs. Laminate plastic plates shall be black-white for normal systems and red-white for emergency systems. Characters shall be cut through the black or red to show the white of the plate. Inscriptions shall be symmetrical to the centerline of plates. Single line plates shall have minimum 1/4" high letters. Multiple line plates shall have minimum 1/8" high letters. Verify wording for all labels before ordering, and use area identification terminology as directed.
- B. Plastic equipment labels stock shall be similar and equal to Rowmark Ultra matte Series 300.

### **2.2 STAINLESS STEEL COVERPLATES**

- A. All device coverplates shall be type 302 satin finish stainless steel. Inscriptions shall be a minimum of 1/4 inch high by engraving filled with black engravers enamel or black silkscreen lettering.

### **2.3 WIRE MARKERS**

- A. Wire markers shall be self-adhesive write-on tape with clear adhesive over-wrap, as manufactured by Brady Manufacturing, T & B, Panduit, or Ideal.
- B. Embossed adhesive tape shall not be used.

### **2.4 UNDERGROUND PLASTIC WARNING TAPE**

- A. Plastic tape shall be listed for intended service, inert plastic, not less than 3 inches wide and 4 mils thick, red colored with the words "Caution Buried Electric Lines Below" repeatedly printed along the length of the tape. Tape shall be Panduit or equal.

## **PART III - EXECUTION**

### **3.1 INSTALLATION**

- A. Installation of identification/labels shall be performed as soon as is practical. The contactor shall remain responsible to replace labels damaged during the balance of the construction.
- B. Identification materials and products shall be affixed/applied to equipment, etc such that the label may be viewed without disrupting operation of the equipment.

### 3.2 **FASTENING OF NAMEPLATES/SIGNS**

- A. Interior and exterior laminated plastic nameplates and signs shall be attached to the equipment or device by double-backed PE foam-style (Rub) outdoor-rated adhesive tape equal to that manufactured by JDS Industries (800-843-8853). Surfaces MUST be clean and dry prior to applying the self-adhesive tape.
- B. Alternatively, self-tapping stainless steel pan-head screws may be used to affix interior labels and permanently bonding epoxy glue may be used to affix exterior labels. Panhead screws may NOT be used for fastening nameplates to exterior equipment and epoxy glue may NOT be used to affix interior labels.

### 3.3 **INSCRIPTIONS**

- A. Inscription characters on the switchboard, panelboards, metering, terminal cabinets and fuse storage cabinet, unless otherwise noted, shall be minimum 1/4 inch high. Inscription characters on other identification plates shall be minimum 1/8 inch high.

### 3.4 **NORMAL EQUIPMENT-IDENTIFICATION**

- A. Certain types of equipment, controls, and switchplates are to be labeled with identifying words, names, numbers or characters. Hand printing shall not be used where permanently visible. All identifications shall be performed with a laminated plastic nameplates sized appropriately for the equipment to be labeled, and as a minimum, shall be as specified below and as acceptable to the VA:
  - 1. In addition to the following requirements, every protective device which is a series-rated over-current device shall be labeled as such consistent with the latest version of the NEC.
  - 2. Motor or heater control devices - manual motors switches, motor toggle switches, pushbuttons, thermostats, etc. Nameplate inscriptions shall indicate the equipment being controlled, i.e. "Toilet Exh, Range Hood Exh, Heater, A.C. Unit # 1, H.W. Pump #2", etc. as described in the mechanical/electrical schedule or as indicated on drawings, and the branch circuit source, i.e. "Panel L1-2".

3. Motor or heater disconnects and starters - each safety switch, toggle switch, or starter, shall be identified. Nameplate inscriptions shall indicate the equipment being controlled defined by its motor number as listed in the mechanical/electrical schedule or as indicated on the drawings, i.e. "Toilet Exh (PRV- 1), Heater (UH-3), A.C. Unit #1 (RTU-2)", etc. and to include the branch circuit source, i.e. "Panel L1-2". EXAMPLE: EF-1, 120V, 1ø, 3W/CKT #5 MDP MECH ROOM-101. In addition, series rated over-current devices shall be labeled as required by the latest version of the NEC. EXAMPLE: EF-1, 120V, 1ø, 3W/CKT #5 MDP MECH ROOM-101. Where rating of fuse disc/switch exceeds the ampacity of the conductors being protected, a permanent label noting maximum fuse size shall be installed inside switch and listed on exterior label.
4. Call bell pushbuttons, door release pushbuttons, alarm pushbuttons, or other similar systems input/control stations, etc. shall be identified. Nameplate inscriptions shall indicate the function of the device, i.e. "Call Bell, Door Release, Silent Alarm", unless noted otherwise on the drawings.
5. Switchboards, Motor Control Centers and Panelboards - Panel labels shall be provided on the outside of each panelboard in mechanical and electrical equipment rooms and on the inside of the door of each panelboard located in other finished areas. Inscriptions shall indicate the panel name, voltage, phase, # wires, feeder size, and feeder source, i.e.: "Panel L1, 120/208-3PH-4W, 3#2 & 1#8 GRD THHN, fed from Panel H1." At the contractor's option, separate labels defining feeder size may be located on the inside of operable doors. All wild legs shall be identified per the NEC. Where existing panels are modified, the contractor shall provide the VA with a computer printed directory showing the as built condition.
6. In addition, where the premises wiring system has branch circuits supplied from more than one nominal voltage system, each conductor shall be identified with a phase designation in agreement with a laminated nameplate attached to the front of panelboards, switchboards, junction boxes or motor control centers. The nameplates for two systems shall indicate:

208Y/120V 3PH,4W SYSTEM
PHASE A - BLACK
PHASE B - RED
PHASE C - BLUE
NEUTRAL - WHITE

7. In addition, a laminated nameplate attached to the front of main panelboard shall be labeled with the following, as applicable.

208Y/120V 3PH,4W SYSTEM
PHASE A - BLACK
PHASE B - RED
PHASE C - BLUE
NEUTRAL - WHITE

Dry-Type Transformers - Nameplates shall be provided which shall indicate the name of the transformer, and primary feeder size and source, i.e. "TF-1, #1 & 1 #8 GRD, fed from Panel H1."

Bus Duct - Nameplates shall be provided every 50 feet along the length of the bus duct which shall indicate the name of bus duct, voltage, phase and neutral, bus size, and the source and feeder size, i.e. "BD-1, 277/480V, 3 phase, 4W, (2) sets 3 ½ inches-4 #500 MCM & 1 #1/0 GRD, fed from MSB-1." Nameplate lettering shall be minimum ½" high. Nameplates on bus plugs shall be installed to face the floor.

8. Time switches, contactor cabinets, automatic lighting controls, shall be identified. Inscriptions shall indicate the equipment controlled, i.e. "Parking Lot Lights, Night Lights, Ext. Security Lights, Night Set Back Control", etc.
9. Devices: Note the panel and circuit number on the inside of the pull/j-box.
10. Systems pull/j-box: Paint blank covers with the following colors:  
telephone/data: green, fire alarm: red, television: white.

### **3.5 EMERGENCY EQUIPMENT -IDENTIFICATION**

- A Electrical equipment that is connected to the building emergency system shall be labeled as specified herein (red as applicable) and in addition, shall be clearly labeled by supplemental nameplate as "Emergency Power", "Life-Safety System", "Critical Power System", or "Emergency Equipment System" as applicable. In addition, each label shall indicate the panel and circuit number at the bottom of the nameplate (for example 86CR1A - 5, for circuit 5). See Section 26 27 26, WIRING DEVICES.

### **3.6 EMERGENCY SYSTEM DEVICE WALLPLATES -LABELING**

- A. Emergency branch circuit devices shall be identified as may be further required elsewhere in these specifications, by the NEC, the VA, other applicable NFPA codes and if applicable, the healthcare industry Joint Commission and State Department of Health. See Section 26 27 26, WIRING DEVICES.

- B. All device wallplates connected to emergency power systems shall be labeled to define the emergency power system from which it is powered and identify the panel and branch circuit source, i.e. "EMERGENCY" at the top of the wall plate and "L1-2" at the bottom of the wall plate.

### **3.7 SWITCHBOARDS, PANELBOARDS, MCCs DIRECTORIES**

- A. Per the NEC, every branch circuit and circuit modification shall be legibly identified as to its clear, evident, and specific purpose or use. The individual circuit identification shall include sufficient detail to allow each circuit to be distinguished from all others. Install computer generated circuit directories to indicate the branch loads served in panelboards. The identification shall be included in a circuit directory that is located on the inside of the panel door in the case of a panelboard, and located at each switch on a switchboard or MCC. Circuit nameplates shall indicate the device powered, i.e. "Panel L1, HVAC Unit #1, Capacitors", etc.
- B. Provide computer generated directories in all new and existing panels. At the conclusion of the project provide the VA with a computer file with all as-installed conditions.
- C. Directories in existing panels where circuits have been modified, added or deleted shall be modified to reflect the final as-built condition. At the conclusion of the work, turn over old directories to the VA.
- D. The directory shall also identify the date the directory was installed and the installation contractor name.

### **3.8 CONDUITS AND JUNCTION BOXES - LESS THAN 600V**

- A. In junction boxes and pull boxes, carrying conductors less than 600 volts (including all branch circuit conductors) the boxes shall be identified by marking inside the box not on the box cover **and** on the face of the box cover with black indelible "Magic Marker" to indicate circuit numbers of the conductors contained in the box (i.e.,: "B-2, 4, 6").
- B. New conduits and all conduits in which emergency branches conduits and /or wiring have been revised shall be identified with the following color scheme by painting the cover of the all junction boxes per the following scheme.
  - a. Fire Detection - RED
  - b. ESS Life Safety - Yellow
  - c. Emergency Equipment Branch - Pink
  - d. Voice / Telephone - Blue
  - e. Data - Green



f. TV - White

### **3.9 RACEWAYS -SPECIAL CONDITIONS - LESS THAN 600V**

- A. Label raceways at entry to any enclosure supplied/fed from any nominal voltage system. Each conduit shall be identified with black indelible "Magic Marker" written or stenciled to indicate the circuit number, voltage/phase of the sources contained in the raceway and where more than one nominal voltage system enters an enclosure, the conductor color coding scheme employed shall also be indicated. (i.e.,: "B-2, 4, 120/208V 3PH. 4W, A-BLK, B-RED, C-BLUE, NEUTRAL - WHT"). Labeling shall be neat and legible. The VA and the engineer retain the right to require the label to be stenciled onto the conduit.
- B. Empty/Spare raceway at the conclusion of the project must contain a pull string with opposite end labeling and typed description of the purpose of the raceway and the location of the opposite end. Provide the VA with a computer generated spreadsheet indicating any/all empty raceway, size of raceway, tag/label description of purpose, location of opposite ends and associated conduit size(s). Spreadsheet shall also indicate exact locations where raceway size reduces or increases.

### **3.10 EQUIPMENT -ARC FLASH**

- A. Panelboards, switchboards, motor starters, fused disconnect switches, industrial control panels, motor control centers and other electrical equipment located in other than dwelling units which may require service while energized shall be labeled to warn of potential arc-flash per NEC 110.16 as acceptable to the local Authority Having Jurisdiction (AHJ). The label may be laminated plastic nameplates, or preprinted self-adhesive warning label. In either case, the label shall be approved by the local AHJ.

### **3.11 DATA/COMMUNICAITONS -LABELING**

- A. Provide labeling for data and telecommunications system in full accordance with the latest NEC, BICSI Standards, consistent with VA labeling preferences, and/or as may be further required in other project specification sections.

### **3.12 WARNING, CAUTION AND INSTRUCTION SIGNS**

- A. At a minimum, apply warning and caution signs as required by OSHA, NFPA 70 and NFPA 70E.

### **3.13 OTHER REQUIREMENTS**

- A. In addition to the equipment/system labeling required herein, the NEC and other divisions specifications and drawings may require additional specific labeling for the following: Access doors to electrical systems, substations, power transfer equipment, contactors, dimmers,

inverters, UPS's, battery equipment, power generation units, telephone and communications equipment, nurse call and other healthcare systems, TV antennae systems, fire alarm systems, security systems, etc. The contractor is to be familiar with and perform the required labeling.

### **3.14 CONDUCTORS -IDENTIFICATION**

A. Branch circuit conductors shall be identified as follows:

1. In junction boxes and pull boxes - where splicing has been implemented, (splicing should be approved by the project documentation) all conductors shall be identified by a full-wrap self-adhesive wire-marker to indicate panelboard circuit number (i.e.: "L1-2").

- - - END - - -

**SECTION 26 05 71**  
**ELECTRICAL SYSTEM PROTECTIVE DEVICE STUDY**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the requirements of the Electrical System Protective Device Study (herein, "the study").
- B. A short-circuit and selective coordination study shall be prepared for the electrical overcurrent devices to be installed under this project.
- C. The study shall present an organized time-current analysis of each protective device in series from the multi-pole individual device and each system panelboard back to the utility and the on-site generator sources. The study shall reflect the operation of each device during normal and abnormal current conditions.

**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 24 11, DISTRIBUTION SWITCHBOARDS: Low-voltage distribution switchboards.D. Section 26 24 16, PANELBOARDS: Low-voltage panelboards.
- C. 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.
- B. The protective device study shall be prepared by the equipment manufacturer's qualified engineers or an approved consultant. The contractor is responsible for providing all pertinent information required by the preparers to complete the study.

**1.4 SUBMITTALS**

- A. In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:
- B. Product data on the software program to be used for the study. Software shall be in mainstream use in the industry, shall provide device settings and ratings, and shall show selective coordination by time-current drawings.
- C. Complete short-circuit and coordination study as described in paragraph 1.6.

- D. Protective equipment shop drawings shall be submitted simultaneously with or after the protective device study. Protective equipment shop drawings will not be accepted prior to protective device study.
- E. Certification: Three (3) weeks prior to final inspection, submit four copies of the following to the COTR:
  - 1. Certification by the contractor that the protective devices have been adjusted and set in accordance with the approved protective device study.

### **1.5 QUALIFICATIONS**

- A. **THE PROTECTIVE DEVICE STUDY SHALL BE PREPARED BY QUALIFIED ENGINEERS OF THE SWITCHGEAR MANUFACTURER OR A SUBMITTED AND APPROVED CONSULTANT.**

### **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 Electronics Engineers (IEEE):
  - 242-01.....Recommended Practice for Protection and  
Coordination of Industrial and Commercial Power  
Systems
  - 399-97.....Recommended Practice for Power Systems Analysis
  - 1584a-04.....Guide for Performing Arc-Flash Hazard  
Calculations

### **1.7 REQUIREMENTS**

- A. The complete study shall include a system one line diagram, short-circuit and ground fault analysis, and protective coordination plots for all overcurrent protective devices.
- B. One-Line Diagram:
  - 1. On the one-line diagram, show all electrical equipment and wiring to be protected by the overcurrent devices installed under this project.
  - 2. On the one-line diagram, also show the following specific information:
    - a. Calculated fault impedance, X/R ratios, and short-circuit values at each feeder and branch circuit bus.
    - b. Breaker and fuse ratings.
    - c. Generator kW and Transformer kVA and voltage ratings, percent impedance, X/R ratios, and wiring connections.
    - d. Voltage at each bus.
    - e. Identification of each bus, matching the identification on the construction drawings.

f. Conduit, cable, and busway material and sizes, length, and X/R ratios.

C. Short-Circuit Study:

1. Systematically calculate the fault impedance to determine the available short-circuit and ground fault currents at each bus. Incorporate the motor contribution in determining the momentary and interrupting ratings of the protective devices.
2. The study shall be calculated by means of a computer program. Pertinent data and the rationale employed in developing the calculations shall be incorporated in the introductory remarks of the study.
3. Present the data conclusions of the short-circuit study in a table format. Include the following:
  - a. Device identification.
  - b. Operating voltage.
  - c. Protective device.
  - d. Device rating.
  - e. Calculated short-circuit current.

D. Coordination Curves:

1. Prepare the coordination curves to determine the required settings of protective devices to ensure selective coordination. Graphically illustrate on log-log paper that adequate time separation exists between series devices, including the utility company upstream device. Plot the specific time-current characteristics of each protective device in such a manner that all upstream devices are clearly depicted on one sheet.
2. The following specific information shall also be shown on the coordination curves:
  - a. Device identification.
  - b. Voltage and current ratio for curves.
  - c. 3-phase and 1-phase ANSI damage points for each transformer.
  - d. No-damage, melting, and clearing curves for fuses.
  - e. Cable damage curves.
  - f. Transformer in-rush points.
  - g. Maximum short-circuit cutoff point.
3. Develop a table to summarize the settings selected for the protective devices. Include the following in the table:
  - a. Device identification.
  - b. Relay CT ratios, tap, time dial, and instantaneous pickup.
  - c. Circuit breaker sensor rating, long-time, short-time, and instantaneous settings, and time bands.

- d. Fuse rating and type.
- e. Ground fault pickup and time delay.

#### **1.8 ANALYSIS**

- A. Analyze the short-circuit calculations, and highlight any equipment determined to be underrated as specified. Propose approaches to effectively protect the underrated equipment. Provide minor modifications to conform with the study (examples of minor modifications are trip sizes within the same frame, the time-current curve characteristics of induction relays, CT ranges, etc.).
- B. After developing the coordination curves, highlight areas lacking coordination. Present a technical evaluation with a discussion of the logical compromises for best coordination.

#### **1.9 ADJUSTMENTS, SETTINGS AND MODIFICATIONS**

- A. Necessary final field adjustments, settings, and minor modifications shall be made to conform with the study without additional cost to the Government.
- B. All final circuit breaker and relay settings and fuse sizes shall be made in accordance with the recommendations of the study.
- C. The contractor shall include in the bid slight adjustments to the breaker types, etc as may be required to facilitate coordination. Any deviation shall be approved by the Engineer prior to any adjustment.

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**SECTION 26 09 23**  
**LIGHTING CONTROLS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

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

**1.2 RELATED WORK**

- A. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC: Interface of lighting controls with HVAC control systems.
- B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General requirements 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 to ground for possible ground fault currents.
- E. Section 24 26 16, PANELBOARDS: panelboard enclosure and interior bussing used for lighting control panels.
- F. 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 control, submit the following information.
1. Manufacturer's catalog data.
  2. Wiring schematic and connection diagram.
  3. Installation details.
- 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. Three (3) weeks prior to the final inspection, submit four copies of the final updated maintenance and operating manuals, including any changes, to the COTR.
- D. Certifications:

1. Three (3) weeks prior to final inspection, submit four copies of the following certifications to the COTR:

- a. Certification by the Contractor that the equipment has been properly installed, adjusted, and tested.

#### **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. Green Seal (GS):  
GC-12.....Occupancy Sensors
- C. Illuminating Engineering Society of North America (IESNA):  
IESNA LM-48.....Guide for Calibration of Photoelectric Control Devices
- D. National Electrical Manufacturer's Association (NEMA)  
C136.10.....American National Standard for Roadway Lighting Equipment-Locking-Type Photocontrol Devices and Mating Receptacles - Physical and Electrical Interchangeability and Testing  
ICS-1.....Standard for Industrial Control and Systems General Requirements  
ICS-2.....Standard for Industrial Control and Systems: Controllers, Contractors, and Overload Relays Rated Not More than 2000 Volts AC or 750 Volts DC: Part 8 - Disconnect Devices for Use in Industrial Control Equipment  
ICS-6.....Standard for Industrial Controls and Systems Enclosures
- E. Underwriters Laboratories, Inc. (UL):  
20.....Standard for General-Use Snap Switches  
773.....Standard for Plug-In Locking Type Photocontrols for Use with Area Lighting  
773A .....Nonindustrial Photoelectric Switches for Lighting Control  
98.....Enclosed and Dead-Front Switches  
917.....Clock Operated Switches

#### **PART 2 - PRODUCTS**

##### **2.1 ELECTRONIC TIME SWITCHES**

- A. Electronic, solid-state programmable units with alphanumeric display; complying with UL 917.
  - 1. Contact Configuration: SPST.



2. Contact Rating: /20A ballast load, 120/240VAC.
3. Astronomical Clock: Capable of switching a load on at sunset and off at sunrise, and automatically changing the settings each day in accordance with seasonal changes of sunset and sunrise. Additionally, it shall be programmable to a fixed on/off weekly schedule.
4. Battery Backup: For schedules and time clock.

## **2.2 OUTDOOR PHOTOELECTRIC SWITCHES**

- A. Solid state, with SPST dry contacts rated for 1800 VA tungsten or 1000 VA inductive, complying with UL 773A.
  1. Light-Level Monitoring Range: 1.5 to 10 fc [16.14 to 108 lx], with adjustable turn-on and turn-off levels.
  2. Time Delay: 15-second minimum.
  3. Surge Protection: Metal-oxide varistor.
  4. Mounting: Twist lock, with base-and-stem mounting or stem-and-swivel mounting accessories as required.

## **2.3 CEILING-MOUNTED PHOTOELECTRIC SWITCHES**

- A. Solid-state, light-level sensor unit, with separate relay unit.
  1. Sensor Output: Contacts rated to operate the associated relay. Sensor shall be powered from the relay unit.
  2. Relay Unit: Dry contacts rated for 20A ballast load at 120V and 277V, for 13A tungsten at 120V, and for 1 hp at 120V.
  3. Monitoring Range: 10 to 200 fc [108 to 2152 lx], with an adjustment for turn-on and turn-off levels.
  4. Time Delay: Adjustable from 5 to 300 seconds, with deadband adjustment.
  5. Indicator: Two LEDs to indicate the beginning of on-off cycles.

## **2.4 INDOOR OCCUPANCY SENSORS**

- A. Wall- or ceiling-mounting, solid-state units with a power supply and relay unit, suitable for the environmental conditions in which installed.
  1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a 1 to 15 minute adjustable time delay for turning lights off.
  2. Sensor Output: Contacts rated to operate the connected relay. Sensor shall be powered from the relay unit.
  3. Relay Unit: Dry contacts rated for 20A ballast load at 120V and 277V, for 13A tungsten at 120V, and for 1 hp at 120V.
  4. Mounting:
    - a. Sensor: Suitable for mounting in any position on a standard outlet box.

- b. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
- 5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
- 6. Bypass Switch: Override the on function in case of sensor failure.
- 7. Manual/automatic selector switch.
- 8. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc [21.5 to 2152 lx]; keep lighting off when selected lighting level is present.
- 9. Faceplate for Wall-Switch Replacement Type: Refer to wall plate material and color requirements for toggle switches, as specified in Section 26 27 26, WIRING DEVICES.
- B. Dual-technology Type: Ceiling mounting; combination PIR and ultrasonic detection methods, field-selectable.
  - 1. Sensitivity Adjustment: Separate for each sensing technology.
  - 2. Detector Sensitivity: Detect occurrences of 6-inch [150mm] minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. [232 sq. cm], and detect a person of average size and weight moving not less than 12 inches [305 mm] in either a horizontal or a vertical manner at an approximate speed of 12 inches/s [305 mm/s].
  - 3. Detection Coverage: as scheduled on drawings.

### **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. Aim outdoor photocell switch according to manufacturer's recommendations. Set adjustable window slide for 1 footcandle photocell turn-on.
- C. Aiming for wall-mounted and ceiling-mounted motion sensor switches shall be per manufacturer's recommendations.
- D. Set occupancy sensor "on" duration to 15 minutes.
- E. Locate light level sensors as indicated and in accordance with the manufacturer's recommendations. Adjust sensor for the scheduled light level at the typical work plane for that area.
- F. Label time switches and contactors with a unique designation.

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

- A. Perform in accordance with the manufacturer's recommendations.
- B. Upon completion of installation, conduct an operating test to show that equipment operates in accordance with requirements of this section.

- C. Test for full range of dimming ballast and dimming controls capability. Observe for visually detectable flicker over full dimming range.
- D. Test occupancy sensors for proper operation. Observe for light control over entire area being covered.
- E. Program lighting control panels per schedule on drawings.
- F. Upon completion of the installation, the system shall be commissioned by the manufacturer's factory-authorized technician who will verify all adjustments and sensor placements.

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

- A. Upon completion of acceptance checks and tests, the Contractor shall show by demonstration in service that the lighting control devices are in good operating condition and properly performing the intended function.

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**SECTION 26 22 00**  
**LOW-VOLTAGE TRANSFORMERS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

This section specifies the furnishing, installation, and connection of dry-type general-purpose transformers.

**1.2 RELATED WORK**

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items 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 fault currents.
- D. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits and outlet boxes.

**1.3 QUALITY ASSURANCE**

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. Clearly present sufficient information to determine compliance with drawings and specifications.
  - 2. Include electrical ratings, impedance, dimensions, weight, mounting details, decibel rating, terminations, temperature rise, no load and full load losses, and connection diagrams.
  - 3. 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 originally submitted, then submit four copies of the updated maintenance and operating manuals to the COTR two weeks prior to final inspection.

- D. Certifications: Two weeks prior to the final inspection, submit four copies of the following to the COTR:
1. Certification by the manufacturer that the materials conform to the requirements of the drawings and specifications.
  2. Certification by the contractor that the equipment has been properly installed and tested.

#### **1.4 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 Fire Protection Association (NFPA):  
70-2011.....National Electrical Code (NEC)
- C. National Electrical Manufacturers Association (NEMA):  
ST20-92.....Dry-Type Transformers for General Applications  
TP1-02.....Guide for Determining Energy Efficiency for  
Distribution Transformers  
TR1-00.....Transformers, Regulators, and Reactors

### **PART 2 - PRODUCTS**

#### **2.1 GENERAL PURPOSE DRY-TYPE TRANSFORMERS**

- A. Unless otherwise specified, dry-type transformers shall be in accordance with NEMA, NEC, and as shown on the drawings. Transformers shall be UL-listed and labeled.
- B. Dry-type transformers shall have the following features:
1. Transformers shall be self-cooled by natural convection, isolating windings, indoor dry-type. Autotransformers will not be accepted.
  2. Rating and winding connections shall be as shown on the drawings.
  3. Transformers shall have copper windings.
  4. Ratings shown on the drawings are for continuous duty without the use of cooling fans.
  5. Insulation systems:
    - a. Transformers 30 kVA and larger: UL rated 220° C system with an average maximum rise by resistance of 150 ° C in a maximum ambient of 40 ° C.
    - b. Transformers below 30 kVA: Same as for 30 kVA and larger or UL rated 185 ° C system with an average maximum rise by resistance of 115 ° C in a maximum ambient of 40 ° C.
  6. Core and coil assemblies:
    - a. Rigidly braced to withstand the stresses caused by short-circuit currents and rough handling during shipment.
    - b. Cores shall be grain-oriented, non-aging, and silicon steel.

- c. Coils shall be continuous windings without splices except for taps.
  - d. Coil loss and core loss shall be minimized for efficient operation.
  - e. Primary and secondary tap connections shall be brazed or pressure type.
  - f. Coil windings shall have end filters or tie-downs for maximum strength.
7. Certified sound levels determined in accordance with NEMA, shall not exceed the following:

Transformer Rating	Sound Level Rating
0 - 9 KVA	40 dB
10 - 50 KVA	45 dB
51 - 150 KVA	50 dB
151 - 300 KVA	55 dB
301 - 500 KVA	60 dB

- 8. If not shown on drawings, nominal impedance shall be as permitted by NEMA.
- 9. Single phase transformers rated 15 kVA through 25 kVA shall have two 5% full capacity taps below normal rated primary voltage. All transformers rated 30 kVA and larger shall have two 2.5% full capacity taps above, and four 2.5% full capacity taps below normal rated primary voltage.
- 10. Core assemblies shall be grounded to their enclosures with adequate flexible ground straps.
- 11. Enclosures:
  - a. Comprised of not less than code gauge steel.
  - b. Outdoor enclosures shall be NEMA 3R.
  - c. Temperature rise at hottest spot shall conform to NEMA Standards, and shall not bake and peel off the enclosure paint after the transformer has been placed in service.
  - d. Ventilation openings shall prevent accidental access to live components.
  - e. The enclosure at the factory shall be thoroughly cleaned and painted with manufacturer's prime coat and standard finish.
- 12. Standard NEMA features and accessories, including ground pad, lifting provisions, and nameplate with the wiring diagram and sound level indicated on it.

13. Dimensions and configurations shall conform to the spaces designated for their installations.
14. Transformers shall meet the minimum energy efficiency values per NEMA TP1 as listed below:

kVA Rating	Output efficiency (%)
15	97
30	97.5
45	97.7
75	98
112.5	98.2
150	98.3
225	98.5
300	98.6
500	98.7
750	98.8

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Installation of transformers shall be in accordance with the NEC, as recommended by the equipment manufacturer and as shown on the drawings.
- B. Install transformers with manufacturer's recommended clearance from wall and adjacent equipment for air circulation. Minimum clearance shall be 6 in [150 mm].
- C. Install transformers on vibration pads designed to suppress transformer noise and vibrations.
- D. Use flexible metal conduit to enclose the conductors from the transformer to the raceway systems.

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

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

- 1. Compare equipment nameplate data with specifications and approved shop drawings.
- 2. Inspect physical and mechanical condition.
- 3. Inspect all field-installed bolted electrical connections, using the calibrated torque-wrench method to verify tightness of accessible bolted electrical connections.

4. Perform specific inspections and mechanical tests as recommended by manufacturer.
5. Verify correct equipment grounding.
6. Verify proper secondary phase-to-phase and phase-to-neutral voltage after energization and prior to connection to loads.

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

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

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

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

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

**1.2 RELATED WORK**

- 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 fault currents.
- E. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduit and outlet boxes.
- F. Section 26 05 71, ELECTRICAL SYSTEM PROTECTIVE DEVICE STUDY: Coordination study of overcurrent protection devices.
- G. 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.
- C. Furnish four (4) copies of certified manufacturer's factory test reports to the COTR prior to shipment of the switchboards to ensure that the switchboards have been successfully tested as specified.
- D. The Government shall have an option to witness the factory tests. All expenses of the Government Representative's trips to witness the testing will be paid by the Government. Notify the COTR not less than 30 days prior to making tests at the factory.

#### **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. Four (4) weeks prior to final inspection, deliver four copies of the final updated maintenance and operating manuals to the COTR.
  - 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 COTR:
    - 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):
  - 70-2011.....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 compartmented. May not begroup mounted with feeder breakers.
    - b. Feeder breakers: Individually mounted and compartmented. May not be group mounted with feeder breakers.
    - c. Should the switchboard be able to be constructed in compliance with the NEC compartmentalization requirements for ESS systems (NEC 700.9(B)) without full vertical sections, the engineers would be willing to review this at the time of bid. However, the

switchboard shall be listed for use to feed separate transfer switches according to NEC 700.9(B).

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**

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

## **2.6 METERING**

Refer to Section 251010 **ADVANCED UTILITY METERING SYSTEM.**

## **2.7 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. See also 26 05 53 IDENTIFICATION AND LABELING for further information and requirements.
- B. Mimic Bus: Provide an approved mimic bus on front of each switchboard assembly. Color shall be black for the Normal Power system and red for the Essential Electrical System, either factory-painted plastic or metal strips. Plastic tape shall not be used. Use symbols similar to one line diagram shown on drawings. Plastic or metal strips shall be mounted with plated screws.

## **2.8 PROVISION FOR FUTURE**

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.

## **2.9 CONTROL WIRING**

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 GENERAL CIRCUIT BREAKERS FOR SWITCHBOARD REQUIREMENTS**

- A. General. Circuit breakers shall be rated for the application (i.e. Service Equipment breakers shall be service-rated, breakers serving HVAC loads shall be rated for HVAC, breakers utilized for coordination shall be adjustable as required, etc.
- B. Except as specifically indicated otherwise, provide circuit breakers of frame size, type, rating, and electrical characteristics indicated or required which comply with the manufacturer's standard design, materials, components, and construction in accordance with the manufacturer's published information, and as required for a complete installation in accordance with Section 26 05 71, ELECTRICAL SYSTEM PROTECTIVE DEVICE STUDY.
- C. Breakers shall include a quick-make, and quick-break operating mechanism.
- D. 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. An overload on one pole of a multipole breaker shall automatically cause all the poles of the breaker to open.
- E. An operating handle which indicates ON, TRIPPED, and OFF positions.
  - 1. Line connections shall be bolted.
  - 2. Interrupting rating shall not be less than the maximum short circuit current available at the line terminals as shown on the electrical system protective device study as required in Section 26 05 71, ELECTRICAL SYSTEM PROTECTIVE DEVICE STUDY.
- F. A "push-to-trip" button located on the front of the breaker to mechanically operate the tripping mechanism and shall be suitable for use during maintenance and testing.
- G. Breakers shall be UL listed for reverse connection without restrictive line and load marking and be suitable for mounting in any position and suitable for an ambient temperature of 40°C.
- H. Breakers shall be designed for and capable of accepting bus connections.
- I. Breakers shall be field adjustable to facilitate compliant coordination.
- J. Breaker size and SCCR ratings and adjustments shall be per equipment supplier recommendations and as required in Section 26 05 71, ELECTRICAL SYSTEM PROTECTIVE DEVICE STUDY.
- K. Main and feeder termination lugs shall, at a minimum, accept the conductors number and sizes indicated on the plans.
- L. Breakers shall be constructed with mechanical screw-type connectors, CU rated.

## 2.11 MAIN CIRCUIT BREAKERS AND FEEDER BREAKERS 400 AMPERE OR ABOVE

- A. Type I Switchboard: Provide UL listed and labeled molded case 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 LSI tripping characteristics as follows:
    - a. Ampere setting (continuous).
    - b. Long time band.
    - c. Short time trip point (Pickup).
    - d. Short time delay (Delay- $I^2T$  IN).
    - e. Instantaneous trip point (High-Level selectable override).
  2. Breaker trip setting shall be set in the field, based on the approved protective device study as specified in Section 26 05 71, ELECTRICAL SYSTEM PROTECTIVE DEVICE STUDY.
  3. Breakers, which have same rating, shall be interchangeable with each other.
  4. Breakers shall be fully rated and UL listed to carry 100% of their ampere rating continuously, 600VAC, 60Hz, 3-phase, 3-pole with bus matching RMS symmetrical ampere interrupting ratings.
  5. Breakers shall be constructed to allow tripping characteristics adjustments from the face of the breaker or behind a secured cover.
  6. Breaker construction shall provide local visual indication for overload, short circuit, and ground fault indication-no trip.
  7. Construct with trip-free mechanisms, and with positive handle indication.
  8. Breakers shall be equipped with back-up thermal and magnetic trip systems.
  9. Testing or field adjusting shall not require disassembly of the breaker.
  10. Breakers shall be equipped with an ammeter display capable for true RMS individual phase currents and indication of ground fault and long-term pickup warning indication.
  11. Main and Feeder Breakers shall be Square D type PowerPact (P or R-frame) or approved equal with powertrip monitoring system or approved equal.
  12. Breakers shall be equipped and configured for web-based, networkable power monitoring equal to Square D breaker-integral PowerMeter Series 800 or equal.



## **2.12 FEEDER CIRCUIT BREAKERS, 100 AMPERE OR LESS**

- 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. Electrically and mechanically trip free.
    - e. Line and load connections shall be bolted.
    - f. Interrupting rating shall not be less than the maximum short circuit current available at the line.

## **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 COTR.

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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. Panelboards shall be manufactured by Square D or a pre-approved equal.

**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.
- F. Section 26 05 71, ELECTRICAL SYSTEM PROTECTIVE DEVICE STUDY: Requirements for installing the over-current protective devices to ensure proper equipment and personnel protection.
- G. Section 26 09 23, LIGHTING CONTROLS: Lighting controls integral to panelboards.
- H. Section 26 43 13, TRANSIENT-VOLTAGE SURGE SUPPRESSION: Surge suppressors installed in panelboards.

**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 COTR three (3) weeks prior to final inspection.

D. Certification: Three (3) weeks prior to final inspection, submit four copies of the following to the COTR:

1. Certification by the manufacturer that the materials conform to the requirements of the drawings and specifications.
2. Certification by the contractor that the materials have been properly installed, connected, and tested and loads are balanced to the extent possible.

### 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):

70-2011 .....National Electrical Code (NEC)  
 70E-2012.....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 and shall all be supplied by the same manufacturer.
- 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, such as surge protective devices per Section 26 43 13, TRANSIENT-VOLTAGE SURGE SUPPRESSION, metering devices per Section 25 10 10, ADVANCED UTILITY METERING, 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 panelboard 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 a minimum of 100% rated or higher rating as noted on panelboard schedules, 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 22,000 A symmetrical for 208Y/120V panelboards, and 14,000 A symmetrical for 480Y/277V 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.

## **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. 208Y/120V Panelboard: 22,000 A symmetrical.
- D. Molded case circuit breakers shall have automatic, trip free, non-adjustable, inverse time, and instantaneous magnetic trips for 100A frame or lower. Magnetic trip shall be adjustable from 3x to 10x for breakers with 400A frames and higher. Breaker trip setting shall be set in the field, based on the approved protective device study as specified in Section 26 05 71, ELECTRICAL SYSTEM PROTECTIVE DEVICE STUDY.
- 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.
    - a. Line connections shall be bolted.
    - b. Interrupting rating shall not be less than the panelboard rating or the maximum short circuit current available at the line terminals as shown on the electrical system protective device study as required in 26 05 71, ELECTRICAL SYSTEM PROTECTIVE DEVICE STUDY.
  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.
- F. Electronic Trip Circuit Breakers with STR Trip system (for all 60A to 600A 3-pole breakers) as follows:
1. Shall be Square D PowerPact type or approved equal.
  2. The circuit breaker trip system shall be a microprocessor-based true RMS sensing design. Sensor ampere ratings shall be as indicated on the one-line diagram or panelboard schedule.
  3. The integral trip system shall be independent of any external power source and shall contain no less than industrial grade electronic components.
  4. All trip units shall be removable to allow for field upgrades.
  5. The STR trip unit functions shall consist of adjustable long-time pickup and adjustable delay, short-time pickup and adjustable delay, optional instantaneous pickup.
  6. Adjustable rating plug shall allow for six long-time ( $I_o$ ) pickup settings from .5 to 1 times; the sensor plug ( $I_n$ ) and fine adjustment ( $I_r$ ) with eight settings ranging from .8 to 1 times  $I_o$ . Adjustable long-time delay shall be available in bands from .5 to 8 seconds at six times  $I_r$ .
  7. Short-time pickup shall allow for seven settings:

- a. From 2 to 9 times  $I_r$ , short time delay shall be fixed in trip units STR23SP and SR23SP.
- b. From 1.5 to 7 times  $I_r$ , short time delay shall be in eight bands from 0 to .3  $I_{2t}$  ON and 0 to .3  $I_{2t}$  OFF in trip units STR53UP.
- 8. Instantaneous settings on the trip units with LSI protection shall be available in seven bands from 1.5 to 9 times  $I_n$ .
- 9. All trip units shall have the capability for the adjustments to be set and read locally by a rotating switch.
- 10. Trip unit shall provide local trip indications.
- 11. An ammeter (a digital display) shall be provided to indicate the current of the phase with the greatest load. By pressing a scroll button, it shall also be possible to display successively the readings of the  $I_1, I_2, I_3$ , and  $I$  Neutral. LEDs shall indicate the phase for which the current is displayed.
- 12. All electronic breakers shall be coordinated with non-electronic breakers, both new and existing, to the extent possible per Section 26 06 71, ELECTRICAL SYSTEM PROTECTIVE DEVICE STUDY.

#### **2.4 SURGE SUPPRESSION**

- A. Where shown on drawings, furnish panelboard with integral transient voltage surge suppression device. Refer to Section 26 43 13, TRANSIENT-VOLTAGE SURGE SUPPRESSION.

#### **2.5 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. Coordinate the sizes of cabinets with designated electrical closet space.
- C. In accordance with Section 09 91 00, PAINTING, paint the panelboard system voltage, and feeder sizes as shown on the one-line diagram in 1



inch block lettering on the inside cover of the cabinet door. Paint the words "LIFE SAFETY BRANCH", "CRITICAL BRANCH", or "EQUIPMENT SYSTEM" as applicable and the panel designation in one inch block letters on the outside of the cabinet doors.

- C. Install a typewritten schedule of circuits in each panelboard after approval by the COTR. 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. All new breakers 400A and above shall be electronic trip type.

### **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**

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.

- A. Provide ARC flash identification per NFPA 70E.

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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 four copies of the following to the COTR: Technical data sheets and information for ordering replacement units.
- D. Certifications: Three (3) weeks prior to final inspection, submit four copies of the following to the COTR: Certification by the Contractor that the devices comply with the drawings and specifications, and have been properly installed, aligned, and tested.

**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):
  - 70-2011.....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. Normal Power - Bodies shall be ivory in color.
  - 2. Emergency Power - Bodies shall be red in color.
  - 3. Duplex Receptacles on Emergency Circuit:
    - a. Bodies shall be red in color
    - b. In rooms without emergency powered general lighting, the emergency receptacles shall be of the self-illuminated type.
  - 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.

5. Safety Type (Tamperproof) Duplex Receptacles:

a. Bodies shall be ivory in color.

1) Shall permit current to flow only while a standard plug is in the proper position in the receptacle.

2) Screws exposed while the wall plates are in place shall be the tamperproof type.

6. Duplex Receptacles in Resident rooms:

a. Receptacles installed in resident rooms shall be hospital grade, ground-fault, and tamper resistant, with wallplate secured by tamperproof screws.

7. Receptacles on Emergency Circuits:

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. In addition, the panel number and circuit shall be indicated on the wall plate, similar to "7CR1A-5."

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 ground-fault weather-resistant duplex receptacle, mounted in box with a gasketed, weatherproof, cast metal cover plate and cap over each receptacle opening to receive code-required "in-use" rating. 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 fasteners 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.

## 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. In Resident rooms, wall plates shall be 302 stainless steel, have tamperproof screws and beveled edges.
- E. Wall plates for data, telephone or other communication outlets shall be as specified in the associated specification.
- F. Duplex Receptacles on Emergency Circuit:
  - 1. Bodies shall be red in color. Wall plates shall be stainless steel with the word "EMERGENCY" engraved in 6 mm, (1/4 inch) white letters on the upper portion of the wall plate above the device. In addition, the panel number and circuit shall be indicated on the wall plate, similar to "7CR1A-5" engraved in 6 mm, (1/4 inch) white letters in the lower portion of the wall plate below the device.
- G. Duplex Receptacles on Normal Circuit:
  - 1. Bodies shall be ivory in color. The panel number and circuit shall be indicated on the wall plate, similar to "7CR1A-5" engraved in 6 mm, (1/4 inch) white letters in the lower portion of the wall plate below the device.

## 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.

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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.
- 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. Three (3) weeks prior to the project final inspection, submit four copies of the final updated maintenance and operating manual to the COTR.
- D. Certification: Three (3) weeks prior to final inspection, unless otherwise noted, submit four copies of the following certifications to the COTR:
  1. Certification that the equipment has been properly installed, adjusted, and tested.
  2. Certification by the manufacturer that medium voltage motor controller(s) conforms to the requirements of the drawings and specifications. This certification must be furnished to the COTR prior to shipping the controller(s) to the job site.

#### 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):
  - 70-2011.....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 (thermal or induction type).
    - b. One for each pole.
    - c. Manual reset on the door of each motor controller enclosure.
    - d. Correctly sized for the associated motor's rated full load current.
    - e. Check every motor controller after installation and verify that correct sizes of protective devices have been installed.
    - f. Deliver four copies of a summarized list to the Resident 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. Additional requirements for specific motor controllers, as indicated in other sections, shall also apply.
- E. 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. Manual motor starters.
  - 1. Starters shall be general-purpose Class A, manually operated type with full voltage controller for induction motors, rated in horsepower.
  - 2. Units shall include overload protection, red pilot light, NO auxiliary contact and toggle operator.
- C. Fractional horsepower manual motor starters.
  - 1. Starters shall be general-purpose Class A, manually operated 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 heavy-duty, Class A magnetic controllers for induction motors rated in horsepower. Minimum size NEMA 1.
- 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 120VAC 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: 3900 feet AMSL
  - Temperatures: Maximum +90°F Minimum -10°F
  - Relative Humidity: 95%
  - Drive Location: Climate controlled Building
- E. Controllers shall be Danfoss or approved equal. Manufacturer and products 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.
10. Bidirectional Autospeed Search: Capable of starting VSC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.
- 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.
- N. Building automation system interface and integration (BAS): Factory-installed hardware and software to enable the BAS to monitor, control, and display controller status and alarms. Coordinate to provide the capability for seamless control with the existing building BAS system.
- O. Network Communications Ports: Ethernet.
- P. Embedded BAS Protocols for network communications.

### **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.
- C. 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.

- D. 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.
- E. Install manual motor starters in flush enclosures in finished areas.
- F. 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. Three (3) weeks prior to the final inspection, provide:
  - 1. One complete set of spare fuses (including heater elements) for each starter/controller installed on this project.
  - 2. Provide one spare VFD per motor horsepower size included on the 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**

- 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, 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 COTR three (3) 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.



- D. Certifications: Three (3) weeks prior to the final inspection, submit four copies of the following certifications to the COTR:
1. Certification by the manufacturer that the materials conform to the requirements of the drawings and specifications.
  2. Certification by the contractor that the materials have been properly installed, connected, and tested.

### **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):
- 70-2011.....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 RATED 600 AMPERES AND LESS**

- 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).
- d. Enclosures shall be continuous-hinged, side opening and viewing window.

E. Minimum short circuit rating shall be 200kAIC.

F. Disconnect shall only be configured for and used for service entrance where specifically indicated on plans. Where required, service-entrance disconnects:

- a. Shall be listed for service entrance.
- b. Shall be equipped for and comply with VA Standards, UL, NEC, ANSI, NFPA, etc for the use.

## **2.2 LOW VOLTAGE UNFUSED SWITCHES RATED 600 AMPERES AND LESS**

A. Shall be the same as Low Voltage Fusible Switches Rated 600 Amperes and Less, but without provisions for fuses.

## **2.3 LOW VOLTAGE FUSIBLE SWITCHES RATED OVER 600 AMPERES TO 1200 AMPERES**

A. Shall be the same as Low Voltage Fusible Switches Rated 600 Amperes and Less.

## **2.4 MOTOR RATED TOGGLE SWITCHES**

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

## **2.5 LOW VOLTAGE CARTRIDGE FUSES**

- A. In accordance with NEMA FU1. Fuses shall be as indicated or recommended by the protected equipment manufacturer and be capable of interrupting the calculated symmetrical available fault current.
- B. Feeders: 1-600A: Class R, type LPN-RK.
- C. Main and Feeders 601A and above: Class L, type KRP-C.
- D. Motor Branch Circuits: Class R, type LPN-RK.
- E. Other Branch Circuits: Class R, type LPN-RK.
- F. Control Circuits: Class CC, time delay.

## **2.6 IDENTIFICATION**

- A. Install nameplate identification signs on each disconnect switch to identify the equipment controlled and, as applicable, service entrance according to the NEC.
- B. Nameplates shall be laminated black phenolic resin with a white core, with engraved lettering, a minimum of 6 mm (1/4-inch) high. Secure nameplates with screws.

**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.

**3.2 SPARE PARTS**

- A. Two weeks prior to the final inspection, furnish one complete set or 10%, whichever is greater, of spare fuses for each fusible disconnect switch installed on the project. In addition, provide fuse pullers for each type and size of fuses. Deliver the spare fuses and fuse pullers to the COTR.

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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 switches with bypass isolation. Units shall be manufactured by ASCO or a pre-approved equal.

**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 05 71, ELECTRICAL SYSTEM PROTECTIVE DEVICE STUDY: Requirements for a coordinated electrical system.
- F. Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS: General communications requirements that are common to more than one section in Division 27.

**1.3 QUALITY ASSURANCE**

**A. QUALITY ASSURANCE**

- 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. Three (3) weeks prior to final inspection, submit four copies of a final updated maintenance and operating manual to the COTR.
  - 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. Three (3) weeks prior to final inspection, submit four copies of the following to the COTR:
  - 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):

70-2011.....National Electrical Code (NEC)  
 99-2012.....Health Care Facilities  
 110-2010.....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 draw-out 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. Each automatic transfer switch shall be equipped with an integral bypass/isolation switch.
5. 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. Ratings shall be with non-welding of contacts during the performance of withstand and closing tests.
  - d. Maximum automatic transfer switch rating: 800 A.
6. 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.
7. 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.
8. 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.

9. 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:

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. Annunciation, Control, and Programming Interface Components: Devices for communicating with remote programming devices, annunciators, or control panels shall have open-protocol communication capability matched with remote device.
- 9. 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.
- 10. 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 BYPASS/ISOLATION SWITCH**

- A. Provide each automatic transfer switch with two-way bypass/isolation manual type switch. The bypass-isolation switch shall permit load bypass to either normal or emergency power source and complete isolation of the automatic transfer switch, independent of transfer switch position. Bypass and isolation shall be possible under all conditions including when the automatic transfer switch is removed from service.
- B. Operation: The bypass/isolation switch shall have provisions for operation by one person through the movement of a maximum of two handles at a common dead front panel in no more than 15 seconds. Provide a lock, which must energize to unlock the bypass switch, to prevent bypassing to a dead source. Provide means to prevent simultaneous connection between normal and emergency sources.
  - 1. Bypass to normal (or emergency): Operation of bypass handle shall allow direct connection of the load to the normal (or emergency)

source, without load interruption or by using a break-before-make design, or provide separate load interrupter contacts to momentarily interrupt the load.

- a. Ensure continuity of auxiliary circuits necessary for proper operation of the system.
  - b. A red indicating lamp shall light when the automatic transfer switch is bypassed.
  - c. Bypassing source to source: If the power source is lost while in the bypass position, bypass to the alternate source shall be achievable without re-energization of the automatic transfer switch service and load connections.
2. Isolation: Operation of the isolating handle shall isolate all live power conductors to the automatic transfer switch without interruption of the load.
- a. Interlocking: Provide interlocking as part of the bypass/isolation switch to eliminate personnel-controlled sequence of operation, and to prevent operation to the isolation position until the bypass function has been completed.
  - b. Padlocking: Include provisions to padlock the isolating handle in the isolated position.
  - c. Visual verification: The isolation blades shall be visible in the isolated position.
3. Testing: It shall be possible to test (normal electrical operation) the automatic transfer switch and engine-generator(s) with the isolation contacts closed and the load bypassed without interruption of power to the load.
- C. Ratings: The electrical capabilities and ratings of the bypass/isolation switch shall be compatible with those of the associated automatic transfer switch, including any required additional withstand tests.
- D. Bypass switches must comply with NEC, NFPA, and be UL listed for the service designed. All transfer switches shall be factory tested.

#### **2.4 REMOTE ANNUNCIATOR SYSTEM**

- A. Remote annunciator panel shall annunciate conditions for indicated automatic transfer switches. Annunciation shall include the following:
1. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
  2. Switch position.
  3. Switch in test mode.
  4. Failure of communication link.
- B. Annunciator Panel: LED-lamp type with audible signal and silencing switch.

1. Indicating Lights: Grouped for each automatic transfer switch monitored.
2. Label each group, indicating the automatic transfer switch it monitors, the location of switch, and the identity of load it serves.
3. Mounting: Flush, modular steel cabinet, unless otherwise indicated.
4. Lamp Test: Push-to-test or lamp-test switch on front panel.

## **2.5 SPARE PARTS**

- A. 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, NFPA, as shown on the drawings, and as recommended by the manufacturer.
- B. Anchor control and annunciator panel to wall.
- C. For floor-mounted units, 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. For floor-mounted units, 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. Ground equipment as shown on the drawings and as required by NFPA 70.
- F. Set field-adjustable intervals and delays, relays, and engine exerciser.

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

- A. 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 COTR and Commissioning Agent of the site testing within two weeks 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. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
    - a. Verify grounding connections and locations and ratings of sensors.
    - b. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
    - c. Power failure of normal source shall be simulated by opening upstream protective device. This test shall be performed a minimum of five times.
    - d. Power failure of emergency source with normal source available shall be simulated by opening upstream protective device for emergency source. This test shall be performed a minimum of five times.
    - e. Low phase-to-ground voltage shall be simulated for each phase of normal source.
    - f. Operation and settings shall be verified for specified automatic transfer switch operational feature, such as override time delay, transfer time delay, return time delay, engine shutdown time delay, exerciser, auxiliary contacts, and supplemental features.

- g. Manual and automatic transfer and bypass isolation functions shall be verified.
- 4. When any defects are detected, correct the defects and repeat the test as requested by the COTR at no additional cost to the Government.

### **3.3 DEMONSTRATION**

- A. At the final inspection in the presence of the COTR and Commissioning Agent demonstrate that the complete auxiliary electrical power system operates properly in every respect. Coordinate this demonstration with the demonstration of the engine-generator set.

### **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 COTR. Coordinate this training with that of the generator training.

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**SECTION 26 41 00**  
**FACILITY LIGHTNING PROTECTION**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the furnishing and installation of a complete master labeled lightning protection system, complying with NFPA 780, UL 96 and UL 96A.

**1.2 RELATED WORK**

- A. Section 07 60 00, FLASHING AND SHEET METAL: penetrations through the roof.
- B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements 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 to ground for possible ground faults.

**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. Isometric and plan views showing layout and connections to the required metal surfaces.
  - 2. Show the methods of mounting the system to the adjacent construction.
- C. Qualifications: Submit proof that the installer of the lightning protection system is a certified Lightning Protection Institute (LPI) installer, and has had suitable and adequate experience installing other lightning protection systems, and is capable of installing the system as recommended by the manufacturer of the equipment.
- D. Certification: Three weeks prior to final inspection, submit four copies of the following certifications to the COTR:
  - 1. Certification that the lightning protection system has been properly installed and tested.
  - 2. Certification that the lightning protection system has been inspected by a UL representative and has been approved by UL without variation.



## 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 Fire Protection Association (NFPA):
  - 70-2012.....National Electrical Code (NEC)
  - 780-2011.....Standard for the Installation of Lightning Protection Systems
- C. Underwriters Laboratories, Inc. (UL):
  - 96.....Lightning Protection Components
  - 96A.....Installation Requirements for Lightning Protection Systems
  - UL 467 .....Standard for Grounding and Bonding Equipment

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Attach master labels to each item by its manufacturer as evidence that the materials have been manufactured in conformance with the UL Standards for master label lightning protection materials.
- B. In addition to conformance to UL 96, the component material requirements are as follows:
  - 1. Conductors: Electrical grade copper. Conductors shall be in accordance with NFPA 780 and UL 96 for Class I, Class II, or Class II modified materials as applicable.
  - 2. Air terminals: Solid copper, 18 inches long, not less than 3/8 inch [9mm] diameter, with sharp nickel-plated points.
  - 3. Ground rods: Copper clad steel, not less than 1/2 inch [13mm] diameter by 10 feet [2400mm] long. Rods made of copper-clad steel shall conform to UL 467 and galvanized ferrous rods shall conform to IEEE C135.30. Ground rods of copper-clad steel, steel, stainless steel, galvanized ferrous, and solid copper shall not be mixed on the project.
  - 4. Ground plates: Solid copper, not less than 1/16 inch [2mm] thick.
  - 5. Tubing: Stiff copper or brass.
- C. Anchors and fasteners: Bolt type which are most suitable for the specific anchor and fastener installations. Clamp-type connectors for splicing conductors shall conform to UL 96, class as applicable, and, Class 2, style and size as required for the installation. Clamp-type connectors shall only be used for the connection of the roof conductor to the air terminal and to the guttering. All other connections, bonds, and splices shall be done by exothermic welds or by high compression fittings. The exothermic welds and high compression fittings shall be

listed for the purpose. The high compression fittings shall be the type which require a hydraulically operated mechanism to apply a minimum of 10,000 psi.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Installation shall be coordinated with the roofing manufacturer and installer.
- B. Install the conductors as inconspicuously as practical and with the proper bends.
- C. **Install the vertical conductors within the concealed cavity of exterior walls.** Run the conductors to the exterior at elevations below the finished grade and make the ground connections to the earth outside of the building or stack perimeter.
- D. Make connections of dissimilar metal with bimetallic type fittings to prevent electrolytic action.
- E. Use the exothermic welding type connections that form solid metal joints in the main vertical and horizontal conductors, and for connections that are not exposed in the finish work.
- F. Protect copper conductors with stiff copper or brass tubing, which enclose the conductors from the top to the bottom of the tubing, between one foot [300mm] below and seven feet [2100mm] above the finished grade. The conductor shall be bonded to the top and bottom of the tubing.
- G. Sheath copper conductors, which pass over cast stone, cut stone, architectural concrete and masonry surfaces, with not less than a 1/16 inch [2mm] thickness of lead to prevent staining of the exterior finish surfaces.
- H. For the earth connections, install ground rods and ground plates, and the conductor connections to them and the main water pipes in the presence of the COTR. For the conductors located outside of the building or stack, install the conductors not less than two feet [600mm] below the finished grade.
- I. For structural steel buildings, connect the steel framework of the buildings to the main water pipe near the water system entrance to the building.
- J. Connect lightning protection cables to all metallic projections, equipment, and components above the roof as indicated on the drawings.
- K. Connect exterior metal surfaces, located within three feet [900mm] of the lightning protection system conductors, to the lightning protection system conductors to prevent flashovers.

- L. Maintain horizontal or downward coursing of main conductor and insure that all bends have at least an 8-inch radius and do not exceed 90 degrees.
- M. Conductors shall be rigidly fastened every three feet [900mm] along the roof and down to the building to ground.
- N. Air terminals shall be secured against overturning either by attachment to the object to be protected or by means of a substantial tripod or other braces permanently and rigidly attached to the building or structure. Install air terminal bases, cable holders and other roof-system supporting means without piercing roof metal.
- O. Use clamp supports to secure supporting means to roof standing seams only.
- P. Use through-roof connectors for down-conductor attachment to roof system. Provide flashing in accordance with Section 07 60 00, FLASHING AND SHEET METAL.
- Q. Down-conductors coursed on or in reinforced concrete columns or on structural steel columns shall be connected to the reinforcing steel or the structural steel member at its upper and lower extremities. In the case of long vertical members an additional connection shall be made at intervals not exceeding 100 feet [30m].
- R. A counterpoise, where shown, shall be of No. 1/0 copper cable or equivalent material having suitable resistance to corrosion and shall be laid around the perimeter of the structure in a trench not less than 2 feet [600mm] deep at a distance not less than 3 feet [900mm] nor more than 8 feet [2.5m] from the nearest point of the structure.
- S. On construction utilizing post tensioning systems to secure precast concrete sections, the post tension rods shall not be used as a path for lightning to ground. Down conductors shall be provided on structures using post tensioning systems. Down conductors shall have sufficient separation from post tension rods to prevent side-flashing. Post tension rods shall be bonded to the lightning protection and grounding systems only at the base of the structure; this bonding shall be performed in strict accordance with the recommendations of the post tension rod manufacturer, and shall be done by, or in the presence of, a representative of the manufacturer.
- T. Grounding: Test the ground resistance to earth by standard methods and conform to the ground resistance requirements specified in Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.
- U. Where shown, use the structural steel framework or reinforcing steel as the main conductor:

1. Weld or bond the non-electrically-continuous sections together and make them electrically continuous.
  2. Verify the electrical continuity by measuring the ground resistances to earth at the ground level, at the top of the building or stack, and at intermediate points with a sensitive ohmmeter. Compare the resistance readings.
  3. Connect the air terminals together with an exterior conductor connected to the structural steel framework at not more than 60 foot [18m] intervals.
  4. Install ground connections to earth at not more than 60 foot [18m] intervals around the perimeter of the building.
  5. Weld or braze bonding plates, not less than 8 inches [200mm] square, to cleaned sections of the steel and connect the conductors to the plates.
  6. Do not pierce the structural steel in any manner. Connections to the structural steel shall conform to UL Publication No. 96A.
- V. When the lightning protection systems have been installed, have the systems inspected by a UL representative. Obtain and install a UL numbered master label for each of the lightning protection systems at the location directed by the UL representative and the Resident Engineer.

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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.
- B. Section 26 24 11, DISTRIBUTION SWITCHBOARDS: For factory-installed TVSS.
- C. Section 26 24 16, PANELBOARDS: For factory-installed TVSS.

### 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. Four (4) weeks prior to final inspection, submit four copies of the following to the COTR:
    - 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 70-2011.....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.
  9. LED indicator lights for power and protection status.
  10. Audible alarm, with silencing switch, to indicate when protection has failed.
  11. Form-C contacts rated at 5A and 250VAC, 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: 320kA per mode/640kA 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: 70,000A.
  2. Line to Ground: 70,000A.

3. Neutral to Ground: 50,000A.

D. Protection modes and UL 1449 SVR for grounded wye circuits shall be as follows:

1. Line to Neutral: 400V for 208Y/120V.
2. Line to Ground: 400V for 208Y/120V.
3. Neutral to Ground: 400V for 208Y/120V.

## **2.2 PANELBOARD SUPPRESSORS**

A. Surge Protection Devices:

1. Non-modular.
2. LED indicator lights for power and protection status.
3. Audible alarm, with silencing switch, to indicate when protection has failed.

B. Peak Single-Impulse Surge Current Rating: 80kA per mode/160kA 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: 70,000A.
2. Line to Ground: 70,000A.
3. Neutral to Ground: 50,000A.

D. Protection modes and UL 1449 SVR for grounded wye circuits shall be as follows:

1. Line to Neutral: 400V for 208Y/120V.
2. Line to Ground: 400V for 208Y/120V.
3. Neutral to Ground: 400V for 208Y/120V.

## **2.2 ENCLOSURES**

A. Indoor Enclosures: NEMA 250 Type 12.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

A. Install TVSS devices at 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 molded case 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 LUMINAIRE SCHEDULE, arranged in order of luminaire 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. Three (3) weeks prior to the final inspection, submit four copies of the final updated maintenance and operating manuals, including any changes, to the Resident Engineer.

D. Certifications:

1. Three (3) weeks prior to final inspection, submit four copies of the following certifications to the COTR:
  - a. Certification by the Contractor that the equipment has been properly installed, adjusted, and tested.

### 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):
  - 70-2011.....National Electrical Code (NEC)
  - 101-2012.....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 (IC rated).
- 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. Lighting fixtures in hazardous areas shall be suitable for installation in Class and Group areas as defined in NFPA 70, and shall comply with UL 844.
- K. 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 (120-277VAC) electronic programmed-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 (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. Where three-lamp fixtures are indicated, unless switching arrangements dictate otherwise, utilize a common two-lamp ballast to operate the center lamp in pairs of adjacent units that are mounted in a continuous row. The ballast fixture and slave-lamp fixture shall be factory wired with leads or plug devices to facilitate this circuiting. Individually mounted fixtures and the odd fixture in a row shall utilize a single-lamp ballast for operation of the center lamp.
  13. Dimming ballasts shall be as per above, except dimmable from 100% to 5% of rated lamp lumens.
  14. Five year full replacement warranty.
  15. Provide integral, factory installed, ballast disconnect for each ballast in the luminaire in compliance with NEC Article 410.130(G).
- 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. Five year full replacement warranty.

### **2.3 FLUORESCENT EMERGENCY BALLAST**

- A. Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with ballast. Comply with UL 924.
  1. Emergency Connection: Operate two fluorescent lamps continuously at an output of 700 lumens each. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
  2. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.
    - a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
    - b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
  3. Battery: Sealed, maintenance-free, nickel-cadmium type.
  4. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
  5. Integral Self-Test: Automatically initiates test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing LED.

### **2.4 LAMPS**

- A. Linear T5 and T8 Fluorescent Lamps:
  1. Rapid start fluorescent lamps shall comply with ANSI C78.1; and instant-start lamps shall comply with ANSI C78.3.
  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 between 3500° and 4100°K, a Color Rendering Index (CRI) of greater than 82, 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
    - a. Other areas as indicated on the drawings.
- B. Compact Fluorescent Lamps:

1. T4, CRI 80 (minimum), color temperature 3500 K, and suitable for use with dimming ballasts, unless otherwise indicated.
- D. 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. Pulse-Start, Metal-Halide Lamps: Minimum CRI 65, and color temperature 4000°K.
3. Ceramic, Pulse-Start, Metal-Halide Lamps: CRI 80 (minimum), and color temperature 4000°K.
4. Low-Pressure Sodium Lamps: ANSI 78.41, CRI 0, and color temperature 1800°K.

## **2.5 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 be fine-grain brushed 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 Luminaire 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. 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. 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.
- K. Dispose of lamps per requirements of Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.

- - - 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 09 06 00, SCHEDULE FOR FINISHES: Finishes for exterior light poles and luminaires.
- 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): Low voltage power and lighting 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, fittings, and boxes for raceway systems.
- F. Section 26 05 41, UNDERGROUND ELECTRICAL CONSTRUCTION: Underground handholes and conduits.
- G. Section 26 09 23, LIGHTING CONTROLS: Controls for exterior lighting.

**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. Include electronic photometric files in IES format, or provide link (URL) to manufacturer's website that contains photometric data for each specific fixture used, excluding wallpack fixtures.

- C. Manuals: Three (3) weeks prior to final inspection, submit four copies of operating and maintenance manuals to the COTR. Include technical data sheets, wiring and connection diagrams, and information for ordering replacement lamps, ballasts, and parts.
- D. Certifications: Three (3) weeks prior to final inspection, submit four copies of the following to the COTR:
  - 1. Certification by the manufacturer that the materials 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

- 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):

70-2011 .....National Electrical Code (NEC)

## K. Underwriters Laboratories, Inc. (UL):

496-08 .....Lampholders

773-95.....Plug-In, Locking Type Photocontrols for Use  
with Area Lighting773A-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. Where indicated on drawings, provide finishes as indicated in Section 09 06 00, SCHEDULE FOR FINISHES.

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. Where indicated on drawings, provide finishes as indicated in Section 09 06 00, SCHEDULE FOR FINISHES.
- 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. Metal-Halide Lamps: NEMA C78.43 or NEMA C78.1381.
- D. Mercury vapor lamps shall not be used.

## **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 METAL HALIDE ELECTRONIC BALLASTS**

- A. Ballast shall be low-frequency electronic type, and shall operate pulse start and ceramic metal halide lamps at a frequency of 90 to 200 Hz square wave.
- B. Ballast shall be labeled Type '1' outdoor, suitable for recessed use, Class 'P'.
- C. Ballast shall have auto-resetting thermal protector to shut off ballast when operating temperatures reach unacceptable levels.
- D. Ballast shall have an end of lamp life detection and shut-down circuit.
- E. Lamp current crest factor shall be 1.5 or less.
- F. Ballasts shall comply with FCC Title 47 CFR Part 18 Non-consumer RFI/EMI Standards.
- G. Ballast shall have a minimum ballast factor of 1.0.
- H. Input current THD shall not exceed 20% for the primary lamp.
- I. Ballasts shall have ANSI C62.41, category 'A' transient protection.
- J. Ballasts shall have power factor greater than 90%.
- K. Ballast shall have a Class 'A' sound rating.

## **2.8 EXISTING LIGHTING SYSTEMS**

- A. For modifications or additions to existing lighting systems, the new components shall be compatible with the existing systems.
- B. Acceptably clean, re-lamp, and relocate existing luminaires as shown on the drawings.

**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 05 11**  
**REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This Section, and all the requirements herein, shall apply to all products and their installation as specified in Sections of Division 27 and Division 28.
- B. Furnish and install cabling, systems, equipment, and accessories in accordance with the specifications and drawings. Capacities and ratings of transformers, cables, and other items and arrangements for the specified systems shall be as noted on the Drawings, as recommended by the manufacturer or sized to meet loads served and/or applicable Code.
- c. Related Work:
  - Section 07 84 00 Firestopping
  - Section 01 00 00 General Requirements, As-Builts, Project Closeout
  - Section 01 33 23 Shop Drawings / Submittals

**1.2 MINIMUM REQUIREMENTS**

- A. References to industry and trade association standards and codes 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 GENERAL REQUIREMENTS**

- A. Specification Order of Precedence (applies to all Div 27 and Div 27 Sections): In the event of a conflict between the text within a specification document and the Project's Contract Drawings outlined and/or cited herein; THE TEXT OF THE SPECIFICATION DOCUMENT TAKES PRECEDENCE. *HOWEVER, NOTHING within SPECIFICATION DOCUMENTS WILL SUPERSEDE APPLICABLE EMERGENCY LAWS AND REGULATIONS, SPECIFICALLY NATIONAL AND/OR LOCAL LIFE AND PUBLIC SAFETY CODES.* The Local Fire Marshall and/or VA Public Safety Officer are the only authorities that may modify this document's EMERGENCY CODE COMPLIANCE REQUIREMENTS, on a case by case basis, in writing and confirmed by VA's Resident Engineer (RE) and TVE-0050P3B. The VA RESIDENT ENGINEER is the only approving authority for other amendments to this document that may be granted, on a case by case basis, in writhing with technical concurrencies by VA are RE, TVE-0050P3B and identified Facility Project Personnel.
- B. Specifications contained herein as set forth in this document detail the salient operating and performance characteristics of equipment in order

for VA to distinguish acceptable items of equipment from unacceptable items of equipment. When an item of equipment is offered or furnished for which there is a specification contained herein, the item of equipment offered or furnished shall meet or exceed the specification for that item of equipment.

C. RELATED SECTIONS:

1. RACEWAY SYSTEMS: Raceways and related rough-ins for low voltage systems shall comply with Section 26 05 33 RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS.
2. GROUNDING: Grounding and bonding for low voltage systems shall comply with Section 26 05 26 GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.
3. Power Conductors: Line voltage conductors serving low voltage systems shall comply with Section 26 05 21 LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES.
4. UPS Power: Refer to Section 26 26 00 and Electrical Drawings for UPS power serving low voltage headend equipment.

D. Project Contacts:

1. Headquarters (aka VACO) Technical Review, for National and VA Communications and Security, Codes, Frequency Licensing Standards, Guidelines and Compliance:
2. Resident Engineer/Project Manager:  
BHHCS, Fort Meade, SD  
Mr. Matt Erpenback, P.E.  
Ph: 605-720-7075
3. Low Voltage Systems Engineer:  
Red Rock Consulting Engineers  
Manitou Springs, CO 80829  
Mr. Jeff Tanner, P.E.  
Ph: 719-685-1266

**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.
- D. The Original Equipment Manufacturer (OEM) and Contractor shall ensure that all management, sales, engineering and installation personnel have read and understand the requirements of this specification before the system is designed, engineered, delivered and provided. The Contractor shall furnish a written statement attesting this requirement as a part of the technical submittal that includes each name and certification, including the OEMs.

#### 1.5 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 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 Resident Engineer a minimum of 15 working days prior to the manufacturers making the factory tests.

2. Four copies of certified test reports containing all test data shall be furnished to the Resident 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.

#### **1.6 DEFINITIONS AND ABBREVIATIONS**

A. Refer to the Legend on the Drawings for abbreviations used on the plans. The terms below are used within various Sections:

OEM	Original Equipment Manufacturer
RE	Resident Engineer (VA Project Manager)
VACO	VA Central Office

B. The term "provide", as used herein, shall be defined as: designed, engineered, furnished, installed, certified, and tested, by the Contractor.

C. Work: Materials furnished and completely installed.

D. Shop Drawing or Submittals Review: 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.

E. (pending)

#### **1.7 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 and test reports as required.
  3. Elementary and interconnection wiring diagrams for communication and signal systems, control system and equipment assemblies. All terminal points and wiring shall be identified on wiring diagrams.
  4. Parts list which shall include those replacement parts recommended by the equipment manufacturer, quantity of parts, current price and availability of each part.
- 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 four copies, bound in hardback binders, (manufacturer's standard binders) or an approved equivalent. Furnish one complete manual as specified in the technical section but in no case later than prior to performance of systems or equipment test, and furnish the remaining manuals prior to contract completion.
  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, and contract number. 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 and maintenance instructions.
    - e. Safety precautions.

- f. Diagrams and illustrations.
  - g. Testing methods.
  - 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. Appendix; list qualified permanent servicing organizations for support of the equipment, including addresses and certified qualifications.
- G. Approvals will be based on complete submission of manuals together with shop drawings.
- H. After approval and prior to installation, furnish the Resident Engineer with one sample of each of the following:
- 1. A 300 mm (12 inch) length of each type and size of wire and cable along with the tag from the coils of reels from which the samples were taken.
  - 2. Each type of conduit and pathway coupling, bushing and termination fitting.
  - 3. Raceway and pathway hangers, clamps and supports.
  - 4. Duct sealing compound.
- I. In addition to the requirement of SUBMITTALS, the VA reserves the right to request the manufacturer to arrange for a VA representative to see typical active systems in operation, when there has been no prior experience with the manufacturer or the type of equipment being submitted.

#### **1.8 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. Coordinate with the GC for product storage. There may be little or no storage space available on site. Plan to potentially store materials off site.
- D. Do not install damaged products. Remove damaged products from the site and replaced with new product at no cost to the Owner.

#### **1.9 EQUIPMENT REQUIREMENTS**

Where variations from the contract requirements are requested in accordance with the 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.

#### **1.10 EQUIPMENT PROTECTION**

- A. Equipment and materials shall be protected during shipment and storage against physical damage, dirt, moisture, cold and rain:
  - 1. During installation, enclosures, equipment, controls, controllers, circuit protective devices, and other like items, shall be protected against entry of foreign matter; and be vacuum cleaned both inside and outside before testing and operating and repainting if required.
  - 2. Damaged equipment shall be, as determined by the Resident Engineer, placed in first class operating condition or be returned to the source of supply for repair or replacement.
  - 3. Painted surfaces shall be protected with factory installed removable heavy kraft paper, sheet vinyl or equal.
  - 4. 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.

#### **1.11 WORK PERFORMANCE**

- A. Job site safety and worker safety is the responsibility of the contractor.
- B. For work on existing stations, arrange, phase and perform work to assure communications service for other buildings at all times. Refer to Article OPERATIONS AND STORAGE AREAS under Section 01 00 00, GENERAL REQUIREMENTS.
- C. New work shall be installed and connected to existing work neatly and carefully. Disturbed or damaged work shall be replaced or repaired to its prior conditions, as required by Section 01 00 00, GENERAL REQUIREMENTS.
- D. Coordinate location of equipment and pathways with other trades to minimize interferences. See the GENERAL CONDITIONS.

#### **1.12 WARRANTIES / GUARANTY**

- A. The Contractor shall warrant the installations to be free from defect in material and workmanship for a period of two (2) years from the date of acceptance of the project by the owner. The Contractor shall agree to remedy covered defects within four (4) hours of notification of major failures or within twenty-four (24) hours of notification for individual station related problems.
- B. The Contractor shall agree to grantee the systems according to the guidelines outlined in Article 4 within each Section.

#### **1.13 EQUIPMENT INSTALLATION AND REQUIREMENTS**



- A. The Contractor shall coordinate work of all disciplines such that all equipment, devices, rough-ins, wiring, control wiring, and all ancillary components for complete working systems are included by the various subcontractors and vendors associated with providing the LV Systems.
- B. Equipment location shall be as close as practical to locations shown on the drawings.
- 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 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.
- D. Backboards: Provide plywood backboards in all communications closets as noted on the Drawings.
- E. Conduits: Provide raceway for all communications and low voltage systems in accordance with Conduit spec section. Specialty backboxes shall be provided under individual Division 26 sections. Comply with the following:
  - 1. Conduit fill shall never exceed 40% for any system.
  - 2. Provide labels at ends of conduit stub-ups to identify origin / associated outlet and as noted in the Drawings.
  - 3. Do not combine different system wiring within same conduit.
  - 4. Backbone conduits and associated inner-ducts are future where noted on the Drawings.
- F. (pending)

#### **1.14 CUTTING, CLEANING AND PATCHING**

- A. It shall be the responsibility of the contractor to keep their work area clear of debris and clean area daily at completion of work.
- B. It shall be the responsibility of the contractor to patch and paint any wall or surface that has been disturbed by the execution of this work.
- C. The Contractor shall be responsible for providing any additional cutting, drilling, fitting or patching required that is not indicated as provided by others to complete the Work or to make its parts fit together properly.
- D. The Contractor shall not damage or endanger a portion of the Work or fully or partially completed construction of the Owner or separate contractors by cutting, patching or otherwise altering such construction, or by excavation. The Contractor shall not cut or

otherwise alter such construction by the Owner or a separate contractor except with written consent of the Owner and of such separate contractor; such consent shall not be unreasonably withheld. The Contractor shall not unreasonably withhold from the Owner or a separate Contractor the Contractor's consent to cutting or otherwise altering the Work.

- E. Where coring of existing (previously installed) concrete is specified or required, including coring indicated under unit prices, the location of such coring shall be clearly identified in the field and the location shall be approved by the Project Manager prior to commencement of coring work.

#### **1.15 EQUIPMENT IDENTIFICATION**

- A. Install an identification sign which clearly indicates information required for use and maintenance of equipment.
- B. Nameplates shall be laminated black phenolic resin with a white core with engraved lettering, a minimum of 6 mm (1/4 inch) high. Secure nameplates with screws. Nameplates that are furnished by manufacturer as a standard catalog item, or where other method of identification is herein specified, are exceptions.

#### **1.16 GROUNDING AND BONDING**

- A. Furnish and install grounding and bonding for communications systems per Drawings and Specifications, and Grounding spec section. All products and their installation shall comply with the following:
  - 1. UL 467
  - 2. ANSI/TIA/EIA-607
  - 3. ANSI/TIA/EIA-606A
  - 4. NFPA 70 (NEC)
- B. Equipment grounding conductors: UL 83, insulated stranded copper, except that sizes 10 AWG and smaller shall be solid copper. Insulation color shall be continuous green for all equipment grounding conductors, except that wire sizes 4 AWG and larger shall be permitted to be identified per NEC.
- C. Bonding Conductors: ASTM B8; bare stranded copper, except that sizes 10 AWG and smaller shall be ASTM B1 solid bare copper wire. Ground bonding jumpers shall be short as possible and continuous without splices. Bond all metallic conduit systems. Bond communications equipment per code and manufacturer's instructions. Bonding fasteners shall comply with the following:
  - 1. Conduit: Fasten bonding jumpers using screw lugs on grounding bushings or conduit strut clamps, or the clamp pads on push-type conduit fasteners. When screw lug connection to a conduit strut

clamp is not possible, fasten the plain end of a bonding jumper wire by slipping the plain end under the conduit strut clamp pad; tighten the clamp screw firmly. Where appropriate, use zinc-plated external tooth lock washers.

2. Cable Tray: Fasten bonding jumpers using zinc-plated bolts, external tooth lock washers, and nuts. Install protective cover, e.g., zinc-plated acorn nuts on any bolts extending into wireway or Busbars: Fasten bonding jumpers using two-hole compression lugs. Use tin-plated copper or copper alloy bolts, external tooth lock washers, and nuts.
3. Unistrut and Raised Floor Stringers: Fasten bonding jumpers using zinc-plated, self-drill screws and external tooth lock washers.
4. Equipment racks: Install a 6 AWG bonding between the rack and the local telecommunications ground busbar.
5. (pending)

D. Communications Ground Busbars: Provide solid copper busbar, pre-drilled from two-hole lug connections with a minimum thickness of 1/4 inch for wall and backboard mounting using standard insulators. Connect busbars to the main ground bar for the addition. Busbars shall be sized as follows:

1. Room Signal Grounding: 12 inches x 4 inch.
2. Master Signal Ground: 18 inches x 4 inch.

E. Ground Connections: Provide connections as follows:

1. Bonding Jumpers: compression type connectors, using zinc-plated fasteners and external tooth lock washers.
2. Ground Busbars: Two-hole compression type lugs using tin-plated copper or copper alloy bolts and nuts.
3. Rack and Cabinet Ground Bars: one-hole compression-type lugs using zinc-plated or copper alloy fasteners.

F. (pending)

#### **1.17 SINGULAR NUMBER**

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.

#### **1.18 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 marked in pen to include the following:
  1. Each device specific locations with UL labels affixed.
  2. Conduit locations.
  3. Each interface and equipment specific location.

4. Head-end equipment and specific location.
5. Wiring diagram.
6. Labeling and administration documentation.
7. Warranty certificate.
8. System test results.

#### **1.19 TRAINING**

- A. Training shall be provided in accordance with Article, 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 Resident Engineer at least 30 days prior to the planned training.

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**SECTION 27 1000  
STRUCTURED CABLING**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

Drawings and General Provisions of the contract, including General and Supplementary Conditions and Division 1 Specification Sections.

**1.2 SUMMARY**

- A. This section includes installation, testing, documentation and training for a fully functional EIA Category 6 structured horizontal cabling system, referred to as 'the Cabling System'.
- B. The Cabling System shall include, but not be limited to: Equipment racks, patch panels, cable management, horizontal UTP copper cabling, information outlets, patch cords, station cords, terminal blocks, horizontal cross-connects, cable terminations and connections, testing and all other ancillary devices necessary for a complete system as specified and as shown on the Drawings.
- C. The Cabling System shall support three independent systems within the Addition. These systems include:
  - 1. Voice / Telephone
  - 2. Data / I.T.
  - 3. Data / Biometrics
- D. Existing Telecommunication Demolition: Existing telecommunications gear is to remain, except as noted on the Drawings for adding pathways into the Addition and in Phase 1A; remodel of existing Surgery Waiting Area as noted on second floor. Where required, remove any communications outlets and associated cabling back to nearest closet if the outlet(s) have to be abandoned to facilitate the construction of this Project.

**1.3 DEFINITIONS**

- A. EMI: ELECTROMAGNETIC INTERFERENCE.
- B. IDC: INSULATION DISPLACEMENT CONNECTOR.
- C. LAN: LOCAL AREA NETWORK.
- D. PVC: POLYVINYL CHLORIDE.
- E. STP: SHIELDED TWISTED PAIR.
- F. UTP: UNSHIELDED TWISTED PAIR.

**1.4 WORK PROVIDED UNDER OTHER SECTIONS**

- A. Power wiring, wiring devices, cable trays and other work related to the Cabling System will be provided under other specification sections unless noted otherwise.
- B. Refer to SECTION 27 05 11 - COMMON WORK RESULTS FOR LOW VOLTAGE SYSTEMS.

**1.5 WORK FURNISHED, INSTALLED, AND CONNECTED BY OTHER**

- A. Electronic data equipment, such as data switches, hubs and similar electronics equipment are not included under this Contract and will be furnished by the Owner. Adequate space shall be allocated within the racks provided for the Owner's electronic equipment. Field coordinate mounting space requirements with the VA RA and I.T.
- B. Fiber and copper backbones associated with the Cabling System are not included under this Contract and will be furnished by the Owner or under a separate Contract, unless specifically noted otherwise.

**1.6 SUBMITTALS**

- A. Product Data: Submit manufacturer's product data cut sheets on equipment, cable, and components. Include a complete Bill of Material that summarizes all components included in the system.

- B. Shop Drawings: Submit scaled plan and elevation drawings showing proposed layout of products within each equipment rack, including space allocated for Owner furnished electronics.
- C. As-Built Drawings: Submit scaled as-built drawings showing outlets denoted with ID number, horizontal cable routes, and equipment racks. Include Owner approved labeling/numbering scheme for each cable drop, information outlet jacks and patch panels.
- D. Testing: Submit field test results for all runs in an 8-1/2 x 11 format and on a labeled CD disc.
- E. As-Built Drawings: Submit scaled as-built drawings showing outlets denoted with ID number, main distribution frame, equipment racks, cable routes, and Owner approved numbering scheme for each cable run and outlet.
- F. Submit installers qualifications.
- G. Warranty: Include documentation for certified factory warranty for the Cabling System.
- H. Operation and Maintenance Data: Product data for the Cabling System to be included in Operation and Maintenance manuals:
  - 1. Descriptions of network cabling equipment and normal operating procedures.
  - 2. Riser Diagrams showing complete installed UTP cabling.
  - 3. Proof of Performance Report outlining the operating parameters tested, complete test results, and a summary of industry standards used for each parameter.
  - 4. Warranty documentation.

#### **1.7 CODES AND STANDARDS**

- A. Electrical Code Compliance: Comply with applicable local electrical code requirements of the public authority having jurisdiction and NEC - ART 800.
- B. UL Compliance: Provide system equipment which is UL listed and labeled. All Category 6 cabling shall be UL verified and shall be labeled as such every two feet on the cable jacket as part of the cabling identification.
- C. FCC Compliance: Comply with Parts 68 and 76 and Subpart J of Part 15.
- D. Products and their installation shall comply with applicable requirements of EIA/TIA, including but not limited to the following:
  - 1. NEC Article 800
  - 2. ANSI/TIA/EIA 568C, Commercial Bldg. Telecomm Cabling Std.
  - 3. ANSI/TIA/EIA 569
  - 4. ANSI/TIA/EIA 606, Administration Standard for Telecomm.
  - 5. ANSI/TIA/EIA 607, Commercial Grounding/Bonding for Telecomm.
  - 6. TSB-36
  - 7. TSB-40
  - 8. TSB-67, Performance Specs for Field Testing UTP Cabling
- E. IEEE Compliance: Comply with IEEE 802.3.

#### **1.8 GUARANTEES AND WARRANTIES**

- A. Cabling System Infrastructure Components: Fifteen (15) year replacement warranty provided by manufacturer of the components. Warranty shall include the replacement of any defective Category 5 cabling infrastructure component with the same, or most current replacement part for a period of 15 years. Infrastructure components include information outlets, horizontal wiring, backbone cable, patch panels, and patch cords.
- B. Guarantee system, in writing, against defects in workmanship and associated material not covered by cabling system warranty, for one year after final acceptance. During this time, the entire system shall be kept in proper operating condition at no additional labor or material cost to the Owner.

- C. The manufacturer of the major components shall maintain a replacement parts department and provide test equipment when needed. The parts department shall be located in a geographical proximity consistent with rendering service within the stated period of time. An ample stock of individual components and equivalent unit replacement shall be carried for as long a period as demand warrants. This period shall extend beyond the normal life expectancy of the equipment.

#### **1.9 QUALITY ASSURANCE**

- A. Contractor shall have at least 3 years of successful installation experience with projects utilizing systems similar to those required for this project.
- B. References: Provide a list of references for similar projects including contact name, phone number, name and type of project.
- C. Certification: Provide documentation showing that the installer of the cabling system has been certified prior to bid by the manufacturer of the proposed products. Include details of the terms and expiration date of the arrangement.
- D. One certified BISC installer with 3 years minimum experience shall be on site at all times.
- E. All installers shall have a minimum of 2 years' experience working on Cat6 cabling systems.
- F. Contractor shall comply with the testing requirements of Part 4.

#### **1.10 PROJECT/SITE CONDITIONS**

- A. Examine areas and conditions under which the system is to be installed, and notify COTR in writing of any conditions that do not match the Drawings. The Contractor accepts existing conditions upon submitting their Bid.

#### **1.11 MANUFACTURER'S CERTIFICATION**

- A. Manufacturer of cabling products shall be ISO9001 Certified.

### **PART 2 - PRODUCTS**

#### **2.1 GENERAL REQUIREMENTS**

- A. All horizontal cabling drops shall be tested by an independent party as specified in Part 4.
- B. All terminations shall comply with EIA/TIA 568B.

#### **2.2 MANUFACTURERS**

- A. Subject to compliance with specified requirements, provide specified materials, or prior approved equal to the referenced products included for the design of the Cabling system.
- B. Ft. Meade VA prefers patch panels and information outlets as manufactured by Panduit.
- C. Cable manufacturers shall be one of the following:
  - 1. Avaya
  - 2. AMP
  - 3. Beldon
  - 4. Berk-tek
  - 5. General Cable
  - 6. Mohawk
  - 7. Superior Essex
  - 8. No other manufacturer products shall be considered an equal.

- D. Information Outlet and Termination Components shall be by Panduit as noted above. Products by one of the following may be submitted as a voluntary alternate:
  - 1. Avaya
  - 2. Hubbell
  - 3. Leviton
  - 4. Panduit (preferred)
  - 5. Siemon
  - 6. Ortronics
  - 7. No other manufacturer products shall be considered an equal
- E. Equipment racks shall be by one of the following or approved equal:
  - 1. Homaco
  - 2. Panduit
  - 3. Ortronics
  - 4. Or approved equal product by a major manufacturer.
- F. Cable Distribution products shall be by one of the following:
  - 1. Panduit
  - 2. Caddy
  - 3. Arlington
  - 4. Burndy
  - 5. Or approved equal product by a major manufacturer.
- G. Backboards: 3/4-inch, interior-grade, treated plywood, 4'x8' sheets arranged as noted on the Drawings.
- H. Cable Tray: See cable tray specifications.

### 2.3 HORIZONTAL CABLING

- A. Horizontal cabling shall be UL, ETL-verified, CMP, 22 or 23AWG, 4-pair, Category 6, unshielded twisted pair (UTP), plenum-rated, 100-ohm cabling meeting or exceeding TIA/EIA-568B.2-1, ISO/IEC 11801, Category 6 Class E gigabit requirements, and rated for horizontal and vertical cable in metal raceway and cable trays.
- B. ETL-verified to ANSI/TIA/EIA-568-B.2-1 Category 6.
- C. Cabling shall meet the following minimum electrical requirements:
  - 1. Attenuation: 30.5 dB/100m max (250MHz insertion loss)
  - 2. NEXT (dB): 48dB min. (250MHz)
  - 3. Mutual Capacitance: 5.6 nF/100m max.
  - 4. DC Resistance: 9.4 ohms/100m max.
  - 5. DC Resistance Unbal: 5% max.
  - 6. Delay Skew: 45 ns/100m max.
  - 7. Propagation Delay: 536ns/100m @ 250MHz
  - 8. Velocity of Prop: 69% min.
- D. Provide horizontal cabling with 8-position Modular Plug at each end and with the following jacket colors:
  - 1. Biomed Data: Blue, or as selected by VA Biomed/IT Staff.
  - 2. I.T. Data: Grey/Black, or as selected by VA Biomed/IT Staff.
  - 3. Voice: White, or as selected by VA Biomed/IT Staff.
- E. Provide AMP TE Cat6 non-plenum cable or approved equal.

### 2.4 INFORMATION OUTLETS

- A. Provide UL, Category 6 giga-speed modular information outlets in 6-position faceplates, flush mounted in locations as noted on the Drawings.
- B. Modular outlets shall meet or exceed ANSI/TIA-568-C.2, Cat 6, IEEE 802.3an-2006 and ISO 802.3 & 11801. Factory testing shall ensure NEXT and RL performance.
- C. Backboxes shall be deep 2-gang, with 1-gang mudrings and 3/4"C stubbed up from outlet and routed out to nearest cable tray.



- D. Information outlets shall be UL, modular, RJ-45 with integral IDC-type terminals. Modular jacks shall match the color of the corresponding horizontal cabling. Panduit or approved equal.
  - 1. Voice outlet color: White, or as selected by VA Biomed/IT.
  - 2. I.T. Data outlet color: Grey/Black, or as selected by VA Biomed/IT.
  - 3. Biomed Data outlet color: Blue, or as selected by VA Biomed/IT.
- E. Modular faceplates shall be single-gang, flush-mount, 6-position unless noted otherwise, ivory or off-white in color, with a horizontal admin labeling position at the top and bottom.
- F. Arrange modular outlets to have voice jacks on top; I.T. data jacks in the middle (bottom of 4-port plates), and Biomed jacks at the bottom. Arrange as appropriate for types of jacks at each location.
- G. Outlets shall meet the following minimum electrical requirements:
  - 1. Insulation resistance: 500 MΩ minimum
  - 2. Dielectric withstand voltage 1,000 VAC RMS, 60 Hz, minimum contact-to-contact and 1,500 VAC RMS, 60 Hz minimum from any contact to exposed conductive surface.
  - 3. Contact resistance: 20 MΩ maximum
  - 4. Current rating: 1.5A at 68 degrees F per IEC Publication 512-3, Test 5b
- H. Faceplates shall be UL, smooth nylon, 94V-0 high impact, flame-retardant, thermoplastic, integral label card and cover.
- I. Dust Cover/Blank: Provide a dust cover for each unused position in faceplates.
- J. Labeling. Label each faceplate to as noted herein.

## 2.5 EQUIPMENT RACKS

- A. Rack: Free-standing, 19"Wx84"H, self-supporting, constructed of high-strength aluminum, black in color. 5/8" - 5/8" - 1/2" alternating hole pattern compatible with EIA 1 1/4" - 1/2" alternating hole patterns. Includes 50 pilot point #12-24 mounting screws. Anchor to floor and provide connection to electrical ground bus bar, green, #6, 19-strand.
  - 1. Provide products manufactured by one of the following:
    - a. Chatsworth Products (CPI) #46053-703 series
    - b. Prior approved equal.
- B. Wire Management: Furnish and install cable management ducts on side of racks as noted. Vertical ducts shall be 3" or 6" wide, as indicated on drawings, with integrated molded plastic cable guides and a hinged door/cover. Furnish and install horizontal wire management panel for each modular patch panel. Horizontal duct shall be black plastic with removable top cover.
  - 1. Provide products that mate and match with the racks.
  - 2. Provide products manufactured by one of the following:
    - a. Vertical Management: Chatsworth products (CPI) #30094-703 series or OR-MM6VMS704. Provide one on each end and one between each pair of racks.
    - b. Horizontal Management: Chatsworth Products (CPI) #13075-719 series or OR-MM6HMF2RU. Provide one per patch panel in each rack, plus one additional.

## 2.6 PATCH PANELS

- A. Provide modular 19-inch wide, 568B patch panels on communications equipment racks, in 24 or 48-port sizes with modular RJ-45 outlets.
- B. Meets or exceeds ANSI/TIA-568-C.2, Cat 6, IEEE 802.3 and ISO 11801. Factory testing shall ensure NEXT and RL performance.
- C. All cables shall be secured to the strain relief bar using vinyl/plastic tie wraps. Provide labeling strip above each jack.

- D. Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables
- E. Quantity of patch panel ports shall be 125 percent of the total number of terminated information outlets required for the project.
- F. Panduit DP\*\*688TGY or approved equal.

## 2.7 DISTRIBUTION CABLING PRODUCTS

- A. Provide UL listed products for installing horizontal cabling from each information outlet to terminations in the communications closets.
- B. Voice Cross-Connects: UTP cable connecting hardware shall comply with TIA/EIA-568, IDC type, using modules designed for punch-down caps or tools. Provide 110-block style terminations in the I.T. Telco Closet mounted on plywood backboards with admin labeling.
- C. Supply velcro straps, length and strength as required to properly organize and bundle cables. Vinyl/plastic tie wraps are prohibited throughout except where allowed in section 2.6.
- D. Install cables in conduit and wireway systems provided by the electrical contractor. Coordinate with the electrical contractor for specific requirements.

## 2.8 TERMINATION PRODUCTS

- 1. Provide TIA/EIA-568 IDC type connecting hardware using punch down caps or tools.
- 2. Voice cross-connects shall be BIX 110 type termination blocks.

## 2.9 ADMINISTRATION LABELING

- A. Comply with EIA/TIA 606 for cable plant labeling.
- B. Comply with specifications on labeling patch panels and information outlets.
- C. Refer to specifications in Part 3.

## 2.10 PATCH CORDS AND STATION CORDS

- A. The VA will provide all patch cords and station cords required for this project.

## 2.11 CATEGORY 6 CHANNEL

- A. The Category 6 - 4 pair UTP channel consists of all cable and components with up to four connections that comprise the full 100 meter circuit from the LAN Electronics to the work station device. The channel shall support applications such as 10Base-T, 100Base-T, 155 Mbs ATM, 77 channel broadband video, 1.0 Gbps Ethernet, 1.2 Gbps, and proposed 2.4 Gbps ATM technologies.
- B. The channel shall include the patch panels, horizontal cabling, and the station cord, and shall have a positive PSACR across the full frequency range of 1MHz - 350MHz and higher.
- C. All components shall be backward compatible with existing Category 3, 4 and 5 networks.
- D. The cabling channel with specified manufacturers above shall exceed Category 6 requirements.

## PART 3 - EXECUTION

### 3.1 GENERAL

Install equipment, cabling and components in accordance with manufacturer's written instructions, NEC, all TIA/EIA requirements and

with recognized industry practices. Ensure that all work complies with specifications and serves the intent of the construction documents.

### 3.2 INSTALLATION

#### A. General Requirements:

1. Provide dedicated, continuous horizontal cable runs from Telco Data closets to all information outlets as described above and indicated on the Drawings (Voice, I.T., Biomed, and Other).
2. Data cabling shall be terminated to patch panels within either the Biomed or I.T. Telco Closet. Voice cabling shall be terminated to 110-blocks in the I.T. Telco Closet.
3. Provide a 6-position faceplate for all information outlet locations, regardless of the quantity of jacks noted, unless noted otherwise. Include blank-offs for all unused port positions. Provide a wall-phone mounting plate at each wall phone location.
4. Data racks shall be installed with minimum work clearances of 3 feet in front and rear, and offset from adjacent walls per RE.
5. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors.
6. Do not exceed manufacturer data on cable bending radius. Supervise cable pulling to prevent bending that may damage cabling. Do not exceed manufacturer's recommended pulling tensions for all cable pulls.
7. Provide Velcro straps to bundle and organize horizontal cabling for a quality and professional installation. Vinyl/plastic tie wraps are prohibited.
8. Fittings or connections are allowed only at the input and output of devices. Splicing shall not be accepted in cable runs. Spliced cable runs shall be rejected and replaced with continuous cables, prior to acceptance.
9. Separation of Wires: Comply with EIA/TIA-569 rules for separation of UTP cables from potential EMI sources.
10. All cabling outside the data closet shall be routed in conduit, cable tray or on cable supports.
  - a. Conduit fill shall not exceed 40%. This applies to both raceways and sleeves. Each conduit end not terminated in a box shall be equipped with an insulated bushing or protective insulator to cover the conduit end to protect the wire or cable during installation and remaining in the conduit.

#### B. Cabling Requirements:

1. Maximum distance limitations for installed cabling shall be as follows:
  - a. Horizontal Cabling: 90M, 295ft.
  - b. Cross-connects: 20M, 66ft.
  - c. Patch cables: 3M, 10ft.
  - d. Station Cables: 3M, 10ft.
2. All cables shall be properly supported. Route cables in cable tray wherever possible. Provide cable distribution J-Hooks or D-rings in all other locations
3. Bending radius of all cabling during pulling and final installation shall not exceed 6 times cable diameter. Any cable showing physical wear from bending shall be replaced at no cost.
4. Maintain separation from power cables per TIA/EIA 568-B.1.
5. All 4-pairs of each cable shall be terminated.

6. Allow a service loop of one foot at the work area outlet and a 10-foot loop above the data rack.
  7. Cabling in cable tray shall be properly trained and installed in an organized, neatly run manner.
- C. Sleeving: All cabling penetrating a wall or floor and not in a raceway shall be sleeved. Sleeves shall be sized to limit cable fill to 40%. A penetrator sleeve system and method for using same provides an encasement for wires and cables passing through a wall or floor. The system should include appropriate securing devices for tightly retaining the penetrant in place. This will also create a space between the penetrant and surrounding structure, which must be fire stopped in order to restore the fire-resistance rating of the parent assembly. The penetrant shall be one of the following;
1. EMT conduit with bushed ends and appropriate fire-proofing.
  2. Prefabricated fire-rated pathway. Recommend the following or approved equivalent. Follow manufacturer's conduit fill recommendations.
    - a. EZ-PATH Fire Rated Pathway
    - b. Spec Seal Ready Sleeve
- D. Firestopping: Provide fire stopping after cabling installation at all fire wall/floor penetrations. Refer to Firestop Specification. Provide special firestop for cabletray pathways between closets as noted.
- E. Grounding: The Contractor shall be responsible for installing a ground bus in each of three low voltage rooms per TIA/EIA 607. Refer to the Grounding Specification.
- F. Labeling, in accordance with VA Standards and EIA/TIA 606A:
1. Use Owner's room numbers for labeling. Confirm room numbers with RE prior to labeling. See attached graphical information for labeling of face plates.
  2. Utilize the following labeling scheme:
    - a. Top of coverplate shall include a label indicating "Room No./Outlet No".
    - b. Modular jacks shall be numbered by type, in sequence starting with the first outlet on the left as you enter each room.
    - c. Each modular voice jack shall be labeled "V1", "V2", etc.
    - d. Each modular I.T. data jack shall be labeled "D1", "D2", etc.
    - e. Each modular Biomed data jack shall be labeled "B1", "B2", etc.
    - f. Special use jacks shall be labeled as directed by the RE.
    - g. Label associated jacks in Patch Panels with a matching labeling scheme.
    - h. The bottom of the coverplate shall include a label denoting the location where outlet is served from; denoting "Bldg No./TC Room No.".
  3. Label both ends of each cabling run within 6 inches of termination points with Panduit Pan-Ty marker and flag ties, a label machine, or approved equal. Label the room end of the cable with the data closet identification number (closet number and jack number) and label the data closet end of the cable with the room jack number (room number, voice and data jack number).

## PART 4 - TESTING

### 4.1 GENERAL REQUIREMENTS

- A. All copper wiring shall be performance tested up to 350MHz as specified herein and per ANSI/TIA 568B. Testing shall be performed by a qualified RCDD professional with a minimum of five years' experience testing Cat6 structured cabling systems. The Owner/RE reserves the right to have an Independent 3<sup>rd</sup> party test or re-test any or all of the cabling. Any and all rework attributed to non-compliance with these specifications shall be at the Contractor's expense.
- B. The testing company shall notify the RE of any recommendations regarding the testing specified herein that would benefit the VA.
- C. Provide a Fluke DTX-1800 or equal cable analyzer for testing.

#### 4.2 STRUCTURED CABLING TESTING

- A. All horizontal cables shall be tested for all Category 6 100% Channel parameters using the specified level 3 tester. Test all Category 6 Channel parameters, including attenuation, NEXT, PS NEXT, FEXT, ELFEXT, return loss, and delay skew.
- B. Patch cord, workstation cord, and cable lengths shall be recorded as part of the testing.
- C. Testing documentation shall include the following for each cable run; with identification that easily correlates to individual jacks and associated labeling provided on outlet coverplates:
  - 1. Wire Map
  - 2. Length of each cable run
  - 3. Attenuation (Insertion Loss)
  - 4. Crosstalk (NEXT)
  - 5. Powersum NEXT (PSNEXT)
  - 6. Prop. Delay
  - 7. Delay/Skew
  - 8. Return Loss
  - 9. Resistance
- D. All PASS/FAIL results shall be based on TIA/EIA specifications for Cat6 cabling.
- E. Any faults or failed cable runs shall be corrected and retested.
- F. Test information along with manufacturer and model number of test equipment shall be recorded and provided to Owner as part of the project closeout.
- G. Provide proof of factory calibration of test meter within 6 months of the beginning of testing.
- H. The "\* pass" option on the test meter must be set to the "on" state. The "\* pass" symbol indicates a channel that is within 1 db of failing.
- I. Provide test data in electronic format with corresponding software for viewing of testing documentation on CD-ROM provided from the test meter. Contractor shall provide one CD-ROM to Owner and one to Engineer.
- J. Provide all cross connect information (X-Conn) to RE.

---END---

**SECTION 27 41 31**  
**MASTER ANTENNA TELEVISION EQUIPMENT AND SYSTEMS**

**PART 1 - GENERAL**

**1.1 SECTION SUMMARY**

- A. Work covered by this document includes design, engineering, labor, material, a fully operational extension off an existing 75 ohm, 50-1000 MHz Master Antenna Television (MATV) as detailed herein.
- C. The installer shall be responsible to coordinate, adjust and balance the distribution system to provide the minimum dBmV at each outlet added to the system.
- 3. Attenuation: The Contractor shall perform dBmV signal loss calc's based on existing and actual equipment.
- D. All work shall be complete, complete, labeled, tested and certified and ready for operation.

**1.2 RELATED SECTIONS**

- A. Section 01 33 23, Shop Drawings, Product Data And Samples.
- B. Section 27 05 11 - Common Work Results For Low Voltage Systems.
- C. Section 27 52 23, Nurse Call/Code Blue Equipment And Systems.

**1.3 DEFINITIONS**

- A. Provide: Design, engineer, furnish, install, connect complete, test, certify and guarantee.
- B. Work: Materials furnished and completely installed.

**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/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) Underwriter's 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) 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.
  - d) 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.
- 4) 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.
- 5) CFR, Title 47 - Telecommunications, in addition to FCC: Part 15 - Restrictions of use for Part 15 listed Radio Equipment in Safety of Life/Emergency Functions/Equipment/Locations (also see CFR, Title 15 - Department of Commerce, Chapter XXIII - NTIA):

Part 73	Radio Broadcast Service,
Part 90	Rules and Regulations, Appendix C.
Form 854	Antenna Structure Registration.

- 6) Public Law 89-670, Department of Transportation, CFR-49, Part 1, Subpart C - Federal Aviation Administration (FAA):
  - a) Standards AC 110/460-ID and AC 707/460-2E - Advisory Circulars for Constructions of Antenna Towers.
  - b) Forms 7450 and 7460-2 - Antenna Construction Registration.



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. American Society of Mechanical Engineers (ASME):
  - 1) Standard 17.4, Guide for Emergency Personnel.

- 2) Standard 17.5, Elevator and Escalator Equipment (prohibition of installing non-elevator equipment in Elevator Equipment Room/Mechanical Penthouse).

e. 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 OEM shall have had experience with three or more installations of systems of comparable size and complexity about type and design as specified herein. Each of these installations shall have performed satisfactorily for at least 1 year after final acceptance by the user. Include the names, locations and point of contact for these installations as a part of the submittal.
- B. The Contractor shall submit certified documentation that they have been an authorized distributor and service organization for the OEM for a minimum of 3 years. The Contractor shall be authorized by the OEM to pass thru the OEM's warranty of the installed equipment to VA. In addition, the OEM and Contractor shall accept complete responsibility for the design, installation, certification, operation, and physical support for the system. This documentation, along with the System Contractor and OEM certifications must be provided in writing as part of the Contractor's Technical submittal.
- C. 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.

- D. Applicable national, state and local licenses.
- E. Certificate of successful completion of OEM's installation/training school for installing technicians of the equipment being proposed.

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

- A. Provide all necessary permits and schedule all inspections as identified in the contract's milestone chart, so that the system is proof of performance tested and ready for operation on a date directed by the Owner.
- B. The contractor is responsible to adhere to all codes described herein and associated contractual, state and local codes.

#### **1.7 SCHEDULING**

- A. The Contractor shall not interrupt service for the existing MATV system except for a one-time outage to tie the extension into the existing MATV system.
- B. The outage shall be scheduled with the Resident Engineer a minimum of 2 weeks prior to performing the work. The outage shall be limited to 1 hour, and shall be performed during off-hours as directed by the Owner.
- C. It is the responsibility of the Contractor to coordinate all work with the other trades for scheduling, rough-in, and finishing all work specified. The owner will not be liable for any additional costs due to missed dates or poor coordination of the supplying contractor with other trades.

### **PART 2 - PRODUCTS AND FUNCTIONAL REQUIREMENTS**

#### **2.1 GENERAL REQUIREMENTS FOR EQUIPMENT AND MATERIALS**

- A. Extend an existing master antenna TV distribution system into the surgical suite Addition. Provide a tap off an existing coaxial trunk line to serve the additional TV outlets. Include all cables, outlets, attenuators, splitters, amplifier and power supplies as needed, and all other parts necessary for the distribution of existing programming to match the existing MATV system.
- B. Coordinate features and select components to form an integrated system. Match components and interconnections for optimum performance of specified functions.
- D. Distribute cable channels to all TV outlets to permit simple connection of EIA high definition television (HDTV) receivers furnished by the

Owner. Field coordinate connection types and cable(s) required for the connections to each TV.

- E. Deliver at all outlets all HDTV monochrome and color television signals without introducing noticeable effect on picture and color fidelity or sound. System picture fidelity shall be equal to that received from the cable company and other modulated channels.
- G. 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.
- H. Meet all FCC requirements regarding low radiation and/or interference of RF signal(s). The system shall be designed to prevent direct pickup of signals from the building structure.

## **2.2 SYSTEM DESCRIPTION**

- A. General: Select 75-ohm products compatible with the existing MATV distribution system, and to provide specified performance and meet minimum requirements specified herein. All equipment shall be listed for adjacent channel operation (consumer-grade equipment is unacceptable).
- B. The Contractor shall arrange for the interconnection between the MATV and Nurse Call Systems with the appropriate responsible parties for proper operation of all pillow speaker TV functions.
- C. The System Contractor shall connect the system ensuring that all NFPA and Underwriters Laboratory, Inc. (UL) Critical Care and Life Safety Circuit and system separation guidelines are satisfied.
- D. All trunk, branch, and interconnecting cables and unused equipment ports or taps shall be terminated with proper terminating resistors.
- E. Coaxial cable distribution shall use coaxial cable connections as specified and as recommended by the cable OEM and approved by the system OEM. Crimp type connectors installed with a ratchet type installation tool are acceptable provided the cable dress, pairs, shielding, grounding, connections and labeling are the same as the barrier terminal strip connectors. Tape of any type, wire nuts or solder type connections are unacceptable.
- F. All equipment faceplates utilized in the system shall be Type 302 stainless steel cover plates.
- G. All unused splitter outputs shall be terminated with 75-Ohm terminations.

H. MATV System Quantitative Performance Requirements: Level and quality of signal at each outlet from each designated channel and source comply with the specifications below when tested according to NCTA-02 or FCC Regulations, Part 76.

1. RF Video Carrier Level: Minimum of 6 decibels microvolts (dBmV) at each outlet.
2. Relative Video Carrier Level: Within 3 decibels (dB) to adjacent channel.
3. Carrier Level Stability, Short Term: Level does not change more than 0.5 dB during a 1-hour period.
4. Carrier Level Stability, Long Term: Level does not change more than 2 dB during a 24-hour period.
5. Broadband Frequency Response: Over the frequency range 54 to 220 megahertz (MHz), signal amplitude is plus or minus 3 dB, maximum.
6. Channel Frequency Response: Across any 6-MHz channel in the 54- to 220-MHz range, referenced to video carrier, signal amplitude is plus or minus 1 dB, maximum, except as otherwise indicated.
7. Carrier to Noise Ratio: 45 dB or greater, except as otherwise indicated.
8. RF Visual Signal to System Noise Ratio: 43 dB or greater.
9. Cross Modulation: Less than minus 50 dB.
10. Carrier to Echo Ratio: Greater than 40 dB.
11. Composite Triple Beat: Less than minus 53 dB.
12. Second Order Beat: Less than minus 60 dB.
13. Terminal Isolation TV to TV: 25 dB, minimum.
14. Terminal Isolation between TV and FM: 35 dB, minimum.
15. Hum Modulation: 2 percent, maximum.
16. RF FM Carrier Level: 13 to 17 dB below video carrier level.
17. FM Frequency Response: Over the frequency range 88 to 108 MHz, signal amplitude is plus or minus 0.75 dB, maximum.
18. FM Carrier to Noise Ratio: Greater than 24 dB.

### 2.3 MANUFACTURERS

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

B. MATV System Components:

1. Blonder Tongue Laboratories
2. Contemporary Research
3. RL Drake, LLC
4. Pico Macom

C. MATV Coaxial Cabling:

1. Belden
2. General Cable
3. West Penn

### 2.4 SIGNAL TRANSMISSION COMPONENTS

- A. Cable, general: UL listed, 75-ohms nominal impedance, 100 percent factory sweep tested, 5 to 450 mhz, by the structural return loss method, 16.2pf/ft, black outer jacket. Cables run in environmental air spaces shall be listed for use in plenums (note main hallway is a plenum ceiling). The following cable types are included:
1. MATV Indoor Trunk Cable: RG-11/u, cellular polyethylene dielectric, bare-copper braid shield with 95 percent minimum shielding factor, no. 14 awg solid bare-copper conductor, and pvc jacket. Attenuation  $\leq 0.95-1.81\text{db}/100\text{ft}$  @ 68degF (55-216 mhz).
  2. MATV Indoor Trunk/Branch Cable: RG-6/u, cellular polyethylene dielectric, bare-copper braid shield with 95 percent minimum shielding factor, no. 18 awg solid copper-covered-steel conductor, and pvc jacket. Attenuation  $\leq 1.6-2.87\text{db}/100\text{ft}$  @ 68degf (55-216 mhz).
  3. MATV Indoor Branch Cable: RG-59/u, cellular polyethylene dielectric, bare-copper braid shield with 95 percent minimum shielding factor, no. 20 awg solid copper-covered-steel conductor, and pvc jacket. Attenuation  $\leq 1.88-3.59\text{db}/100\text{ft}$  @ 68degf (55-216 mhz).
  4. Equipment Cables. Provide cables, lengths short as possible, rated for use with equipment as follows:
    - a) RS-232 Cable: extended-distance data cable, pvc clad, aluminum-foil shield, 25-conductor, 24awg stranded, 30 ohms/1000 ft., 12pf/ft ( $\pm 2\text{pf}/\text{ft}$ ), length as shown, with connectors each end with integral male screw locks.
    - b) RGB/Component Cable: Commercial grade, min 22awg center conductor, 75ohm  $\pm 1.5\text{ohms}$ , BNC connectors. Use RCA connectors where BNC is not available. For equipment connections, use connectors compatible with available jack connections.
    - c) RGBHV DB-15 Cable: for use with alternate no. 1 qmod modulator for 1080i video output; as recommended by manufacturer.
- D. Coaxial cable connectors: Type F, 75 ohms, 1000MHz.
1. Connectors shall be listed for intended use.
  2. Provide radial crimp type; use of hex type connectors is not acceptable.
  3. Maintain a 1/8" center conductor length when making connections.
- E. Line Splitters:

1. Provide low-radiation line splitters with a flat frequency response from 50MHz to 1,000MHz. Provide units of a hybrid design with a 75-ohm match on input and outputs and a VSWR no greater than 1.4:1. Ferrule-bead type are unacceptable.
  2. Two way line splitters shall have a signal loss of not more than 3.5dB at each output.
  3. Four way line splitters shall have a signal loss of not more than 7.2dB at each output.
- E. Directional taps: solder-back, 550mhz, 120db RFI shielding, ground block, die-cast housing.
- F. Attenuators: provide 550MHz, pad attenuators, in dbmv size(s) as required to balance the system; and to not exceed specified or rated maximum input signal levels to distribution outlets and equipment.
- G. Combiners: 8-port passive combiner for the combining of all RF signals into one main trunk run for distribution to all building locations. Bandwidth of combiners shall be 0 to 1,000MHz
- H. HDTV Outlets:
1. Provide outlets at each location shown on the plans. Mount in 4" square, 2" deep minimum flush electrical boxes as indicated on plans.
  2. Outlet faceplates shall be configured to include all necessary jacks for pillow speaker control; or include an adjacent backbox for mounting and wiring required TV control jacks.
  3. Provisions shall be incorporated in the network to prevent 60 Hz AC or DC feedback into the distribution lines.
  4. Outlets shall be designed to cover a frequency range of 10MHz to 1,000MHz. Insertion loss shall not exceed 1.0 db at any frequency within the designated frequency range for a 17dB isolation network. Outlets shall be back-matched from 10 to 1,000MHz. Outlets shall have one F-type connector on the front and two F-type connectors on the rear.
  5. The minimum isolation value between any two outlets shall be 24 db.
  6. Provide one 1/4" stereo jack or RJ45 jack in each TV faceplate, connected via interface to the local nurse call DIN outlet for TV control. Contractor to coordinate installation with nurse call manufacturer and installer to provide the functions specified in Section 27 52 23 Nurse Call and Code Blue Systems.

- I. Television Receivers shall be provided by the Owner.
- J. Coaxial Cable:
  - 1. Trunk Cable:
    - a. Description: .500 inch, Semi-Rigid Coax, Riser Rated, 75 ohm.
    - b. Attenuation: 2.92 dB/100ft at 700 MHz, 3.78 dB/100ft at 1000 MHz
  - 2. RG6 Cable:
    - a. Description: CATV RG6 double shielded cable CM Rated, 75ohm
    - b. Attenuation: 1.48 dB/100ft at 50 MHz, 7.45 dB/100ft at 1000 MHz.
  - 3. RG11 Cable:
    - a. Description: CATV RG11 cable CM Rated, 75 Ohm
    - b. Attenuation: 0.90 dB/100ft at 50 MHz, 5.04 dB/100ft at 1000 MHz

### **PART 3 - EXECUTION**

#### **3.1 PROJECT MANAGEMENT**

- A. Assign a single project manager to this project who will serve as the point of contact for the Owner, the General Contractor, and the Architect/Engineer.
- B. The Contractor shall be proactive in scheduling work at the hospital, specifically the Contractor will initiate and maintain discussion with the general contractor regarding the schedule for ceiling cover up and install cables to meet that schedule.

#### **3.2 COORDINATION WITH OTHER TRADES**

- A. Coordinate with the cabling contractor the location of the faceplate and the faceplate opening for the MATV backbox.
- B. Coordinate with the cabling contractor the location of MATV equipment in the Telecommunications Closets.
- C. Before beginning work, verify the location, quantity, size and access for the following:
  - Isolated ground AC power circuits provided for systems.
  - Primary, emergency and extra auxiliary AC power generator requirements.
  - Junction boxes, wall boxes, wire troughs, conduit stubs and other related infrastructure for the systems.
  - System components installed by others.
  - Overhead supports and rigging hardware installed by others.
- D. Immediately notify the Owner, General Contractor and Consultant in writing of any discrepancies.

#### **3.4 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. Install cabling in ceiling spaces within cable tray wherever possible; and on D-rings or j-hooks in other locations. Cable shall not be supported from the structure or ceiling supports. All indoor wiring shall be concealed, except in unfinished spaces. 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 manufacturer's recommendations. Provide any hardware, adaptors, brackets, rack mount kits or other accessories as required for correct assembly and installation.
4. Secure equipment firmly in place:
  - 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 on supports provided for other trades or systems. Coordinate outlet locations with blocking installed to support TV's.
  - 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.
- C. Wiring Practice - in addition to the mandatory infrastructure requirements outlined in VA Construction Specification, Section 27 10 00, STRUCTURED COMMUNICATIONS CABLING SYSTEM, 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 abraided during installation. There are no acceptable methods of repairing damaged or abraided 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. Ground shields and drain wires per manufacturer instructions.
11. Field wiring entering equipment racks shall be terminated as follows:
  - a. Provide ample service loops at drops to TV equipment.
  - b. If specified terminal blocks are not designed for rack mounting, utilize 3/4 inch plywood or 1/8 inch thick aluminum plates/blank panels as a mounting surface. Do not mount on the bottom of the rack.
13. Make all connections as follows:
  - D. Cable Installation - In addition to the mandatory infrastructure requirements outlined in VA Construction Specification, Section 27 10 00, STRUCTURED CABLING the following additional practices shall be adhered to:
    1. Support cable on maximum 4'-0" centers. Acceptable means of cable support are cable tray, j-hooks, and bridal rings. Velcro wrap cable bundles loosely to the means of support with plenum rated Velcro straps. Plastic tie wraps are not acceptable as a means to bundle cables.
    2. Run cables parallel to walls.

3. Install maximum of 10 cables in a single row of J-hooks. Provide necessary rows of J-hooks as required by the number of cables.
4. Do not lay cables on top of light fixtures, ceiling tiles, mechanical equipment, or ductwork. Maintain at least 2'-0" clearance from all shielded electrical apparatus.
5. All cables shall be tested after the total installation is fully complete. All test results are to be documented. All cables shall pass acceptable test requirements and levels. Contractor shall remedy any cabling problems or defects in order to pass or comply with testing. This includes the re-pull of new cable as required at no additional cost to the Owner.
6. Ends of cables shall be properly terminated on both ends per industry and OEM's recommendations.
7. Provide proper temporary protection of cable after pulling is complete before final dressing and terminations are complete. Do not leave cable lying on floor. Bundle and tie wrap up off of the floor until you are ready to terminate.
12. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Cables may not be spliced.
13. Bundle, lace, and train conductors to terminal points without exceeding OEM's limitations on bending radii. Install lacing bars and distribution spools.
15. Cable shall not be run through structural members or be in contact with pipes, ducts, or other potentially damaging items.

E. Labeling:

1. Clearly, consistently, logically and permanently mark connectors, jacks, and other equipment.
5. Permanently label coaxial cable drops at each end.

**3.6 CUTTING AND PATCHING**

- A. It shall be the responsibility of the contractor to keep their work area clear of debris and clean area daily at completion of work.
- B. It shall be the responsibility of the contractor to patch and paint any wall or surface that has been disturbed by the execution of this work.
- C. The Contractor shall be responsible for providing any additional cutting, drilling, fitting or patching required that is not indicated

as provided by others to complete the Work or to make its parts fit together properly.

- D. The Contractor shall not damage or endanger a portion of the Work or fully or partially completed construction of the Owner or separate contractors by cutting, patching or otherwise altering such construction, or by excavation. The Contractor shall not cut or otherwise alter such construction by the Owner or a separate contractor except with written consent of the Owner and of such separate contractor; such consent shall not be unreasonably withheld. The Contractor shall not unreasonably withhold from the Owner or a separate Contractor, the Contractor's consent to cutting or otherwise altering the work.
- E. Where coring of existing (previously installed) concrete is specified or required, including coring indicated under unit prices, the location of such coring shall be clearly identified in the field and the location shall be approved by the Project Manager prior to commencement of coring work.

### **3.7 FIREPROOFING**

- A. Where MATV cables penetrate fire rated walls, floors and ceilings, fireproof the opening.
- B. Provide conduit sleeves (if not already provided by electrical contractor) for cables that penetrate fire rated walls. After the cabling installation is complete, install fire proofing material in and around all conduit sleeves and openings. Install fire proofing material thoroughly and neatly. Seal all floor and ceiling penetrations.
- C. Use only materials and methods that preserve the integrity of the fire stopping system and its rating.

### **3.8 GROUNDING**

- A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, commonmode returns, noise pickup, cross talk, and other impairments.

## **PART 4 - TESTING/GUARANTEE/TRAINING**

### **4.1 System Classification**

The HDTV MATV System is FCC and NFPA listed. Therefore, the following testing and guaranty provisions are the minimum to be performed and provided by the contractor and Warranted by the OEM.

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

##### **A. Pretesting:**

1. Upon completing installation of the system, the Contractor shall align, balance, and completely pretest the entire system under full operating conditions.

##### **2. Pretesting Procedure:**

a. During the system pretest the Contractor shall verify (utilizing approved test equipment) that the system is fully operational and meets all the system performance requirements of this standard.

##### **B. Performance Testing:**

1. Provide services of a factory authorized service representative to supervise the field assembly and components connection and the pretesting, testing, and adjusting of the system.

2. Inspection: Verify that units and controls are properly installed, connected, and labeled and that interconnecting wires and terminals are identified.

3. Acceptance Tests: Perform system tests after the system has been in normal operation for a minimum of two weeks to verify system conforms to Specifications. Include all modes of system operation. Methodically test for proper system operation in all functional modes per manufacturer recommendations and the specifications herein.

4. MATV System Acceptance Tests: Include the following, performed according to NCTA 02:

1. Instrumentation: Use a field strength meter rated for minus 40 dBmV measuring sensitivity and a frequency range of 54 to 550 MHz, minimum.

2. Headend Signal Levels: Use a signal/field strength meter to measure and record signal levels for designated channels at outputs of headend MATV equipment and document final readings after the system has been adjusted and balanced per specs.

3. Outlet Signal Levels: Use a signal/field strength meter to measure and document signal levels at a minimum of five system outlets with the farthest cable runs in the Addition. Readings on each of the channels designated to be received must be within specified limits.

4. Signal to Noise Ratio Test: As required, include using a field strength meter to take measurements at the output of the closest distribution amplifier or another agreed location in the system serving the Addition to document the existing MATV signal characteristics.

With the system operating at normal levels, tune the meter to the picture carrier frequency of each of the designated channels in turn and record the level. With the signal removed and the input to the corresponding headend amplifier terminated in 75 ohms, measure the level of the noise at the same tuning settings. With the meter correction factor added to the last readings, the differences from the first set must not be less than 45 dB.

5. Picture Quality Test: Field observe the picture quality using a Contractor or Owner furnished HDTV to verify channels do not have evidence of cross channel intermodulation, ghost images, or beat interference at a minimum of six (6) outlets in the Addition.

C. Test Conclusion:

1. 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 Resident Engineer. Any retesting to comply with these specifications will be done at the Contractor's expense and retested until specified requirements are met.
2. If the system is declared unacceptable without conditions, all rescheduled testing expenses will be borne by the Contractor.

E. Acceptable Test Equipment:

1. The test equipment shall furnished by the Contractor shall have a calibration tag of an acceptable calibration service dated not more than 12 months prior to the test. As part of the submittal, a test equipment list shall be furnished that includes the make and model number of the following type of equipment as a minimum:
  - a. Signal/Field-strength Meter.
  - b. Pillow Speaker Test Set (Pillow Speaker with appropriate connections in lieu of the set is acceptable).

**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 Resident Engineer (or Facility Contracting Officer if the Facility has taken procession 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.

4. Additionally, the Contractor shall accomplish the following minimum requirements during the One Year Guarantee Period:

a. Response Time during the One Year Guarantee Period:

1) The Resident Engineer (or Facility Contracting Officer if the system has been turned over to the Facility) is the Contractor's only official reporting and contact official for MATV system trouble calls, during the guarantee period.

2) A standard work week is considered 8:00 A.M. to 5:00 P.M. or as designated by the Resident Engineer (or Facility Contracting Officer), Monday through Friday exclusive of Federal Holidays.

3) The Contractor shall respond and correct on-site trouble calls, during the standard work week to:

a) A routine trouble call within 1 working day of its report. A routine trouble is considered a trouble that causes a pillow speaker or cordset, 1 master IC control station, room station or emergency station to be inoperable.

b) Routine trouble calls in critical emergency health care facilities (i.e., cardiac arrest, intensive care units, etc.) shall also be deemed as an emergency trouble call. The Resident Engineer (or Facility Contracting Officer) shall notify the Contractor of this type of trouble call.

c) An emergency trouble call within 4 hours of its report. An emergency trouble is considered a trouble that causes a sub-system (ward), distribution point, terminal cabinet, or all call system to be inoperable at anytime.

4) If a HDTV MATV component failure cannot be corrected within 6 hours (exclusive of the standard work time limits), the Contractor shall be responsible for providing alternate HDTV MATV equipment. The alternate equipment/system shall be operational within a maximum of 18 hours after the

6 hour trouble shooting time and restore the effected location operation to meet the system performance standards. If any sub-system or major system trouble cannot be corrected within one working day, the Contractor shall furnish and install compatible substitute equipment returning the system or sub-system to full operational capability, as described herein, until repairs are complete.

b. Required On-Site Visits during the One Year Guarantee Period:

1) The Contractor shall visit, on-site, as necessary, during the guarantee period, to perform system preventive maintenance, equipment cleaning, and operational adjustments to maintain the system according the descriptions identified in this document.

2) The Contractor shall arrange all Facility visits with the Resident Engineer (or Facility Contracting Officer) prior to performing the required maintenance visits.

3) Preventive maintenance shall be performed by the Contractor in accordance with the OEM's recommended practice and service intervals during non-busy time agreed to by the Resident Engineer (or Facility Contracting Officer) and Contractor.

4) The preventive maintenance schedule, functions and reports shall be provided to and approved by the Resident Engineer (or Facility Contracting Officer).

5) The Contractor shall provide the Resident Engineer (or Facility Contracting Officer) a type written report itemizing each deficiency found and the corrective action performed during each required visit or official reported trouble call. The Contractor shall provide the Resident Engineer with sample copies of these reports for review and approval at the beginning of the Acceptance Test. The following reports are the minimum required:

a) The Contractor shall provide a monthly summary all equipment and sub-systems serviced during this guarantee period to Resident Engineer (or Facility Contracting Officer) by the fifth (5th) working day after the end of each month. The report shall clearly and concisely describe the services rendered, parts replaced and repairs performed. The report shall prescribe anticipated future needs of the equipment and systems for preventive and predictive maintenance.

b) The Contractor shall maintain a separate log entry for each item of equipment and each sub-system of the system. The log shall list dates and times of all scheduled, routine, and emergency calls. Each emergency call



shall be described with details of the nature and causes of emergency steps taken to rectify the situation and specific recommendations to avoid such conditions in the future.

6) The Resident Engineer (or Facility Contracting Officer) shall convey to the Facility Engineering Officer, 2 copies of actual reports for evaluation.

a) The Resident Engineer (or Facility Contracting Officer) shall ensure a copy of these reports is entered into the system's official acquisition documents.

b) The Facility Chief Engineer shall ensure a copy of these reports is entered into the system's official technical record documents.

B. Work Not Included: Maintenance and repair service shall not include the performance of any work due to improper use; accidents; other vendor, contractor, or owner tampering or negligence, for which the Contractor is not directly responsible and does not control. The Contractor shall immediately notify the Resident Engineer or Facility Contracting Officer in writing upon the discovery of these incidents. The Resident Engineer or Facility Contracting Officer will investigate all reported incidents and render

#### **4.4 TRAINING**

A. Provide thorough training of the owner's engineering and maintenance staff.

B. Provide the following minimum training times and durations:

1. Up to 2 hours prior to opening and/or during opening week as scheduled by the VA RE.

- - - E N D - - -

**SECTION 27 51 16**  
**PUBLIC ADDRESS AND MASS NOTIFICATION SYSTEMS**

**PART 1 - GENERAL**

**1.1 SECTION SUMMARY**

- A. Work covered by this Section includes adding public address (PA) speakers within the surgery suite Addition and extending speaker wiring back to the nearest existing paging speaker. Speakers will not be zoned.
- B. Work covered by this Section also includes music speakers within each of three OR Rooms; wired to local j-boxes for connection to audio systems furnished by the Owner.
- C. Work shall be complete, Occupational Safety and Health Administration (OSHA), National Recognized Testing Laboratory (NRTL - i.e. Underwriters Laboratory [UL]) Listed and Labeled; tested, certified and ready for operation.

**1.2 RELATED SECTIONS**

- A. 01 33 23 - Shop Drawings, Product Data and Samples.
- B. 07 84 00 - Firestopping.
- C. 27 05 11 - Common Work Results For Low Voltage Systems.
- E. 27 05 33 - Raceways and Boxes for Communications Systems.

**1.3 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 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):
      - 1) 606 - Administration Standard for the Telecommunications Infrastructure of Communications Buildings.
      - 2) RS 160-51 - Sound systems.
      - 3) RS 270 - Tools, Crimping, Solderless Wiring Devices, Recommended Procedures for User Certification.
      - 4) SE 101-A49 - Amplifier for Sound Equipment
      - 5) SE 103-49 - Speakers for Sound Equipment

c. NFPA:

- 1) 70 - National Electrical Code (current date of issue) - Articles 517, 645 & 800.
3. State Hospital Code(s).
4. Local Town, City and/or County Codes.

**1.5 QUALIFICATIONS**

- A. The OEM shall have had experience with three (3) or more installations of systems of comparable size and complexity with regards to type and design as specified herein. Each of these installations shall have performed satisfactorily for at least one (1) year after final acceptance by the user. Include the names, locations and point of contact for these installations as a part of the submittal.
- B. The Contractor shall submit certified documentation that they have been an authorized distributor and service organization for the OEM for a minimum of three (3) years. The Contractor shall be authorized by the OEM to pass thru the OEM's warranty of the installed equipment to VA. In addition, the OEM and Contractor shall accept complete responsibility for the design, installation, certification, operation, and physical support for the System. This documentation, along with the System Contractor and OEM certifications must be provided in writing as part of the Contractor's Technical submittal.
- C. 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 RE before being allowed to commence work on the System.
- D. The Contractor shall display all applicable national, state and local licenses.

**1.6 CODES AND PERMITS**

- A. Provide all necessary permits and schedule all inspections as identified in the contract's milestone chart, so that the system is proof of performance tested and ready for operation on a date directed by the Owner.
- B. The contractor is responsible to adhere to all codes described herein and associated contractual, state and local codes.
- C. The Contractor shall display all applicable national, state and local licenses and permits.

## **2.1 SYSTEM DESCRIPTION**

- A. Furnish and install a complete and fully functional and operable extension to the existing PA System. Provide operable stereo speakers within operating rooms as indicated. Provide additional require conduit(s) according to Specification 27 11 00.

## **2.2 SYSTEM PRFORMANCE:**

- A. At a minimum, each distribution, interconnection, interface, terminating point and TCO shall be capable of supporting the Facility's PA system voice and data service as follows:
  - 1. Shall be compliant with and not degrade the operating parameters of the Public Switched Telephone Network (PSTN) and the Federal Telecommunications System (FTS) at each PSTN and FTS interface, interconnection and terminating locations in the TERs.
  - 2. Audio Input: The signal level of each audio input channel at each input point shall be a MINIMUM of zero decibels measured (dBm), +0.10 dBm across 150 Ohms, balanced.
  - 3. Audio Output: The audio signal level at each speaker shall be a MINIMUM of +0.25 Watt (W) and a maximum of +20 W, 600 Ohms balanced impedance, on a 70.7 V audio distribution line Contractor to determine and set each speaker's proper audio signal level (top) based on speaker location and the ambient noise level in speaker coverage area.
  - 4. The system shall meet the following MINIMUM parameters at each speaker:
    - a. Cross Modulation: -46 dB
    - b. Hum Modulation: -55 dB
    - c. Isolation (outlet-outlet): 24 dB
    - d. Impedance:
      - 1) Distribution: 600 Ohm balanced @ 70.7 V audio line level.
      - 2) Speaker: Selectable, as required.
    - e. Audio Gain: 10 dB minimum @ mid-range measured with a sound pressure level meter (SPL)
    - f. Signal to noise (S/N) ratio: 35 dB, minimum
- B. Audio Level Processing: The head-end equipment shall consist of audio mixer(s), volume limiter(s) and/or compressor(s), and power amplifier(s) to process, adjust, equalize, isolate, filter, and amplify each audio channel for each zone or sub-zone in the system and distribute them into the system's distribution trunks. It is acceptable

to use identified telephone system cable pairs designated for PA use or identified as spare telephone cable pairs by the Facility's Telephone System Contractor.

1. THE USE OF TELEPHONE CABLE TO DISTRIBUTE PA SIGNALS CARRYING AC OR DC VOLTAGE IS NOT ACCEPTABLE AND WILL NOT BE APPROVED.
2. Additionally, each remote location shall be provided with the equipment required to ensure the system supervision and designed audio channel capacity at each speaker identified on the contract drawings.

### **2.3 MANUFACTURERS**

- A. The products specified shall be new, FCC and UL Listed, labeled and produced by OEM of record.

### **2.4 PRODUCTS**

#### **A. GENERAL:**

1. Match components and interconnections for optimum performance with the existing PA system.
2. The system shall provide high-quality sound reproduction and be free from noises at all times during system operation, including standby.

#### **B. DISTRIBUTION SYSTEM:**

##### **1. PA Ceiling Speakers:**

###### **a. The PA Ceiling Speakers shall be as follows:**

- 1) Sensitivity: 93 dB at one meter, with 1-W input.
- 2) Frequency Response: Within plus or minus 3 dB from 65 to 17,000 Hz.
- 3) Minimum Dispersion Angle: 100 degrees.
- 4) Line Transformer: Voltage to match existing PA distribution system, with a minimum of four level taps.
- 5) Tap Selector: Control mounted on backbox.
- 6) Enclosures: Steel housings or back boxes, acoustically dampened, with front face of at least 0.0478-inch steel and whole assembly rust proofed and factory primed; complete with mounting assembly and suitable for surface ceiling, flush ceiling, pendant or wall mounting; with relief of back pressure.
- 7) Baffle: Flush, mar-proof baked white epoxy baffle that matches ceiling tiles.
- 8) Size: 8 inches with minimum 5-oz. ceramic magnet.
- 9) Provide Rauland-Borg Model BAFKIT1X2S or approved equal.

2. The Operating Room (OR) Speakers shall be as follows:
  - 1) General: Full range, high-performance, multi-tap, 8-ohm speakers for use with a home stereo and shallow backboxes for use within a ceiling having limited space.
  - 2) Maximum SPL: 87 dB SPL at one meter, with 1-W input.
  - 3) Frequency Response: Within plus or minus 3 dB from 70 to 19,000 Hz.
  - 4) Nominal Dispersion Angle: 125 degrees.
  - 5) Power Handling, Long Term: 40W, 160W peak.
  - 6) Enclosures: Shallow, steel housings or back boxes, acoustically dampened.
  - 7) Baffle: Flush, polypropylene baffle with powder-coated white steel grille, nominal 11-inch diameter.
  - 8) Provide Bose Model 'FreeSpace' DS-40F speakers or approved equal.
3. Volume Attenuator Stations: Provide wall plate-mounted autotransformer type volume control stations where indicated.
  - 1) Wattage Rating: 10 W.
  - 2) Attenuation per Step: 3 dB, with 10-steps and positive OFF.
  - 3) Insertion Loss: 0.4 dB maximum.
  - 4) Label Coverplate: "Spkr Volume"
  - 5) Provide Atlas Sound AT10D with decora plate or approved equal.
4. System Cables: In addition to the TIP provided under Specification Section 27 15 00 - TIP Horizontal and Vertical Communications Cabling, provide the following additional TIP installation and testing requirements, provide the following minimum System TIP cables & interconnections:
  - 1) Line Level Audio and Microphone Cable:
    - a) Line level audio and microphone cable for inside racks and conduit.
    - b) Shielded, twisted pair Minimum 22 American Wire Gauge (AWG), stranded conductors and 24 AWG drain wire with overall jacket.
  - 2) Speaker Level (Audio 70.7Volt [V]) Cable, Riser Rated:
    - a) For use with 70.7 V audio speaker circuits.
    - b) 18 AWG stranded pair, minimum.
    - c) UL-1333 listed.
  - 3) Speaker Level Audio Cable, Plenum Rated (70.7V):

- a) For use with 70.7 V audio speaker circuits.
  - b) 18 AWG stranded pair, minimum.
  - 4) All cabling shall be **plenum** rated.
  - 5) Provide one (1) spare 1,000 foot roll of approved System (not microphone) cable only.
2. Raceways, Back Boxes and conduit:
- a. Raceways:
    - 1) In addition to the Raceways, Equipment Room Fittings provided under Specification Sections 27 15 00 TIP Communication Room Fittings and 27 15 00 - TIP Communications Horizontal and Vertical Cabling, provide the following additional TIP raceway and fittings:
    - 2) Each raceway that is open top, shall be: UL certified for telecommunications systems, partitioned with metal partitions in order to comply with NEC Parts 517 & 800 to "mechanically separate telecommunications systems of different service, protect the installed cables from falling out when vertically mounted and allow junction boxes to be attached to the side to interface "drop" type conduit cable feeds.
    - 3) Intercommunication System cable infrastructure: EMT or in J-hooks above accessible ceilings, 24 inches on center.
    - 4) Junction boxes shall be not less than 2-1/2 inches deep and 6 inches wide by 6 inches long.
    - 5) Flexible metal conduit is prohibited unless specifically approved by 0050P3B.
  - b. System Conduit:
    - 1) The PA system is NFPA listed as Emergency / Public Safety Communication System which requires the entire system to be installed in a separate conduit system.
    - 2) The use of centralized mechanically partitioned wireways may be used to augment main distribution conduit on a case by case basis when specifically approved by VA Headquarters (0050P3B).
    - 3) Conduit Sleeves:
      - a) The AE has made a good effort to identify where conduit sleeves through full-height and fire rated walls on the drawings, and has instructed the electrician to provide the sleeves as shown on the drawings.

b) While the sleeves shown on the drawings will be provided by others, the contractor is responsible for installing conduit sleeves and fire-proofing where necessary. It is often the case, that due to field conditions, the nurse-call cable may have to be installed through an alternate route. Any conduit sleeves required due to field conditions or those omitted by the engineer shall be provided by the cabling contractor.

3. Device Back Boxes:

- a. Furnish to the electrical contractor all back boxes required for the PA system devices.
- b. The electrical contractor shall install the back boxes as well as the system conduit. Coordinate the delivery of the back boxes with the construction schedule.

**PART 3 - EXECUTION**

**3.4 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 speakers, 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. Include safety wires.



5. Locate overhead ceiling-mounted loudspeakers as shown on drawings, and coordinated with final reflected ceiling plan and field coordinated with other ceiling mounted devices.
    - a. Mount transformers securely to speaker brackets or enclosures using screws. Adjust torsion springs as needed to securely support speaker assembly.
    - b. Speaker back boxes shall be completely filled with fiberglass insulation.
    - c. Seal cone speakers to their enclosures to prevent air passing from one side of the speaker to the other.
  7. 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.
  9. Color code all distribution wiring to conform to the PA Industry Standard, EIA/TIA, and to match existing. At a minimum, all equipment, cable duct and/or conduit, enclosures, wiring, terminals, and cables shall be clearly and permanently labeled according to and using the provided record drawings, to facilitate installation and maintenance.
- D. Wiring Practice: Comply with the following additional practices shall be adhered too:
1. Comply with applicable codes, including ANSI/TIA/EIA and NEC.
  5. 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.
  6. 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.
  7. 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.
  8. Use wire pulling lubricants and pulling tensions as recommended by the OEM.
  9. Use grommets around cut-outs and knock-outs where conduit or chase nipples are not installed.

10. Do not use tape-based or glue-based cable anchors.
11. Ground shields and drain wires to the Facility's signal ground system as indicated by the drawings.
12. Use only balanced audio circuits unless noted otherwise
13. Make all connections as follows:
  - a. Make all connections using rosin-core solder or mechanical connectors appropriate to the application.
  - b. For crimp-type connections, use only tools that are specified by the manufacturer for the application.
  - c. Use only insulated spade lugs on screw terminals. Spade lugs shall be sized to fit the wire gauge. Do not exceed two lugs per terminal.
  - d. Wire nuts, electrical tape or "Scotch Lock" connections are not acceptable for any application.
14. Make all connections as follows:
  - a. Make all connections using rosin-core solder or mechanical connectors appropriate to the application.
  - b. For crimp-type connections, use only tools that are specified by the manufacturer for the application.
  - c. Use only insulated spade lugs on screw terminals. Spade lugs shall be sized to fit the wire gauge. Do not exceed two lugs per terminal.
  - d. Wire nuts, electrical tape or "Scotch Lock" connections are not acceptable for any application.
15. Wires or cables **intended to be** installed outside of conduit, cable trays, wireways, cable duct, etc shall be approved by the RE:
  - a. Only when specifically authorized as described herein, will wires or cables be identified and approved to be installed outside of conduit. The wire or cable runs shall be UL rated plenum and OEM certified for use in air plenums.
  - b. Wires and cables shall be hidden, protected, fastened and tied at 600 mm (24 in.) intervals, maximum, as described herein to building structure.
  - c. Closer wire or cable fastening intervals may be required to prevents sagging, maintain clearance above suspended ceilings, remove unsightly wiring and cabling from view and discourage tampering and vandalism. Wire or cable runs, not provided in conduit, that penetrate outside building walls, supporting walls,

and two hour fire barriers shall be sleeved and sealed with an approved fire retardant sealant.

- d. Wire or cable runs to system components installed in walls (i.e.: volume attenuators, equipment j-boxes, etc.) may, when specifically authorized by the RE, be fished through hollow spaces in walls and shall be certified for use in air plenum areas.
  - e. Completely test all of the cables after installation and replace any defective cables.
- E. Cable Installation: The following additional practices shall be adhered too:
- 1. Support cable at intervals not exceeding manufacturer's recommendations, EIA/TIA recommendations and not more than 6 inches (152 mm) from cabinets, boxes, or fittings. Acceptable means of cable support are cable tray, j-hooks, and bridal rings. Velcro wrap cable bundles loosely to the means of support with plenum rated Velcro straps. Plastic tie wraps are not acceptable as a means to bundle cables.
  - 2. Run cables parallel to walls.
  - 3. Install maximum of 10 cables in a single row of J-hooks. Provide necessary rows of J-hooks as required by the number of cables.
  - 4. Do not lay cables on top of light fixtures, ceiling tiles, mechanical equipment, or ductwork. Maintain at least 2'-0" clearance from all shielded electrical apparatus.
  - 5. All cables shall be tested after the total installation is fully complete. All test results are to be documented. All cables shall pass acceptable test requirements and levels. Contractor shall remedy any cabling problems or defects in order to pass or comply with testing. This includes the re-pull of new cable as required at no additional cost to the Owner.
  - 6. Ends of cables shall be properly terminated on both ends per industry and OEM's recommendations.
  - 7. Provide proper temporary protection of cable after pulling is complete before final dressing and terminations are complete. Do not leave cable lying on floor. Bundle and tie wrap up off of the floor until you are ready to terminate.
  - 8. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at outlets and terminals.

9. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Cables may not be spliced.
  10. Bundle, lace, and train conductors to terminal points without exceeding OEM's limitations on bending radii. Install lacing bars and distribution spools.
  11. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used.
  12. Cable shall not be run through structural members or be in contact with pipes, ducts, or other potentially damaging items.
  13. Separation of Wires: (REFER TO RACEWAY INSTALLATION) Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inches apart for speaker microphones and adjacent parallel power and telephone wiring. Separate other intercommunication equipment conductors as recommended by equipment manufacturer.
  14. Serve all cables as follows:
    - a. Cover the end of the overall jacket with a 1" (minimum) length of transparent heat-shrink tubing. Cut unused insulated conductors 2" (minimum) past the heat-shrink, fold back over jacket and secure with cable-tie. Cut unused shield/drain wires 2" (minimum) past the Heatshrink and serve as indicated below.
    - b. Cover shield/drain wires with heat-shrink tubing extending back to the overall jacket. Extend tubing ¼" past the end of unused wires, fold back over jacket and secure with cable tie.
    - c. For each solder-type connection, cover the bare wire and solder connection with heat-shrink tubing.
- F. Labeling: Provide labeling in accordance with ANSI/EIA/TIA-606-A. All lettering for PA circuits shall be stenciled using laser.
1. Cable and Wires (Hereinafter referred to as "Cable"): Cables shall be labeled at both ends in accordance with ANSI/EIA/TIA-606-A. Labels shall be permanent in contrasting colors. Cables shall be identified according to the System "Record Wiring Diagrams."
  2. Provide other labels as noted herein and in other Division 26 Specifications.

### **3.7 FIREPROOFING**

- A. Where PA wires, cables and conduit penetrate fire rated walls, floors and ceilings, fireproof the opening per "Fireproofing" specification.
- B. Provide conduit sleeves where cables penetrate fire rated walls ceilings if alternative raceways are not available. Field inspect and plan the cable route prior to installation. After the cabling installation is complete, install fire proofing material in and around all conduit sleeves and openings. Install fire proofing material thoroughly and neatly. Seal all floor and ceiling penetrations.

### **3.8 GROUNDING**

- A. Ground PA cable shields to eliminate shock hazard and to minimize ground loops, common mode returns, noise pickup, cross talk, and other impairments.

## **PART 4 - TESTING**

### **4.0 SYSTEM TESTING / GUARANTEE**

- A. General Requirements: The scope of work for this Section does not warrant staff training, nor a special guarantee beyond the standard manufacturer's guarantee associated with the products installed. Provide the Resident Engineer warranty documentation for each product installed under this Section.
- B. Acceptance Test Procedure:
  - 1. Pretesting and Inspection:
    - a. The Contractor shall tour all areas where the PA system was installed to insure they are operationally ready for proof of performance testing.
    - b. The System diagrams, record drawings, equipment manuals, TIP 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. Operational Test:
    - a. After the Pretesting and Inspection, the system shall be tested in the presence of the Resident Engineer (RE) and/or Architect/Engineer in all modes of operation to demonstrate the added speakers and zones are operating properly.
    - b. Field adjust speaker taps in each area to provide the desired sound levels as directed by the RE and surgery staff.

3. OR Operational Testing: A portable stereo system of adequate wattage rating shall be furnished by the Contractor to demonstrate the speakers in each OR operate properly.

#### **4.2 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 two (2) years from date of final acceptance of the System by the VA. The Contractor shall provide OEM's equipment warranty documents, to the RE (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.

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

**PART 1 - GENERAL**

**1.1 SECTION SUMMARY**

- A. Work covered by this document includes labor, material and products, equipment warranty and system guarantee, training and services for, and incidental to, the complete installation of new and fully operating National Fire Protection Association (NFPA) - Life Safety Code 101.3-2 (a) Labeled and (b) Listed, Emergency Service Nurse-Call and Life Safety listed Code Blue Communication System and associated equipment (here-in-after referred to as the NC System or System). The system shall be a complete stand-alone system serving the surgery suite in the Addition, and connected to the existing nurse call network within the VA facility.
- B. Work shall be complete, Occupational Safety and Health Administration (OSHA), National Recognized Testing Laboratory (NRTL - i.e. Underwriters Laboratory [UL]) Listed and Labeled; and tested, certified and ready for operation.
- C. The System shall be delivered free of engineering, manufacturing, installation, and functional defects. It shall be designed, engineered and installed for ease of operation, maintenance, and testing.

**1.2 RELATED SECTIONS**

- A. 01 33 23 - Shop Drawings, Product Data and Samples.
- B. 07 84 00 - Firestopping.
- C. 10 25 13 - Patient Bed Service Walls.
- D. 27 05 11 - Common Work Results For Low Voltage Systems.
- E. 27 41 31 - Master Antenna Television Equipment and Systems.

**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:
    - a. Departments of:
      - 1) Commerce, Consolidated Federal Regulations (CFR), Title 15 - 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; CFR, Title 47 Federal communications Commission (FCC) Part 15, Radio Frequency Restriction of Use and Compliance in "Safety of Life" Functions & Locations.
- 2) FCC - Communications Act of 1934, as amended, CFR, Title 47 - Telecommunications, in addition to Part 15 - Restrictions of use for Part 15 listed Radio Equipment in Safety of Life / Emergency Functions / Equipment/ Locations (also see CFR, Title 15 - Department of Commerce, Chapter XXIII - NTIA):
  - a) Part 15 - Restrictions of use for Part 15 listed Radio Equipment in Safety of Life / Emergency Functions / Equipment/Locations.
  - b) Part 58 - Television Broadcast Service.
  - c) Part 90 - Rules and Regulations, Appendix C.
- 3) Health, (Public Law 96-88), CFR, Title 42, Chapter IV Health & Human Services, CFR, Title 46, Subpart 1395(a)(b) JCAHO "a hospital that meets JCAHO accreditation is deemed to meet the Medicare conditions of Participation by meeting Federal Directives:"
  - a) All guidelines for Life, Personal and Public Safety; and, Essential and Emergency Communications.
- 4) Labor, CFR, Title 29, Part 1910, Chapter XVII - Occupational Safety and Health Administration (OSHA), Occupational Safety and Health Standard:
  - a) Subpart 7 - Definition and requirements (for a NRTL - 15 Laboratory's, for complete list, contact ([http://www.osha.gov/dts/otpc/nrtl/faq\\_nrtl.html](http://www.osha.gov/dts/otpc/nrtl/faq_nrtl.html)):
    - 1) UL:
      - a) 44-02 - Standard for Thermoset-Insulated Wires and



Cables.

- b) 65 - Standard for Wired Cabinets.
- c) 83-03 - Standard for Thermoplastic-Insulated Wires and Cables.
- d) 467-01 - Standard for Electrical Grounding and Bonding Equipment
- e) 468 - Standard for Grounding and Bonding Equipment.
- f) 486A-01 - Standard for Wire Connectors and Soldering Lugs for Use with Copper Conductors
- g) 486C-02 - Standard for Splicing Wire Connectors.
- h) 486D-02 - Standard for Insulated Wire Connector Systems for Underground Use or in Damp or Wet Locations.
- i) 486E-00 - Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors.
- j) 493-01 - Standard for Thermoplastic-Insulated Underground Feeder and Branch Circuit Cable.
- k) 514B-02 - Standard for Fittings for Cable and Conduit.
- l) 1069 - Hospital Signaling and Nurse Call Equipment.
- m) 1449 - Standard for Transient Voltage Surge Suppressors.
- n) 1479-03 - Standard for Fire Tests of Through-Penetration Fire Stops.
- o) 1666 - Standard for Wire/Cable Vertical (Riser) Tray Flame Tests.
- p) 1863 - Standard for Safety, Communications Circuits Accessories.
- q) 2024 - Standard for Optical Fiber Raceways.
- r) 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.
- 5) Department of Transportation, CFR, Title 49 (Public Law 89-670), Part 1, Subpart C - Federal Aviation Administration (FAA):
- a) Standards AC 110/460-ID & AC 707 / 460-2E - Advisory Circulars for Construction of Antenna Towers.
  - b) Forms 7450 and 7460-2 - Antenna Construction Registration.
- 6) Veterans Affairs (Public Law No. 100-527), CFR, Title 38, Volumes I & II:
- a) Office of Telecommunications:
    - 1) Handbook 6100 - Telecommunications.
      - a) Spectrum Management FCC & NTIA Radio Frequency Compliance and Licensing Program.
      - b) Special Communications Proof of Performance Testing, VACO Compliance and Life Safety Certification(s).
  - 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) VA's National Center for Patient Safety - Veterans Health Administration Warning System, Failure of Medical Alarm Systems using Paging Technology to Notify Clinical Staff, July 2004.
  - d) VA's Center for Engineering Occupational Safety and Health, concurrence with warning identified in VA Directive 7700.
  - e) Office of Construction and Facilities Management (CFM):
    - 1) Master Construction Specifications (PG-18-1).
    - 2) Standard Detail and CAD Standards (PG-18-4).
    - 3) Equipment Guide List (PG-18-5).
    - 4) Electrical Design Manual for VA Facilities (PG 18-10), Articles 7 & 8.
    - 5) Minimum Requirements of A/E Submissions (PG 18-15):
      - a) Volume B, Major New Facilities, Major Additions; and Major Renovations, Article VI, Paragraph B.

- b) Volume C - Minor and NRM Projects, Article III, Paragraph S.
  - c) Volume E - Request for Proposals Design/Build Projects, Article II, Paragraph F.
- 6) Mission Critical Facilities Design Manual (Final Draft - 2007).
- 7) Life Safety Protected Design Manual (Final Draft - 2007).
- 8) Solicitation for Offerors (SFO) for Lease Based Clinics - (05-2009).
- b. Federal Specifications (Fed. Specs.):
  - 1) A-A-59544-00 - Cable and Wire, Electrical (Power, Fixed Installation).
- 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):
    - 1) 568-B - Commercial Building Telecommunications Wiring Standards:
      - a) B-1 - General Requirements.
      - b) B-2 - Balanced twisted-pair cable systems.
      - c) B-3 - Fiber optic cable systems.
    - 2) 569 - Commercial Building Standard for Telecommunications Pathways and Spaces.
    - 3) 606 - Administration Standard for the Telecommunications Infrastructure of Communications Buildings.
    - 4) 607 - Commercial Building Grounding and Bonding Requirements for Telecommunications.
    - 5) REC 127-49 - Power Supplies.
    - 6) RS 270 - Tools, Crimping, Solderless Wiring Devices, Recommended Procedures for User Certification.
  - c. American Society of Mechanical Engineers (ASME):
    - 1) Standard 17.4 - Guide for Emergency Personnel.
    - 2) Standard 17.5 - Elevator & Escalator Equipment (prohibition of installing non-elevator equipment in Elevator Equipment Room / Mechanical Penthouse).

- d. American Society of Testing Material (ASTM):
  - 1) D2301-04 - Standard Specification for Vinyl Chloride Plastic Pressure Sensitive Electrical Insulating Tape.
- e. Building Industries Communications Services Installation (BICSI):
  - 1) All standards for smart building wiring, connections and devices for commercial and medical facilities.
  - 2) Structured Building Cable Topologies.
  - 3) In consort with ANSI/EIA/TIA.
- f. Institute of Electrical and Electronics Engineers (IEEE):
  - 1) 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.
  - 2) 0739-5175/08/©2008 IEEE - Medical Grade - Mission Critical - Wireless Networks.
  - 3) C62.41 - Surge Voltages in Low-Voltage AC Power Circuits.
- g. NFPA:
  - 1) 70 - National Electrical Code (current date of issue) - Articles 517, 645 & 800.
  - 2) 75 - Standard for Protection of Electronic Computer Data-Processing Equipment.
  - 3) 77 - Recommended Practice on Static Electricity.
  - 4) 99 - Healthcare Facilities.
  - 5) 101 - Life Safety Code.
- 3. State Hospital Code(s).
- 4. Local Town, City and/or County Codes.
- 5. Accreditation Organization(s):
  - a. Joint Commission on Accreditation of Hospitals Organization (JCAHO) - Section VI, Part 3a - Operating Features.

#### 1.5 QUALIFICATIONS

- A. The OEM shall have had experience with three (3) or more installations of Nurse Call systems of comparable size and interfacing complexity with regards to type and design as specified herein. Each of these installations shall have performed satisfactorily for at least one (1) year after final acceptance by the user. Include the names, locations and point of contact for these installations as a part of the submittal.

- B. The Contractor shall submit certified documentation that they have been an authorized distributor and service organization for the OEM for a minimum of three (3) years. The Contractor shall be authorized by the OEM to pass thru the OEM's warranty of the installed equipment to VA. In addition, the OEM and Contractor shall accept complete responsibility for the design, installation, certification, operation, and physical support for the System. This documentation, along with the System Contractor and OEM certifications must be provided in writing as part of the Contractor's Technical submittal.
- C. 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 RE before being allowed to commence work on the System.
- D. The Contractor shall display all applicable national, state and local licenses.
- E. The Contractor shall submit copy (s) of Certificate of successful completion of OEM's installation/training school for installing technicians of the System's Nurse Call and/or Code Blue equipment being proposed.
- F. Contacts: The preferred provider and installer of Nurse Call Systems at Ft. Meade VA are as follows:
  - Beacon Communications LLC, Kiffie Hester, 303-750-6500
  - DakTech Inc., Jason Simms, 605-484-8576

#### 1.6 CODES AND PERMITS

- A. Provide all necessary permits and schedule all inspections as identified in the contract's milestone chart, so that the system is proof of performance tested, certified and approved by VA and ready for operation on a date directed by the Owner.
- B. The contractor is responsible to adhere to all codes described herein and associated contractual, state and local codes.

#### 1.7 SCHEDULING

- A. The Contractor shall schedule any downtime to connect the network cabling with the Resident Engineer. The Work shall be completed at the time and date designated, including off-hours or weekends as required.

## 1.8 NC SYSTEM SUBMITTALS

- A. Submit NC System product data and technical literature detailing the electrical and technical characteristics of each item of equipment to be furnished.
- B. Submit a scaled plan showing Nurse Call devices and cable system layout.
- C. Document the length of network cabling connecting this NC System into the existing NC System network. Notify the RE if maximum cable lengths are exceeded.

## PART 2 - PRODUCTS / FUNCTIONAL REQUIREMENTS

### 2.0 GENERAL REQUIREMENTS FOR EQUIPMENT AND MATERIALS

- A. Furnish and install a complete and fully functional and operable Nurse Call System for each location shown on the Contract Drawings and TCOs. The System manufacturer shall be Rauland-Borg to match the existing NC Systems within the VA facility. No manufacturer substitutions will be accepted unless approved by the Resident Engineer.
- C. Coordinate features and select interface components to form an integrated Nurse Call system. Match components and interconnections between the systems for optimum performance of specified functions.
- D. Expansion Capability: The Nurse Call equipment interfaces and cables shall be able to increase number of enunciation points in the future by a minimum of 50 percent (%) above those indicated without adding any internal or external components or main trunk cable conductors.
- E. Equipment: Active electronic type shall use solid-state components, fully rated for continuous duty unless otherwise indicated. Select equipment for normal operation on input power usually supplied between 110 to 130 VAC, 60 Hz supplied from the Facility's Emergency Electrical Power System.
- F. Meet all FCC requirements regarding equipment listing, low radiation and/or interference of RF signal(s). The system shall be designed to prevent direct pickup of signals from within and outside the building structure.

### 2.1 SYSTEM DESCRIPTION

- A. Furnish and install a complete and fully functional and operable Rauland Borg Nurse Call and Code Blue System.

- B. The Contractor is responsible for interfacing the NC System with MATV outlets in patient rooms; and mounting of devices within Service Walls located in patient rooms and PACU.
- C. The Contractor shall continually employ interfacing methods that are approved by the OEM and VA. At a minimum, an acceptable interfacing method requires not only a physical and mechanical connection, but also a matching of signal, voltage, and processing levels with regard to signal quality and impedance. The interface point must adhere to all standards described herein for the full separation of Critical Care and Life Safety systems.
- D. The System Contractor shall connect the System ensuring that all NFPA and UL Critical Care and Life Safety Circuit and System separation guidelines are satisfied. The System Contractor is not allowed to make any connections to the Telephone System. The Contractor shall arrange all required interconnections between the NC System, MATV, Patient Bed Service Walls and other Systems with the appropriate responsible parties.
- E. System hardware shall consist of a standalone (separate) nurse call and Code Blue patient communications system tied into the NC network. 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 call and Code Blue communications network.
- F. System firmware shall be the product of a reputable firmware OEM of record with a proven history of product reliability and sole control over all source code. Manufacturer shall provide, free of charge, product firmware/software upgrades for a period of two (2) years from date of acceptance by VA for any product feature enhancements. System configuration programming changes shall not require any exchange of parts and shall be capable of being executed remotely.
- H. The System shall utilize microprocessor components for all signaling and programming circuits and functions. Self contained or on board system program memory shall be non-volatile and protected from erasure from power outages for a minimum of 12 hours.
- I. The System shall be served by a central UPS to allow normal operation and function (as if there was no AC power failure) in the event of an AC power failure or during input power fluctuations for a minimum of 30 minutes.

- J. The System is defined as Critical Service and the Code Blue functions is defined as Life Safety/Support by NFPA (re Part 1.1.A) and so evaluated by JCAHCO. Ensure the system has a minimum of two (2) additional remote enunciation points, via the NC System network, in order to satisfy NFPA's Life Safety Code 101.
- K. Each Code Blue 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.
- L. When the System is approved to connect to a separate communications system (i.e. LAN, WAN, Telephone, Public Address, radio raging, wireless systems, etc) the connection point shall meet the following minimum requirements for each hard wired / wireless connection (note each wireless system connection MUST BE APPROVED PRIOR TO CONTRACT BID BY VA HEADQUARTERS TVE - 0050P3B AND SPECTRUM MANAGEMENT - 0050P2B - hereinafter referred to as SM - 0050P2B):
1. UL 60950-1/2.
  2. FIPS 142.
  3. FCC Part 15 Listed Radio Equipment restriction compliance approved by SM - 0050P2B.
- M. All passive distribution equipment shall meet or exceed -80 dB radiation shielding (aka RFI) shielding specifications and be provided with connectors specified by the OEM.
- N. All equipment face plates utilized in the system shall be stainless steel, anodized aluminum or UL approved cyclac plastic for the areas where provided.
- O. Noise filters and surge protectors shall be provided for each equipment interface cabinet, headend cabinet, control console and local and remote amplifier locations to insure protection from input primary AC



power surges and to insure noise glitches are not induced into low voltage data circuits.

- P. Plug-in connectors shall be provided to connect all equipment, except coaxial cables. Coaxial cable distribution points shall use coaxial cable connections recommended by the cable OEM and approved by the system OEM. Base band cable systems shall utilize barrier terminal screw type connectors, at a minimum. As an alternate, crimp type connectors installed with a ratchet type installation tool are acceptable provided the cable dress, pairs, shielding, grounding, connections and labeling are the same as the barrier terminal strip connectors. Tape of any type, wire nuts or solder type connections are unacceptable and will not be approved.
- R. Audio Level Processing: The control equipment shall consist of audio mixer(s), volume limiter(s) and/or compressor(s), and power amplifier(s) to process, adjust, equalize, isolate, filter, and amplify each audio channel for each sub-zone in the system and distribute them into the System's RF interfacing distribution trunks and amplification circuits. It is acceptable to use identified Telephone System cable pairs designated for Two-Way Radio interface and control use or identified as spare telephone cable pairs by the Facility's Telephone System Contractor. The use of telephone cable to distribute RF signals, carrying system or sub-system AC or DC voltage is not acceptable and will not be approved. Additionally, each control location shall be provided with the equipment required to insure the system can produce its designed audio channel capacity at each speaker identified on the contract drawings. The Contractor shall provide: a spare set of telephone paging modules as recommended by the OEM (as a minimum provide one spare module for each installed module); one spare audio power amplifier, one spare audio mixer, one spare audio volume limiter and/or compressor, and one spare audio automatic gain adjusting device, and minimum RF equipment recommended by the OEM.
- S. Contractor is responsible to include all accessories and miscellaneous equipment required to form a complete and operating system. Unless otherwise noted in this Part, equipment quantities shall be as indicated on the drawings.
- R. System Performance:
  - 1. At a minimum, each distribution, interconnection, interface, terminating point and TCO shall be capable of supporting the

Facility's Nurse Call and/or Code Blue System voice and data service as follows:

- a. Shall be compliant with and not degrade the operating parameters of the Public Switched Telephone Network (PSTN) and the Federal Telecommunications System (FTS) at each PSTN and FTS interface (if attachment is permitted by TVE 0050P3B), interconnection and TCO terminating locations detailed on the contract drawings.
- b. The System shall provide the following minimum operational functions:
  - 1) Code Blue calls shall be cancelable at the calling station only. The nurse call master station (s) that a managing Code Blue functions shall not have the ability to cancel Code Blue calls.
  - 2) Each Code Blue system shall be able to receive audio calls from all bedside stations simultaneously.
  - 3) Calls placed from any Code Blue station shall generate Code Blue emergency type audible and visual signals at each associated nurse control and duty station, respective dome lights and all local and remote annunciator panels. Calls placed from a bedside station shall generate emergency type visual signals at the bedside station and associated dome light(s) in addition to the previous stated stations and panels.
  - 4) Activating the silencing device at any location, while a Code Blue call or system fault is occurring shall mute the audible signals at the alarm location.
    - a) The audible alarm shall regenerate at the end of the selected time-out period until the call or fault is corrected.
    - b) The visual signals shall continue until the call is canceled and/or a fault is corrected. When the fault is corrected, all signals generated by the fault shall automatically cease, returning the System to a standby status.
    - c) Audible signals shall be regenerated in any local or remote annunciator panel that is in the silence mode, in the event an additional Code Blue call is placed in any Code Blue system.

- d) The additional Code Blue call shall also generate visual signals at all annunciators to identify the location of the call.
- 2. Each System Nurse Call location shall generate a minimum of distinct calls:
  - a. Routine: single flashing dome lights & master station color and audio tone,
  - b. Staff Assist: rapid flashing dome lights & master station color and audio tone,
  - c. Emergency: Red flashing dome lights & master station color and audio tone,
  - d. Code Blue: Blue flashing dome lights and master station color and audio tone,
  - e. Each generated call shall be cancelable at ONLY the originating location,
  - g. The Contractor shall verify dome lamp color(s), flashing and other dome light features with the Resident Engineer prior to ordering.

### 2.3 MANUFACTURERS

- A. Provide nurse call products shall be manufactured by Rauland-Borg unless noted otherwise.
- B. Products shall be new, FCC and UL Listed, labeled and produced by OEM manufacturer of record. An OEM of record shall be defined as a company whose main occupation is the manufacture for sale of the items of equipment supplied and which:
  - 1. Maintains a stock of replacement parts for the item submitted,
  - 2. Maintains engineering drawings, specifications, and operating manuals for the items submitted, and
  - 3. Has published and distributed descriptive literature and equipment specifications on the items of equipment submitted at least 30 days prior to the Invitation for Bid.
- C. Equipment Standards and Testing:
  - 1. The System has been defined herein as connected to systems identified as Critical Service performing various Emergency and Life Support Functions. Therefore, at a minimum, the system shall conform to all aforementioned National and/or Local Life Safety Codes (which ever are the more stringent), NFPA, NEC, this specification, JCAHCO

Life Safety Accreditation requirements, and the OEM recommendations, instructions, and guidelines.

2. All supplies and materials shall be listed, labeled or certified by UL or a NRTL where such standards have been established for the supplies, materials or equipment.
3. The provided equipment required by the System design and approved technical submittal must conform with each UL standard in effect for the equipment, as of the date of the technical submittal (or the date when the RE approved system equipment necessary to be replaced) was technically reviewed and approved by VA. Where a UL standard is in existence for equipment to be used in completion of this contract, the equipment must bear the approved UL seal.
4. Each item of electronic equipment to be provided under this contract must bear the approved UL seal or the seal of the testing laboratory that warrants the equipment has been tested in accordance with, and conforms to the specified standards. The placement of the UL Seal shall be a permanent part of the electronic equipment that is not capable of being transportable from one equipment item to another.

#### 2.4 PRODUCTS

##### A. General.

1. Provide a Rauland Borg NC System, including 'slim-line' and other products with model numbers as indicated in sub-paragraphs below.
2. Contractor is responsible for including all accessories and miscellaneous equipment required to form a complete and operating system. Provide quantities of equipment as indicated on the drawings and specified herein, including indicated spare equipment. All equipment shall be UL Listed and meet applicable ANSI/UL requirements.
3. Contractor Furnished Equipment List (CFEs):
  - a. The Contractor is required to provide a list of the CFE equipment to be furnished. The quantity, make and model number of each item is required. Select the required equipment items quantities that will satisfy the needs of the system as described herein and on the Drawings and with the OEM's concurrence applied to the list(s), in writing.
3. Provide the nurse call equipment as noted below. The model numbers herein refer to Rauland-Borg products:

##### B. Headend Equipment:

1. Model NC2828: Terminal Cabinet, Surface mounted.
2. Model R4KPR400: Power Supply, 15.5VDC, quantity as required.
3. Model R4KBK400: Battery Backup Kit. Provides 10-minutes of emergency power. Provide one per each R4KPR400 power supply.
4. Model R4KNIM: Network Interface Module. Hub for 1 K-bus connection.
5. Model R4KTMB: Termination Board. Connections for power & K-bus data/audio (Up to 12 K-bus runs). Provide quantity as required.
6. Provide other ancillary components within the Terminal Cabinet as required; including but not limited to other interfaces, modules, amplification, adaptors, or control modules.
7. Contractor shall include configuring the system to meet project requirements, and provide required annunciation of Nurse Call system at other existing remote monitoring stations as directed by Resident Engineer.

C. Staff Area Call Stations:

1. Model R4K4020: Nurse Call Master LCD Console, with display, handset, and 24-programmable buttons. Located at Nurse Stations.
2. Model R4KRECP: Wall Outlet for Master LCD console. Field coordinate mounting location of the outlet; above counter or below at 24" AFF.
3. Model R4KSS: Staff Station. Push button two-way intercom
4. Model R4KDY: Duty Station: Utility area two-way intercom
5. Model DCA214D: Duty Domeless Controller; for Duty Station without a corridor light.

D. Patient Area Call Stations:

1. Model R4KPB23: Staff Assist, slim-line, call and code push buttons.
2. Model R4KCB13: Code Station, slim-line.
3. Model R4KPC11: Pull Cord Station, slim-line, emergency pull cord.
5. Model R4K2JACK: Dual Patient Station, slim-line, two 1/4" jacks.
6. Model R4K17V: Enhanced Single Bed Station, slim-line, with one DIN receptacle. Include one pillow speaker with each station.
7. Model NCDS: Pillow Speaker. Units shall include a 10-foot shielded (ESD) cable with matching DIN plug, stainless steel positioning clip, strain reliefs and the following features:
  - a. Integral Speaker, liquid resistant, 2-1/4".
  - b. "Red Cross" Nurse Call Button
  - c. Thumbwheel Volume Control
  - d. TV Control, compatible with TV's being installed.
  - e. TV Channel Control

- f. Closed Caption Control
- g. Mute Control
- h. Light Control with compatible relay module. Field coordinate the required interface and style of jack(s) to be compatible with interface of TV's installed in patient rooms.

- 8. Model NC2JACK: Provide a minimum of one latching and one non-latching 1/4" phono jack in the headwall at each bed location for I.V. alarms.

E. Dome Lights:

- 1. Model CLV144: Corridor Light, 4-lamp LED
- 2. Model CLA214D: Corridor Light, 4-lamp LED, Duty type.
- 3. Provide lamp color(s) to match existing and as directed by RE.

F. Auxiliary Alarm Input Station:

- 1. UL, four (4) 1 /4" phono jack inputs for auxiliary alarms mounted in 1-gang ABS light-gray coverplate.
- 2. Inputs shall be latching and non-latching as specified herein.
- 3. Provide Rauland Model NC4JACK or approved equal.

G. Miscellaneous Equipment: Provide additional products as required for a complete and operational NC System.

H. Rough-In Requirements

- 1. Provide backbox types as recommended by the manufacturer and as listed on product data for each device.
- 2. A majority of the call stations require a 1-gang, non-gangable, 2.25" wide by 4" high by 3.5" deep backbox.

I. General System Requirements:

- 1. Locate the Nurse Call distribution equipment as required by system design and OEM direction. Provide secured and lockable cabinet.
- 2. Head-End Equipment:
  - a. Provide all required power supplies, communications hubs, network switches, intelligent controllers and other devices necessary to form a complete system.
  - d. Equipment Cabinet: Comply with TIA/EIA-310-D. Lockable, ventilated metal cabinet houses terminal strips, power supplies, amplifiers, system volume control, and other switching and control devices required for conversation channels and control functions.
- 4. Spare Components:

- a. Provide one (1) spare pillow speaker for each twenty (20) speakers installed, minimum of 1.
- b. Provide one (1) spare TV interface for each 20 interfaces installed, minimum of 1.
- c. Provide one (1) spare bed interface for each 20 interfaces installed, minimum of 1.
- d. Provide one (1) spare lighting relay module for each ten (10) modules installed, minimum of 2.
- e. (pending)

J. Interface Equipment:

1. Hospital Bed Interface (s):

- a. Provide a multi-pin receptacle for bed connection.
- b. Connect cable from the multi-pin receptacle to the nurse-call system, so that alarms, such as bed exit, shall be monitored by the nurse-call system.
- c. Connect cable from the multi-pin receptacle to the nurse-call system, so that the bedside control buttons, such as nurse call, and television controls are functional and monitored.
- d. The hospital uses the following beds:
  - 1) Hill Rohm.

7. TV Control Jack and Wiring:

- a. Provide connection from the pillow speaker to the TV location. Terminate wire on a jack in the TV low voltage faceplate. Coordinate faceplate opening with the cabling contractor. Coordinate jack type with the TV (typically it is a ¼" phono jack, but verify prior to installation).
- b. Provide patch cord from the TV control jack to the TV.

K. Call Initiation, Annunciation and Response:

1. Light and Tones:

- a. Calls may be initiated through:
  - 1) Patient station.
  - 2) Staff station.
  - 3) Code Blue station.
  - 4) Toilet Emergency Station pull cord / push button.
  - 5) Shower Emergency Station pull cord.
  - 6) Bed Pillow speaker.
  - 7) Bed Push-button cordset.
  - 8) Hospital 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) Each duty station.
  - 4) Each staff station.
  - 5) Each remote location.
- c) All calls must be displayed until they are cleared by the nursing staff ONLY from the initiating device location.

2. Voice:

- a Calls may be initiated through:
  - 1) Patient station.
  - 2) Staff station.
  - 3) Code Blue station.
  - 4) Toilet Emergency pull cord / push button station.
  - 5) Shower Emergency pull cord station.
  - 6) Pillow speaker.
  - 7) Push-button cordset.
  - 8) Integrated bed controls.
  - 9) Master Station.

K. Auxiliary Alarm Monitoring:

- 1. Each patient station must have the ability to connect a separate and isolated auxiliary alarm to it such as an infusion pump or data tracking / recording device (patient life support units ARE NOT allowed to be connected to these units UNLESS APPROVED BY TVE - 0050P3B DURING THE PROJECT DEVELOPMENT PHASE AS DESCRIBED HEREIN. The System must support naming the device that is being monitored as well as display its alarms at the master station and via the room / corridor dome light(s).
- 2. Provide (2) alarm jacks at each patient station.

K. Patient and Staff Assignment:

- 1. System may provide for transfer of one or more individual or groups of stations from one master station to another without mechanical switches or additional wiring of the stations. The transfer may be initiated manually by the nurse or automatically at certain times of the day.



L. Reports:

1. The system shall be configured to generate reports through the existing nurse call reporting system. Log all calls, alarms, response time, bed, and other metrics to match existing.
2. Reports function shall be limited by passwords and security tier level access to match existing.
3. Provide training and/or instructions to the owner on how to use the reporting functions when requested.

M. System/Management Software:

1. The VA Nurse Call system has updated software currently installed. Include provisions to update the system/management software as required by Work of this Section.

N. Distribution Cabling System:

1. In addition to the requirements of other applicable Specification Sections, the contractor shall provide the following additional TIP installation and testing requirements, provide the following minimum additional System TIP requirements, cables & interconnections:
  - a. Each wire and cable used in the System shall be specifically OEM certified by tags on each reel and recommended and approved for installation in the Facility.
  - b. The Contractor shall provide the RE a 610 mm (2 foot) sample of each wire and/or cable actually employed in the System and each certification tag for approval before continuing with the installation as described herein.
  - c. Copper Cables: Provide Cat 5e, jacketed single and multi-twisted pair, untinned solid copper, insulated conductors. Sizes and types as recommended by Rauland Bord, but not smaller than 22AWG.
  - d. Shielded: Provide tinned, soft-copper shielded conductors for speaker and/or microphone wiring as recommended by Rauland Borg.
  - e. Plenum: Nurse Call system cabling is not required to be plenum rated per owner; since all NC wiring is contained within the second floor with a ducted air return system. Any related riser cabling and NC network backbone cabling shall be plenum rated cable.
- d. Line Level Audio and Microphone Cable:
  - 1) Line level audio and microphone cable for inside racks and conduit.

- 2) Shielded, twisted pair Minimum 22AWG, stranded conductors and 24AWG drain wire with overall jacket.
- e. Speaker Level Audio (70.7Volt RMS):
  - 1) For use with 70.7V speaker circuits.
  - 2) 18AWG stranded pair, minimum.
- f. All cabling shall be plenum or riser (UL-1666) rated.
- 2. Raceways, Back Boxes and conduit:
  - b. System cable infrastructure: EMT.
  - c. Junction boxes shall be not less than 2-1/2 inches deep and 6 inches wide by 6 inches long.
  - d. Flexible metal conduit is prohibited unless specifically approved by 0050P3B.
  - e. System Conduit:
    - 1) The system is NFPA listed as Emergency / Public Safety Communication System which requires the entire system to be installed in a separate conduit system.
    - 2) Conduit Sleeves:
      - b) Contractor is responsible for installing conduit sleeves and fire-proofing where necessary.
  - g. Device Back Boxes:
    - 1) Furnish to the electrical contractor all back boxes required for the system devices.
    - 2) The Contractor shall install the back boxes as well as the system conduit. Coordinate the delivery of any specialty back boxes with the construction schedule.
- O. Patient Bedside Prefabricated Units (PBPUs):
  - 1. Where PBPUs exist in the Facility; the Contractor shall identify the "gang box" location on the PBPUs designated for installation of the telephone jack. This location shall here-in-after be identified as the unit's TCO. The Contractor shall be responsible for obtaining written approval and specific instructions from the PBPUs OEM regarding the necessary disassembly and reassembly of each PBPUs to the extent necessary to pull wire from above the TIP ceiling junction box to the PBPUs reserved gang box for the unit's TCO. A Contractor provided stainless steel cover plate approved for use by the PBPUs OEM and Facility IRM Chief shall finish out the jack installation.

2. Under no circumstances shall the Contractor proceed with the PBPV installations without the written approval of the PBPV OEM and the specific instructions regarding the attachment to or modifying of the PBPV. The RE shall be available to assist the Contractor in obtaining approvals and instructions in a timely manner as related to the project's time constraints.
3. It is the responsibility of the Contractor to maintain the UL integrity of each PBPV. If the Contractor violates that integrity, it shall be the responsibility of the Contractor to obtain on site UL re-certification of the violated PBPV at the direction of the RE and at the Contractor's expense.

P. Installation Kit:

1. General: The kit shall be provided that, at a minimum, includes all connectors and terminals, labeling systems, audio spade lugs, barrier strips, punch blocks or wire wrap terminals, heat shrink tubing, cable ties, solder, hangers, clamps, bolts, conduit, cable duct, and/or cable tray, etc., required to accomplish a neat and secure installation. All wires shall terminate in a spade lug and barrier strip, wire wrap terminal or punch block. Unfinished or unlabeled wire connections shall not be allowed. Turn over to the RE all unused and partially opened installation kit boxes, coaxial, fiberoptic, and twisted pair cable reels, conduit, cable tray, and/or cable duct bundles, wire rolls, physical installation hardware. The following are the minimum required installation sub-kits:
  2. System Grounding:
    - a. The grounding kit shall include all cable and installation hardware required. All radio equipment shall be connected to earth ground via internal building wiring, according to the NEC.
    - b. This includes, but is not limited to:
      - 1) Coaxial Cable Shields.
      - 2) Control Cable Shields.
      - 3) Data Cable Shields
      - 4) Equipment Cabinets.
      - 5) Conduits.
      - 6) Cable Trays.
      - 7) Power Panels.
      - 8) Connector Panels or Grounding Blocks.

3. Coaxial Cable: The coaxial cable kit shall include all coaxial connectors, cable tying straps, heat shrink tubing, hangers, clamps, etc., required to accomplish a neat and secure installation.
4. Wire and Cable: The wire and cable kit shall include all connectors and terminals, audio spade lugs, barrier straps, punch blocks, wire wrap strips, heat shrink tubing, tie wraps, solder, hangers, clamps, labels etc., required to accomplish a neat and orderly installation.
5. Equipment Interface: The equipment kit shall include any item or quantity of equipment, cable, mounting hardware and materials needed to interface the systems with the identified sub-system(s) according to the OEM requirements and this document.
8. Labels: The labeling kit shall include any item or quantity of labels, tools, stencils, and materials needed to completely and correctly label each subsystem according to the OEM requirements, as-installed drawings, and this document.
6. Documentation: The documentation kit shall include any item or quantity of items, computer discs, as installed drawings, equipment, maintenance, and operation manuals, and OEM materials needed to completely and correctly provide the system documentation as required by this document and explained herein.

## PART 3 - EXECUTION

### 3.1 PROJECT MANAGEMENT

- A. Assign a single project manager to this project who will serve as the point of contact for the Owner, the General Contractor, and the Engineer.
- B. The Contractor shall be proactive in scheduling work at the hospital, specifically the Contractor will initiate and maintain discussion with the general contractor regarding the schedule for ceiling cover up and install cables to meet that schedule.
- C. Contact the Office of Telecommunications, Special Communications Team (0050P2B) at (301) 734-0350 to have a VA Certified Telecommunications COTR assigned to the project for telecommunications review, equipment and system approval and co-ordination with VA's Spectrum Management and OCIS Teams.

### 3.2 COORDINATION WITH OTHER TRADES

- A. Coordinate with the cabling contractor the location of the TV faceplate and the faceplate opening for the nurse call TV control jack.
- B. Coordinate with the cabling contractor the location of TIP equipment in the TER, TCR, PCR, SCC, ECR, STRs, NSs, and TCOs in order to connect to

the TIP cable network that was installed as a part of Section Specification 27 11 00. Contact the RE immediately, in writing, if additional location(s) are discovered to be activated that was not previously provided.

- C. Before beginning work, verify the location, quantity, size and access for the following:
  - 1. Isolated ground AC power circuits provided for systems.
  - 2. Primary, emergency and extra auxiliary AC power generator requirements.
  - 3. Junction boxes, wall boxes, wire troughs, conduit stubs and other related infrastructure for the systems.
  - 4. System components installed by others.
  - 5. Overhead supports and rigging hardware installed by others.
- D. Immediately notify the Owner, GC and Consultant(s) in writing of any discrepancies.

### 3.3 NEEDS ASSESSMENT

Include one on-site meeting with the surgery nursing manager to review the nurse call/code blue system. Review the floor plan drawing, educate the nursing manager with the functions of the equipment that is being provided and gather details specific to the individual units; coverage and priorities of calls; staffing patterns; and other pertinent details that will affect system programming and training. Coordinate the meeting through the RE. Notify the A/E of any revisions requested in the assessment meeting.

### 3.4 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, Owner and TVE 0050P3B.
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 in size and quantity required. Do not allow cable to leave or enter boxes without cover plates installed.
7. Active electronic component equipment shall consist of solid state components, be rated for continuous duty service, comply with the requirements of FCC standards for telephone and data equipment, systems, and service.
8. Color code all distribution wiring to conform to the Nurse Call Industry Standard, EIA/TIA, and this document, whichever is the more stringent. At a minimum, all equipment, cable duct and/or conduit, enclosures, wiring, terminals, and cables shall be clearly and permanently labeled according to and using the provided record drawings, to facilitate installation and maintenance.
9. Connect the System's primary input AC power to the Facility's Critical Branch of the Emergency AC power distribution system as shown on the plans or if not shown on the plans consult with RE regarding a suitable circuit location prior to bidding.
10. Product Delivery, Storage and Handling:
  - a. Delivery: Deliver materials to the job site in OEM's original unopened containers, clearly labeled with the OEM's name and equipment catalog numbers, model and serial identification

numbers. The RE may inventory the cable, patch panels, and related equipment.

- b. Storage and Handling: Store and protect equipment in a manner, which will preclude damage as directed by the RE.
- 11. Where TCOs are installed adjacent to each other, install one outlet for each instrument.
- 12. Equipment installed outdoors shall be weatherproof or installed in weatherproof enclosures with hinged doors and locks with two keys.

B. Equipment Cabinets:

- 1. Fill unused equipment mounting spaces with blank panels or vent panels. Match color to equipment racks/cabinets.
- 2. Provide security covers for all devices not requiring routine operator control.
- 3. Provide vent panels and cooling fans as required for the operation of equipment within the OEM' specified temperature limits. Provide adequate ventilation space between equipment for cooling. Follow manufacturer's recommendations regarding ventilation space between amplifiers.
- 4. Provide insulated connections of the electrical raceway to equipment racks.
- 5. Provide continuous raceway/conduit with no more than 40% fill between wire troughs and equipment racks/cabinets for all non-plenum-rated cable. Ensure each system is mechanically separated from each other in the wireway.
- 6. Ensure a minimum of 36 inches around each cabinet and/or rack to comply with OSHA Safety Standards. Cabinets and/or Racks installed side by side - the 36" rule applies to around the entire assembly

C. Cabling.

- 1. Equipment shall be wired in accordance with industry standards and shall employ "latest state-of-the-art" devices.
- 2. Equipment cabinets shall be connected to the local system ground.

D. Network WAN Cabling: Field verify that the total length of the Nurse Call WAN network cable does not exceed the manufacturer maximum allowable distance. Where required, install a network module for this project in a lockable NEMA 1 backbox in a location approved by the VA Biomed staff and extend the network to the NC headend on First Level.

- E. Wiring Practice - in addition to the MANDATORY infrastructure requirements outlined in VA Construction Specifications 27 10 00 - TIP Structured Communications Cabling, 27 11 00 - TIP Communications Rooms Fittings and 27 15 00 - TIP Horizontal and Vertical Communicators Cabling, the following additional practices shall be adhered too:
1. Comply with requirements for raceways and boxes specified in Division 26 Section "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. Wiring shall be classified according to the following low voltage signal types:
    - a. Balanced microphone level audio (below -20dBm) or Balanced line level audio (-20dBm to +30dBm)
    - b. 70V audio speaker level audio.
    - c. Low voltage DC control or power (less than 48VDC)
  4. 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 four (4) inches. Where Wiring of differing classifications must cross, they shall cross perpendicular to one another.
  5. 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.
  6. 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.
  7. Replace the entire length of the run of any wire or cable that is damaged or abraided during installation. There are no acceptable methods of repairing damaged or abraided wiring.
  8. Use wire pulling lubricants and pulling tensions as recommended by the OEM.
  9. Use grommets around cut-outs and knock-outs where conduit or chase nipples are not installed.
  10. Do not use tape-based or glue-based cable anchors.



11. Ground shields and drain wires to the Facility's signal ground system as indicated by the drawings.
12. Field wiring entering equipment racks shall be terminated as follows:
  - a. Provide OEM directed 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. Line level and speaker level wiring may be terminated inside the equipment rack using specified terminal blocks (see "Products.") Provide 15% spare terminals inside each rack. Microphone level wiring may only be terminated at the equipment served.
  - c. Employ permanent strain relief for any cable with an outside diameter of 1" or greater.
13. Use only balanced audio circuits unless noted otherwise directed and indicated on the drawings.
14. Make all connections as recommended by the system manufacturer and as follows:
  - a. Make all connections using rosin-core solder or mechanical connectors appropriate to the application.
  - b. For crimp-type connections, use only tools that are specified by the manufacturer for the application.
  - c. Use only insulated spade lugs on screw terminals. Spade lugs shall be sized to fit the wire gauge. Do not exceed two lugs per terminal.
  - d. Wire nuts, electrical tape or "Scotch Lock" connections are not acceptable for any application.
15. Noise filters and surge protectors shall be provided for each equipment interface cabinet, switch equipment cabinet, control console, local, and remote active equipment locations to ensure protection from input primary AC power surges and noise glitches are not induced into low Voltage data circuits.
16. Wires or cables, where specifically approved by the RE to be installed outside of conduit, cable trays, wireways, cable duct, etc:
  - a. Only where specifically authorized as described herein, will wires or cables be identified and approved to be installed

outside of conduit. The wire or cable runs shall be UL rated plenum and OEM certified for use in air plenums.

- b Wires and cables shall be hidden, protected, fastened and tied at 600 mm (24 in.) intervals, maximum, as described herein to building structure.
  - c Closer wire or cable fastening intervals may be required to prevents sagging, maintain clearance above suspended ceilings, remove unsightly wiring and cabling from view and discourage tampering and vandalism. Wire or cable runs, not provided in conduit, that penetrate outside building walls, supporting walls, and two hour fire barriers shall be sleeved and sealed with an approved fire retardant sealant.
  - d Completely test all of the cables after installation and replace any defective cables.
  - e Wires or cables that are installed outside of buildings shall be in conduit, secured to solid building structures. If specifically approved, on a case by case basis, to be run outside of conduit, the wires or cables shall be installed, as described herein. The bundled wires or cables must: Be tied at not less than 460 mm (18 in.) intervals to a solid building structure; have ultra violet protection and be totally waterproof (including all connections). The laying of wires or cables directly on roof tops, ladders, drooping down walls, walkways, floors, etc. is not allowed and will not be approved.
- F. Cable Installation - Cable Installation - In addition to the *MANDATORY* infrastructure requirements outlined in VA Construction Specifications 27 10 00 - Structured TIP Communications Cabling, 27 11 00 - TIP Communications Rooms and Fittings and 27 15 00 - TIP Communications Horizontal and Vertical Cabling and the following additional practices shall be adhered too:
- 1. Support cable on maximum 2'-0" centers and within 6-inches of cabinets, boxes or fittings. Acceptable means of cable support are cable tray, j-hooks, and bridal rings. Velcro wrap cable bundles loosely to the means of support with plenum rated Velcro straps. Plastic tie wraps are not acceptable as a means to bundle cables.
  - 2. Run cables parallel to walls.
  - 3. Install maximum of 10 cables in a single row of J-hooks. Provide necessary rows of J-hooks as required by the number of cables.

4. Do not lay cables on top of light fixtures, ceiling tiles, mechanical equipment, or ductwork. Maintain at least 2'-0" clearance from all shielded electrical apparatus.
5. All cables shall be tested after the total installation is fully complete. All test results are to be documented. All cables shall pass acceptable test requirements and levels. Contractor shall remedy any cabling problems or defects in order to pass or comply with testing. This includes the re-pull of new cable as required at no additional cost to the Owner.
6. Ends of cables shall be properly terminated on both ends per industry and OEM's recommendations.
7. Provide proper temporary protection of cable after pulling is complete before final dressing and terminations are complete. Do not leave cable lying on floor. Bundle and tie wrap up off of the floor until you are ready to terminate.
8. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at outlets and terminals.
9. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Cables may not be spliced.
10. Bundle, lace, and train conductors to terminal points without exceeding OEM's limitations on bending radii. Install lacing bars and distribution spools.
11. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used.
12. Cable shall not be run through structural members or be in contact with pipes, ducts, or other potentially damaging items.
13. Separation of Wires: (REFER TO RACEWAY INSTALLATION) Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inches apart for speaker microphones and adjacent parallel power and telephone wiring. Separate other intercommunication equipment conductors as recommended by equipment manufacturer.
14. Serve all cables as follows:
  - a. Cover the end of the overall jacket with a 1" (minimum) length of transparent heat-shrink tubing. Cut unused insulated conductors 2" (minimum) past the heat-shrink, fold back over jacket and

- secure with cable-tie. Cut unused shield/drain wires 2" (minimum) past the Heatshrink and serve as indicated below.
  - b. Cover shield/drain wires with heat-shrink tubing extending back to the overall jacket. Extend tubing ¼" past the end of unused wires, fold back over jacket and secure with cable tie.
  - c. For each solder-type connection, cover the bare wire and solder connection with heat-shrink tubing.
- G. Labeling: Provide labeling in accordance with ANSI/EIA/TIA-606-A. All lettering for Nurse Call and/or Code Blue circuits shall be stenciled using laser printers.
1. Cable and Wires (Hereinafter referred to as "Cable"): Cables shall be labeled at both ends in accordance with ANSI/EIA/TIA-606-A. Labels shall be permanent in contrasting colors. Cables shall be identified according to the System "Record Wiring Diagrams."
  2. Equipment: System equipment shall be permanently labeled with contrasting plastic laminate or Bakelite material. System equipment shall be labeled on the face of the unit corresponding to its source.
    - a. Clearly, consistently, logically and permanently mark switches, connectors, jacks, relays, receptacles and electronic and other equipment.
    - b. Engrave and paint fill all receptacle panels using 1/8" (minimum) high lettering and contrasting paint.
    - c. 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.
  3. Conduit, Cable Duct, and/or Cable Tray: The Contractor shall label all conduit, duct and tray, including utilized GFE, with permanent marking devices or spray painted stenciling a minimum of 3 meters (10 ft.) identifying it as the System. In addition, each enclosure shall be labeled according to this standard.
  4. Termination Hardware: The Contractor shall label TCOs and patch panel connections using color coded labels with identifiers in accordance with ANSI/EIA/TIA-606-A and the "Record Wiring Diagrams."
  5. 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.

6. 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.
  7. Contractor's name shall appear no more than once on each continuous set of racks. The Contractor's name shall not appear on wall plates or portable equipment.
  8. Ensure each OEM supplied item of equipment has appropriate UL Labels / Marks for the service the equipment is performed permanently attached / marked to a *non-removal* board in the unit. EQUIPMENT INSTALLED NOT BEARING THESE UL MARKS WILL NOT BE ALLOWED TO BE A PART OF THE SYSTEM. THE CONTRACTOR SHALL BEAR ALL COSTS REQUIRED TO PROVIDE REPLACEMENT EQUIPMENT WITH APPROVED UL MARKS.
- H. Conduit and Signal Ducts: When the Contractor and/or OEM determines additional system conduits and/or signal ducts are required in order to meet the system minimum performance standards outlined herein, the contractor shall provide these items as follows:
1. Conduit:
    - a. The Contractor shall employ the latest installation practices and materials. The Contractor shall provide conduit, junction boxes, connectors, sleeves, and associated sealing materials not specifically identified in this document as GFE. Conduit penetrations of walls, ceilings, floors, interstitial space, fire barriers, etc., shall be sleeved and sealed.
    - b. All cables shall be installed in separate conduit and/or signal ducts (exception from the separate conduit requirement to allow Nurse Call and/or Code Blue cables to be installed in partitioned cable tray with voice cables may be granted in writing by the RE if requested). Conduits shall be provided in accordance with Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS, and NEC Articles 517 for Critical Care and 800 for Communications systems, at a minimum.
    - c. When metal, plastic covered, etc., flexible cable protective armor or systems are specifically authorized to be provided for use in the System, their installation guidelines and standards shall be as specified herein, Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS, and the NEC.

- d. When "interduct" flexible cable protective systems is specifically authorized to be provided for use in the System, it's installation guidelines and standards shall be as the specified herein, Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS, and the NEC.
  - e. Conduit fill (including GFE approved to be used in the system) shall not exceed 40%. Each conduit end shall be equipped with a protective insulator or sleeve to cover the conduit end, connection nut or clamp, to protect the wire or cable during installation and remaining in the conduit. Electrical power conduit shall be installed in accordance with the NEC. AC power conduit shall be run separate from signal conduit.
  - f. Ensure that Critical Care Nurse Call and/or Code Blue Systems (as identified by NEC Section 517) are completely separated and protected from all other systems.
2. Signal Duct, Cable Duct, or Cable Tray:
- a. The Contractor shall use GFE signal duct, cable duct, and/or cable tray, when identified and approved by the RE.
  - b. Verify the cable tray installation includes required protective sleeves, guides or barriers on all sharp corners, openings, anchors, bolts or screw ends, junction, interface and connection points.
  - c. All cable junctions and taps shall be accessible. Provide an 8" X 8" X 4" (minimum) junction box attached to the cable duct or raceway for installation of distribution system passive equipment. Ensure all equipment and tap junctions are accessible

### 3.5 PROTECTION OF NETWORK DEVICES

- A. Contractor shall protect network devices during unpacking and installation by wearing manufacturer approved electrostatic discharge (ESD) wrist straps tied to chassis ground. The wrist strap shall meet OSHA requirements for prevention of electrical shock, should technician come in contact with high voltage.

### 3.7 FIREPROOFING

- A. Where Nurse Call and/or Code Blue wires, cables and conduit penetrate fire rated walls, floors and ceilings, fireproof the opening.
- B. Provide conduit sleeves (if not already provided by electrical contractor) for cables that penetrate fire rated walls and Telecommunications Rooms floors and ceilings. After the cabling

installation is complete, install fire proofing material in and around all conduit sleeves and openings. Install fire proofing material thoroughly and neatly. Seal all floor and ceiling penetrations.

- C. Use only materials and methods that preserve the integrity of the fire stopping system and its rating.
- D. Install fireproofing where low voltage cables are installed in the same manholes with high voltage cables; also cover the low voltage cables with arc proof and fireproof tape.
- E. Use approved fireproofing tape of the same type as used for the high voltage cables, and apply the tape in a single layer, one-half lapped or as recommended by the manufacturer. Install the tape with the coated side towards the cable and extend it not less than 25 mm (one inch) into each duct.
- F. Secure the tape in place by a random wrap of glass cloth tape.

### 3.8 GROUNDING

- A. Ground Nurse Call and/or Code Blue cable shields and equipment to eliminate shock hazard and to minimize ground loops, commonmode returns, noise pickup, cross talk, and other impairments as specified in CFM Division 27, Section 27 05 26 - Grounding and Bonding for Communications Systems.
- B. Facility Signal Ground Terminal: Locate at main room or area signal ground within the room (i.e. head end and telecommunications rooms) or area(s) and indicate each signal ground location on the drawings.
- C. Extend the signal ground to inside each equipment cabinet and/or rack. Ensure each cabinet and/or rack installed item of equipment is connected to the extended signal ground. Isolate the signal ground from power and major equipment grounding systems.

## PART 4 - TESTING / GUARANTY / TRAINING

### 4.0 SYSTEM LISTING

The Nurses Call System is NFPA listed as an "Emergency" Communication system. Where Code Blue signals are transmitted, that listing is elevated to "Life Support/Safety." Therefore, the following testing and guaranty provisions are the minimum to be performed and provided by the contractor and Warranted by the OEM.

### 4.1 PROOF OF PERFORMANCE TESTING

- A. Intermediate Testing:
  - 1. After completion of 30 - 40% of the installation of a head end cabinet(s) and interconnection to the corresponding System Patient

- Head Wall Units and equipment, one master stations, local and remote stations, treatment rooms, and prior to any further work, this portion of the system must be pretested, inspected, and 1certified. Each item of installed equipment shall be checked to ensure appropriate UL Listing and Certification Labels are affixed as required by NFPA -Life Safety Code 101-3.2 (a) & (b), UL Nurse Call Standard 1069 and JCHCO evaluation guidelines, and proper installation practices are followed. The intermediate test shall include a full operational test.
2. All inspections and tests shall be conducted by an OEM-certified contractor representative and witnessed by TVE-0050P3B if there is no local Government Representative that processes OEM and VA approved Credentials to inspect and certify the system. The results of the inspection will be officially recorded by the Government Representative and maintained on file by the RE, until completion of the entire project. The results will be compared to the Acceptance Test results. An identical inspection may be conducted between the 65 - 75% of the system construction phase, at the direction of the RE.

B. Pretesting:

1. Upon completing installation of the Nurse Call and/or Code Blue System, the Contractor shall align, balance, and completely pretest the entire system under full operating conditions.
2. Pretesting Procedure:
  - a. During the System Pretest the Contractor shall verify (utilizing approved test equipment) that the System is fully operational and meets all the System performance requirements of this standard.
  - b. The Contractor shall pretest and verify that all PSM System functions and specification requirements are met and operational, no unwanted aural effects, such as signal distortion, noise pulses, glitches, audio hum, poling noise, etc. are present. At a minimum, each of the following locations shall be fully pretested:
    - 1) Central Control Cabinets.
    - 2) Nurse Control Stations.
      - a) Master Stations
      - b) Patient Stations
      - c) Staff Stations



- d) Emergency Stations
- e) Code Blue Stations
- 3) Dome Lights.
  - a) Patient Rooms
  - b) Corridors
  - c) Intersectional
- 4) STRs
- 5) Local and Remote Enunciation Panels (code blue).
- 6) Electrical Supervision Panels/Functions/locations.
- 7) All Networked locations.
- 8) System interface locations (i.e. wireless, PA, telephone, etc.).
- 9) System trouble reporting.
- 10) System electrical supervision.
- 11) UPS operation.
- 12) Primary / Emergency AC Power Requirements
- 13) Extra Auxiliary Generator Requirements.
- 14) NSs.
- 3. The Contractor shall provide four (4) copies of the recorded system pretest measurements and the written certification that the System is ready for the formal acceptance test shall be submitted to the RE.

C. Acceptance Test:

- 1. After the Nurse Call and/or Code Blue System has been pretested and the Contractor has submitted the pretest results and certification to the RE, then the Contractor shall schedule an acceptance test date and give the RE 15 working days written notice prior to the date the acceptance test is expected to begin. The System shall be tested in the presence of a TVE 0050P3B and OEM certified representatives. The System shall be tested utilizing the approved test equipment to certify proof of performance and Life Safety / Critical Service compliance. The tests 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 four (4) hours, shall be cause for terminating the acceptance test of the System. Repeated failures that result in a cumulative time of eight (8) hours to affect repairs shall cause the entire System to be declared unacceptable.

3. Retesting of the entire System shall be rescheduled at the convenience of the Government and costs borne by the Contractor at the direction of the SRE.

D. Acceptance Test Procedure:

1. Physical and Mechanical Inspection:

- a. The TVE 0050P3B Representative will tour all major areas where the Nurse Call and/or Code Blue System and all sub-systems 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, TIP 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. Operational Test:

- a. After the Physical and Mechanical Inspection, the central terminating and nurse call master control equipment shall be checked to verify that it meets all performance requirements outlined herein. A spectrum analyzer and sound level meter may be utilized to accomplish this requirement.
- b. Following the central equipment test, a pillow speaker (or on board speaker) shall be connected to the central terminating and nurse call master control equipment's output tap to ensure there are no signal distortions such as intermodulation, data noise, popping sounds, erratic system functions, on any function.

- c. The distribution system shall be checked at each interface, junction, and distribution point, first, middle, and last intersectional, room, and bed dome light in each leg to verify that the nurse call distribution system meets all system performance standards.
  - d. Each MATV outlet that is controlled by a nurse call pillow speaker shall be functionally tested at the same time utilizing the Contractor's approved hospital grade HDTV receiver and TV remote control cable.
  - e. The RED system and volume stepper switches shall be checked to insure proper operation of the pillow speaker, the volume stepper and the RED system (if installed).
  - f. Additionally, each installed emergency, patient, staff, duty, panic station, intersectional, room, and bed dome light, power supply, code one, and remote annunciator panels shall be checked insuring they meet the requirements of this specification.
  - g. Once these tests have been completed, each installed sub-system function shall be tested as a unified, functioning and fully operating system. The typical functions are: nurse follower, three levels of emergency signaling (i.e. flashing red emergency, flashing white patient emergency, flashing white or combination lights for staff emergency, separate flashing code blue), minimum of 10 minutes of UPS operation, memory saving, minimum of ten station audio paging, canceling emergency calls at each originating station only, and storage and prioritizing of calls.
  - h. Individual Item Test: The TVE 0050P3B Representative will select individual items of equipment for detailed proof of performance testing until 100% of the System has been tested and found to meet the contents of this specification. Each item shall meet or exceed the minimum requirements of this document.
3. 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 borne by the Contractor.
- E. Acceptable Test Equipment: The test equipment shall be furnished by the Contractor shall have a calibration tag of an acceptable calibration service dated not more than 12 months prior to the test. As part of the submittal, a test equipment list shall be furnished that includes the make and model number of the following type of equipment as a minimum:
  - 1. Spectrum Analyzer.
  - 2. Signal Level Meter.
  - 3. Volt-Ohm Meter.
  - 4. Sound Pressure Level (SPL) Meter.
  - 5. Oscilloscope.
  - 6. Pillow Speaker Test Set (Pillow Speaker with appropriate load and cross connections in lieu of the set is acceptable).
  - 7. Patient Push Button Cord Test Set.
  - 8. Patient Bed with connecting multiple conductor cord.

#### 4.2 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 RE (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 two (2) copies of current and qualified OEM training certificates and OEM certification upon request.
  - 4. Additionally, the Contractor shall accomplish the following minimum requirements during the one year warranty period:

- a. Response Time during the Two Year Guaranty Period:
- 1) The RE (or Facility Contracting Officer if the system has been turned over to the Facility) is the Contractor's ONLY OFFICIAL reporting and contact official for nurse call system trouble calls, during the guaranty period.
  - 2) A standard work week is considered 8:00 A.M. to 5:00 P.M. or as designated by the RE (or Facility Contracting Officer), Monday through Friday exclusive of Federal Holidays.
  - 3) The Contractor shall respond and correct on-site trouble calls, during the standard work week to:
    - a) A routine trouble call within one (1) working day of its report. A routine trouble is considered a trouble which causes a pillow speaker or cordset, one (1) master nurse control station, patient station, emergency station, or dome light to be inoperable.
    - b) Routine trouble calls in critical emergency health care facilities (i.e., cardiac arrest, intensive care units, etc.) shall also be deemed as an emergency trouble call. The RE (or Facility Contracting Officer) shall notify the Contractor of this type of trouble call.
    - c) An emergency trouble call within four hours of its report. An emergency trouble is considered a trouble which causes a sub-system (ward), distribution point, terminal cabinet, or code one system to be inoperable at anytime.
  - 4) If a Nurse Call and/or Code Blue/ component failure cannot be corrected within four (4) hours (exclusive of the standard work time limits), the Contractor shall be responsible for providing alternate nurse call equipment. The alternate equipment/system shall be operational within a maximum of 20 hours after the four (4) hour trouble shooting time and restore the effected location operation to meet the System performance standards. If any sub-system or major system trouble cannot be corrected within one working day, the Contractor shall furnish and install compatible substitute equipment returning the System or sub-system to full operational capability, as described herein, until repairs are complete.
- b. Required On-Site Visits during the *Two Year Guaranty Period*

- 1) The Contractor shall visit, on-site, for a minimum of eight (8) hours, once every 12 weeks, during the guaranty period, to perform system preventive maintenance, equipment cleaning, and operational adjustments to maintain the System according the descriptions identified in this document.
- 2) The Contractor shall arrange all Facility visits with the RE (or Facility Contracting Officer) prior to performing the required maintenance visits.
- 3) Preventive maintenance shall be performed by the Contractor in accordance with the OEM's recommended practice and service intervals during non-busy time agreed to by the RE (or Facility Contracting Officer) and Contractor.
- 4) The preventive maintenance schedule, functions and reports shall be provided to and approved by the RE (or Facility Contracting Officer).
- 5) The Contractor shall provide the RE (or Facility Contracting Officer) a type written report itemizing each deficiency found and the corrective action performed during each required visit or official reported trouble call. The Contractor shall provide the RE with sample copies of these reports for review and approval at the beginning of the Acceptance Test. The following reports are the minimum required:
  - a) The Contractor shall provide a monthly summary all equipment and sub-systems serviced during this guarantee period to RE (or Facility Contracting Officer) by the fifth (5<sup>th</sup>) working day after the end of each month. The report shall clearly and concisely describe the services rendered, parts replaced and repairs performed. The report shall prescribe anticipated future needs of the equipment and systems for preventive and predictive maintenance.
  - b) The Contractor shall maintain a separate log entry for each item of equipment and each sub-system of the System. The log shall list dates and times of all scheduled, routine, and emergency calls. Each emergency call shall be described with details of the nature and causes of emergency steps taken to rectify the situation and specific recommendations to avoid such conditions in the future.

6) The RE (or Facility Contracting Officer) shall convey to the Facility Engineering Officer, two (2) copies of actual reports for evaluation.

a) The RE (or Facility Contracting Officer) shall ensure a copy of these reports is entered into the System's official acquisition documents.

b) The Facility Chief Engineer shall ensure a copy of these reports is entered into the System's official technical record documents.

B. Work Not Included: Maintenance and repair service shall not include the performance of any work due to improper use; accidents; other vendor, contractor, or owner tampering or negligence, for which the Contractor is not directly responsible and does not control. The Contractor shall immediately notify the RE or Facility Contracting Officer in writing upon the discovery of these incidents. The RE or Facility Contracting Officer will investigate all reported incidents and render

#### 4.3 TRAINING

A. Provide thorough training of all nursing staff assigned to those nursing units receiving new networked nurse/patient communications equipment. This training shall be developed and implemented to address two different types of staff. Floor nurses/staff shall receive training from their perspective, and likewise, unit secretaries (or any person whose specific responsibilities include answering patient calls and dispatching staff) shall receive operational training from their perspective. A separate training room will be set up that allows this type of individualized training utilizing in-service training unit, prior to cut over of the new system.

B. Provide the following minimum training times and durations:

1. 48 hours prior to opening for nursing staff (in 8-hour increments) - split evenly over 3 weeks and day and night shifts. Coordinate schedule with Owner.
2. 32 hours during the opening week for nursing staff - both day and night shifts.
3. 24 hours for supervisors and system administrators.

- - - E N D - - -

**SECTION 28 13 16**  
**ACCESS CONTROL SYSTEM**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the finishing, installation, connection, testing and certification of a complete and fully operation Access Control System, hereinafter referred to as the ACS.
- B. This section includes connecting the system into the existing ACS network and configuring the existing system to monitor devices added under this Work.
- C. This products provided for this Section shall be from Johnson Controls, Inc., hereinafter referred to as JCI.

**1.2 RELATED WORK**

- A. Section 01 00 00 - General Requirements.
- B. 27 05 11 - Requirements For Low Voltage Systems Installations.

**1.3 QUALITY ASSURANCE**

- A. The Contractor shall be responsible for providing, installing, and the operation of the Access Control System and Database Management as shown. The Contractor shall also provide certification as required.
- B. The security system shall be installed and tested to ensure all components are fully compatible as a system and can be integrated with all associated security subsystems, whether the security system is stand-alone or a part of a Information Technology (IT) computer network.
- C. The Contractor or security sub-contractor shall be a licensed security Contractor as required within the state or jurisdiction of where the installation work is being conducted.
- D. The manufacturers of all hardware and software components employed in the SMS shall be established vendors to the access control/security monitoring industry for no less than five (5) years and shall have successfully implemented at least 5 systems of similar size and complexity.
- E. Contractor / Integrator Qualifications
  - 1. The security system integrator shall have been regularly engaged in the installation and maintenance of integrated



- access control systems and have a proven track record with similar systems of the same size, scope, and complexity.
2. The security system integrator shall supply information attesting to the fact that their firm is an authorized product integrator certified with the SMS. A minimum of one technician shall be a installer certified by the SMS manufacturer.
  3. The security system integrator shall supply information attesting to the fact that their installation and service technicians are competent factory trained and certified personnel capable of maintaining the system and providing reasonable service time.
  4. The security system integrator shall provide a minimum of three (3) references whose systems are of similar complexity and have been installed and maintained by the security system integrator in the last five (5) years.
  5. There shall be a local representative and factory authorized local service organization that shall carry a complete stock of parts and provide maintenance for these systems.
- F. 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.

#### **1.4 SUBMITTALS**

- A. Submit below items in conjunction with Master Specification Sections 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, and Section 02 41 00, DEMOLITION.
- B. Provide certificates of compliance with Section 1.3, Quality Assurance.
- C. Provide a pre-installation and as-built design package in both electronic format and on paper, minimum size 48 x 48 inches (1220mm x 1220mm); drawing submittals shall be per the established project schedule.
- D. Pre-installation design and as-built packages shall include, but not be limited to:
  1. Index Sheet that shall:

- a. Define each page of the design package to include facility name, building name, floor, and sheet number.
  - b. Provide a list of all security abbreviations and symbols.
  - c. Reference all general notes that are utilized within the design package.
  - d. Specification and scope of work pages for all security systems that are applicable to the design package that will:
    - 1) Outline all general and job specific work required within the design package.
    - 2) Provide a device identification table outlining device Identification (ID) and use for all security systems equipment utilized in the design package.
2. Drawing sheets that will be plotted on the individual floor plans or site plans shall:
- a. Include a title block as defined above.
  - b. Define the drawings scale in both standard and metric measurements.
  - c. Provide device identification and location.
  - d. Address all signal and power conduit runs and sizes that are associated with the design of the electronic security system and other security elements (e.g., barriers, etc.).
  - e. Identify all pull box and conduit locations, sizes, and fill capacities.
  - f. Address all general and drawing specific notes for a particular drawing sheet.
3. A riser drawing for each applicable security subsystem shall:
- a. Indicate the sequence of operation.
  - b. Relationship of integrated components on one diagram.
  - c. Include the number, size, identification, and maximum lengths of interconnecting wires.
  - d. Wire/cable types shall be defined by a wire and cable schedule. The schedule shall utilize a lettering system that will correspond to the wire/cable it represents (example: A = 18 AWG/1 Pair Twisted, Unshielded). This schedule shall also provide the manufacturer's name and part number for the wire/cable being installed.
4. A system drawing for each applicable security system shall:

- a. Identify how all equipment within the system, from main panel to device, shall be laid out and connected.
  - b. Provide full detail of all system components wiring from point-to-point.
  - c. Identify wire types utilized for connection, interconnection with associate security subsystems.
  - d. Show device locations that correspond to the floor plans.
  - e. All general and drawing specific notes shall be included with the system drawings.
- 5. A schedule for all of the applicable security subsystems shall be included. All schedules shall provide the following information:
  - a. Device ID.
  - b. Device Location (e.g. site, building, floor, room number, location, and description).
  - c. Mounting type (e.g. flush, wall, surface, etc.).
  - d. Power supply or circuit breaker and power panel number.
  - e. In addition, for the CCTV Systems, provide the camera ID, camera type (e.g. fixed or pan/tilt/zoom (P/T/Z), lens type (e.g. for fixed cameras only) and housing model number.
- 6. Detail and elevation drawings for all devices that define how they were installed and mounted.
- E. Pre-installation design packages shall be reviewed by the Contractor along with a VA representative to ensure all work has been completed. All reviews shall be conducted in accordance with the project schedule. There shall be four (4) stages to the review process:
  - 1. 35 percent
  - 2. 65 percent
  - 3. 90 percent
  - 4. 100 percent
- F. Provide manufacturer security system product cut-sheets. Submit for approval at least 30 days prior to commencement of formal testing, a Security System Operational Test Plan. Include procedures for operational testing of each component and security subsystem, to include performance of an integrated system test.

- G. Submit manufacture's certification of Underwriters Laboratories, Inc. (UL) listing as specified. Provide all maintenance and operating manuals per Section 01 00 00, GENERAL REQUIREMENTS.

#### 1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below (including amendments, addenda, revisions, supplement, and errata) form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American National Standards Institute (ANSI)/ Security Industry Association (SIA):
- AC-03.....Access Control: Access Control Guideline  
Dye Sublimation Printing Practices for  
PVC Access Control Cards
  - TVAC-01.....CCTV to Access Control Standard - Message  
Set for System Integration
- C. American National Standards Institute (ANSI)/ International Code Council (ICC):
- A117.1.....Standard on Accessible and Usable  
Buildings and Facilities
- D. Department of Justice American Disability Act (ADA)
- 28 CFR Part 36.....2010 ADA Standards for Accessible Design
- E. Federal Communications Commission (FCC):
- (47 CFR 15) Part 15.....Limitations on the Use of Wireless  
Equipment/Systems
- F. Government Accountability Office (GAO):
- GAO-03-8-02Security.....Responsibilities for Federally Owned and  
Leased Facilities
- G. National Electrical Contractors Association
- 303-2005.....Installing Closed Circuit Television  
(CCTV) Systems
- H. National Electrical Manufacturers Association (NEMA):
- 250-08.....Enclosures for Electrical Equipment (1000  
Volts Maximum)
- I. National Fire Protection Association (NFPA):
- 70-11..... National Electrical Code
- J. Underwriters Laboratories, Inc. (UL):

294-99.....The Standard of Safety for Access Control  
System Units

305-08.....Standard for Panic Hardware

639-97.....Standard for Intrusion-Detection Units

752-05.....Standard for Bullet-Resisting Equipment

827-08.....Central Station Alarm Services

1076-95.....Standards for Proprietary Burglar Alarm  
Units and Systems

1981-03.....Central Station Automation System

2058-05.....High Security Electronic Locks

K. Homeland Security Presidential Directive (HSPD):

HSPD-12.....Policy for a Common Identification  
Standard for Federal Employees and  
Contractors

L. Federal Information Processing Standards (FIPS):

FIPS-201-1.....Personal Identity Verification (PIV) of  
Federal Employees and Contractors

M. National Institute of Standards and Technology (NIST):

IR 6887 V2.1.....Government Smart Card Interoperability  
Specification (GSC-IS)

Special Pub 800-37.....Guide for Applying the Risk Management  
Framework to Federal Information Systems

Special Pub 800-63.....Electronic Authentication Guideline

Special Pub 800-73-3....Interfaces for Personal Identity  
Verification (4 Parts)

.....Pt. 1- End Point PIV Card Application  
Namespace, Data Model & Representation

.....Pt. 2- PIV Card Application Card Command  
Interface

.....Pt. 3- PIV Client Application Programming  
Interface

.....Pt. 4- The PIV Transitional Interfaces &  
Data Model Specification

Special Pub 800-76-1....Biometric Data Specification for Personal  
Identity Verification

Special Pub 800-78-2....Cryptographic Algorithms and Key Sizes  
for Personal Identity Verification

- Special Pub 800-79-1....Guidelines for the Accreditation of  
Personal Identity Verification Card  
Issuers
- Special Pub 800-85B-1...DRAFTPIV Data Model Test Guidelines
- Special Pub 800-85A-2...PIV Card Application and Middleware  
Interface Test Guidelines (SP 800-73-3  
compliance)
- Special Pub 800-96.....PIV Card Reader Interoperability  
Guidelines
- Special Pub 800-104A....Scheme for PIV Visual Card Topography
- Special Pub 800-116.....Recommendation for the Use of PIV  
Credentials in Physical Access Control  
Systems (PACS)
- N. International Organization for Standardization (ISO):
  - 7810.....Identification cards - Physical  
characteristics
  - 7811.....Physical Characteristics for Magnetic  
Stripe Cards
  - 7816-1.....Identification cards - Integrated  
circuit(s) cards with contacts - Part 1:  
Physical characteristics
  - 7816-2.....Identification cards - Integrated circuit  
cards - Part 2: Cards with contacts -  
Dimensions and location of the contacts
  - 7816-3.....Identification cards - Integrated circuit  
cards - Part 3: Cards with contacts -  
Electrical interface and transmission  
protocols
  - 7816-4.....Identification cards - Integrated circuit  
cards - Part 11: Personal verification  
through biometric methods
  - 7816-10.....Identification cards - Integrated circuit  
cards - Part 4: Organization, security  
and commands for interchange
  - 14443.....Identification cards - Contactless  
integrated circuit cards; Contactless  
Proximity Cards Operating at 13.56 MHz in  
up to 5 inches distance

15693.....Identification cards -- Contactless  
integrated circuit cards - Vicinity  
cards; Contactless Vicinity Cards  
Operating at 13.56 MHz in up to 50 inches  
distance

19794.....Information technology - Biometric data  
interchange formats

O. Uniform Federal Accessibility Standards (UFAS) 1984

P. Section 508 of the Rehabilitation Act of 1973

#### **1.6 WARRANTY OF CONSTRUCTION.**

- A. Warrant ACS work subject to the Article "Warranty of Construction" of FAR clause 52.246-21 and Section 280500.
- B. Demonstration and training shall be performed prior to system acceptance.

### **PART 2 - PRODUCTS**

#### **2.1 GENERAL REQUIREMENTS**

- A. Provide ACS equipment and components that are 100% compatible with the existing Johnson Controls Inc. security system.
- B. Provide programming, upgrades, modifications and any required components to incorporate all equipment and devices of this Section into the existing ACS system. All monitoring and alarm functions shall match existing unless noted otherwise.

#### **2.2 SECURITY CONTROL PANELS**

- A. Provide headend security control panels(s) sized for the quantity of doors being controlled and configured to provide the features and functions as specified herein and to match the existing ACS system. Include power supplies/chargers with multi-outputs.
- B. Door control modules for future doors (noted as rough-in only), spare mounting space within security control panel(s), and any additional security control panels required to mount these future modules, are not to be included under this Scope of Work.
- C. Control panels shall be pre-wired, pre-assembled, nominal 5-inches deep, with a network controller with a quantity of two-

door interface modules as required for the door control indicated on the Drawings and other components as specified herein. ACS control panels shall include the following features:

1. Enclosure: Type 1, with keyed lock, door tamper switch, and battery support brackets.
2. Network Controller.
3. Door Modules: Include up to four (4) two-door interface modules in a 24"x 30" enclosure; and up to eight (8) two-door modules in a 30" x 42" enclosure.
4. Power Supplies.
5. Provide JCI SPA1B400-2D10 (8 Reader, 2PS, 1NC) or JCI SPA1B800-\*E10 (16 Reader, 3PS, 1NC) or approved equals.

D. Network Controllers: Advanced, intelligent controller, DIN mounted, capable of high volume, high-speed traffic with host security management systems. Features include:

1. 128MB flash memory
2. Up to 64 readers per panel
3. Embedded 32 bit processor
4. 10/100 Base-T network connection
5. DB9 port for configuration, commissioning and service maintenance.
6. 64MB memory for 200,000 cardholders
7. Accepts up to 20-digit badge numbers
8. 12 facility codes per reader
9. 40 Holidays
10. 64 Time zones
11. 32 Access group/time zone pairs per badge
12. Supports Wiegand, proximity, magnetic stripe, barium ferrite, smart card, most biometric readers and bar code card technologies.
13. Provide JCI Model CK721-A or approved equal.

E. Two-Door Interface Modules: Two state or 4 state, RS-485 communications interface, supporting up to two fully-configured doors per unit. Module specifications:

1. Input Power: 24 VDC @ 1.5 amps maximum
2. Lock Output: 2-wire Wiegand (up to 256 bits),  
5/12/24 VDC (5 W), R & G indicators



3. General Purpose Inputs: Resistive load
  4. General Purpose Outputs: 0-12 VDC
  5. Communications: 2-wire RS-485
  6. Certifications: UL 294, UL 1076, CSA/CUL  
C22.2 No. 205, FCC, Class B,
  7. Provide JCI S300-DIN-RDR2S PS or approved equal.
- F. Battery: Provide 12VDC, 7Ah, sealed lead-acid batteries with quick-disconnect tabs, for each panel. Provide the quantity of batteries as recommended by JCI for the devices being powered within each cabinet. Battery specifications:
1. Nominal Capacity:
 

20 hour rate (350mA to 10.50 volts):	7.0 A.H.
10 hour rate (650mA to 10.50 volts):	6.5 A.H.
5 hour rate (1.2A to 10.20 volts):	6.0 A.H.
1 hour rate (4.5A to 9.00 volts):	4.5 A.H.
15 min rate (14A to 9.00 volts):	3.5 A.H.
  2. Energy Density (20 hour rate): 1.43 Watt-hours/cubic inch (87.3 Watt-hours/l)
  3. Specific Energy (20 hour rate): 14.7 Watt-hours/pound (32.4 Watt-hours/kg)
  4. Internal Resistance (Fully Charged Battery): 22 milliohms (approximately)
  5. Maximum Discharge Current ( <\_ 7 Min.): 21 amperes
  6. Maximum Short-Duration Discharge Current ( <\_ 10 Sec.): 70 amperes
  7. Include appropriate bracket mounting kit.
  8. Provide JCI S8300-BAT battery or approved equal.
- G. Door Lock Power Supplies: Provide UL, 120VAC input/12VDC-24VDC output, 6-ampere, eight (8) independently controlled and protected outputs, quantity as required for the system. Power supply specifications:
1. 12VDC or 24VDC @ 6 amp supply current.
  2. Power supply input options:
    - a) One (1) common power input or
    - b) Two (2) isolated power inputs - one PS and one lock
  3. Eight (8) Access Control System trigger inputs. Options:
    - a) Eight (8) normally open (NO) inputs.
    - b) Eight (8) open collector inputs.
    - c) Any combination of the above.

4. Eight (8) independently controlled outputs. Options:
  - a) Eight (8) Fail-Safe and/or Fail-Secure power outputs.
  - b) Eight (8) form "C" 5 amp rated relay outputs-ACM only
  - c) Any combination of the above (AL600ULACM only)
5. Eight (8) auxiliary power outputs (unswitched)
6. Output ratings:
  - a) Fuses are rated @ 3.5 amp (AL600ULACM)
  - b) PTCs are rated @ 2.5 amp (AL600ULACMCB)
7. Input 115VAC 60Hz rated @ 1.9 amp.
8. Filtered and electronically regulated outputs
9. (built-in power supply)
10. Red LEDs indicate outputs are triggered (relays energized).
11. Built-in charger for sealed lead acid or gel type batteries.
12. AL600ULXB maximum charge current .7 amp.
13. Automatic switch over to stand-by battery when AC fails.
14. AC input and DC output LED indicators.
15. Zero voltage drop when unit switches over to battery backup (AC failure condition).
16. Short circuit and thermal overload protection.
17. AC fail supervision (form "C" contact).
18. Battery fail and battery presence supervision(form "C" contact).
19. Provide Altronix Model AL600ULACMCB or approved equal.

### 2.3 CARD READERS

- A. Provide contactless, 64-bit, audible, smart card readers with rugged polycarbonate enclosures for access control on the secure side of each secure door location.
- B. General Specifications: Select product options to match existing devices and features of the existing JCI ACS system:
  1. Black or gray housing.
  2. Standard or Elite key management.
  3. Terminal strip or 18" pigtail terminations
  4. Program LED/Beeper operation to match existing.
- C. Technical Specifications:
  1. Read range: 2" for Key/Tag, up to 4" for Card.

2. Dimensions: 3.3" x 4.8" x 1.0"
3. Power Supply: 5-16VDC (linear power supply)
4. Transmit Freq: 13.56MHz
5. Cable Distance: 500 feet, 22AWG
6. Housing: UL94 polycarbonate, IP55 rating
7. Certifications: UL294, FCC
8. Provide HID R40 iClass Proximity Reader Model 6120CGN0008-G3.0, 18/6 STP, or approved equal.

#### 2.4 ACCESS DOOR CONTROL DEVICES - GENERAL:

- A. Provide UL devices compatible with JCI ACS system; rated for intended use with features as specified herein.
- B. Refer to ADC details on Sheet T150. Review all ACS device locations with RE and VA Security prior to beginning rough-in work.
- C. Request-to-Exit Detectors: Field adjust each device to best suit the individual situation at each secure door.
  1. Adjust sounder volume as directed by Resident Engineer.
  2. Adjust mounting height and alignment for optimum operation and to prevent activation by through-traffic in hallways traveling past stairway doors and similar secure door locations. Field adjust nuisance trip locations as directed by the Resident Engineer.
  3. Include matching trim plates as required.
- D. Push To Exit: Field adjust each device to best suit the individual situation at each secure door.
  1. Adjust the time delay as directed by Resident Engineer and VA Security.
- E. Device Options: Configure each device to be compatible with, and to function similar to, the existing ACS system in the facility.
- F. Fire Alarm Input: Configure the ACS power supply integral fire alarm inputs to drop individual outputs upon a General Fire Alarm condition as noted and as required to meet Code.
- G. ACS Interface Device Mounting Locations: Field adjust device rough-in locations, mounting heights and horizontal offset distances from door swings and door jambs as directed by the Resident Engineer to best serve the facility and staff.

- H. Electric Strikes: Fail-secure type, as specified in Door Hardware.

## 2.5 SINGLE DOOR WITH PANIC BAR

- A. Provide the following products at each single door:
1. Power supply: JCI Model XYZ (secure side)
  2. 120V j-box (see electrical)
  3. Card Reader (non-secure side)
  4. Door Position Switch (Status Contact), recessed: JCI 1078, 20/2 STP (Surface Mounted: Sentrol 2505A-L or approved equal)
  5. Request to Exit, Automated (Motion Detector): Bosch DS160 (12VDC/24VDC, 20/4 STP, secure side)
  6. Electric Strike: See Door Hardware Spec.

## 2.6 ACCESS CONTROL, SINGLE DOOR (No Panic Bar)

- A. Provide the following products at each single door:
1. Power supply: JCI Model XYZ (secure side)
  2. 120V j-box (see electrical)
  3. Card Reader (non-secure side - see above)
  4. Door Position Switch (Status Contact), recessed secure side: JCI 1078, 20/2 STP (Surface Mounted: Sentrol 2505A-L or approved equal)
  5. Request to Exit, Automated (Motion Detector): Bosch DS160 (12VDC/24VDC, 20/4 STP, secure side)
  6. Push-to-Exit, Manual (push button): GE TS-40 (Illuminated, 20/4 STP, secure side)
  7. Electric Strike: See Door Hardware Spec.

## 2.7 ACCESS CONTROL, DOUBLE DOOR

- A. Provide the following products at each double door:
1. Power supply: JCI Model XYZ (secure side)
  2. 120V j-box (see electrical)
  3. Card Reader (non-secure side - see above)
  4. Door Position Switch (Status Contact), recessed: JCI 1078, 20/2 STP (Surface mounted: Sentrol 2505A-L)
  5. Request to Exit, Automated (Motion Detector): Bosch DS-160 12/24VDC, 20/4 STP
  6. Push-to-Exit, Manual (push button): GE TS-40 (Illuminated, 20/4 STP)

7. Electric Mortise: See Door Hardware Spec; wired via electrified hinge.

## 2.8 CABLING

- A. Provide UL listed cables as recommended by the manufacturer for each product, device and control required. Cables shall be plenum rated unless noted otherwise.
- B. Cables 25\_Series (For Reader, Lock, Contact, Motion, EM Door)
- C. Cables: 20AWG, 4-pair, STP
- D. Cables: 20AWG, 2-pair, STP

## 2.9 FIRMWARE

- A. Include all required updates to the existing ACS system firmware, central station monitors and all related notification systems as part of this Work.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. System installation shall be in accordance with manufacturer and related documents and references, for each type of security subsystem designed, engineered and installed.
- B. All software shall be installed per the design package and the manufacturer's installation specifications.
- C. Coordinate installation and door control devices with door hardware and architectural door details and specifications.
- D. Install system control panel and power supplies per manufacturer and as shown on the Drawings. Connect headend panels to UPS power.
- E. Install Request-to-Exit devices on secure side of each door with access control.

## 3.2 TESTING AND TRAINING

- A. All testing and training shall be compliant with the VA General Requirements, Section 01 00 00, GENERAL REQUIREMENTS.
- B. Perform testing and system certification as outlined in section 28 05 00 COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY.
- C. The software shall be entered into the SMS computer systems and debugged. The Contractor shall be responsible for documenting and entering the initial database into the system. The Contractor

shall provide the necessary blank forms with instructions to fill in all the required data information that will make up the database. The database shall then be reviewed by the Contractor and entered into the system. Prior to full operation, a complete demonstration of the computer real time functions shall be performed. A printed validation log shall be provided as proof of operation for each software application package. In addition, a point utilization report shall be furnished listing each point, the associated programs utilizing that point as an input or output and the programs which that point initiates.

- D. Upon satisfactory on line operation of the system software, the entire installation including all subsystems shall be inspected. The Contractor shall perform all tests, furnish all test equipment and consumable supplies necessary and perform any work as required to establish performance levels for the system in accordance with the specifications. Each device shall be tested as a working component of the completed system. All system controls shall be inspected for proper operation and response.
- E. Tests shall demonstrate the response time and display format of each different type of input sensor and output control device. Response time shall be measured with the system functioning at full capacity. Computer operation shall be tested with the complete data file.
- F. The Contractor shall provide a competent trainer who has extensive experience on the installed systems and in delivering training to provide the instruction. As an alternative, the Contractor may propose the use of factory training personnel and coordinate the number of personnel to be trained.

### **3.3 MAINTENANCE**

- A. The Contractor shall offer a Support Agreement (SSA) in order for Technical Support Specialists to reactively troubleshoot system problems.
- B. As part of the agreement, 5x9 telephone support (Standard and Enhanced SSA) will be provided to the Contractor by Certified Technicians. An option of 7x24 Standby telephone support (Enhanced SSA) shall be offered.
- C. As part of the agreement, Flashable and Non-Flashable (Chips) firmware updates and documentation shall be provided.

- D. As part of the agreement, access to Security Management System (SMS) software patches and software release updates shall be provided.
- E. The Support Agreement shall cover the current version of the SMS software release one full version back, and associated controller hardware.

-----END-----

**SECTION 28 23 10**  
**VIDEO MONITORING SYSTEMS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Provide and install a complete local Video Monitoring System, which is identified as the VMS (Video Monitoring System) hereinafter referred to as the VMS System as specified in this section.
- B. This Section includes video surveillance system consisting of cameras, data transmission wiring, and a control station with its associated equipment.
- C. Video Monitoring System is a stand-alone system for the Surgical Suite, with multiple viewing/control locations within the suite.

**1.2 RELATED WORK**

- A. Section 01 00 00 - GENERAL REQUIREMENTS. For General Requirements.
- B. Section 07 84 00 - FIRESTOPPING. Requirements for firestopping application and use.
- F. Section 26 05 11 - REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- G. Section 26 05 21 - LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW). Requirements for power cables.
- J. SECTION 27 05 11 - COMMON WORK RESULTS FOR LOW VOLTAGE SYSTEMS. Requirements for general requirements that are common to all Sections in Division 27 and Division 28.

**1.3 DEFINITIONS**

- A. AGC: Automatic gain control.
- B. B/W: Black and white.
- C. CCD: Charge-coupled device.
- D. CIF: Common Intermediate Format CIF images are 352 pixels wide and 88/240 (PAL/NTSC) pixels tall (352 x 288/240).
- E. 4CIF: resolution is 704 pixels wide and 576/480 (PAL/NTSC) pixels tall (704 x 576/480).
- F. H.264 (also known as MPEG4 Part 10): a encoding format that compresses video much more effectively than older (MPEG4) standards.
- G. ips: Images per second.
- H. MPEG: Moving picture experts group.
- I. MPEG4: a video encoding and compression standard that uses inter-frame encoding to significantly reduce the size of the video stream being transmitted.
- J. NTSC: National Television System Committee.



- K. UPS: Uninterruptible power supply.
- L. PTZ: refers to a movable camera that has the ability to pan left and right, tilt up and down, and zoom or magnify a scene.

#### **1.4 QUALITY ASSURANCE**

- A. The Contractor shall be responsible for providing, installing, and the operation of the VMS System as shown. The Contractor shall also provide certification as required.
- B. The system shall be installed and tested to ensure all components are fully compatible as a system.
- C. The Contractor or security sub-contractor shall be a licensed security Contractor as required within the state or jurisdiction of where the installation work is being conducted.
- D. 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.
- E. 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.
- F. Contractor Qualification:
  - 1. The Contractor or security sub-contractor shall be a licensed security Contractor with a minimum of five (5) years experience installing and servicing systems of similar scope and complexity. The Contractor shall be an authorized regional representative of the Video Monitoring System's (VMS) manufacturer(s). The Contractor shall provide copies of system manufacturer certification for all technicians. The Contractor shall only utilize factory-trained technicians to install, program, and service the VMS. The Contractor shall only utilize factory-trained technicians to install, terminate and service cameras, control, and recording equipment. The technicians shall have a minimum of five (5) continuous years of technical experience in electronic security systems. The Contractor shall have a local service facility. The facility shall be located within 60 miles of the project site. The

local facility shall include sufficient spare parts inventory to support the service requirements associated with this contract. The facility shall also include appropriate diagnostic equipment to perform diagnostic procedures.

- G. 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 SUBMITTALS**

- A. Submit below items in conjunction with Master Specification Sections 01 33 23, Shop Drawings, Product Data, and Samples, and Section 02 41 00, Demolition Drawings.
- B. Provide certificates of compliance with Section 1.4, Quality Assurance.
- D. Pre-installation design and as-built packages shall include, but not be limited to:
2. Floor plans:
    - a. Include a title block as defined above.
    - b. Define the drawings scale in both standard and metric measurements.
    - c. Provide device identification and location.
    - d. Address all signal and power conduit runs and sizes that are associated with the design of the electronic security system.
    - e. Identify all pull box and conduit locations, sizes, and fill capacities.
  3. A riser drawing for each applicable security subsystem shall:
    - a. Relationship of integrated components on one diagram.
    - b. Include the number, size, identification, and maximum lengths of interconnecting wires.
  6. Detail and elevation drawings for all devices that define how they were installed and mounted.
- E. Pre-installation design packages shall be reviewed by the Contractor along with a VA representative to ensure all work has been clearly defined and completed.
- F. Provide manufacturer security system product cut-sheets.

## 1.6 APPLICABLE PUBLICATIONS

- A. The publications listed below (including amendments, addenda, revisions, supplement, and errata) form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American National Standards Institute (ANSI)/Electronic Industries Alliance (EIA):
  - 330-09.....Electrical Performance Standards for CCTV Cameras
  - 375A-76.....Electrical Performance Standards for CCTV Monitors
- C. Institute of Electrical and Electronics Engineers (IEEE):
  - C62.41-02.....IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits
  - 802.3af-08.....Power over Ethernet Standard
- D. Federal Communications Commission (FCC):
  - (47 CFR 15) Part 15 Limitations on the Use of Wireless Equipment/Systems
- E. National Electrical Contractors Association (NECA):
  - 303-2005.....Installing Closed Circuit Television (CCTV) Systems
- F. National Fire Protection Association (NFPA):
  - 70-08.....Article 780-National Electrical Code
- G. Federal Information Processing Standard (FIPS):
  - 140-2-02.....Security Requirements for Cryptographic Modules
- H. Underwriters Laboratories, Inc. (UL):
  - 983-06.....Standard for Surveillance Camera Units
  - 3044-01.....Standard for Surveillance Closed Circuit Television Equipment

## 1.7 COORDINATION

- A. Coordinate arrangement, mounting, and support of video surveillance equipment:
  - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
  - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
  - 3. To allow right of way for piping and conduit installed at required slope.

4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. Coordinate location of access panels and doors for video surveillance items that are behind finished surfaces or otherwise concealed.

#### **1.8 WARRANTY OF CONSTRUCTION**

- A. Warrant VMS System work subject to the Article "Warranty of Construction" of FAR clause 52.246-21.
- B. Demonstration and training shall be performed prior to system acceptance.

### **PART 2 - PRODUCTS**

#### **2.1 GENERAL**

- A. Video signal format shall comply with the NTSC standard composite video, interlaced. Composite video signal termination shall be 75 ohms.
- B. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor entry connection to components.
- C. Power Connections: Comply with requirements in Section 28 05 00 COMMON WORK REQUIREMENTS FOR ELECTRONIC SAFETY AND SECURITY, Part 2, as recommended by manufacturer for type of line being protected.
- D. Tamper Protection: Tamper switches on enclosures, control units, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled. Control-station, control-unit alarm display shall identify tamper alarms and indicate locations.

#### **2.2 CAMERAS**

- A. All Cameras will be EIA 330 and UL 1. Minimum Protection for Power Connections 120 V and more: Auxiliary panel suppressors shall comply with requirements in Section 28 05 00 COMMON WORK REQUIREMENTS FOR ELECTRONIC SAFETY AND SECURITY, Part 2.

B. Minimum Protection for Communication, Signal, Control, and Low-Voltage 983 compliant as well as:

1. Will be charge coupled device (CCD cameras and shall conform to National Television System Committee (NTSC) formatting.
2. Fixed cameras shall be color, with white housings and installed with corner mounts.
3. Shall be powered by either 12 volts direct current (VDC) or 24 volts alternate current (VAC). Power supplies shall be Class 2 and UL compliant and have a back-up power source to ensure cameras are still operational in the event of loss of primary power to the VMS System.
4. Shall be rated for continuous operation under the environmental conditions listed in Part 1, Project Conditions.
5. Each function and activity shall be addressed within the system by a unique user defined name, with minimum of twenty (20) characters. The use of codes or mnemonics identifying the VMS action shall not be accepted.
6. Shall come with built-in video motion detection that shall automatically monitor and process information from each camera. The camera motion detection shall detect motion within the camera's field of view and provide automatic visual, remote alarms as a result of detected motion.
7. Appropriate signage shall be designed, provided, and posted that notifies people that an area is under camera surveillance.

C. Interior Cameras for Operating Rooms:

1. Provide high-performance 540TVL, indoor, color, wide-dynamic range dome camera with weatherproof housing for each OR room.
2. General Specifications:
  - a. Horizontal resolution: 540 TVL
  - b. Signal-to-noise ratio: >50 dB
  - c. AGC: Auto, maximum level selectable 28 dB
  - d. Auto black: On/off selectable
  - e. Electronic shutter: Flickerless, on/off, default shutter
  - f. NightSense: (XF only) Auto, forced, off selectable
  - g. Day/Night: (DN only) Auto, monochrome, color selectable
  - h. Dynamic range: 32 x dynamic range enhancement
  - i. Dynamic noise reduction: Automatic, off, selectable

- j. Sharpness correction: Horizontal & vertical, symmetrical
  - k. Backlight compensation: Off, programmable window and level selectable
  - l. White balance: Automatic sensing (2500 to 9000 K), AWB hold and manual
  - m. Video motion detector: Four (4) areas, sensitivity selectable.
  - n. Camera ID: 16-character editable string, position selectable
  - o. Video output: Composite video 1.0 Vpp, 75 ohm
  - p. Remote control: Bi-directional coaxial communication
  - q. Synchronization: Internal or LineLock.
  - r. Humidity: 5 to 93% relative humidity
  - s. Dome Impact rating: IEC
3. Lens: Select lens from available options, based on final mounting, to provide a 'wall-to-wall' view of the OR Room.
- a. 3.7mm to 9.5mm lens; Wide (95°H x 69°V)
  - b. 3.7mm to 12mm lens; Wide (76.1°H x 55.8°V)
4. Provide Bosch VDC-485V03/4-20 dome cameras or approved equal.
- D. Interior Cameras (Non-OR rooms):
- 1. Provide high-performance 540TVL, indoor, 1/3-inch, color, wide-dynamic range dome camera with weatherproof housing for the Surgery Waiting Room and other locations as indicated.
  - 2. General specifications:
    - a. Horizontal resolution: 540 TVL
    - b. Signal-to-noise ratio: >50 dB
    - c. AGC: Auto, maximum level selectable 28 dB
    - d. Auto black: On/off selectable
    - e. Electronic shutter: Flickerless, on/off, default shutter
    - f. NightSense: Auto, forced, off selectable
    - g. Dynamic range: 32 x dynamic range enhancement
    - h. Dynamic noise reduction: Automatic, off, selectable
    - i. Sharpness correction: Horizontal & vertical, symmetrical
    - j. Backlight compensation: Off, programmable window and level selectable
    - k. White balance: Automatic sensing (2500 to 9000 K), AWB hold and manual

- l. Video motion detector: Four (4) areas, sensitivity selectable.
- m. Camera ID: 16-character editable string, position selectable
- n. Video output: Composite video 1.0 Vpp, 75 ohm
- o. Remote control: Bi-directional coaxial communication
- p. Synchronization: Internal or LineLock.
- q. Humidity: 5 to 93% relative humidity
- r. Dome Impact rating: IEC
- 3. Lens: Select lens from available options, based on final mounting, to provide a 'wall-to-wall' view of the OR Room.
  - a. 3.7 to 12mm lens; Wide (95°H x 69°V)
  - b. 9 to 12mm lens; Wide (76.1°H x 55.8°V)
- 4. Provide Bosch VDC-480V03/4-20 dome cameras or approved equal.

E. Lens:

- 1. Provide varifocal, 1/3-inch image format lens with focal lengths and angles of view as noted.
- 2. Camera Field of View shall be set by the Contractor to produce full view of the entire room being monitored.
- 3. Camera Lenses shall be of the type supplied with the camera from the manufacture.
- 4. Lenses shall have optical-quality coated optics, designed specifically for video surveillance applications, and matched to specified camera. Provide color-corrected lenses with color cameras, megapixel lenses for megapixel cameras, and lenses with day/night for color/B&W cameras.
- 5. Auto-Iris Lens: Electrically controlled iris with circuit set to maintain a constant video level in varying lighting conditions.
- 6. Lenses: Shall be utilized in a manner that provides maximum coverage of the area being monitored by the camera. The lenses shall:
  - a. Be 1/3" to fit CCD fixed camera.
  - b. Be all glass with coated optics.
  - c. Have mounts that are compatible with the camera selected.
  - d. Be packaged and supplied with the camera.
  - e. Have a maximum f-stop of f/1.3 for fixed lenses, and a maximum f-stop of f/1.6 for variable focus lenses.

- f. Be equipped with an auto-iris mechanism.
- g. Have sufficient circle of illumination to cover the image sensor evenly.
- h. Not be used on a camera with an image format larger than the lens is designed to cover.
- i. Be provided with pre-set capability.

F. CAMERA HOUSINGS AND MOUNTS

1. This section pertains to all interior housings, domes, and applicable wall, ceiling, and corner mounts associated with the housing. Housings and mounts shall be specified in accordance to the type of cameras used.
2. All cameras and lenses shall be enclosed in a tamper resistant housing. Any additional mounting hardware required to install the camera housing at its specified location shall be provided along with the housing.
3. The camera and lens contained inside the housing shall be installed on a camera mount. All additional mounting hardware required to install the camera housing at its specified location shall be provided along with the housing.
4. Environmentally Sealed
  - a. Shall be designed in manner that it provides a condensation free environment for correct camera operation.
  - b. Shall be operated in a 100 percent condensing humidity atmosphere.
  - c. Shall be constructed in a manner that:
    - 1) Has a fill valve to allow for the introduction of nitrogen into the housing to eliminate existing atmospheric air and pressurize the housing to create moisture free conditions.
    - 2) Has an overpressure valve to prevent damage to the housing in the event of over pressurization.
    - 3) Is equipped with a humidity indicator that is visible to the eye to ensure correct atmospheric conditions at all times.
    - 4) The leak rate of the housing is not to be greater than 13.8kPa or 2 pounds per square inch at sea level within a 90 day period.
    - 5) It shall contain camera mounts or supports as needed to allow for correct positioning of the camera and lens.



- 6) The housing and sunshield are to be white in color.
6. All electrical and signal cables required for correct operations shall be supplied in a hardened carrier system from the controller to the camera.
7. The mounting bracket shall be adjustable to allow for the housing weight of the camera and the housing unit it is placed in.
8. Accessibility to the camera and mounts shall be taken into consideration for maintenance and service purposes.

G. Interior Domes

1. The interior dome shall be corner mounted equipment.
2. The lower portion of the dome that provides camera viewing shall be made of black opaque acrylic and shall have a light attenuation factor of no more than 1 f-stop.
3. The housing shall be complete with wiring, wiring harness, connectors, receiver/driver, or any other hardware and equipment as needed to fully provide a fully functional pan/tilt dome.

H. Ancillary Components:

1. Include all required power supplies and related components to power the units.
2. Include configuration software, adaptors and all other ancillary components to configure the cameras to operate properly.
3. Include specialty back boxes, mounting hardware and all other ancillary components required for mounting the equipment. Include Bosch Model VDA-CMT-DOME corner mount or similar and mount cameras in corner of the room that provides the best overall view of the room.

### **2.3 DIGITAL QUAD VIDEO PROCESSOR**

- A. Provide a high-quality, color, quad, NTSC, real-time video processor.
- B. General features shall include:
  1. High 1280 × 1024 SXGA resolution
  2. Anti-Burn-in™ technology
  3. Video inputs (BNC in x 1, BNC out x 1)
  4. Looping video inputs for multiple connections

5. Quick signal-switching time ( $\leq 0.8$  sec.)
6. NTSC/PAL auto-detection
7. Selectable signal source
8. PC compatible
9. Built-in speakers
10. Key lock function
11. Auto-adjustment for optimal setting
12. Security socket
13. VESA standard wall mount

C. General specifications:

1. Operating Temperature 32° to 120°F (0° to 49°C)
2. Relative Humidity 95%, non-condensing
3. Dimensions 1.73" H x 10.20" D x 8.44" W
4. (4.39 x 25.90 x 21.43 cm)
5. Finish Charcoal gray
6. Unit Weight 3 lb (1.36 kg)
7. Shipping Weight 4 lb (1.81 kg) approximate
8. Certifications: FCC, Class B

D. Video specifications shall meet or exceed the following:

1. Input Level 1 Vp-p, composite
2. Video Standard 525 lines, 60 fields/second
3. Digital Image 1024 (H) x 512 (V) pixels
4. Quad Update Rate Real time
5. Analog Frequency
6. Response Better than 12 MHz
7. Crosstalk at Color
8. Subcarrier Better than -60 dB
9. Differential Gain Less than 2 percent
10. Differential Phase Less than 2 degrees
11. Signal-to-Noise Ratio Better than -60 dB

E. Electrical specifications shall meet or exceed the following:

1. Input Power: 120VAC, 60Hz
2. Operating Voltage 12 VAC; unit includes power supply
3. Power 6 watts
4. Video Inputs Four, BNC, looping, 75-ohm/Hi Z termination
5. Monitor Outputs Two, BNC, 75 ohms
6. Alarm Inputs Five N.O. inputs
7. Alarm Output 10K ohm output resistance; TTL, CMOS

8. compatible
  9. Alarm Clearance Automatic with manual override
  10. Sequence Dwell Times Programmable for 2, 4, 8, or 16 sec
- F. Include a mounting kit as required. Coordinate final mounting with casework details and General Contractor.
- G. Provide Pelco Model QD104C or approved equal.

## 2.4 VIDEO DISPLAY EQUIPMENT

### A. Video Display Equipment

1. Provide a 19-inch, color, high resolution video monitor with features and inputs/outputs specifically designed for use as a video monitoring system display.
2. Equipment shall be able to display analog, digital, and other images in either NTSC or MPEG format associated with the operation of the VMS.

### B. General Panel Specifications:

- |                        |                     |
|------------------------|---------------------|
| 1. Panel Type          | TFT LCD             |
| 2. Panel Size          | 19.0" (483mm)       |
| 3. Max. Resolution     | SXGA 1280 x 1024    |
| 4. Pixel Pitch         | 0.294 mm            |
| 5. Brightness          | 250 cd/m2 (Typical) |
| 6. Contrast Ratio      | 1000:1 (Typical)    |
| 7. Viewing Angle (H/V) | 170°/160° (Typical) |
| 8. Display Color       | 16.7M               |
| 9. Response Time       | 3 ms (GTG)          |

### C. Technical Specifications:

1. Horizontal Resolution: TV Lines 550TVL (NTSC)
2. Frequency: H:31 kHz - 80 kHz, V:50 Hz - 75 Hz
3. Input; Analogue 15-Pin D-Sub  
                   Digital 24-Pin DVI-D  
                   CVBS BNC x 1  
                   S-Video 4-Pin mini DIN
4. Output; CVBS BNC x 1
5. Audio; Audio In 3.5mm Audio Line-in  
                   Audio Out 3.5 mm Audio Line-in  
                   Speaker 1W x 2
6. Power; AC-DC Adaptor External

Power	AC 100-240 V, 50-60 Hz
Consumption	< 39 W (On)
	< 1.5 W (Off)
7. Plug & Play; VESA	DCC 2B
8. Operating Temperature	0 °C ~ 40 °C
Humidity	10% ~ 85%
9. Mounting, VESA FPMPI	Yes (100 mm)
10. Tilt	-5° ~ +15°
11. Dimensions (W x H x D)	16.8" x 16.2" x 7.6"
12. Weight	12.5 lbs
13. Certifications	UL/CUL, CB, FCC, CE, BSMI, GOST-R, WEEE, RoHS
14. Accessories:	Power cord, power adaptor, 15-Pin D-Sub cable, audio cable, warranty card

D. Provide AG Neovo Model SC-19 or approved equal.

## 2.8 POWER SUPPLIES

- A. Power supplies shall be a low-voltage power supplies matched for voltage and current requirements of cameras and accessories, type as recommended by camera[, infrared illuminator,] and lens manufacturer.
- B. Technical specifications:
  - 1. Input: 115VAC, 50/60Hz, 2.7 amps
  - 2. Outputs:
    - a. Number of outputs, [16] <insert number of outputs>
    - b. [Fuse/PTC] <insert type> protected, power limited
    - c. Output voltage & power:
      - 1) 24VAC @ 12.5 amps (300VA) or 28VAC @ 10 amp (280VA) supply current
  - 3. Illuminated power disconnect circuit breaker with manual reset
  - 4. Surge suppression
  - 5. Camera synchronization
  - 7. Enclosure: NEMA 250, Type 1

## 2.12 WIRES AND CABLES

- A. Shall meet or exceed the manufactures recommendation for power and signal.

- B. Will be carried in an enclosed conduit system, utilizing electromagnetic tubing (EMT) to include the equivalent in flexible metal.
- C. All conduits will be sized and installed per the NEC.
- D. All conduit, pull boxes, and junction boxes shall be clearly marked with colored permanent tape or paint that will allow it to be distinguished from all other conduit and infrastructure.
- E. Conduit fills shall not exceed 50 percent unless otherwise documented.
- F. A pull string shall be pulled along and provided with signal and power cables to assist in future installations.
- G. At all locations where there is a wall penetration or core drilling is conducted to allow for conduit to be installed, fire stopping materials shall be applied to that area
- H. Line voltage and signal cables shall not share the same conduit and shall be kept separate up to the point of connection. High voltage for the security system shall be defined as any cable or sets of cables carrying 30 VDC/VAC or higher.
- I. For all equipment that is carrying digital data between the Physical Access Control System and Database Management or at a remote monitoring station, shall not be less than 20 AWG and stranded copper wire for each conductor. The cable or each individual conductor within the cable shall have a shield that provides 100% coverage. Cables with a single overall shield shall have a tinned copper shield drain wire.
- J. All cables and conductors, except fiber optic cables, that act as a control, communication, or signal lines shall include surge protection. Surge protection shall be furnished at the equipment end and additional triple electrode gas surge protectors rated for the application on each wire line circuit shall be installed within 1 m. (3 ft.) of the building cable entrance. The inputs and outputs shall be tested in both normal and common mode using the following wave forms:
  - 1. A 10 microsecond rise time by 1000 microsecond pulse width waveform with a peak voltage of 1500 volts and peak current of 60 amperes.
  - 2. An 8 microsecond rise time by 20 microsecond pulse width wave form with a peak voltage of 1000 volts and peak current of 500 amperes.
- K. The surge suppression device shall not attenuate or reduce the video or sync signal under normal conditions. Fuses and relays shall not be used as a means of surge protection.
- L. Coaxial Cables

1. All video signal cables for the VMS System, with exception to the PoE cameras, shall be a coaxial cable and have a characteristic impedance of 75 ohms plus or minus 3 ohms.
2. For runs up to 750 feet use of an RG-59/U is required. The RG-59/U shall be shielded which provides a minimum of 95 percent coverage, with a stranded copper center conductor of a minimum 23 AWG, polyethylene insulation, and black non-conductive polyvinylchloride (PVC) jacket.
3. For runs between 750 feet and 1250 feet, RG-6/U is required. RG-6/U shall be shielded which provides a minimum of 95 percent coverage, with a stranded copper center conductor of a minimum 18 AWG, polyethylene insulation, and black non-conductive polyvinylchloride (PVC) jacket.
4. For runs of 1250 to 2750 feet, RG-11/U is required. RG-11/U shall be shielded which provides a minimum of 95 percent coverage, with a stranded copper center conductor of a minimum 14 AWG, polyethylene insulation, and black non-conductive polyvinylchloride (PVC) jacket.
5. All runs greater than 2750 feet will be substituted with a fiber optic cable. If using fiber optics as a signal carrier then the following equipment will be utilized:
  - a. Multimode fiber optic cable a minimum size of 62 microns
  - b. Video transmitter, installed at the camera that utilizes 12 VDC or 24 VAC for power.
  - c. Video receiver, installed at the switcher.
6. RG-59/U Technical Characteristics

AWG	22
Stranding	7x29
Conductor Diameter	.031 in.
Conductor Material	BCC
Insulation Material	Gas-injected FHDPE
Insulation Diameter	.145 in.
Outer Shield Type	Braid/Braid
Outer Jacket Material	PVC
Overall Nominal Diameter	.242 in.
UL Temperature Rating	75°C
Nom. Characteristic Impedance	75 Ohms

Nom. Inductance	0.094 $\mu$ H/ft
Nom. Capacitance	Conductor to Shield 17.0 pF/ft
Nom. Velocity of Propagation	80 %
Nom. Delay	1.3 ns/ft
Nom. Conductor DC Resistance @ 20°C	12.2 Ohms/1000 ft
Nom. Outer Shield DC Resistance @ 20°C	2.4 Ohms/1000 ft
Max. Operating Voltage	UL 300 V RMS

7. RG-6/U Technical Characteristics:

AWG	18
Stranding	7x27
Conductor Diameter	.040 in.
Conductor Material	BC
Insulation Material	Gas-injected FHDPE
Insulation Diameter	.180 in.
Outer Shield Material	Trade Name Duofoil
Outer Shield Type	Tape/Braid
Outer Shield %Coverage	100 %
Outer Jacket Material	PVC
Overall Nominal Diameter	.274 in.
Nom. Characteristic Impedance	75 Ohms
Nom. Inductance	0.106 $\mu$ H/ft
Nom. Capacitance	Conductor to Shield 16.2 pF/ft
Nom. Velocity of Propagation	82 %
Nom. Delay	1.24 ns/ft
Nom. Conductor DC Resistance	6.4 Ohms/1000 ft
Nominal Outer Shield DC Resistance @ 20°C	2.8 Ohms/1000 ft
Max. Operating Voltage	UL 300 V RMS

8. RG-11/U Technical Characteristics:

AWG	15
Stranding	19x27

Conductor Diameter	.064 in.
Conductor Material	BC
Insulation Material	Gas-injected FHDPE
Insulation Diameter	.312 in.
Inner Shield Type	Braid
Inner Shield Material	BC - Bare Copper
Inner Shield %Coverage	95 %
Inner Jacket Material	PE - Polyethylene
Inner Jacket Diameter	.391 in.
Outer Shield Type	Braid
Outer Shield Material	BC - Bare Copper
Outer Shield %Coverage	95 %
Outer Jacket Material	Trade Name Belflex
Outer Jacket Material	PVC Blend
Overall Nominal Diameter	.520 in.
Operating Temperature Range	-35°C To +75°C
Non-UL Temperature Rating	75°C
Nom. Characteristic Impedance	75 Ohms
Nom. Inductance	0.097 $\mu$ H/ft
Nom. Capacitance	Conductor to Shield 17.3 pF/ft
Nom. Velocity of Propagation	78 %
Nom. Delay	1.30 ns/ft
Nom. Conductor DC Resistance	3.1 Ohms/1000 ft
Nom. Inner Shield DC Resistance	1.8 Ohms/1000 ft
Nom. Outer Shield DC Resistance	1.4 Ohms/1000 ft
Max. Operating Voltage Non-UL	300 V RMS

9. Signal Cables:

- a. Signal wiring for PoE cameras depends on the distance the camera is being installed from either a hub or the server.
- b. If the camera is up to 300 ft from a hub or the server, then use a shielded UTP category 5 (CAT-V) cable with standard RJ-45 connector at each end. The cable will comply with the Power over Ethernet, IEEE802.3af, Standard.
- c. If the camera is over 300 ft from a hub or server then utilize a multimode fiber optic cable with a minimum size of 62 microns.



d. Provide a separate cable for power.

e. CAT-5 Technical Characteristics:

Number of Pairs	4
Total Number of Conductors	8
AWG	24
Stranding	Solid
Conductor Material	BC - Bare Copper
Insulation Material	PO - Polyolefin
Overall Nominal Diameter	.230 in.
IEC Specification	11801 Category 5
TIA/EIA Specification	568-B.2 Category 5e
Max. Capacitance Unbalance	(pF/100 m) 150 pF/100 m
Nom. Velocity of Propagation	70 %
Max. Delay	(ns/100 m) 538 @ 100MHz
Max. Delay Skew	(ns/100m) 45 ns/100 m
Max. Conductor DC Resistance	9.38 Ohms/100
Max. DCR Unbalance@ 20°C	3 %
Max. Operating Voltage	UL 300 V RMS

10. Fiber Optic Cables Technical Characteristics:

Fiber Type	62.5 Micron
Number of Fibers	4
Core Diameter 6	2.5 +/- 2.5 microns
Core Non-Circularity	5% Maximum
Clad Diameter	125 +/- 2 microns
Clad Non-Circularity	1% Maximum
Core-clad Offset	1.5 Microns Maximum
Primary Coating Material	Acrylate
Primary Coating Diameter	245 +/- 10 microns
Secondary Coating Material	Engineering Thermoplastic
Secondary Coating Diameter	900 +/- 50 microns
Strength Member Material	Aramid Yarn
Outer Jacket Material	PVC
Outer Jacket Color	Orange
Overall Diameter	.200 in.
Numerical Aperture	.275
Maximum Gigabit Ethernet	300 meters

Maximum Gigabit Ethernet	550 meters
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#### 11. Power Cables

- a. Will be sized accordingly and shall comply with the NEC. High voltage power cables will be a minimum of three conductors, 14 AWG, stranded, and coated with a non-conductive polyvinylchloride (PVC) jacket. Low voltage cables will be a minimum of 18 AWG, stranded and non-conductive polyvinylchloride (PVC) jacket.
- b. Will be utilized for all components of the VMS System that require either a 110 VAC 60 Hz or 220 VAC 50 Hz input. Each feed will be connected to a dedicated circuit breaker at a power panel that is primarily for the security system.
- c. All equipment connected to AC power shall be protected from surges. Equipment protection shall withstand surge test waveforms described in IEEE C62.41. Fuses shall not be used as a means of surge protection.
- d. Shall be rated for either 110 or 220 VAC, 50 or 60 Hz, and shall comply with VA Master Spec 26 05 21 Low Voltage Electrical Power Conductors and Cables (600 Volts and Below).
- e. Low Voltage Power Cables
  - 1) Shall be a minimum of 18 AWG, Stranded and have a polyvinylchloride outer jacket.
  - 2) Cable size shall determined using a basic voltage over distance calculation and shall comply with the NEC's requirements for low voltage cables.

### **PART 3 - EXECUTION**

#### **3.1. GENERAL**

- A. Installation: The Contractor shall install all system components and appurtenances in accordance with the manufacturer's instructions, ANSI C2 and as shown, and shall furnish all necessary connectors, terminators, interconnections, services, and adjustments required for a complete and operable data transmission system.
- B. Identification and Labeling: The Contractor shall supply permanent identification labels for each cable at each end that will appear on the as-built drawings. The labeling format shall be identified and a complete record shall be provided to the Owner with the final documentation. Each cable shall be identified by type or signal being

carried and termination points. The labels shall be printed on letter size label sheets that are self laminated vinyl that can be printed from a computer data base or spread sheet. The labels shall be E-Z code WES12112 or equivalent.

1. The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform all testing.

D. Contractor's Field Test: The Contractor shall verify the complete operation of the system.

E. Identification and Labeling: The Contractor shall supply identification tags or labels for each cable. Cable shall be labeled at both end points and junction boxes. The labeling format shall be identified and a complete record shall be provided to the Owner with the final documentation. Each cable shall be identified with type of signal being carried and termination points.

### **3.2 INSTALLATION**

A. System installation shall be in accordance with NECA 303, manufacturer and related documents and references, for each type of security subsystem installed.

D. The VMS System will be tested to ensure all components are fully compatible as a system.

G. Refer to the manufacturers requirements for correct system operations. Ensure computers being utilized for system integration meet or exceed the minimum system requirements outlined on the systems software packages.

H. A complete VMS System shall be comprised of, but not limited to, the following components:

1. Cameras
2. Lenses
3. Video Display Equipment
4. Camera Housings and Mounts
5. Video Processor Equipment
7. Wiring and Cables

N. Cameras:

1. Install the cameras with the focal length lens as indicated for each room.
2. Connect power and signal lines to the camera.

3. Aim camera to provide desired field of view.
5. Focus the lens to give a sharp picture (to include checking for day and night focus and image quality) over the entire field of view
6. Synchronize all cameras so the picture does not roll on the monitor when cameras are selected.

O. Monitors:

1. Install the monitors as shown and specified in design and construction documents.
2. Connect all signal inputs and outputs as shown and specified.
3. Terminate video input signals as required.
4. Connect the monitor to AC power.

P. Processor/Switcher:

1. Install unit as shown in the construction documents, and according to the OEM.
2. Connect all subassemblies as specified by the manufacturer and as shown.
3. Connect video signal inputs and outputs as shown and specified; terminate video inputs as required.
4. Connect alarm signal inputs and outputs as shown and specified; connect control signal inputs and outputs for ancillary equipment or secondary control/monitoring sites as specified by the manufacturer and as shown.
5. Connect the unit to AC power.
6. Load all software as specified and required for an operational VMS System configured for the site and building requirements.
7. Provide the original and 2 backup copies for all accepted software upon successful completion of the endurance test.
8. Program the video annotation for each camera.

X. Camera Housings, Mounts:

1. Install the camera housings and mounts as specified by the manufacturer and as shown, provide mounting hardware sized appropriately to secure each camera, housing.
4. Provide electrical and signal transmission cabling to the mount location via a hardened carrier system from the Physical Access Control System and Database Management to the device.
5. Connect signal lines and AC power to the housing interfaces.
6. Connect pole wiring harness to camera.

### **3.3 SYSTEM START-UP**

- A. The Contractor shall not apply power to the VMS System until the following items have been completed:
  - 1. VMS System equipment items and have been set up in accordance with manufacturer's instructions.
  - 2. A visual inspection of the VMS System has been conducted to ensure that defective equipment items have not been installed and that there are no loose connections.
  - 3. System wiring has been tested and verified as correctly connected as indicated.
  - 4. All system grounding and transient protection systems have been verified as installed and connected as indicated.
  - 5. Power supplies to be connected to the VMS System have been verified as the correct voltage, phasing, and frequency as indicated.
- B. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the Resident Engineer and Commissioning Agent. Provide a minimum of 7 days prior notice.
- C. Satisfaction of the above requirements shall not relieve the Contractor of responsibility for incorrect installation, defective equipment items, or collateral damage as a result of Contractor work efforts.

### **3.4 SUPPLEMENTAL CONTRACTOR QUALITY CONTROL**

- A. The Contractor shall provide the services of technical representatives who are familiar with all components and installation procedures of the installed VMS System; and are approved by the Contracting Officer.
- B. The Contractor will be present on the job site during the preparatory and initial phases of quality control to provide technical assistance.
- C. The Contractor shall also be available on an as needed basis to provide assistance with follow-up phases of quality control.
- D. The Contractor shall participate in the testing and validation of the system and shall provide certification that the system installed is fully operational as all construction document requirements have been fulfilled.

### **3.5 TRAINING**

- A. Provide thorough training of all nursing staff assigned to the surgery area receiving the camera monitoring equipment.
- B. Provide the following minimum training times and durations. Coordinate dates and times for all training with RE.

1. Up to **2** hours, prior to opening for nursing staff.
3. Allow **1** hour for supervisors and system administrators.

-----END-----

**SECTION 28 25 15**  
**CLOCK SYSTEMS**

**PART 1 - GENERAL**

**1.1 SECTION SUMMARY**

- A. Work covered by this Section includes providing a Code Blue elapsed time system within each operating room.
- B. Battery clocks noted on the Drawings are not covered by this Section.
- C. Work shall be complete, National Recognized Testing Laboratory (NRTL - i.e. Underwriters Laboratory [UL]) Listed and Labeled; tested, certified and ready for operation.

**1.2 RELATED SECTIONS**

- A. 01 33 23 - Shop Drawings, Product Data and Samples.
- B. 07 84 00 - Firestopping.
- C. 27 05 11 - Common Work Results For Low Voltage Systems.
- E. 27 05 33 - Raceways and Boxes for Communications Systems.

**1.3 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 National Codes:
    - a. American Institute of Architects (AIA): Guidelines for Healthcare Facilities.
  - B. NFPA:
    - 1) 70 - National Electrical Code (current date of issue) - Articles 517, 645 & 800.
  - 3. State Hospital Code(s).
  - 4. Local Town, City and/or County Codes.

**1.5 QUALIFICATIONS**

- A. The OEM shall have had experience with three (3) or more installations of systems of comparable size and complexity with regards to type and design as specified herein. Each of these installations shall have performed satisfactorily for at least one (1) year after final acceptance by the user. Include the names, locations and point of contact for these installations as a part of the submittal.
- B. The Contractor shall submit certified documentation that they have been an authorized distributor and service organization for the OEM for a minimum of five (5) years. The Contractor shall be authorized by the OEM to pass thru the OEM's warranty of the installed equipment to VA.

In addition, the OEM and Contractor shall accept complete responsibility for the design, installation, certification, operation, and physical support for the System. This documentation, along with the System Contractor and OEM certifications must be provided in writing as part of the Contractor's Technical submittal.

- C. 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 RE before being allowed to commence work on the System.
- D. The Contractor shall display all applicable national, state and local licenses.
- E. The Contractor shall submit copy (s) of Certificate of successful completion of OEM's installation/training school for installing technicians of the System's PA equipment being proposed.

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

- A. Provide all necessary permits and schedule all inspections as identified in the contract's milestone chart, so that the system is proof of performance tested and ready for operation on a date directed by the Owner.
- B. The contractor is responsible to adhere to all codes described herein and associated contractual, state and local codes.
- C. The Contractor shall display all applicable national, state and local licenses and permits.

#### **1.6 SUBSTITUTIONS**

- A. Proposed substitutions, to be considered, shall be manufactured of equivalent materials that meet or exceed specified requirements of this Section.
- B. Proposed substitutions shall be identified not less than 10 days prior to bid date.
- C. The manufacturer of the proposed substitutions shall be a company specializing in Code Blue elapsed time systems and have documented experience manufacturing such systems for at least four (4) years.



## **PART 2 - PRODUCTS**

### **2.1 SYSTEM DESCRIPTION**

- A. Furnish and install a complete and fully functional elapsed timer system as shown on the drawings and specified herein.

### **2.2 SUBMITTALS**

- A. Product Data: Submit complete catalog data for each component, describing physical characteristics and method of installation. Submit brochure showing available colors and finishes.
- B. Manufacturer's Instructions: Submit complete installation, set-up and maintenance instructions.

### **2.3 MANUFACTURERS**

- A. The products specified shall be new, FCC and UL Listed, labeled and produced by OEM of record.
- B. Provide products from Primex Wireless or approved equal.

### **2.4 PRODUCTS**

- A. GENERAL: The furnished equipment shall comply with applicable regulatory requirements. Furnished equipment shall be the manufacturer's latest model(s); and shall not cause harmful interference with any medical equipment and operate properly with other interference associated with the facility.
- B. Elapsed Time Clocks
  - 1. UL, ETL, stainless steel cover, flush mount or surface-mount with slope bracket as selected by surgery staff, with cord/plug or cord/pigtail coordinated with associated electrical rough-in.
  - 2. Final configurations and options shall be selected by the RE and surgical staff at the time of Bid. Options include the following:
    - a. Power: 120V or PoE. Drawings show 120V at each unit.
    - b. Time Signal: Provide a clock time signal to each unit by either a PoE time packet via IT data drop or by an option system antenna. The Drawings show a network data drop.
    - c. Code Event Recording: Manual (XS series) or software based recording (SNS series). Software/maintenance package will be purchased under separate funding as needed.
    - d. Mounting: Flush or surface mount with option angle bracket. Bid as flush mount since that cost will cover either option.
  - 3. Provide an elapsed time clock system with the following features:

- a. Highly visible 7-segment LED digits
  - b. 12 or 24 hour time display
  - c. Alternating time and date display option
  - d. Beep option; 3KHz  $\pm$  0.5KHz frequency
  - e. LED dimmer option
  - f. Power outage memory backup for up to 10 hours
  - g. Audible Tone Option: Configured as directed by surgery staff.
  - h. Code Blue input range: 5-120VAC or DC.
4. Timer features shall include:
- a. 6-digit counters
  - b. Up Counter, with a range of 00:00:00 to 99:59:59.
  - c. Down Counter with a range of 99:59:59 to 00:00:00.
  - d. Code Blue Mode, immediately starts counting up from 00:00:00, with visual indicator, with background display of other counts and/or last Code Blue event.
  - e. Start times can be preset by user.
5. Control unit, flush wall mount, stainless steel cover, shall include three (3) control buttons labeled as follows:
- a. Display / Exit
  - b. Stop/Start / Increment
  - c. Reset / Set/Change
6. Include a means to provide a national time protocol signal to each Code Blue digital clock unit to display local time while not in xx.
- a. Include a IT Cat6 cable drop at each clock location for providing time packets via Ethernet.
  - b. Provide an antenna to provide RF time signals to each clock.
7. Unit shall be flush mount. Where directed by RE, include a surface mount model with either 4-degree or 18-degree slope brackets as selected by the RE/surgery staff.
8. Contractor shall include interface to local Nurse Call Code Blue, along with required relays and other ancillary devices for a complete system.
9. Provide Primex Code Blue Digital Timer, SNS or XS-Series as approved by RE or approved equal.

## **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 equipment, clocks, system cables, etc.
5. Locate clocks and equipment as shown on drawings, with minor changes as directed and approved by RE.
6. Install clocks at the locations indicated, plumb, level and flush or tight against the wall for surface mount clocks.

### **3.2 ELAPSED TIMER SYSTEM**

- A. Install the clock unit and controls per manufacturer instructions.
- B. Connect each unit to receive local Code Blue signals from the Nurse Call System.
- C. Contractor shall configure the Code Blue Digital Elapsed Timer controls for normal state, set state and Code Blue state as directed by Resident Engineer.

### **3.3 FIREPROOFING**

- A. Where system wiring and conduit penetrate fire rated walls, floors and ceilings, fireproof the opening per Section "Fireproofing".
- B. Provide conduit sleeves where cables penetrate fire rated walls ceilings if alternative raceways are not available.

## **PART 4 - TESTING**

### **4.0 SYSTEM TESTING / GUARANTEE**

- A. General Requirements: The scope of work for this Section does not warrant staff training, nor a special guarantee beyond the standard manufacturer's guarantee associated with the products installed. Provide the Resident Engineer warranty documentation for each product installed under this Section. Replace any defective clocks as required.
- B. Acceptance Test Procedure:

1. Physical and Mechanical Inspection:

- a. The Resident Engineer/Architect/Engineer will tour all areas where the Clock systems were installed to insure they are operationally ready for proof of performance testing.
- 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. Operational Test:

- a. After the Physical and Mechanical Inspection, conduct operational tests to assure proper reception of signal at each clock.

C. Training: Allow up to two (2) hours for training, demonstration and instructions to select staff members.

- - - E N D - - -

**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 the 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, control units, fire safety control devices, annunciators, power supplies, and wiring as shown on the drawings and specified.
- B. Fire alarm systems shall comply with requirements of the most recent VA FIRE PROTECTION DESIGN MANUAL and 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 Resident Engineer. Installers shall have a minimum of 2 years experience installing fire alarm systems.
- C. Fire alarm signals:
  - 1. Building shall have a Private Mode general alarm evacuation signal. Staff and common areas shall be covered. Patient Areas shall be covered by Private Mode guidelines. Provide voice evacuation through fire alarm speakers and speaker/strobes.
- D. Alarm signals (by device), supervisory signals (by device) and system trouble signals (by device not reporting) shall be distinctly transmitted to the existing main fire alarm system control unit

**1.2 SCOPE**

- A. A fully addressable fire alarm system shall be designed and installed in accordance with the specifications and drawings. Device location shown on the drawings are for reference only unless specifically

dimensioned. Actual locations shall be in accordance with NFPA 72 and this specification.

**B. 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 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 (2,090 square meters) 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 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES. Requirements for procedures for submittals.
- B. Section 07 84 00 - FIRESTOPPING. Requirements for fire proofing wall penetrations.
- C. Section 08 71 00 - DOOR HARDWARE. For combination Closer-Holders.
- D. Section 21 13 13 - WET-PIPE SPRINKLER SYSTEMS. Requirements for sprinkler systems.

**1.4 SUBMITTALS**

- A. General: Submit 5 copies 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 software and include all contractor information. Layering shall be by VA criteria as provided by the

- Resident Engineer. Bid drawing files on AutoCAD will be provided to the Contractor at the pre-construction meeting. Contractor shall be responsible for verifying all critical dimensions shown on the drawings provided by VA.
2. Floor plans: Provide locations of all 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, 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 Resident Engineer three sets of as-built drawings and one set of the as-built drawing computer files. As-built drawings (floor plans) shall show all new and/or existing conduit used for the fire alarm system.

C. Manuals:

1. Submit simultaneously with the shop drawings, companion copies of complete maintenance and operating manuals including technical data

sheets for all items used in the system, power requirements, device wiring diagrams, dimensions, and information for ordering replacement parts.

- a. Wiring diagrams shall have their terminals identified to facilitate installation, operation, expansion and maintenance.
- b. Wiring diagrams shall indicate internal wiring for each item of equipment and the interconnections between the items of equipment.
- c. Include complete listing of all software used and installation and operation instructions including the input/output matrix chart.
- d. Provide a clear and concise description of operation that gives, in detail, the information required to properly operate, inspect, test and maintain the equipment and system. Provide all manufacturer's installation limitations including but not limited to circuit length limitations.
- e. Complete listing of all digitized voice messages.
- f. Provide standby battery calculations under normal operating and alarm modes. Battery calculations shall include the magnets for holding the doors open for one minute.
- g. Include information indicating who will provide emergency service and perform post contract maintenance.
- h. Provide a replacement parts list with current prices. Include a list of recommended spare parts, tools, and instruments for testing and maintenance purposes.
- i. A computerized preventive maintenance schedule for all equipment. The schedule shall be provided on disk in a computer format acceptable to the VAMC and shall describe the protocol for preventive maintenance of all equipment. The schedule shall include the required times for systematic examination, adjustment and cleaning of all equipment. A print out of the schedule shall also be provided in the manual. Provide the disk in a pocket within the manual.
- j. Furnish manuals in 3 ring loose-leaf binder or manufacturer's standard binder.
- k. A print out for all devices proposed on each signaling line circuit with spare capacity indicated.



2. Two weeks prior to final inspection, deliver 4 copies of the final updated maintenance and operating manual to the Resident Engineer.
  - a. The manual shall be updated to include any information necessitated by the maintenance and operating manual approval.
  - b. Complete "As installed" wiring and schematic diagrams shall be included that shows all items of equipment and their interconnecting wiring. Show all final terminal identifications.
  - c. Complete listing of all programming information, including all control events per device including an updated input/output matrix.
  - d. Certificate of Installation as required by NFPA 72 for each building. The certificate shall identify any variations from the National Fire Alarm Code.
  - e. Certificate from equipment manufacturer assuring compliance with all manufacturers installation requirements and satisfactory system operation.

D. Certifications:

1. Together with the shop drawing submittal, submit the technician's NICET level III fire alarm certification as well as certification from the control unit manufacturer that the proposed performer of contract maintenance is an authorized representative of the major equipment manufacturer. Include in the certification the names and addresses of the proposed supervisor of installation and the proposed performer of contract maintenance. Also include the name and title of the manufacturer's representative who makes the certification.
2. Together with the shop drawing submittal, submit a certification from either the control unit manufacturer or the manufacturer of each component (e.g., smoke detector) that the components being furnished are compatible with the control unit.
3. Together with the shop drawing submittal, submit a certification from the major equipment manufacturer that the wiring and connection diagrams meet this specification, UL and NFPA 72 requirements.

### 1.5 WARRANTY

All work performed and all material and equipment furnished under this contract shall be free from defects and shall remain so for a period of

one year from the date of acceptance of the entire installation by the Contracting Officer.

#### **1.6 GUARANTY PERIOD SERVICES**

- A. Complete inspection, testing, maintenance and repair service for the fire alarm system shall be provided by a factory trained authorized representative of the manufacturer of the major equipment for a period of 1 years from the date of acceptance of the entire installation by the Contracting Officer.
- B. Contractor shall provide all necessary test equipment, parts and labor to perform required inspection, testing, maintenance and repair.
- C. All inspection, testing, maintenance and permanent records required by NFPA 72, and recommended by the equipment manufacturer shall be provided by the contractor. Work shall include operation of sprinkler system alarm and supervisory devices. It shall include all interfaced equipment including but not limited to HVAC shutdown, and extinguishing systems.
- D. Maintenance and testing shall be performed in accordance with NFPA 72. A computerized preventive maintenance schedule shall be provided and shall describe the protocol for preventive maintenance of equipment. The schedule shall include a systematic examination, adjustment and cleaning of all equipment.
- E. Non-included Work: Repair service shall not include the performance of any work due to improper use, accidents, or negligence for which the contractor is not responsible.
- F. Service and emergency personnel shall report to the Engineering Office or their authorized representative upon arrival at the hospital and again upon the completion of the required work. A copy of the work ticket containing a complete description of the work performed and parts replaced shall be provided to the VA Resident Engineer or his authorized representative.
- G. Emergency Service:
  - 1. Warranty Period Service: Service other than the preventative maintenance, inspection, and testing required by NFPA 72 shall be considered emergency call-back service and covered under the warranty of the installation during the first year of the warranty period, unless the required service is a result of abuse or misuse by the Government. Written notification shall not be required for

emergency warranty period service and the contractor shall respond as outlined in the following sections on Normal and Overtime Emergency Call-Back Service. Warranty period service can be required during normal or overtime emergency call-back service time periods at the discretion of the Resident Engineer or his authorized representative.

2. Normal and overtime emergency call-back service shall consist of an on-site response within 2 hours of notification of a system trouble.
  3. Normal emergency call-back service times are between the hours of 7:30 a.m. and 4:00 p.m., Monday through Friday, exclusive of federal holidays. Service performed during all other times shall be considered to be overtime emergency call-back service. The cost of all normal emergency call-back service for years 2 through 5 shall be included in the cost of this contract.
  4. Overtime emergency call-back service shall be provided for the system when requested by the Government. The cost of the first 40 manhours per year of overtime call-back service during years 2 through 5 of this contract shall be provided under this contract. Payment for overtime emergency call-back service in excess of the 40 man hours per year requirement will be handled through separate purchase orders. The method of calculating overtime emergency call-back hours is based on actual time spent on site and does not include travel time.
- H. The contractor shall maintain a log at each fire alarm control unit. The log shall list the date and time of all examinations and trouble calls, condition of the system, and name of the technician. Each trouble call shall be fully described, including the nature of the trouble, necessary correction performed, and parts replaced.

#### **1.7 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 and the latest editions of these publications shall be applicable.
- B. National Fire Protection Association (NFPA):
  - NFPA 13, Installation of Sprinkler Systems, 2010 edition
  - NFPA 14, Installation of Standpipes and Hose Systems, 2010 edition

NFPA 70, National Electrical Code (NEC), 2010 edition

NFPA 72, National Fire Alarm Code, 2010 edition

NFPA 101, Life Safety Code, 2012 edition

C. Underwriters Laboratories, Inc. (UL): Fire Protection Equipment Directory, 2012

D. Factory Mutual Research Corp (FM): Approval Guide, 2012

E. American National Standards Institute (ANSI):

S3.41, Audible Emergency Evacuation Signal, 2008 edition

F. International Code Council, International Building Code (IBC), 2009

## **PART 2 - PRODUCTS**

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

A. 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 manufacturers' requirements and that satisfactory total system operation has been achieved.

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

A. Conduit shall be in accordance with Section 28 05 28.33 CONDUIT AND BACKBOXES FOR ELECTRONIC SAFETY AND SECURITY and as follows:

1. All new conduits shall be installed in accordance with NFPA 70.
2. Conduit fill shall not exceed 40 percent of interior cross sectional area.
3. All new conduits shall be 3/4 inch (19 mm) minimum.

B. Wire:

1. Wiring shall be in accordance with NEC article 760, Section 28 05 13, CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY, 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.
2. 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.

C. Terminal Boxes, Junction Boxes, and Cabinets:

1. Shall be galvanized steel in accordance with UL requirements.
2. All boxes shall be sized and installed in accordance with NFPA 70.
3. 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 3/4 inch (19 mm) 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 Resident Engineer.

### **2.3 FIRE ALARM CONTROL UNIT**

- A. General: Existing to remain. Connect all new equipment to existing FACP, Simplex 4100U.

### **2.4 ALARM NOTIFICATION APPLIANCES**

A. Speakers:

1. UL listed, selectable wattage..
2. Unless otherwise shown on the drawings, shall be 6 inches (150 mm) diameter and have a minimum nominal rating of 80 dBA at 10 feet (3,000 mm).
3. Mount on removable adapter plates on outlet boxes.

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 1/2 inch (13 mm) 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 20 percent spare capacity.

4. Strobes may be combined with the audible notification appliances specified herein.

## **2.8 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.
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 photoelectric type and 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. Heat Detectors:

1. Heat detectors shall be of the addressable restorable rate compensated fixed-temperature spot type.
2. Detectors shall have a minimum smooth ceiling rating of 2,500 square feet (230 square meters).

D. 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. All new water flow switches shall be of a single manufacturer and series and non-accumulative retard type. See Fire Protection Drawings for new switches added. Connect all switches shown on the approved shop drawings.
3. All new switches shall have an alarm transmission delay time that is conveniently adjustable from 0 to 60 seconds. Initial settings shall be 30-45 seconds. Timing shall be recorded and documented during testing.

## 2.9 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.

**B. Sprinkler and Standpipe System Supervisory Switches:**

1. Each sprinkler system water supply control valve, riser valve or zone control valve, and each standpipe system riser control valve shall be equipped with a supervisory switch. Standpipe hose valves, and test and drain valves shall not be equipped with supervisory switches.
2. PIV (post indicator valve) or main gate valve shall be equipped with a supervisory switch.
3. Valve supervisory switches shall be connected to the fire alarm system by way of address reporting interface device. See Section 21 13 WET-PIPE SPRINKLER SYSTEMS for new switches to be added. Connect tamper switches for all control valves shown on the approved shop drawings.
4. The mechanism shall be contained in a weatherproof die-cast aluminum housing that shall provide a 3/4 inch (19 mm) tapped conduit entrance and incorporate the necessary facilities for attachment to the valves.
5. The entire installed assembly shall be tamper-proof and arranged to cause a switch operation if the housing cover is removed or if the unit is removed from its mounting.

**2.10 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.

**2.11 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.

#### **2.12 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.
- B. Key-operated manual fire alarm stations shall have a single standardized lock and key separate from the control equipment.
- C. All keys shall be delivered to the Resident Engineer.

#### **2.13 SPARE AND REPLACEMENT PARTS**

- A. Provide spare and replacement parts as follows:
  1. Manual pull stations - 2
  2. Heat detectors - 2 of each type
  3. Fire alarm strobes - 2
  4. Fire alarm speaker/strobes - 2
  5. Smoke detectors - 2
  6. Sprinkler system water flow switch - 1 of each size
  7. Sprinkler valve tamper switch - 1 of each type
  8. Monitor modules - 1
  9. Fire alarm SLC cable (same as installed) - 100 feet
- B. Spare and replacement parts shall be in original packaging and submitted to the Resident Engineer.
- C. Use existing spare parts storage cabinet.
- D. Provide to the VA, all hardware, software, programming tools, license and documentation necessary to permanently modify the fire alarm system on site. The minimum level of modification includes addition and

deletion of devices, circuits, zones and changes to system description, system operation, and digitized evacuation and instructional messages.

### **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 28 05 13 CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY, Section 28 05 26 GROUNDING AND BONDING FOR ELECTRONIC SAFETY AND SECURITY, Section 28 05 28.33 CONDUIT AND BACKBOXES FOR ELECTRONIC SAFETY AND SECURITY, and all penetrations of smoke and fire barriers shall be protected as required by Section 07 84 00, FIRESTOPPING.
- B. All conduits, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas.
- C. All new and reused exposed conduits shall be painted in accordance with Section 09 91 00, PAINTING to match surrounding finished areas and red in unfinished areas.
- D. All fire detection and alarm system devices, control units and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas. Exact locations are to be approved by the Resident Engineer.
- E. Strobes shall be flush wall mounted with the bottom of the unit located 80 inches (2,000 mm) above the floor or 6 inches (150 mm) below ceiling, whichever is lower. Locate and mount to maintain a minimum 36 inches (900 mm) clearance from side obstructions.
- F. Manual pull stations shall be installed not less than 42 inches (1,050 mm) or more than 48 inches (1,200 mm) from finished floor to bottom of device and within 60 inches (1,500 mm) of a stairway or an exit door.
- G. Where possible, locate water flow and pressure switches a minimum of 12 inches (300 mm) from a fitting that changes the direction of the flow and a minimum of 36 inches (900 mm) from a valve.
- H. Mount valve tamper switches so as not to interfere with the normal operation of the valve and adjust to operate within 2 revolutions toward the closed position of the valve control, or when the stem has moved no more than 1/5 of the distance from its normal position.

J. Connect flow and tamper switches installed under Section 21 13 13, WET-PIPE SPRINKLER SYSTEMS.//

K. Connect combination closer-holders installed under Section 08 71 00, DOOR HARDWARE.

### 3.2 TYPICAL OPERATION

- A. Activation of any manual pull station, water flow or pressure switch, heat detector, or smoke detector shall cause the following operations to occur:
  - 1. Continuously sound prerecorded voice evacuation message general alarm and flash all strobes in the building in alarm until reset at the local fire alarm control unit.
  - 3. Release only the magnetic door holders in the smoke zone after the alert signal.
  - 4. Transmit a separate alarm signal, via the main fire alarm control unit to the fire department.
  - 5. Unlock the electrically locked exit doors within the zone of alarm.
- B. Operation of a smoke detector at a corridor door used for automatic closing shall also release only the magnetic door holders in that smoke zone.
- C. Operation of duct smoke detectors shall cause a system supervisory condition and shut down the ventilation system and close the associated smoke dampers as appropriate.
- D. Operation of any sprinkler or standpipe system valve supervisory switch, high/low air pressure switch, or fire pump alarm switch shall cause a system supervisory condition.
- E. Alarm verification shall not be used for smoke detectors installed for the purpose of early warning.

### 3.3 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 Resident 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 Resident 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 Resident 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.

#### **3.4 FINAL INSPECTION AND ACCEPTANCE**

- A. Prior to final acceptance a minimum 30 day "burn-in" period shall be provided. The purpose shall be to allow equipment to stabilize and potential installation and software problems and equipment malfunctions to be identified and corrected. During this diagnostic period, all system operations and malfunctions shall be recorded. Final acceptance will be made upon successful completion of the "burn-in" period and where the last 14 days is without a system or equipment malfunction.
- B. 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.

#### **3.5 INSTRUCTION**

- A. The manufacturer's authorized representative shall provide instruction and training to the VA as follows:
  1. Six 1-hour sessions to engineering staff, security police and central attendant personnel for simple operation of the system. Two sessions at the start of installation, 2 sessions at the completion

- of installation and 2 sessions 3 months after the completion of installation.
2. Four 2-hour sessions to engineering staff for detailed operation of the system. Two sessions at the completion of installation and 2 sessions 3 months after the completion of installation.
  3. Three 8-hour sessions to electrical technicians for maintaining, programming, modifying, and repairing the system at the completion of installation and one 8-hour refresher session 3 months after the completion of installation.
- B. The Contractor and/or the Systems Manufacturer's representative shall provide a typewritten "Sequence of Operation" including a trouble shooting guide of the entire system for submittal to the VA. The sequence of operation will be shown for each input in the system in a matrix format and provided in a loose leaf binder. When reading the sequence of operation, the reader will be able to quickly and easily determine what output will occur upon activation of any input in the system. The INPUT/OUTPUT matrix format shall be as shown in Appendix A to NFPA 72.
- C. Furnish the services of a competent instructor for instructing personnel in the programming requirements necessary for system expansion. Such programming shall include addition or deletion of devices, zones, indicating circuits and printer/display text.

- - END - -

**SECTION 31 20 11  
EARTH MOVING (SHORT FORM)**

**PART 1 - GENERAL**

**1.1 DESCRIPTION:**

This section specifies the requirements for furnishing all equipment, materials, labor and techniques for earthwork including excavation, fill, backfill and site restoration utilizing fertilizer, seed and/or sod.

**1.2 DEFINITIONS:**

A. Unsuitable Materials:

1. Fills: Topsoil, frozen materials; construction materials and materials subject to decomposition; clods of clay and stones larger than 75 mm (3 inches); organic materials, including silts, which are unstable; and inorganic materials, including silts, too wet to be stable.
2. Existing Subgrade (except footings): Same materials as listed in above paragraph, that are not capable of direct support of slabs, pavement, and similar items, with the possible exception of improvement by compaction, proofrolling, or similar methods of improvement.
3. Existing Subgrade (footings only): Same as Paragraph 1, but no fill or backfill. If materials differ from reference borings and design requirements, excavate to acceptable strata subject to Resident Engineer's approval.

B. Earthwork: Earthwork operations required within the new construction area. It also includes earthwork required for auxiliary structures and buildings and sewer and other trenchwork throughout the job site.

C. Degree of Compaction: Degree of compaction is expressed as a percentage of maximum density obtained by the test procedure presented in ASTM D698.

D. The term fill means fill or backfill as appropriate.

**1.3 RELATED WORK:**

A. Materials testing and inspection during construction: Section 01 45 29, TESTING LABORATORY SERVICES.

B. Safety Requirements and blasting operations: Section 00 72 00, GENERAL CONDITIONS, Article, ACCIDENT PREVENTION.

C. Protection of existing utilities, fire protection services, existing equipment, roads, and pavements: Section 01 00 00, GENERAL REQUIREMENTS.

D. Subsurface Investigation: Section 01 00 00, GENERAL REQUIREMENTS, Article, PHYSICAL DATA.

#### **1.4 CLASSIFICATION OF EXCAVATION:**

- A. Unclassified Excavation: Removal and disposal of pavements and other man-made obstructions visible on the surface; utilities, and other items including underground structures indicated to be demolished and removed; together with any type of materials regardless of character of material and obstructions encountered.
- B. Rock Excavation:
1. Solid ledge rock (igneous, metamorphic, and sedimentary rock).
  2. Bedded or conglomerate deposits so cemented as to present characteristics of solid rock which cannot be excavated without blasting; or the use of a modern power excavator (shovel, backhoe, or similar power excavators) of no less than 1 cubic yard capacity, properly used, having adequate power and in good running condition.
  3. Boulders or other detached stones each having a volume of 1/2 cubic yard or more.

#### **1.5 MEASUREMENT AND PAYMENT FOR ROCK EXCAVATION:**

- A. Measurement: Cross section and measure the uncovered and separated materials, and compute quantities by the Registered Professional Land Surveyor or Registered Civil Engineer, specified in Section 01 00 00, GENERAL REQUIREMENTS. Do not measure quantities beyond the following limits:
1. 12 inches outside of the perimeter of formed footings.
  2. 24 inches outside the face of concrete work for which forms are required, except for footings.
  3. 6 inches below the bottom of pipe and not more than the pipe diameter plus 24 inches in width for pipe trenches.
  4. The outside dimensions of concrete work for which no forms are required (trenches, conduits, and similar items not requiring forms).
- B. Payment for Differing Site Conditions: When rock excavation, as classified, is encountered, the contract price and time will be adjusted in accordance with Articles, DIFFERING SITE CONDITIONS, CHANGES and CHANGES-SUPPLEMENT of the GENERAL CONDITIONS as applicable.

#### **1.6 SUBMITTALS:**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Rock Excavation Report:
1. Certification of rock quantities excavated.

2. Excavation method.
3. Labor.
4. Equipment.
5. Land Surveyor's or Civil Engineer's name and official registration stamp.
6. Plot plan showing elevations.

#### **1.7 APPLICABLE PUBLICATIONS:**

- A. Publications listed below form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.
- B. American Nursery and Landscape Association (ANLA):  
2004.....American Standard for Nursery Stock
- C. American Society for Testing and Materials (ASTM):  
D698-07.....Laboratory Compaction Characteristics of Soil  
Using Standard Effort
- D. South Dakota Department of Transportation Standard Specifications for Roads and Bridges, current edition.
- E. Geotechnical Engineering Report, Proposed VA Surgery Tower/Wing Addition, Ft. Meade VA Hospital, Ft. Meade, South Dakota, prepared by Terracon Consultants, Inc., dated April 30, 2012.

### **PART 2 - PRODUCTS**

#### **2.1 MATERIALS:**

- A. Fills: Materials approved from on site and off site sources having a minimum dry density of 110 pcf, a maximum Plasticity Index of 6, and a maximum Liquid Limit of 30.
- B. Granular Fill:
  1. Aggregate Base Course - Under asphalt, sidewalk and curb and/or gutter, shall be crushed limestone that meets all of the requirements of Limestone Ledge Rock Base Course as specified in the South Dakota Department of Transportation's Standard Specifications for Road and Bridge Design.
  2. Type 1 Bedding Material - Bedding for sewer and storm sewer lines 3-inch and larger shall be crushed limestone rock having two (2) fractured faces and meet the following gradation requirements by dry weight:
 

Passing 1-inch sieve.....	100%
Passing 3/4-inch sieve.....	90 - 100%
Passing 3/8-inch sieve.....	20 - 55%



Passing #8 sieve.....0 - 8%

- | Gradation | Percent Finer by Weight (ASTM C136) |
|-----------|-------------------------------------|
|-----------|-------------------------------------|

Passing No. 4 Sieve..... 40 - 85

Liquid Limit ..... 30 (max)

Plasticity Index..... 10 (max)

- | Gradation.....                   | Percent Passing |
|----------------------------------|-----------------|
| 3/4" (19mm) Sieve                | 100             |
| No. 4 (4.75mm) Sieve             | 100             |
| No. 10 (2.0mm) Sieve             | 100             |
| No. 20 (75mm) Sieve              | 100             |
| No. 40 (4.75mm) Sieve            | 100             |
| No. 60 (2.5mm) Sieve             | 100             |
| No. 100 (1.5mm) Sieve            | 100             |
| No. 200 (75mm) Sieve             | 100             |
| No. 425 (30mm) Sieve             | 100             |
| No. 600 (250mm) Sieve            | 100             |
| No. 840 (100mm) Sieve            | 100             |
| No. 1180 (75mm) Sieve            | 100             |
| No. 1490 (50mm) Sieve            | 100             |
| No. 1900 (30mm) Sieve            | 100             |
| No. 2500 (20mm) Sieve            | 100             |
| No. 3250 (15mm) Sieve            | 100             |
| No. 4250 (10mm) Sieve            | 100             |
| No. 5400 (7.5mm) Sieve           | 100             |
| No. 6750 (5mm) Sieve             | 100             |
| No. 8400 (3.75mm) Sieve          | 100             |
| No. 10500 (3mm) Sieve            | 100             |
| No. 12800 (2.5mm) Sieve          | 100             |
| No. 15800 (2mm) Sieve            | 100             |
| No. 20000 (1.18mm) Sieve         | 100             |
| No. 25000 (75mm) Sieve           | 100             |
| No. 31500 (50mm) Sieve           | 100             |
| No. 39600 (30mm) Sieve           | 100             |
| No. 50000 (20mm) Sieve           | 100             |
| No. 63000 (15mm) Sieve           | 100             |
| No. 79000 (10mm) Sieve           | 100             |
| No. 99000 (7.5mm) Sieve          | 100             |
| No. 125000 (5mm) Sieve           | 100             |
| No. 158000 (3.75mm) Sieve        | 100             |
| No. 200000 (3mm) Sieve           | 100             |
| No. 250000 (2.5mm) Sieve         | 100             |
| No. 315000 (2mm) Sieve           | 100             |
| No. 396000 (1.18mm) Sieve        | 100             |
| No. 500000 (75mm) Sieve          | 100             |
| No. 630000 (50mm) Sieve          | 100             |
| No. 790000 (30mm) Sieve          | 100             |
| No. 990000 (20mm) Sieve          | 100             |
| No. 1250000 (15mm) Sieve         | 100             |
| No. 1580000 (10mm) Sieve         | 100             |
| No. 2000000 (7.5mm) Sieve        | 100             |
| No. 2500000 (5mm) Sieve          | 100             |
| No. 3150000 (3.75mm) Sieve       | 100             |
| No. 3960000 (3mm) Sieve          | 100             |
| No. 5000000 (2.5mm) Sieve        | 100             |
| No. 6300000 (2mm) Sieve          | 100             |
| No. 7900000 (1.18mm) Sieve       | 100             |
| No. 9900000 (75mm) Sieve         | 100             |
| No. 12500000 (50mm) Sieve        | 100             |
| No. 15800000 (30mm) Sieve        | 100             |
| No. 20000000 (20mm) Sieve        | 100             |
| No. 25000000 (15mm) Sieve        | 100             |
| No. 31500000 (10mm) Sieve        | 100             |
| No. 39600000 (7.5mm) Sieve       | 100             |
| No. 50000000 (5mm) Sieve         | 100             |
| No. 63000000 (3.75mm) Sieve      | 100             |
| No. 79000000 (3mm) Sieve         | 100             |
| No. 99000000 (2.5mm) Sieve       | 100             |
| No. 125000000 (2mm) Sieve        | 100             |
| No. 158000000 (1.18mm) Sieve     | 100             |
| No. 200000000 (75mm) Sieve       | 100             |
| No. 250000000 (50mm) Sieve       | 100             |
| No. 315000000 (30mm) Sieve       | 100             |
| No. 396000000 (20mm) Sieve       | 100             |
| No. 500000000 (15mm) Sieve       | 100             |
| No. 630000000 (10mm) Sieve       | 100             |
| No. 790000000 (7.5mm) Sieve      | 100             |
| No. 990000000 (5mm) Sieve        | 100             |
| No. 1250000000 (3.75mm) Sieve    | 100             |
| No. 1580000000 (3mm) Sieve       | 100             |
| No. 2000000000 (2.5mm) Sieve     | 100             |
| No. 2500000000 (2mm) Sieve       | 100             |
| No. 3150000000 (1.18mm) Sieve    | 100             |
| No. 3960000000 (75mm) Sieve      | 100             |
| No. 5000000000 (50mm) Sieve      | 100             |
| No. 6300000000 (30mm) Sieve      | 100             |
| No. 7900000000 (20mm) Sieve      | 100             |
| No. 9900000000 (15mm) Sieve      | 100             |
| No. 12500000000 (10mm) Sieve     | 100             |
| No. 15800000000 (7.5mm) Sieve    | 100             |
| No. 20000000000 (5mm) Sieve      | 100             |
| No. 25000000000 (3.75mm) Sieve   | 100             |
| No. 31500000000 (3mm) Sieve      | 100             |
| No. 39600000000 (2.5mm) Sieve    | 100             |
| No. 50000000000 (2mm) Sieve      | 100             |
| No. 63000000000 (1.18mm) Sieve   | 100             |
| No. 79000000000 (75mm) Sieve     | 100             |
| No. 99000000000 (50mm) Sieve     | 100             |
| No. 125000000000 (30mm) Sieve    | 100             |
| No. 158000000000 (20mm) Sieve    | 100             |
| No. 200000000000 (15mm) Sieve    | 100             |
| No. 250000000000 (10mm) Sieve    | 100             |
| No. 315000000000 (7.5mm) Sieve   | 100             |
| No. 396000000000 (5mm) Sieve     | 100             |
| No. 500000000000 (3.75mm) Sieve  | 100             |
| No. 630000000000 (3mm) Sieve     | 100             |
| No. 790000000000 (2.5mm) Sieve   | 100             |
| No. 990000000000 (2mm) Sieve     | 100             |
| No. 1250000000000 (1.18mm) Sieve | 100             |
| No. 1580000000000 (75mm) Sieve   | 100             |
| No. 2000000000000 (50mm) Sieve   | 100             |
| No. 250000000                    |                 |

Passing 3/8-inch Sieve..... 95 - 100

No. 8 Sieve ..... 65 - 95

No. 16 Sieve ..... 5 - 30

No. 200 Sieve..... 0 - 10

### PART 3 - EXECUTION

### 3.1 SITE PREPARATION:

- VA Project #568-001

Building materials shall not be stored closer to trees and shrubs that are to remain, than the farthest extension of their limbs.

- D. Stripping Topsoil: Unless otherwise indicated on the drawings, the limits of earthwork operations shall extend anywhere the existing grade is filled or cut or where construction operations have compacted or otherwise disturbed the existing grade or turf. Strip topsoil as defined herein, or as indicated in the geotechnical report, from within the limits of earthwork operations as specified above unless specifically indicated or specified elsewhere in the specifications or shown on the drawings. Topsoil shall be fertile, friable, natural topsoil of loamy character and characteristic of the locality. Topsoil shall be capable of growing healthy horticultural crops of grasses. Stockpile topsoil and protect as directed by the Resident Engineer. Eliminate foreign material, such as weeds, roots, stones, subsoil, frozen clods, and similar foreign materials, larger than 1/2 cubic foot in volume, from soil as it is stockpiled. Retain topsoil on the station. Remove foreign materials larger than 2 inches in any dimension from topsoil used in final grading. Topsoil work, such as stripping, stockpiling, and similar topsoil work, shall not, under any circumstances, be carried out when the soil is wet so that the tilth of the soil will be destroyed.

1. Concrete Slabs, Pavement, Concrete Sidewalk and Curb: Score deeply or saw cut to insure a neat, straight cut, sections of existing concrete slabs and paving to be removed where excavation or trenching occurs. Extend pavement section to be removed a minimum of 12 inches on each side of widest part of trench excavation and insure final score lines are approximately parallel unless otherwise indicated. Remove material from the Medical Center.

- E. Disposal: All materials removed from the property shall be disposed of at a legally approved site, for the specific materials, and all removals shall be in accordance with all applicable Federal, State and local regulations. No burning of materials is permitted onsite.

### **3.2 EXCAVATION:**

- A. Shoring, Sheet piling and Bracing: Shore, brace, or slope to its angle of repose banks of excavations to protect workmen, banks, adjacent paving, structures, and utilities, in compliance with OSHA requirements.
1. Extend shoring and bracing to the bottom of the excavation. Shore excavations that are carried below the elevations of adjacent existing foundations.
  2. If the bearing of any foundation is disturbed by excavating, improper shoring or removal of shoring, placing of backfill, and similar

operations, provide a concrete fill support under disturbed foundations, as directed by Resident Engineer, at no additional cost to the Government. Do not remove shoring until permanent work in excavation has been inspected and approved by Resident Engineer.

- B. Excavation Drainage: Operate pumping equipment as required, to keep excavations free of water and subgrades dry, firm, and undisturbed until approval of permanent work has been received from Resident Engineer. Approval by the Resident Engineer is also required before placement of the permanent work on all subgrades. When subgrade for foundations has been disturbed by water, remove the disturbed material to firm undisturbed material after the water is brought under control. Replace disturbed subgrade in trenches by mechanically tamped sand or gravel. When removed disturbed material is located where it is not possible to install and properly compact disturbed subgrade material with mechanically compacted sand or gravel, the Resident Engineer should be contacted to consider the use of flowable fill.

C. Blasting: Blasting shall not be permitted.

D. Building Earthwork:

1. Excavation shall be accomplished as required by drawings, specifications and geotechnical report.
2. Excavate foundation excavations to solid undisturbed subgrade.
3. Remove loose or soft material to solid bottom.
4. Fill excess cut under footings or foundations with 3000 psi concrete, poured separately from the footings.
5. Do not tamp earth for backfilling in footing bottoms, except as specified.

E. Trench Earthwork:

1. Utility Trenches (except water, sanitary and storm sewer):
  - a. Excavate to a width as necessary for sheeting and bracing and proper performance of the work.
  - b. Grade bottom of trenches with bell-holes, scooped-out to provide a uniform bearing.
  - c. Support piping on undisturbed earth unless a mechanical support is shown.
  - d. The length of open trench in advance of pipe laying shall not be greater than is authorized by the Resident Engineer.
2. Water, Sanitary and Storm Sewer Trenches:
  - a. All water, sanitary sewer and storm sewer pipe, appurtenances, and service lines; except copper water services shall be bedded with Type 1 Bedding material from 3 inches below the pipe invert to 3

inches above the pipe crown over the full width of the trench.

Type 1 Bedding Material shall meet the requirements of Part 2 of this Section.

1) Type 1 Bedding shall be compacted and placed as a separate lift from the trench bottom, or top of Foundation material, to the pipe invert and shall be placed and compacted prior to the pipe or appurtenance being placed in the trench.

2) Type 1 Bedding shall be hand tamped and placed as a separate lift from the pipe invert to the pipe.

b. Place and compact as specified the remainder of backfill using acceptable excavated materials. Do not use unsuitable materials.

c. Use Type 1 Bedding or other granular fill as approved by the Resident Engineer for bedding where rock or rocky materials are excavated.

3. Install "clay plug" recommended in the geotechnical report where utility enters the building footprint.

F. Site Earthwork: Excavation shall be accomplished as required by drawings and specifications. Remove subgrade materials that are determined by the Resident Engineer as unsuitable, and replace with acceptable material. If there is a question as to whether material is unsuitable or not, the Contractor shall obtain samples of the material, under the direction of the Resident Engineer, and the materials shall be examined by an independent testing laboratory for soil classification to determine whether it is unsuitable or not. When unsuitable material is encountered and removed, the contract price and time will be adjusted in accordance with Articles, DIFFERING SITE CONDITIONS, CHANGES and CHANGES-SUPPLEMENT of the GENERAL CONDITIONS as applicable. Adjustments to be based on meters (yardage) in cut section only.

G. Finished elevation of subgrade shall be as follows:

1. Pavement Areas - bottom of the pavement or base course as applicable.
2. Planting and Lawn Areas - 4 inches below the finished grade, unless otherwise specified or indicated on the drawings.

### **3.3 FILLING AND BACKFILLING:**

A. General: Do not fill or backfill until all debris, unsatisfactory soil materials, obstructions, and deleterious materials have been removed from the excavation. Proof-roll exposed subgrades with a fully loaded dump truck. Use excavated materials or borrow for fill and backfill, as applicable. Use free draining granular material for backfilling against basement walls. Do not use unsuitable excavated materials. Do not backfill until foundation walls have been completed above grade and

adequately braced, waterproofing or dampproofing applied, and pipes coming in contact with backfill have been installed, and inspected and approved by Resident Engineer.

- B. Proof-rolling Existing Subgrade: Proof-roll with a fully loaded dump truck. Make a minimum of one pass in each direction. Remove unstable uncompactable material and replace with granular fill material completed to mix requirements specified.
- C. Placing: Place material in horizontal layers not exceeding 8 inches in loose depth and then compacted. Do not place material on surfaces that are muddy, frozen, or contain frost.
- D. Compaction: Use approved equipment (hand or mechanical) well suited to the type of material being compacted. Do not operate mechanized vibratory compaction equipment within 10 feet of new or existing building walls without the prior approval of the Resident Engineer. Moisten or aerate material as necessary to provide the moisture content that will readily facilitate obtaining the specified compaction with the equipment used. Compact each layer to not less than 95 percent of the maximum density determined in accordance with the following test method ASTM D698.

#### **3.4 GRADING:**

- A. General: Uniformly grade the areas within the limits of this section, including adjacent transition areas. Smooth the finished surface within specified tolerance. Provide uniform levels or slopes between points where elevations are indicated, or between such points and existing finished grades. Provide a smooth transition between abrupt changes in slope.
- B. Cut rough or sloping rock to level beds for foundations. In unfinished areas fill low spots and level off with coarse sand or fine gravel.
- C. Slope backfill outside the building away from the building walls for a minimum distance of 10 feet at a minimum ten percent (10%) slope, except where hardscape is proposed.
- D. The finished grade shall be 6 inches below bottom line of windows or other building wall openings unless greater depth is shown.
- E. Place crushed stone or gravel fill under concrete slabs on grade tamped and leveled. The thickness of the fill shall be 6 inches, unless otherwise indicated.
- F. Finish subgrade in a condition acceptable to the Resident Engineer at least one day in advance of the paving operations. Maintain finished subgrade in a smooth and compacted condition until the succeeding operation has been accomplished. Scarify, compact, and grade the

subgrade prior to further construction when approved compacted subgrade is disturbed by contractor's subsequent operations or adverse weather.

- G. Grading for Paved Areas: Provide final grades for both subgrade and base course to +/- 0.25 inches of indicated grades.

**3.6 DISPOSAL OF UNSUITABLE AND EXCESS EXCAVATED MATERIAL:**

- A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Medical Center property.
- B. Place excess excavated materials suitable for fill and/or backfill on site where directed.
- C. Remove from site and dispose of any excess excavated materials after all fill and backfill operations have been completed.
- D. Segregate all excavated contaminated soil designated by the Resident Engineer from all other excavated soils, and stockpile on site on two 6 mil polyethylene sheets with a polyethylene cover. A designated area shall be selected for this purpose. Dispose of excavated contaminated material in accordance with State and Local requirements.

**3.7 CLEAN-UP:**

- A. Upon completion of earthwork operations, clean areas within contract limits, remove tools, and equipment. Provide site clear, clean, free of debris, and suitable for subsequent construction operations. Remove debris, rubbish, and excess material from the Medical Center Property.

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**SECTION 31 23 19**  
**DEWATERING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION:**

This section specifies performance of dewatering required to lower and control ground water table levels and hydrostatic pressures to permit excavation, backfill, and construction to be performed in the dry. Control of surface water shall be considered as part of the work under this specification.

**1.2 SUMMARY:**

- A. The work to be completed by the Contractor includes, but is not necessarily limited to the following:
  - 1. Implementation of the Erosion and Sedimentation Control Plan.
  - 2. Dewater excavations, including seepage and precipitation.
- B. The Contractor shall be responsible for providing all materials, equipment, labor, and services necessary for care of water and erosion control. Excavation work shall not begin before the Erosion and Sedimentation Control Plan is in place.

**1.3 REQUIREMENT:**

- A. Dewatering system shall be of sufficient size and capacity necessary to lower and maintain ground water table to an elevation at least 300 mm (1 foot) below lowest foundation subgrade or bottom of pipe trench and to allow material to be excavated in a reasonably dry condition. Materials to be removed shall be sufficiently dry to permit excavation to grades shown and to stabilize excavation slopes where sheeting is not required. Operate dewatering system continuously until backfill work has been completed.
- B. Reduce hydrostatic head below any excavation to the extent that water level in the construction area is a minimum of 300 mm (1 foot) below prevailing excavation surface.
- C. Prevent loss of fines, seepage, boils, quick conditions or softening of foundation strata.
- D. Maintain stability of sides and bottom of excavation.
- E. Construction operations are performed in the dry.
- F. Control of surface and subsurface water is part of dewatering requirements. Maintain adequate control so that:
  - 1. The stability of excavated and constructed slopes are not adversely affected by saturated soil, including water entering prepared subbase

and subgrades where underlying materials are not free draining or are subject to swelling or freeze-thaw action.

2. Erosion is controlled.
3. Flooding of excavations or damage to structures does not occur.
4. Surface water drains away from excavations.
5. Excavations are protected from becoming wet from surface water, or insure excavations are dry before additional work is undertaken.

G. Permitting Requirements: The contractor shall comply with and obtain the required State and County permits where the work is performed.

#### **1.4 RELATED WORK:**

- A. Materials testing and inspection during construction: Section 01 45 29, TESTING LABORATORY SERVICES.
- B. Safety Requirements: Section 00 72 00, GENERAL CONDITIONS, Article, ACCIDENT PREVENTION.
- C. Submittal requirements as specified in Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- D. Protection of existing utilities, fire protection services, existing equipment, roads, and pavements: Section 01 00 00, GENERAL REQUIREMENTS.
- E. Subsurface Investigation: Section 01 00 00, GENERAL REQUIREMENTS, Article 1.11, PHYSICAL DATA.
- F. Excavation, backfilling, site grade and utilities: Section 31 20 11, EARTH MOVING (Short Form).

#### **PART 2 - PRODUCTS (NOT USED)**

#### **PART 3 - EXECUTION**

##### **3.1 INSTALLATION:**

- A. Install a dewatering system to lower and control ground surface water in order to permit excavation, construction of structure, and placement of backfill materials to be performed under dry conditions. Make the dewatering system adequate to pre-drain the water-bearing strata above and below the bottom of structure foundations, utilities and other excavations.
- B. In addition, reduce hydrostatic pressure head in water-bearing strata below structure foundations, utility lines, and other excavations, to extent that water levels in construction area are a minimum of 300 mm (1 foot) below prevailing excavation surface at all times.

##### **3.2 OPERATION:**

- A. Prior to any excavation below the ground water table, place system into operation to lower water table as required and operate it continuously 24 hours a day, 7 days a week until utilities and structures have been



satisfactorily constructed, which includes the placement of backfill materials and dewatering is no longer required.

- B. Place an adequate weight of backfill material to prevent buoyancy prior to discontinuing operation of the system.

### **3.3 WATER DISPOSAL:**

- A. Dispose of water removed from the excavations in such a manner as:
  - 1. Will not endanger portions of work under construction or completed.
  - 2. Will cause no inconvenience to Government or to others working near site.
  - 3. Will comply with the stipulations of required permits for disposal of water.
  - 4. Will Control Runoff: The Contractor shall be responsible for control of runoff in all work areas including but not limited to: excavations, access roads, parking areas, laydown, and staging areas. The Contractor shall provide, operate, and maintain all ditches, basins, sumps, culverts, site grading, and pumping facilities to divert, collect, and remove all water from the work areas. All water shall be removed from the immediate work areas and shall be disposed of in accordance with applicable permits.
- B. Excavation Dewatering:
  - 1. The Contractor shall be responsible for providing all facilities required to divert, collect, control, and remove water from all construction work areas and excavations.
  - 2. Drainage features shall have sufficient capacity to avoid flooding of work areas.
  - 3. Drainage features shall be so arranged and altered as required to avoid degradation of the final excavated surface(s).
  - 4. The Contractor shall utilize all necessary erosion and sediment control measures as described herein to avoid construction related degradation of the natural water quality.
- C. Dewatering equipment shall be provided to remove and dispose of all surface and ground water entering excavations, trenches, or other parts of the work during construction. Each excavation shall be kept dry during subgrade preparation and continually thereafter until the structure to be built, or the pipe to be installed therein, is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result.

### **3.4 STANDBY EQUIPMENT:**

Provide complete standby equipment, installed and available for immediate operation, as may be required to adequately maintain de-

watering on a continuous basis and in the event that all or any part of the system may become inadequate or fail.

**3.5 CORRECTIVE ACTION:**

If dewatering requirements are not satisfied due to inadequacy or failure of the dewatering system (loosening of the foundation strata, or instability of slopes, or damage to foundations or structures), perform work necessary for reinstatement of foundation soil and damaged structure resulting from such inadequacy or failure by Contractor, at no additional cost to Government.

**3.6 DAMAGES:**

Immediately repair damages to adjacent facilities caused by dewatering operations.

**3.7 REMOVAL:**

Insure compliance with all conditions of regulating permits and provide such information to the Resident Engineer. Obtain written approval from Resident Engineer before discontinuing operation of dewatering system.

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**SECTION 31 23 23.33  
FLOWABLE FILL**

**PART 1 - GENERAL**

**1.1 INTRODUCTION:**

- A. Flowable fill refers to a cementitious slurry consisting of a mixture of fine aggregate or filler, water, and cementitious material(s), which is used as a fill or backfill in lieu of compacted earth. This mixture is capable of filling all voids in irregular excavations and hard to reach places (such as under undercuts of existing slabs), is self-leveling, and hardens in a matter of a few hours without the need for compaction in layers. Flowable fill is sometimes referred to as controlled density fill (CDF), controlled low strength material (CLSM), lean concrete slurry, and unshrinkable fill.
- B. Flowable fill materials will be used as only as a structural fill replacement on VA projects. The materials and mix design for the flowable fill should be designed to produce a comparable compressive strength to the surrounding soil after hardening, making excavation at a later time possible to produce the compressive strength indicated for the placed location, as determined by the Resident Engineer.

**1.2 DESCRIPTION:**

Furnish and place flowable fill in a fluid condition that sets within the required time and, after curing, obtains the desired strength properties as evidenced by the laboratory testing of the specific mix design, at locations shown on the plans or as directed by the Resident Engineer, verbally or in writing. This section specifies flowable fill for use as structural fill to remain easily excavatable using a backhoe as would be utilized for adjoining earth.

**1.3 RELATED WORK:**

- A. Earthwork, excavation and backfill and compaction requirements: Section 31 20 11, EARTH MOVING (Short Form).

**1.4 DEFINITIONS:**

- A. Flowable fill - Ready-mix Controlled Low Strength Material used as an alternative to compacted soil, and is also known as controlled density fill, and several other names, some of which are trademark names of material suppliers. Flowable fill (Controlled Low Strength Material) differs from portland cement concrete as it contains a low cementitious content to reduce strength development for possible future removal. Chemical admixtures may also be used in flowable fill to modify performance properties of strength, flow, set and permeability.

- B. Excavatable Flowable fill - flowable fill designed with a compressive strength that will allow excavation as either machine tool excavatable at compressive strength of 1.5 MPa (200 psi) maximum at 1 year, or hand tool excavatable at compressive strength of 0.7 MPa (100 psi) maximum at 1 year.

#### **1.5 SUBMITTALS:**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Flowable Fill Mix Design: Provide flowable fill mix design containing cement and water. At the contractor's option, it may also contain fly ash, aggregate, or chemical admixtures in any proportions such that the final product meets the strength and flow consistency, and shrinkage requirements included in this specifications.
  - 1. Test and Performance - Submit the following data:
    - a. Flowable fill shall have a minimum strength of 200 psi according to ASTM C 39 at 28 days after placement.
    - b. Flowable fill shall have minimal subsidence and bleed water shrinkage. Evaporation of bleed water shall not result in shrinkage of more than 10.4 mm per m (1/8 inch per ft.) of flowable fill depth (for mixes containing high fly ash content). Measurement of a Final Bleeding shall be as measured in Section 10 of ASTM C 940 "Standard Test Method for Expansion and Bleeding of Freshly Mixed Grouts for Preplaced-Aggregate Concrete in the Laboratory.
    - c. Flowable fill shall have a unit weight of 115 - 145 lb/feet<sup>3</sup> measured at the point of placement after a 60 minute ready-mix truck ride.
- C. Provide documentation that the admixture supplier has experience of at least one year, with the products being provided and any equipment required to obtain desired performance of the product.
- D. Manufacturer's Certificates: Provide Resident Engineer with a certification that the materials incorporated in the flowable fill, following achievement of the required strength, do not represent a threat to groundwater quality.

#### **1.6 APPLICABLE PUBLICATIONS:**

- A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in text by basic designation only.
- B. American Society for Testing and Materials (ASTM):

D4832-02.....Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.

C618-03.....Standard Specifications for Coal Fly Ash and Raw or Calcined Natural Pozzolan for use as Mineral Admixture in Concrete. (Use Fly Ash conforming to the chemical and physical requirements for mineral admixture, Class F listed, including Table 2 (except for Footnote A). Waive the loss on ignition requirement.)

C403/C403M-05.....Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance.

C150-99 Rev.A-04.....Standard Specification for Portland Cement

C33-03.....Standard Specification for Concrete Aggregates

C494/C494M-04.....Standard Specification for Chemical Admixtures for Concrete

C940 RevA-98.....Standard Specification for Expansion and Bleeding of Freshly Mixed Grouts for Preplaced - Aggregate Concrete in the Laboratory

C. American Concrete Institute (ACI):

SP-150-94.....Controlled Low-Strength Materials

#### **1.7 QUALITY ASSURANCE:**

- A. Manufacturer: Flowable fill shall be manufactured by a ready-mix concrete producer with a minimum of 1 year experience in the production of similar products.
- B. Materials: For each type of material required for the work of this Section, provide primary materials that are the products of one manufacturer. If not otherwise specified here, materials shall comply with recommendations of ACI 229, "Controlled Low Strength Materials."
- C. Pre-Approval Procedures: The use of flowable fill during any part of the project shall be restricted to those incidences where, due to field conditions, the Contractor has made the Resident Engineer aware of the conditions for which he recommends the use of the flowable, and the Resident Engineer has confirmed those conditions and approved the use of the flowable fill, in advance. During the submittal process, the contractor shall prepare and submit various flowable fill mix designs corresponding to required conditions or if the contractor desires to use flowable fill due to economics. Approval for the strength of the flowable fill shall be obtained from the Resident Engineer when the contractor desires, or is required, to use flowable fill at specific

location(s) within the project. Prior to commencement of field operations the contractor shall establish procedures to maintain optimum working conditions and to coordinate this work with related and adjacent work.

#### **1.8 DELIVERY, STORAGE, AND HANDLING:**

Deliver and handle all products and equipment required, in strict compliance with manufacturer's recommendations. Protect from damage due to weather, excessive temperatures, and construction operations.

#### **1.9 PROJECT CONDITIONS:**

Perform installation of flowable fill only when approved by the Resident Engineer, and when existing and forecasted weather conditions are within the limits established by the manufacturer of the materials and products used.

### **PART 2 - PRODUCTS**

#### **2.1 MATERIALS:**

Provide flowable fill containing, at a minimum, cementitious materials, sand and water. Cementitious materials shall be portland cement, pozzolanic materials, or other self-cementing materials, or combinations thereof, at the contractor's option, and following approval by the Resident Engineer. The flowable fill mix design may also contain, fine aggregate or filler, and/or chemical admixtures in any proportions such that the final product meets the strength, flow consistency and shrinkage requirements included in this specification, as approved by the Resident Engineer.

- A. Portland Cement: ASTM C150, Type 1 or Type 2. Meeting Wyoming State DOT standards.
- B. Mixing Water: Fresh, clean, and potable. Meeting Wyoming State DOT standards for use as mix-water for cast-in-place concrete.
- C. Air-Entraining Admixture: ASTM C260.
- D. Chemical Admixtures: ASTM C494.
- E. Aggregate: ASTM C33.

#### **2.2 FLOWABLE FILL MIXTURE:**

- A. Mix design shall produce a consistency that will result in a flowable product at the time of placement which does not require manual means to move it into place.
- B. Flowable fill shall have a minimum strength of 200 psi according to ASTM C39 at 28 days after placement.
- C. Flowable fill shall have minimal subsidence and bleed water shrinkage. Evaporation of bleed water shall not result in shrinkage of more than 10.4 mm per m (1/8-inch per foot) of flowable fill depth (for mixes containing high fly ash content). Measurement of a Final Bleeding shall

be as measured in Section 10 of ASTM C 940 "Standard Test Method for Expansion and Bleeding of Freshly Mixed Grouts for Preplaced-Aggregate Concrete in the Laboratory.

- D. Flowable fill shall have a unit weight of 115 - 145 lbs/feet<sup>3</sup> measured at the point of placement after a 60 minute ready-mix truck ride. In the absence of strength data the cementitious content shall be a maximum of 90 kg/m<sup>3</sup> (150 lbs/cy).
- E. Flowable fill shall have an in-place yield of a maximum of 110% of design yield for removable types at 1 year.
- F. Provide equipment as recommended by the Manufacturer and comply with manufacturer's recommendations for the addition of additives, whether at the production plant or prior to placement at the site.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION:**

Examine conditions of substrates and other conditions under which work is to be performed and notify Resident Engineer, in writing, of circumstances detrimental to the proper completion of the work. Do not proceed until unsatisfactory conditions are corrected.

#### **3.2 APPLICATION OF FLOWABLE FILL:**

Secure tanks, pipes and other members to be encased in flowable fill. Ensure that there are no exposed metallic pipes, conduits, or other items that will be in contact with the flowable fill after placement. If so, replace with non-metallic materials or apply manufacturers recommended coating to protect metallic objects before placing the flowable fill. Replacement or protection of metallic objects is subject to the approval of the Resident Engineer.

#### **3.3 PROTECTION AND CURING:**

Protect exposed surfaces of flowable fill from premature drying, wash by rain or running water, wind, mechanical injury, and excessively hot or cold temperature. Curing method shall be subject to approval by Resident Engineer.

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**SECTION 32 05 23**  
**CEMENT AND CONCRETE FOR EXTERIOR IMPROVEMENTS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section shall cover site work concrete constructed upon the prepared subgrade and in conformance with the lines, grades, thickness, and cross sections shown. Construction shall include the following:
- B. Curb and gutter, valley gutter and fillets.
- C. Pedestrian Pavement: Walks, wheelchair curb ramps.
- D. Vehicular Pavement.
- E. Equipment Pads: Transformers and chillers.

**1.2 RELATED WORK**

- A. Laboratory and Field Testing Requirements: Section 01 45 29, TESTING LABORATORY SERVICES.
- B. Subgrade Preparation: Section 31 20 11, EARTH MOVING (short form).
- C. Concrete Materials, Quality, Mixing, Design and Other Requirements: Section 03 30 00, CAST-IN-PLACE-CONCRETE.

**1.3 DESIGN REQUIREMENTS**

- A. Design all elements with the latest published version of applicable codes and applicable sections of the SDDOT Standard Specifications.

**1.4 WEATHER LIMITATIONS**

- A. Placement of concrete shall be as specified under Article 3.8, COLD WEATHER and Article 3.7, HOT WEATHER of Section 03 30 00, CAST-IN-PLACE CONCRETE.

**1.5 SUBMITTALS**

- A. In accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, furnish the following:
- B. Manufacturers' Certificates and Data certifying that the following materials conform to the requirements specified.
  - 1. Expansion joint filler
  - 2. Hot poured sealing compound
  - 3. Reinforcement
  - 4. Curing materials
  - 5. Admixtures.
- C. Data and Test Reports: Select base material (aggregate base course).
  - 1. Job mix formula.
  - 2. Source, gradation, liquid limit, plasticity index, percentage of wear, and other tests as specified and in referenced publications.

## 1.6 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only. Refer to the latest edition of all referenced Standards and codes.
- B. American Association of State Highway and Transportation Officials (AASHTO):
- M031MM031-07-UL.....Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement (ASTM A615/A615M-09)
- M147-65-UL.....Materials for Aggregate and Soil-Aggregate Subbase, Base and Surface Courses (R 2004)
- M148-05-UL.....Liquid Membrane-Forming Compounds for Curing Concrete (ASTM C309)
- M171-05-UL.....Sheet Materials for Curing Concrete (ASTM C171)
- M182-05-UL.....Burlap Cloth Made from Jute or Kenaf and Cotton Mats
- M213-01-UL.....Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Type) (ASTM D1751)
- T180-09-UL.....Moisture-Density Relations of Soils Using a 10 lb. Rammer and a 18 in. Drop
- C. American Society for Testing and Materials (ASTM):
- C94/C94M-09.....Ready-Mixed Concrete
- C143/C143M-09.....Slump of Hydraulic Cement Concrete
- D. SDDOT.....Standard Specification for Road and Bridge Design, current version.

## PART 2 - PRODUCTS

### 2.1 GENERAL

- A. All work shall be completed in conformance with SDDOT Standard Specifications, unless modified herein.
- B. Concrete shall be 4000 psi, air-entrained as specified in Section 03 30 00, CAST-IN-PLACE CONCRETE, with the following exceptions:

<u>TYPE</u>	<u>MAXIMUM SLUMP*</u>
Curb & Gutter	75 mm (3")
Pedestrian Pavement	75 mm (3")
Vehicular Pavement	50 mm (2") (Machine Finished) 100 mm (4") (Hand Finished)
Equipment Pad	75 to 100 mm (3" to 4")

\* For concrete to be vibrated: Slump as determined by ASTM C143.  
Tolerances as established by ASTM C94.

## **2.2 REINFORCEMENT**

- A. The type, amount, and locations of steel reinforcement shall be as shown on the drawings and in the specifications.
- B. Tie bars shall be deformed steel bars conforming to AASHTO M31.

## **2.3 FORMS**

- A. Use metal or wood forms that are straight and suitable in cross-section, depth, and strength to resist springing during depositing and consolidating the concrete, for the work involved.
- B. Do not use forms if they vary from a straight line more than 1/8-inch in any ten foot long section, in either a horizontal or vertical direction.
- C. Wood forms should be at least 2 inches thick (nominal). Wood forms shall also be free from warp, twist, loose knots, splits, or other defects. Use approved flexible or curved forms for forming radii.

## **2.4 CONCRETE CURING MATERIALS**

- A. Concrete curing materials shall conform to one of the following:
  - 1. Burlap conforming to AASHTO M182 having a weight of seven ounces or more per square yard when dry.
  - 2. Impervious Sheeting conforming to AASHTO M171.
  - 3. Liquid Membrane Curing Compound conforming to AASHTO M148 ASTM C309, Type 2 and shall be free of paraffin or petroleum.

## **2.5 EXPANSION JOINT FILLERS**

- A. Material shall conform to AASHTO M213.

## **PART 3 - EXECUTION**

### **3.1 SUBGRADE PREPARATION**

- A. Prepare, construct, and finish the subgrade as specified in Section 31 20 11, EARTH MOVING (short form).
- B. Maintain the subgrade in a smooth, compacted condition, in conformance with the required section and established grade until the succeeding operation has been accomplished.

### **3.2 BASE (AGGREGATE BASE COURSE)**

- A. Placing:
  - 1. Place the material on the prepared subgrade in a uniform layer to the required contour and grades, and to a loose depth not to exceed 6 inches, and that when compacted, will produce a layer of the designated thickness.
  - 2. When the designated compacted thickness exceeds 6 inches, place the material in layers of equal thickness. Remove unsatisfactory areas

and replace with satisfactory mixture, or mix the material in the area.

3. In no case will the addition of thin layers of material be added to the top layer in order to meet grade.
4. If the elevation of the top layer is 1/2-inch or more below the grade, excavate the top layer and replace with new material to a depth of at least 3 inches in compacted thickness.

B. Compaction:

1. Perform compaction with approved equipment (hand or mechanical) well suited to the material being compacted.
2. Moisten or aerate the material as necessary to provide the moisture content that will readily facilitate obtaining the specified compaction with the equipment used.
3. Compact each layer to at least 95 percent of maximum dry density as determined by ASTM D 698.

C. Smoothness Test and Thickness Control:

Test the completed base for grade and cross section with a straight edge.

1. The surface of each layer shall not show any deviations in excess of 3/8-inch.
2. The completed thickness shall be within 1/2-inch of the thickness as shown.

D. Protection:

1. Maintain the finished base in a smooth and compacted condition until the concrete has been placed.
2. When Contractor's subsequent operations or adverse weather disturbs the approved compacted base, excavate, and reconstruct it with new material meeting the requirements herein specified, at no additional cost to the VA.

### 3.3 SETTING FORMS

A. Base Support:

1. Compact the base material under the forms true to grade so that, when set, they will be uniformly supported for their entire length at the grade as shown.
2. Correct imperfections or variations in the base material grade by cutting or filling and compacting.

B. Form Setting:

1. Set forms sufficiently in advance of the placing of the concrete to permit the performance and approval of all operations required with and adjacent to the form lines.

2. Set forms to true line and grade and use stakes, clamps, spreaders, and braces to hold them rigidly in place so that the forms and joints are free from play or movement in any direction.
  3. Forms shall conform to line and grade with an allowable tolerance of 1/8-inch when checked with a straightedge and shall not deviate from true line by more than 1/4-inch at any point.
  4. Do not remove forms until removal will not result in damaged concrete or at such time to facilitate finishing.
  5. Clean and oil forms each time they are used.
- C. The Contractor's Registered Professional Land Surveyor, specified in Section 00 72 00, GENERAL CONDITIONS, shall establish and control the alignment and the grade elevations of the forms or concrete slipforming machine operations.
1. Make necessary corrections to forms immediately before placing concrete.
  2. When any form has been disturbed or any subgrade or subbase has become unstable, reset and recheck the form before placing concrete.

### **3.4 EQUIPMENT**

- A. The Resident Engineer shall approve equipment and tools necessary for handling materials and performing all parts of the work prior to commencement of work.
- B. Maintain equipment and tools in satisfactory working condition at all times.

### **3.5 PLACING REINFORCEMENT**

- A. Reinforcement shall be free from dirt, oil, rust, scale or other substances that prevent the bonding of the concrete to the reinforcement.
- B. Before the concrete is placed, the Resident Engineer shall approve the reinforcement, which shall be accurately and securely fastened in place with suitable supports and ties. The type, amount, and position of the reinforcement shall be as shown.

### **3.6 PLACING CONCRETE - GENERAL**

- A. Obtain approval of the Resident Engineer before placing concrete.
- B. Remove debris and other foreign material from between the forms before placing concrete. Obtain approval of the Resident Engineer before placing concrete.
- C. Before the concrete is placed, uniformly moisten the subgrade, base, or subbase appropriately, avoiding puddles of water.

- D. Convey concrete from mixer to final place of deposit by a method which will prevent segregation or loss of ingredients. Deposit concrete so that it requires as little handling as possible.
- E. While being placed, spade or vibrate and compact the concrete with suitable tools to prevent the formation of voids or honeycomb pockets. Vibrate concrete well against forms and along joints. Over-vibration or manipulation causing segregation will not be permitted. Place concrete continuously between joints without bulkheads.
- F. Install a construction joint whenever the placing of concrete is suspended for more than 30 minutes and at the end of each day's work.
- G. Workmen or construction equipment coated with foreign material shall not be permitted to walk or operate in the concrete during placement and finishing operations.

### **3.7 PLACING CONCRETE FOR CURB AND GUTTER, PEDESTRIAN PAVEMENT, AND EQUIPMENT PADS**

- A. Place concrete in the forms in one layer of such thickness that, when compacted and finished, it will conform to the cross section as shown.
- B. Deposit concrete as near to joints as possible without disturbing them but do not dump onto a joint assembly.
- C. After the concrete has been placed in the forms, use a strike-off guided by the side forms to bring the surface to the proper section to be compacted.
- D. Consolidate the concrete thoroughly by tamping and spading, or with approved mechanical finishing equipment.
- E. Finish the surface to grade with a wood or metal float.
- F. All Concrete pads and pavements shall be constructed with sufficient slope to drain properly.

### **3.8 PLACING CONCRETE FOR VEHICULAR PAVEMENT**

- A. Deposit concrete into the forms as close as possible to its final position.
- B. Place concrete rapidly and continuously between construction joints.
- C. Strike off concrete and thoroughly consolidate by a finishing machine, vibrating screed, or by hand-finishing.
- D. Finish the surface to the elevation and crown as shown.
- E. Deposit concrete as near the joints as possible without disturbing them but do not dump onto a joint assembly. Do not place adjacent lanes without approval by the Resident Engineer.

### **3.9 CONCRETE FINISHING - GENERAL**

- A. The sequence of operations, unless otherwise indicated, shall be as follows:

1. Consolidating, floating, straight-edging, troweling, texturing, and edging of joints.
2. Maintain finishing equipment and tools in a clean and approved condition.

### **3.10 CONCRETE FINISHING CURB AND GUTTER, VALLEY GUTTER AND FILLETS**

- A. Round the edges of the gutter and top of the curb with an edging tool to a radius of 1/4-inch or as otherwise detailed.
- B. Float the surfaces and finish with a smooth wood or metal float until true to grade and section and uniform in textures.
- C. Finish the surfaces, while still wet, with a bristle type brush with longitudinal strokes.
- D. Immediately after removing the front curb form, rub the face of the curb with a wood or concrete rubbing block and water until blemishes, form marks, and tool marks have been removed. Brush the surface, while still wet, in the same manner as the gutter and curb top.
- E. Except at grade changes or curves, finished surfaces shall not vary more than 1/8-inch for gutter and 1/4-inch for top and face of curb, when tested with a 10 foot straightedge.
- F. Remove and reconstruct irregularities exceeding the above for the full length between regularly scheduled joints.
- G. Correct any depressions which will not drain.
- H. Visible surfaces and edges of finished curb and valley gutter shall be free of blemishes, form marks, and tool marks, and shall be uniform in color, shape, and appearance.

### **3.11 CONCRETE FINISHING PEDESTRIAN PAVEMENT**

- A. Walks and Wheelchair Curb Ramps:
  1. Finish the surfaces to grade and cross section with a metal float, trowled smooth and finished with a broom moistened with clear water.
  2. Brooming shall be transverse to the line of traffic.
  3. Finish all slab edges, including those at formed joints, carefully with an edger having a radius as shown on the Drawings.
  4. Unless otherwise indicated, edge the transverse joints before brooming. The brooming shall eliminate the flat surface left by the surface face of the edger. Execute the brooming so that the corrugation, thus produced, will be uniform in appearance and not more than 1/16-inch in depth.
  5. The completed surface shall be uniform in color and free of surface blemishes, form marks, and tool marks. The finished surface of the pavement shall not vary more than 3/16-inch when tested with a 10 foot straightedge.

6. The thickness of the pavement shall not vary more than 1/4-inch.
7. Remove and reconstruct irregularities exceeding the above for the full length between regularly scheduled joints.

### **3.12 CONCRETE FINISHING FOR VEHICULAR PAVEMENT**

- A. Accomplish longitudinal floating with a longitudinal float not less than 10 feet long and 6 inches wide, properly stiffened to prevent flexing and warping. Operate the float from foot bridges in a sawing motion parallel to the direction in which the pavement is being laid from one side of the pavement to the other, and advancing not more than half the length of the float.
- B. After the longitudinal floating is completed, but while the concrete is still plastic, eliminate minor irregularities in the pavement surfaces by means of metal floats, 5 feet in length, and straightedges, 10 feet in length. Make the final finish with the straightedges, which shall be used to float the entire pavement surface.
- C. Test the surface for trueness with a 10 foot straightedge held in successive positions parallel and at right angles to the direction in which the pavement is being laid and the entire area covered as necessary to detect variations. Advance the straightedge along the pavement in successive stages of not more than one half the length of the straightedge. Correct all irregularities and refinish the surface.
- D. The finished surface of the pavement shall not vary more than 1/4-inch in both longitudinal and transverse directions when tested with a 10 foot straightedge.
- E. The thickness of the pavement shall not vary more than 1/4-inch.
- F. When most of the water glaze or sheen has disappeared and before the concrete becomes nonplastic, give the surface of the pavement a broomed finish with an approved fiber broom not less than 18 inches wide. Pull the broom gently over the surface of the pavement from edge to edge. Brooming shall be transverse to the line of traffic and so executed that the corrugations thus produced will be uniform in character and width, and not more than 1/8-inch in depth. Carefully finish the edge of the pavement along forms and at the joints with an edging tool. The brooming shall eliminate the flat surface left by the surface face of the edger.
- G. The finish surfaces of new and existing abutting pavements shall coincide at their juncture.

### **3.13 CONCRETE FINISHING EQUIPMENT PADS**

- A. After the surface has been struck off and screeded to the proper elevation, give it a smooth dense float finish, free from depressions or irregularities.



- B. Carefully finish all slab edges with an edger having a radius of 1/4-inch or as shown in the Drawings.
- C. After removing the forms, rub the faces of the pad with a wood or concrete rubbing block and water until blemishes, form marks, and tool marks have been removed. The finish surface of the pad shall not vary more than 1/8-inch when tested with a 10 foot straightedge.
- D. Correct irregularities exceeding the above.

#### **3.14 JOINTS - GENERAL**

- A. Place joints, where shown, conforming to the details as shown, and perpendicular to the finished grade of the concrete surface.
- B. Joints shall be straight and continuous from edge to edge of the pavement.

#### **3.15 CONTRACTION JOINTS**

- A. Cut joints to depth as shown with a grooving tool or jointer of a radius as shown or by sawing with a blade producing the required width and depth.
- B. Construct joints in curbs and valley gutters by inserting 1/8-inch steel plates conforming to the cross sections of the curb and gutter or saw cutting as shown in the drawings.
- C. Plates shall remain in place until concrete has set sufficiently to hold its shape and shall then be removed.
- D. Finish edges of all joints with an edging tool having the radius as shown.
- E. Score pedestrian pavement with a standard grooving tool or jointer.

#### **3.16 EXPANSION JOINTS**

- A. Use a preformed expansion joint filler material of the thickness as shown to form expansion joints.
- B. Material shall extend the full depth of concrete, cut and shaped to the cross section as shown, except that top edges of joint filler shall be below the finished concrete surface where shown to allow for sealing.
- C. Anchor with approved devices to prevent displacing during placing and finishing operations.
- D. Round the edges of joints with an edging tool.
- E. Form expansion joints as follows:
  - 1. Without dowels, about structures and features that project through, into, or against any site work concrete construction.
  - 2. Using joint filler of the type, thickness, and width as shown.
  - 3. Installed in such a manner as to form a complete, uniform separation between the structure and the site work concrete item.

**3.17 CONSTRUCTION JOINTS**

- A. Locate longitudinal and transverse construction joints between slabs of vehicular pavement as shown.
- B. Place transverse construction joints of the type shown, where indicated and whenever the placing of concrete is suspended for more than 30 minutes.
- C. Use a butt-type joint with dowels in curb and valley gutter if the joint occurs at the location of a planned joint.

**3.18 FORM REMOVAL**

- A. Forms shall remain in place at least 12 hours after the concrete has been placed. Remove forms without injuring the concrete.
- B. Do not use bars or heavy tools against the concrete in removing the forms. Promptly repair any concrete found defective after form removal.

**3.19 CURING OF CONCRETE**

- A. Cure concrete by one of the following methods appropriate to the weather conditions and local construction practices, against loss of moisture, and rapid temperature changes for at least seven days from the beginning of the curing operation. Protect unhardened concrete from rain and flowing water. All equipment needed for adequate curing and protection of the concrete shall be on hand and ready to install before actual concrete placement begins. Provide protection as necessary to prevent cracking of the pavement due to temperature changes during the curing period. If any selected method of curing does not afford the proper curing and protection against concrete cracking, remove and replace the damaged pavement and employ another method of curing as directed by the Resident Engineer.
- B. Burlap Mat: Provide a minimum of two layers kept saturated with water for the curing period. Mats shall overlap each other at least 6 inches.
- C. Impervious Sheeting: Use waterproof paper, polyethylene-coated burlap, or polyethylene sheeting. Polyethylene shall be at least 4 mils in thickness. Wet the entire exposed concrete surface with a fine spray of water and then cover with the sheeting material. Sheets shall overlap each other at least 12 inches. Securely anchor sheeting.
- D. Liquid Membrane Curing:
  - 1. Apply pigmented membrane-forming curing compound in two coats at right angles to each other at a rate of 200 square feet per gallon for both coats.
  - 2. Do not allow the concrete to dry before the application of the membrane.

3. Cure joints designated to be sealed by inserting moistened paper or fiber rope or covering with waterproof paper prior to application of the curing compound, in a manner to prevent the curing compound entering the joint.
4. Immediately re-spray any area covered with curing compound and damaged during the curing period.

### **3.20 CLEANING**

- A. After completion of the curing period:
  1. Remove the curing material (other than liquid membrane).
  2. Sweep the concrete clean.
  3. After removal of all foreign matter from the joints, seal joints as herein specified.
  4. Clean the entire concrete of all debris and construction equipment as soon as curing and sealing of joints has been completed.

### **3.21 PROTECTION**

- A. The contractor shall protect the concrete against all damage prior to final acceptance by the Government. Remove concrete containing excessive cracking, fractures, spalling, or other defects and reconstruct the entire section between regularly scheduled joints, when directed by the Resident Engineer, and at no additional cost to the Government. Exclude traffic from vehicular pavement until the concrete is at least seven days old, or for a longer period of time if so directed by the Resident Engineer.

### **3.22 FINAL CLEAN-UP**

- A. Remove all debris, rubbish and excess material from the Station.

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**SECTION 32 12 16**  
**ASPHALT PAVING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

This work shall cover the composition, mixing, construction upon the prepared subgrade, and the protection of hot asphalt concrete pavement. The hot asphalt concrete pavement shall consist of an aggregate or asphalt base course and asphalt surface course constructed in conformity with the lines, grades, thickness, and cross sections as shown. Each course shall be constructed to the depth, section, or elevation required by the drawings and shall be rolled, finished, and approved before the placement of the next course.

**1.2 RELATED WORK**

- A. Laboratory and field testing requirements: Section 01 45 29, TESTING LABORATORY SERVICES.
- B. Subgrade Preparation: Paragraph 3.3 and Section 31 20 11, EARTH MOVING (short form).

**1.3 INSPECTION OF PLANT AND EQUIPMENT**

- A. The Resident Engineer shall have access at all times to all parts of the material producing plants for checking the mixing operations and materials and the adequacy of the equipment in use.

**1.4 ALIGNMENT AND GRADE CONTROL**

- A. The Contractor's Registered Professional Land Surveyor shall establish and control the pavement (aggregate or asphalt base course and asphalt surface course) alignments, grades, elevations, and cross sections as shown on the Drawings.

**1.5 SUBMITTALS**

- A. In accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, furnish the following:
- B. Data and Test Reports:
  - 1. Aggregate Base Course: Sources, gradation, liquid limit, plasticity index, percentage of wear.
  - 2. Asphalt Base/Surface Course: Aggregate source, gradation, soundness loss, percentage of wear.
  - 3. Job-mix formula.
- C. Certifications:
  - 1. Asphalt tack coat material certificate of conformance to State of South Dakota Department of Transportation Standards.

- 2. Asphalt cement certificate of conformance to State of South Dakota Department of Transportation Standards requirements.
- 3. Job-mix certification - Submit plant mix certification that mix equals or exceeds the State of South Dakota Department of Transportation Standards.
- D. One copy of the current State of South Dakota Department of Transportation "Standard Specifications for Roads and Bridge Design".
- E. Provide MSDS (Material Safety Data Sheets) for all chemicals used on ground.

#### **1.6 QUALITY ASSURANCE**

- A. Perform Work in accordance with State of South Dakota Department of Transportation standards, except as stated in the project specifications.
- B. Mixing Plant: Conform to State of South Dakota Department of Transportation standards.
- C. Obtain materials from same source throughout.
- D. Maintain one copy of each document on site.

### **PART 2 - PRODUCTS**

#### **2.1 GENERAL**

- A. Aggregate base, asphaltic base, and asphalt concrete materials shall conform to the requirements of the sections of the latest version of the South Dakota Department of Transportation Standard Specifications, including amendments, addenda and errata. Where the term "Engineer" is referenced in the South Dakota Department of Transportation Standard Specifications, it shall mean the VA Resident Engineer or VA Contracting Officer.

#### **2.2 AGGREGATE BASE COURSE**

- A. Aggregate Base Course - Under asphalt, sidewalk and curb and/or gutter shall be crushed limestone that meets all of the requirements of Limestone Ledge Rock Base Course as specified in the South Dakota Department of Transportation's Standard Specifications for Road and Bridge Design.

#### **2.3 ASPHALT**

- A. Asphalt concrete materials shall conform to the requirements of the following and other appropriate sections of the latest version of the State of South Dakota Department of Transportation Standards, including amendments, addenda and errata. Where the term "Engineer" is referenced in the State Highway Specifications, it shall mean the VA Resident Engineer or VA Contracting Officer.

- B. Asphalt Cement: ASTM D946 and ASTM D3381, in accordance with State of South Dakota Department of Transportation standards.
- C. Aggregate for Binder Course Mix: In accordance with State of South Dakota Department of Transportation standards.
- D. Aggregate for Wearing Course Mix: In accordance with State of South Dakota Department of Transportation standards.
- E. Fine Aggregate: In accordance with State of South Dakota Department of Transportation standards.
- F. Mineral Filler: Finely ground particles of limestone, hydrated lime or other mineral dust, free of foreign matter.
- G. Tack Coat: Homogeneous, medium curing, liquid asphalt. In accordance with State of South Dakota Department of Transportation standards.
- H. Oil: In accordance with State of South Dakota Department of Transportation standards.
- I. Asphalt Paving Mix:
  - 1. Use dry material to avoid foaming. Mix uniformly.
  - 2. The asphalt paving mix Class E, Type I shall be in accordance with the State of South Dakota Department of Transportation standards.
  - 3. Mix Temperature: In accordance with State of South Dakota Department of Transportation standards.

### **PART 3 - EXECUTION**

#### **3.1 GENERAL**

- A. The Asphalt Concrete Paving equipment, weather limitations, job-mix formula, mixing, construction methods, compaction, finishing, tolerance, and protection shall conform to the requirements of the appropriate sections of the State Highway Specifications for the type of material specified.

#### **3.2 MIXING ASPHALTIC CONCRETE MATERIALS**

- A. Provide hot plant-mixed asphaltic concrete paving materials.
  - 1. Temperature leaving the plant: 290 degrees F minimum, 320 degrees F maximum.
  - 2. Temperature at time of placing: 280 degrees F minimum.

#### **3.3 SUBGRADE**

- A. Shape to line and grade and compact with self-propelled rollers.
- B. All depressions that develop under rolling shall be filled with acceptable material and the area re-rolled.
- C. Soft areas shall be removed and filled with acceptable materials and the area re-rolled.
- D. Should the subgrade become rutted or displaced prior to the placing of the subbase, it shall be reworked to bring to line and grade.

- E. Proof-roll the subgrade with maximum 50 ton gross weight dump truck as directed by VA Resident Engineer or VA Contracting Officer. If pumping, pushing, or other movement is observed, rework the area to provide a stable and compacted subgrade.

### **3.4 BASE COURSES**

- A. Base (Aggregate Base Course):
  - 1. Spread and compact to the thickness shown on the drawings.
  - 2. Rolling shall begin at the sides and continue toward the center and shall continue until there is no movement ahead of the roller.
  - 3. After completion of the base rolling there shall be no hauling over the base other than the delivery of material for the top course.
- B. Thickness tolerance: Provide the compacted thicknesses shown on the Drawings within a tolerance of minus 0.0-inch to plus 0.5-inch.
- C. Smoothness tolerance: Provide the lines and grades shown on the Drawings within a tolerance of 3/16-inch in ten feet.
- D. Moisture content: Use only the amount of moisture needed to achieve the specified compaction.

### **3.5 PREPARATION - TACK COAT**

- A. Apply tack coat in accordance with State of South Dakota Department of Transportation standards.
- B. Apply tack coat to contact surfaces of curbs, gutters and catch basins.

### **3.6 PLACEMENT OF ASPHALTIC CONCRETE PAVING**

- A. Remove all loose materials from the compacted base.
- B. Apply the specified prime coat, and tack coat where required, and allow to dry in accordance with the manufacturer's recommendations as approved by the Architect or Engineer.
- C. Receipt of asphaltic concrete materials:
  - 1. Do not accept material unless it is covered with a tarpaulin until unloaded, and unless the material has a temperature of not less than 280 degrees F.
  - 2. Do not commence placement of asphaltic concrete materials when the atmospheric temperature is below 50 degrees F, not during fog, rain, or other unsuitable conditions.
- D. Spreading:
  - 1. Spread material in a manner that requires the least handling.
  - 2. Where thickness of finished paving will be 3 inches or less, spread in one layer.



E. Rolling:

1. After the material has been spread to the proper depth, roll until the surface is hard, smooth, unyielding, and true to the thickness and elevations shown on the drawings.
2. Roll in at least two directions until no roller marks are visible.
3. Finished paving smoothness tolerance:
  - a. No depressions which will retain standing water.
  - b. No deviation greater than 3mm in 1/8-inch in six feet.

**3.7 PROTECTION**

- A. Protect the asphaltic concrete paved areas from traffic until the sealer is set and cured and does not pick up under foot or wheeled traffic.

**3.8 FINAL CLEAN-UP**

- A. Remove all debris, rubbish, and excess material from the work area.

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**SECTION 32 84 00  
PLANTING IRRIGATION**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

An automatically-controlled lawn and landscape irrigation system, complete, including piping, drip emitters, sprinkler heads, valves, interface with existing controls, control wiring, fittings, electrical connections, and necessary accessories.

**1.2 RELATED WORK**

- A. Concrete: Section 03 30 00, CAST-IN-PLACE CONCRETE.
- B. Maintenance of Existing Utilities: Section 01 00 00, GENERAL REQUIREMENTS.
- C. Excavation, Trench Widths, Pipe Bedding, Backfill, Shoring, Sheeting, Bracing: Section 31 20 11, EARTH MOVING (short form).
- D. Division 26, ELECTRICAL.
- E. Section 32 90 00, PLANTING.

**1.3 QUALITY ASSURANCE**

- A. Criteria:
  - 1. Manufacturer regularly and presently manufactures the item submitted as one of their principal products.
  - 2. Installer, or supplier of a service, has technical qualifications, experience, and trained personnel and facilities to perform the specified work.
- B. Products Criteria:
  - 1. Multiple Units: When two or more units of the same type or class of materials or equipment are required, these units are products of one manufacturer.
  - 2. Assembled Units: Manufacturers of equipment assemblies which use components made by others, assume complete responsibility for the final assembled product.
    - a. All components of an assembled unit need not be products of the same manufacturer but component parts which are alike are the product of a single manufacturer.
    - b. Components are compatible with each other and with the total assembly for the intended service.
  - 3. Nameplates: Nameplate bearing manufacturer's name or identification trademark securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped, or otherwise permanently marked on each item of equipment.

C. System Requirements:

1. Full and complete coverage is required. Contractor shall, at no additional cost to the Government, make necessary adjustments to layout required to achieve full coverage of irrigated areas without overthrow on roadways, sidewalks, window wells, or buildings and to protect trees from close high spray velocity.
2. Layout work as closely as possible to drawings. Drawings are diagrammatic to the extent that swing joints, offsets and all fittings are not shown. Lines are to be common trenched wherever possible.
3. Locations of remote control valves is schematic. Remote control valves shall be grouped wherever possible and aligned at a set dimension back of curb along roads.
4. Connect new system to existing mains.

D. Maintenance and Operating Instructions: Prior to final acceptance, verbal instructions, for a period of not less than 16 hours, shall be provided to the operating personnel. Provide two additional years of software support for one hour each month. Provide manuals as specified in Section 01 00 00, GENERAL REQUIREMENTS.

E. Completely program controller according to approved irrigation schedule. Integrate and coordinate with campus irrigation system.

F. Follow manufacturer's instructions for installation.

G. Manufacturer of Control Systems to certify Control System is able to receive additional solenoid zone connections; including all related components, and totally operational. Submit certificate to Resident Engineer.

H. As-Built Record Drawings: Maintain a complete set of as-built drawings which shall be corrected daily to show changes in locations of all pipe, valves, pumps and related irrigation equipment. Valves shall be shown with dimensions to reference points.

I. Controller Chart:

1. Prepare a map diagram showing location of all valves, lateral lines, and route of the control wires. Identify all valves as to size, station, number and type of irrigation. "As-built" drawings must be approved before charts are prepared. Coordinate with existing systems.
2. Provide one controller chart showing the area covered by controller for each automatic controller supplied at the maximum size controller door will allow. Chart shall be a reduced drawing of the actual "as-built" system. If controller sequence is not legible when the

drawing is reduced to door size, the drawing shall be enlarged to a size that is readable and placed folded, in a sealed plastic container, inside the controller door.

3. Chart shall be a blackline print with a different color used to show area of coverage for each station. Charts must be completed and approved prior to final inspection of the irrigation system.

#### **1.4 SUBMITTALS**

- A. Submit as one package in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturers' Literature and Data:
  1. Piping.
  2. Jointing materials.
  3. Valves.
  4. Automatic control equipment.
  5. Sprinkler heads.
  6. Drip Emitters
  7. Quick couplers.
  8. Valve boxes.
- C. Complete detailed layout shop drawings covering design of system showing pipe sizes and lengths; fittings, locations, types and sizes of sprinkler heads; controls; valves; complete wiring diagram showing routes and wire sizes; wiring details and source of current and connections to existing services. Do not start work before final shop drawing approval.
- D. Name and address of a permanent service organization maintained or trained by the manufacturers that will render satisfactory service within eight hours of receipt of notification that service is requested.
- E. Reproducible "as-built" drawings.
- F. After "as-built" drawings have been approved, submit print of controller chart.

#### **1.5 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. Federal Specifications (Fed. Spec.):
 

A-A-60005.....Frames, Covers, Gratings, Steps, Sump and Catch Basin, Manhole
- C. American National Standard Institute (ANSI):
 

B40.100-05.....Gauge-Pressure Indicating Dial Type-Elastic Element

## D. American Society of Sanitary Engineers (ASSE):

1013-2009.....Reduced Pressure Principle Backflow Preventers

## E. American Society for Testing and Materials (ASTM):

B61-08.....Steam or Valve Bronze Castings

B62-09.....Composition Bronze or Ounce Metal Castings

D1785-06.....Poly(Vinyl Chloride) (PVC) Plastic Pipe,  
Schedule 40, 80, and 120D2241-05.....Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe  
(SDR Series)D2464-06.....Threaded Poly (Vinyl Chloride) (PVC) Plastic  
Pipe Fittings, Schedule 80D2466-06.....Poly(Vinyl Chloride) (PVC) Plastic Pipe  
Fittings, Schedule 40D2564-04.....Solvent Cements for Poly (Vinyl Chloride) (PVC)  
Plastic Piping SystemsD2855-96(R2002).....Making Solvent Cemented Joints with Poly(Vinyl  
Chloride) (PVC) Pipe and FittingsF477-08.....Elastomeric Seals (Gaskets) for Joining Plastic  
Pipe

## F. American Water Works Association (AWWA):

C110/A21.10-08.....Ductile-Iron and Gray-Iron Fittings, 3-Inch  
Through 48-Inch for WaterC111/A21.11-06.....Rubber-Gasket Joints for Ductile-Iron Pressure  
Pipe and Fittings.C115/A21.15-05.....Flanged Ductile-Iron Pipe with Ductile-Iron or  
Gray-Iron Threaded Flanges

C151/A21.51-09.....Ductile-Iron Pipe, Centrifugally Cast, for Water

C504-06.....Rubber Seated Butterfly Valves

C600-05.....Installation of Ductile-Iron Water Mains and  
Their AppurtenancesC900-07.....Polyvinyl Chloride (PVC) Pressure Pipe and  
Fabricated Fittings 4in. Through 12in.

## G. Manufacturers Standardization Society (MSS):

SP-70-06.....Gray Iron Gate Valves, Flanged and Thread Ends

**PART 2 - PRODUCTS****2.1 PIPING**

## A. Irrigation Mains: Provide one of the following materials.

1. Polyvinyl Chloride (PVC) Pressure Pipe, AWWA C900, PVC 1120, working pressure 150 psi.

- B. Irrigation Laterals: Polyvinyl Chloride, ASTM D2241, PVC 1120, SDR 21, solvent welded.
- C. Threaded Pipe: Polyvinyl Chloride, ASTM D1785, PVC 1120, Schedule 80, for threaded connections, risers and swing joints.
- D. Fittings:
  - 1. Irrigation Mains (Ductile Iron and PVC Pipe): Ductile Iron, AWWA C110 Schedule 80 PVC solvent welded socket type, ASTM D 2466.
  - 2. Irrigation Laterals: PVC, schedule 40, solvent welded socket type, ASTM D2466.
  - 3. Threaded Pipe: PVC, schedule 80, ASTM D2464.
  - 4. Swing Joints: Threaded fittings with elastomeric seals that allow 360 degree rotation, and designed for minimum 200 psig working pressure, may be used in lieu of standard threaded fittings.
- E. Jointing Materials:
  - 1. Irrigation Mains: Solvent cement.
  - 2. Irrigation Laterals: Solvent cement, ASTM D2564.

## **2.2 VALVES (EXCEPT REMOTE CONTROL VALVES)**

- A. Underground Shut-Off Valves: Provide One of the Following:
  - 1. Gate valves 2 inches and larger: Iron body, bronze mounted, double disc with parallel or inclined seats, non-rising stem turning clockwise to close, 150 psi minimum working pressure. AWWA C504.
  - 2. all valves (for isolation valves 1-1/2 inches and smaller): Full-port ball valves with bronze body, PTFE seats, and 90 degree on/off handle. Ball valves to have NPT female end connections.
- B. Operations:
  - 1. Underground: furnish valves with 2-inch nut for T-Handle socket wrench operation.
  - 2. Ends of valves shall accommodate the type of pipe installed.
- C. Check: Swing.
  - 1. Smaller than 4 inches: Bronze body and bonnet, ASTM B61 or B62, 125 pounds WSP.
- D. Pressure Reducing Valve: Cast steel body with renewable seats, with stainless steel trim. Flow passages and all parts designed to withstand high velocity applications, flange connected.

## **2.3 VALVE BOX**

- A. Gate and Butterfly Valve: Valve boxes shall be precast concrete (from Rigid Cast Iron Forms) with compressive strength of the concrete in excess of 4000 psi. Box shall be of such length to be adapted to depth of cover required over pipe at valve location. Mark box cover to differentiate between lawn irrigation system and domestic water supply

system and set flush with finished grade. Provide one "T" handle socket wrench of 5/8-inch round stock with sufficient length to extend 2 feet above top of deepest valve box cover.

- B. Remote Control Valves: When in pavement, valve boxes shall be precast concrete (from Rigid Cast Iron Forms) with compressive strength of the concrete in excess of 4000 psi. In planter areas, valve boxes shall be HDPE structural foam Type A, Class III, green in color. Box shall be minimum 19 inches long by 14 inches deep with key-lockable hinged cast iron cover.
- C. Drip zone Lateral Flush Cap Assembly: Round reinforced plastic valve box and lid constructed from HDPE. Opening at top of access box to be 5-3/4 inches diameter, minimum. Height of access box to be 9-1/16 inches, minimum. Lid to have lift-hole for opening.
- D. Emitter Access Boxes: Round plastic boxes with lid constructed of UV resistant thermoplastic material, tan in color. Top diameter to be 5 inches, minimum. Height of box to be 10-1/4 inches, minimum.

#### **2.4 BACKFLOW PREVENTER**

- A. Coordinate with existing elements.

#### **2.5 WATER METER**

- A. Coordinate with existing elements.

#### **2.6 REMOTE CONTROL VALVES:**

- A. Each sprinkler section shall be automatically operated by a remote control valve installed underground and operated by a 24-volt AC electric solenoid. Valves shall be globe type of heavy duty construction and shall have manual shut-off and flow control adjustment and provide for manual operation. Install valves with unions on each side to allow for easy removal. Valves shall have a minimum of 150 psi working pressure.
- B. Valves shall be diaphragm type designed to operate in water containing sand and debris and shall have a self cleaning type contamination filter to filter all water leading to the solenoid actuator and the diaphragm chamber. Valve shall incorporate a non-adjustable type opening and closing speed control for protection against surge pressures, or valves shall operate by means of a slow acting direct drive thermal hydraulic motor without ports, screens or diaphragms.

#### **2.7 SPRINKLER HEADS**

- A. Shall be of make, type and performance as indicated on drawings. The entire internal assembly including filter screen, to be capable of removal from the top without removing the sprinkler case from the riser.
- B. Rotary Pop-up Sprinklers: To be gear-driven.



1. Full Circle Sprinklers: To be a dual or tri-nozzle combination type with positive drive by means of a water-driven gear assembly. Sprinkler head to rotate uniformly and to be driven by means of a train of gears. Sprinklers to be equipped with an integral anti-drain valve to be self-closing at pressures of 3.0m (10 feet) of head or less. Gears and pinions shall be assembled on stainless steel spindles in a water-lubricated sandproof gear case. An inlet screen shall prevent debris from entering the sprinkler and shall be removable with the internal assembly. Sprinklers outer case shall be constructed of corrosion resistant, impact resistant, heavy-duty ABS.
  2. Part circle sprinklers to be variable arc type as required with same type drive used for full circle heads.
- C. Shrub Spray Heads: Nozzle shall be pop-up fully spray type of standard, undersize or oversize configuration as noted on plans. The sprinkler body, stem, nozzle and screen shall be constructed of heavy-duty, ultraviolet resistant plastic. It shall have a heavy duty stainless steel retract spring and a ratcheting system for alignment of the pattern. The sprinkler shall have a soft elastomer pressure-activated comolded wiper seal for cleaning debris from the pop-up stem. The sprinkler shall have a plastic or brass nozzle with an adjusting screw capable of regulating the radius and flow. The sprinkler shall be capable of housing protective, nonclogging filter screens or pressure compensating screens (PCS) under the nozzle.
- D. Drip Emitters: Drip emitters shall be of the pressure compensating, permanently assembled type with 1/2-inch FPT inlet. Emitters shall be capable of providing 1 gpm at inlet pressures between 15 and 50 psi.
- E. Emitter distribution tubing shall be constructed of UV resistant vinyl material with a .22-inch O.D. and a .16-inch I.D. Tubing shall be as manufactured by the same manufacturer as the drip emitters.

## **2.8 QUICK COUPLERS**

- A. Shall have all parts contained in a two-piece unit and shall consist of a coupler water seal valve assembly and a removable upper body to allow the spring and key track to be serviced without shut down of the main.
- B. Metal parts shall be brass.
- C. Lids shall be lockable vinyl covered and have springs for positive closure on key removal.
- D. Furnish two hose swivels and operating keys for each size coupler to the Resident Engineer.

**2.9 LOW VOLTAGE CONTROL VALVE WIRE**

Wire: Solid copper wire, Underwriters Laboratories Inc. approved for direct burial in ground. Size of wire shall be in accordance with manufacturer's recommendations, but in no case less than No. 14.

**2.10 SPLICING MATERIALS: EPOXY WATERPROOF SEALING PACKET. LOW VOLTAGE CONTROLLER CABLE**

Multi-strand cable, Underwriters Laboratories Inc. approved for direct burial in ground. Size and type of wire shall be in accordance with manufacturer's recommendations.

**2.11 SLEEVE MATERIAL**

PVC-1120-5DR 17, Schedule.

**2.12 WARNING TAPE**

Standard, 4-Mil polyethylene 3-inch wide tape, detectable type blue with black letters (if potable water), or purple with black letters (if reclaimed or untreated well water), and imprinted with "CAUTION BURIED IRRIGATION WATER LINE BELOW".

**2.13 TRACER WIRES**

No. 14, Green, Type TW plastic-coated copper tracer wire shall be installed with non-metallic irrigation main lines.

**PART 3 - EXECUTION****3.1 PIPE LAYING - GENERAL**

- A. Do not lay pipe on unstable material, in wet trench or when, in the opinion of Resident Engineer, trench or weather conditions are unsuitable for the work.
- B. Concrete thrust block shall be installed where the irrigation main changes direction as at ells and tees and where the irrigation main terminates. Pressure tests shall not be made for a period of 36 hours following the completion of pouring of the thrust blocks. Concrete thrust blocks for supply mains shall be sized and placed in strict accordance with the pipe manufacturer's specifications and shall be of an adequate size and so placed as to take all thrust created by the maximum internal water pressure. Thrust blocks are required for mainline pipe 3-inch and larger.
- C. Allow a minimum of 3 inches between parallel pipes in the same trench.
- D. Hold pipe securely in place while joint is being made.
- E. Do not work over, or walk on, pipe in trenches until covered by layers of earth well tamped in place to a depth of 12 inches over pipe.
- F. Full length of each section of pipe shall rest upon the pipe bed with recesses excavated to accommodate bells or joints. Do not lay pipe on wood blocking.

- G. Install sprinkler lines to avoid heating trenches, electric ducts, storm and sanitary sewer lines, and existing water and gas mains, all of which have right of way.
- H. Clean interior of pipe of foreign matter before installation. Keep pipe clean during laying operations by means of plugs or other methods. When work is not in progress, securely close open ends of pipe and fittings to prevent water, earth, or other substances from entering.
- I. Minimum cover over water mains shall be 24 inches. Control valves shall never be less than 3 inches below finished grade. Cover laterals to minimum depth of 18 inches.
- J. Existing sidewalks and curbs shall not be cut during trenching and installation of pipe. Install pipe under sidewalks and curbs by jacking, auger boring, or by tunneling. Repair or replace any concrete that cracks, due to settling, during the warranty period.
- K. Close pipe openings with caps or plugs during installation. Tightly cover and protect fixtures and equipment against dirt, water and chemical or mechanical injury. At completion of all work thoroughly clean fixtures, exposed materials and equipment.
- L. Warning tape shall be continuously placed 12 inches above sprinkler system water mains and laterals.

### **3.2 LAYING PLASTIC PIPE**

- A. Shall be snaked in trench at least 1 meter to 1 foot per 100 feet to allow for thermal construction and expansion and to reduce strain on connections.
- B. Joints:
  - 1. Solvent Welded Socket Type: ASTM D2855.
  - 2. Threaded Type: Apply liquid teflon thread lubricant of teflon thread type. After joint is made hand tight (hard), a strap wrench should be used to make up to two additional full turns.
  - 3. Elastomeric Gasket: ASTM F477.
    - a. Immediately before joining two lengths of PVC pipe, the inside of the bell or coupling, the outside of the spigot and the elastomeric gasket shall be thoroughly cleaned to remove all foreign material.
    - b. Lubrication of the joint and rubber gasket shall be done in accordance with the pipe manufacturer's specifications.
    - c. Care shall be taken that only the correct elastomeric gasket, compatible with the annular groove of the bell, is used. Insertion of the elastomeric gasket in the annular groove of the bell or coupling shall be in accordance with the manufacturer's

recommendations. Pipe that is not furnished with a depth mark shall be marked before assembly to assure that the spigot end is inserted to the full depth of the joint.

- d. The spigot and bell or coupling shall be aligned and pushed until the reference line on the spigot is flush with the end of the bell or coupling. Pushing shall be done in a smooth, steady motion.

### **3.3 LAYING EMITTER HOSE**

- A. Use Type 1/11 solvent weld.
- B. Bushing for adaptation from PVC Schedule 40 fittings to flex-vinyl hose shall be line size by 3/8-inch insert bushings.

### **3.4 INSTALLATION OF SPRINKLERS AND QUICK COUPLERS**

- A. Sprinkler heads and quick couplers shall be placed on temporary nipples extending at least 3 inches above finished grade. After turf is established, remove temporary nipples, ensuring that no dirt or foreign matter enters outlet, and install sprinkler heads and quick couplers at ground surface as detailed.
- B. Place part-circle rotary sprinkler heads no more than 6 inches from edge, of and flush with top of adjacent walks, header boards, curbs, and mowing aprons, or paved areas at time of installation.
- C. Install all shrub sprays, sprinklers and quick couplers on swing joints as detailed on plans.
- D. Set shrub heads 8 inches above grade and 300 mm (1 foot) from edge of curb or pavement. Place adjacent to walls. Stake heads prior to backfilling trenches. Stakes to be parallel to riser.
- E. Install sprinklers and quick coupling valves on a swing joint assembly.

### **3.5 INSTALLATION OF CONTROL WIRING**

- A. Wiring from master controllers to satellites and stub-outs for future extension shall be located in trench with new mains or in separate trench at back of curb, unless cross-country route is shown. Locate in trench with mains when possible on cross-country routes.
- B. Wiring bundles located with piping shall be set with top of the bundle below top of the pipe. No two wires in any bundle shall be of the same color. Wires shall be bundled, and tied or taped at 4.5 m (15 foot) intervals. A numbered tag shall be provided at each end of a wire, i.e., at valve, at field located controllers and at master controller. The number at each end of wire is to be the same.
- C. Splicing shall be held to a minimum. A pullbox shall be provided at each splice. No splices will be allowed between field located controllers and remote control valves.

- D. Provide 12-inch expansion loops in wiring at each wire connection or change in wire direction. Provide 24-inch loop at remote control valves.
- E. Power wiring for the operation of irrigation system shall not be run in same conduit as control wiring.

### **3.6 TRACER WIRE INSTALLATION**

- A. Tracer wire shall be installed on bottom of trench, adjacent to vertical pipe projections, carefully installed to avoid stress from backfilling, and shall be continuous throughout length of pipe with spliced joints soldered and covered with insulation type tape.
- B. Tracer wire shall follow main line pipe and branch lines and terminate in yard box with gate valve controlling these main irrigation lines. Provide sufficient length of wire to reach finish grade, bend back end of wire to make a loop and attach a Dymo-Tape type plastic label with designation "Tracer Wire."
- C. Record locations of tracer wires and their terminations on project record documents.

### **3.7 SETTING OF VALVES**

- A. No valves shall be set under roads, pavement or walks.
- B. Clean interior of valves of foreign matter before installation.
- C. Where pressure control valves are installed adjacent to remote control valve, they shall be housed in the same valve box.
- D. Set valve box cover flush with finished grade.

### **3.8 SLEEVING**

- A. Furnish and install where pipe and control wires pass under walks, paving, walls, and other similar areas.
- B. Sleeving to be twice line size or greater to accommodate retrieval for repair of wiring or piping and shall extend 12 inches beyond edges of paving or construction.
- C. Bed sleeves with a minimum of 4 inches of sand backfill above top of pipe.

### **3.9 TEST AND FLUSHING**

- A. Pressure Test: Pressure test lines before joint areas are backfilled. Backfill a minimum of 12 inches over the pipe to maintain pipe stability during test period. Test piping at hydraulic pressure of 150 psi for two hours. Maximum loss shall be 0.8 gallons/inch pipe diameter/1000-feet. Locate pump at low point in line and apply pressure gradually. Install pressure gage shut-off valve and safety blow-off valve between pressure source and piping. Inspect each joint and repair leaks. Line shall be retested until satisfactory.

- B. Flushing: After testing, flush system with a minimum of 150 percent of operating flow passing through each pipe beginning with larger mains and continuing through smaller mains in sequence. Flush lines before installing sprinkler heads and quick couplers.
- C. Operation Test: Upon completion of the final adjustment of the sprinkler heads to permanent level at ground surface, test each sprinkler section by the pan test and visual test to indicate a uniform distribution within any one sprinkler head area and over the entire area. Operate the entire installation to demonstrate the complete and successful operation of all equipment.

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**SECTION 32 90 00  
PLANTING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

This work consists of furnishing and installing all planting materials required for landscaping hereinafter specified in locations as shown.

**1.2 EQUIPMENT**

Maintain all equipment, tools and machinery while on the project in sufficient quantities and capacity for proper execution of the work.

**1.3 RELATED WORK**

- A. Section 31 20 11, EARTH MOVING, Stripping Topsoil and Stock Piling.
- B. Section 01 46 29, TESTING LABORATORY SERVICES, Topsoil and Stock Piling.
- C. Section 31 20 11 EARTH MOVING (short form), Topsoil Materials.
- D. Section 32 84 00, PLANTING IRRIGATION.
- E. Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS.

**1.4 SUBMITTALS**

- A. Samples: Submit the following samples for approval before work is started:

Inert (Mineral) Mulch	2.3 kg (5 pounds) of each type to be used.
Organic Mulch	2.3 kg (5 pounds) of each type to be used.
Pre-Emergent Herbicide	2.3 kg (5 pounds) of each type to be used.

- B. Certificates of Conformance or Compliance: Before delivery, notarized certificates attesting that the following materials meet the requirements specified shall be submitted to the Resident Engineer for approval:

- 1. Plant Materials (Department of Agriculture certification by State Nursery Inspector declaring material to be free from insects and disease).
- 2. Fertilizers.
- 3. Seed.
- 4. Sod.

- C. Manufacturer's Literature and Data:

- 1. Metal edging.
- 2. Erosion control materials.
- 3. Hydro mulch.
- 4. Pre-emergent herbicide.

- D. Soil laboratory testing results and any soil amendment recommendations from the Contractor.

### **1.5 DELIVERY AND STORAGE**

#### **A. Delivery:**

1. Notify the Resident Engineer of the delivery schedule in advance so the plant material may be inspected upon arrival at the job site. Remove unacceptable plant material from the job site immediately.
2. Protect plants during delivery to prevent damage to root balls, or desiccation of leaves. Protect trees during transport by tying in the branches and covering all exposed branches.
3. The use of equipment such as "tree spades" is permitted provided the plant balls are sized in accordance with ANSI Z60.1 and tops are protected from damage.
4. Deliver fertilizer to the site in the original, unopened containers bearing the manufacturer's warranted chemical analysis, name, trade name or trademark, and in conformance to state and federal law. In lieu of containers, fertilizer may be furnished in bulk and a certificate indicating the above information shall accompany each delivery.
5. During delivery: Protect sod, from drying out and seed from contamination.

#### **B. Storage:**

1. Sprinkle sod with water and cover with moist burlap, straw or other approved covering, and protect from exposure to wind and direct sunlight. Covering should permit air circulation to alleviate heat development.
2. Keep seed and fertilizer in dry storage away from contaminants.
3. Store plants not installed on the day of arrival at the site as follows:
  - a. Shade and protect plants from the wind when stored outside.
  - b. Heel in bare root plants.
  - c. Protect plants stored on the project from drying out at all times by covering the balls or roots with moist sawdust, wood chips, shredded bark, peat moss, or other similar mulching material.
  - d. Keep plants, including those in containers, in a moist condition until planted, by watering with fine mist spray.

### **1.6 PLANTING AND TURF INSTALLATION SEASONS AND CONDITIONS**

- A. No work shall be done when the ground is frozen, snow covered, too wet or in an otherwise unsuitable condition for planting. Special conditions may exist that warrants a variance in the specified planting dates or



conditions. Submit a written request to the Resident Engineer stating the special conditions and proposal variance.

#### **1.7 PLANT AND TURF ESTABLISHMENT PERIOD**

A. The Establishment Period for plants and turf shall begin immediately after installation, with the approval of the Resident Engineer, and continue until the date that the Government accepts the project or phase for beneficial use and occupancy. During the Plant and Turf Establishment Period the Contractor shall:

1. Water all plants and turf to maintain an adequate supply of moisture within the root zone. An adequate supply of moisture is the equivalent of 1-inch of absorbed water per week either through natural rainfall or augmented by periodic watering. Apply water at a moderate rate so as not to displace the mulch or flood the plants and turf.
2. Prune plants and replace mulch as required.
3. Replace and restore stakes, guy wires, and eroded plant saucers as required.
4. In plant beds and saucers, remove grass, weeds, and other undesired vegetation, including the root growth, before they reach a height of 3 inches.
5. Spray with approved insecticides and fungicides to control pests and ensure plant survival in a healthy growing condition, as directed by the Resident Engineer.
6. Provide the following turf establishment:
  - a. Eradicate all weeds. Water, fertilize, overseed, and perform any other operation necessary to promote the growth of grass.
  - b. Replant areas void of turf 1 square foot and larger in area.
  - c. Mow the new lawn at least three times prior to the final inspection. Begin mowing when grass is 4 inches high. Mow to a 2-1/2 inch height.
7. Remove plants that die during this period and replace each plant with one of the same size and species.

#### **1.8 PLANT AND TURF WARRANTY**

A. All work shall be in accordance with the terms of the Paragraph, "Warranty" of FAR clause 52.246-21, including the following supplements:

1. A One Year Plant and Turf Warranty will begin on the date that the Government accepts the project or phase for beneficial use and occupancy. The Contractor shall have completed, located, and installed all plants and turf according to the plans and specifications. All plants and turf are expected to be living and in

a healthy condition at the time of final inspection. **This includes any plant materials relocated or transplanted on project.**

2. The Contractor will replace any dead plant material and any areas void of turf immediately. A one year warranty for the plants and turf that were replaced will begin on the day the work is completed.
3. The Government will reinspect all plants and turf at the end of the One Year Warranty. The Contractor will replace any dead, missing, or defective plant material and turf immediately (*any plant material that has lost more than 50% of its growth is considered defective*). The Warranty will end on the date of this inspection provided the Contractor has complied with the work required by this specification. The Contractor shall also comply with the following requirements:
  - a. Replace dead, missing or defective plant material prior to final inspection.
  - b. Mulch and weed plant beds and saucers. Just prior to this inspection, treat these areas to a second application of approved pre-emergent herbicide.
  - c. From plants having been installed for one year, remove stakes, guy wires and any required tree wrappings.
  - d. Complete remedial measures directed by the Resident Engineer to ensure plant and turf survival.
  - e. Repair damage caused while making plant or turf replacements.

#### 1.9 APPLICABLE PUBLICATIONS

- A. The publications listed below, form a part of this specification to the extent referenced. The publications are referenced in the text by basic designation only.
- B. American National Standards Institute (ANSI) Publications:
  - ANSI Z60.1-04.....Nursery Stock
  - ANSI Z133.1-06.....Tree Care Operations-Pruning, Trimming,  
Repairing, Maintaining, and Removing Trees and  
Cutting Brush- Safety Requirements
- C. Hortus Third, A Concise Dictionary of Plants Cultivated in the U.S. and Canada.
- D. American Society for Testing and Materials (ASTM) Publications:
  - C136-06.....Sieve Analysis of Fine and Coarse Aggregates
  - D2103-05.....Polyethylene Film and Sheeting
- E. Turfgrass Producers International: Turfgrass Sodding.
- F. U. S. Department of Agriculture Federal Seed Act.  
1998.....Rules and Regulations
- G. American Wood Protection Association (AWPA):

C2-02.....Lumber, Timbers, Bridge Ties and Mine Ties,  
Pressure Treatment

## **PART 2 - PRODUCTS**

### **2.1 GENERAL**

All plant and turf material will conform to the varieties specified or shown in the plant list and be true to botanical name as listed in Hortus Third.

### **2.2 PLANTS**

- A. Plants shall be in accordance with ANSI Z60.1, except as otherwise stated in the specifications or shown on the plans. Where the drawings or specifications are in conflict with ANSI Z60.1, the drawings and specification shall prevail.
- B. Provide well-branched and formed planting stock, sound, vigorous, and free from disease, sunscald, windburn, abrasion, harmful insects or insect eggs with healthy, normal, and unbroken root systems. Provide trees, deciduous and evergreen, that are single trunked with a single leader, unless otherwise indicated, display no weak crotches. Provide symmetrically developed deciduous trees and shrubs of uniform habit of growth, with straight boles or stems and free from objectionable disfigurements, and evergreen trees and shrubs with well developed symmetrical tops with typical spread of branches for each particular species or variety. Provide ground cover and vine plants with the number and length of runners for the size specified, and the proper age for the grade of plants specified. Provide vines and ground cover plants well established in removable containers, integral containers, or formed homogeneous soil sections. Plants shall have been grown under climatic conditions similar to those in the locality of the project. Spray all plants budding into leaf or having soft growth with an anti-desiccant at the nursery before digging.
- C. The minimum acceptable sizes of all plants, measured before pruning with branches in normal position, shall conform to the measurements designated. Plants larger in size than specified may be used with the approval of the Resident Engineer, with no change in the contract price. When larger plants are used, increase the ball of earth or spread of roots in accordance with ANSI Z60.1.
- D. Provide nursery grown plant material conforming to the requirements and recommendations of ANSI Z60.1. Dig and prepare plants for shipment in a manner that will not cause damage to branches, shape, and future development after planting.

- E. Balled and burlapped (B&B) plant ball sizes and ratios will conform to ANSI Z60.1, consisting of firm, natural balls of soil wrapped firmly with burlap or strong cloth and tied.
- F. Container grown plants shall have sufficient root growth to hold the earth intact when removed from containers, but shall not be root bound.
- G. Make substitutions only when a plant (or its alternates as specified) is not obtainable and the Resident Engineer authorizes a change order providing for use of the nearest equivalent obtainable size or variety of plant having the same essential characteristics with an equitable adjustment of the contract price.
- H. When existing plants are to be relocated, ball sizes shall conform to requirements for collected plants in ANSI Z60.1, and plants shall be dug, handled, and replanted in accordance with applicable sections of these specifications.

### **2.3 LABELS**

Each plant, or group and bundles or containers of the same species, variety, and size of plant, shall be legibly tagged with a durable, waterproof and weather-resistant label indicating the correct plant name and size specified in the plant list. Labels shall be securely attached and not be removed.

### **2.4 TOPSOIL**

- A. Topsoil shall be a well-graded soil of good uniform quality. It shall be a natural, friable soil representative of productive soils in the vicinity. Topsoil shall be free of admixture of subsoil, foreign matter, objects larger than 2 inches in any dimension, toxic substances, weeds and any material or substances that may be harmful to plant growth and shall have a pH value of not less than 5.0 nor more than 7.5.
- B. Obtain material from stockpiles established under Section 31 20 11, EARTH MOVING (short form), subparagraph, Stripping Topsoil, that meet the general requirements as stated above. Amend topsoil not meeting the pH range specified by the addition of pH Adjusters.
- C. If sufficient topsoil is not available on the site to meet the depth as specified herein, the Contractor shall furnish additional topsoil. At least 10 days prior to topsoil delivery, notify the Resident Engineer of the source(s) from which topsoil is to be furnished. Obtain topsoil from well drained areas. Additional topsoil shall meet the general requirements as stated above and comply with the requirements specified in Section 01 45 29, TESTING LABORATORY SERVICES. Amend topsoil not meeting the pH range specified by the addition of pH adjusters.

**2.5 SOIL CONDITIONERS**

- A. Peat shall be a natural product of sphagnum moss, peat moss, and/or peat humus derived from a fresh-water site conforming to Fed. Spec. Q-P-166, except as otherwise specified. Peat shall be shredded and granulated to pass through a 1/2-inch mesh screen and conditioned in storage piles for at least six months after excavation.
- B. Organic Matter shall be commercially prepared compost, composted sufficiently to be free of all woody fibers, seeds, and leaf structures, and free of toxic and nonorganic matter.

**2.6 PLANTING SOIL MIXTURE**

The planting soil mixture shall be composed of 5 parts topsoil and 1 part peat or compost.

**2.7 PLANT FERTILIZER**

- A. Provide plant fertilizer that is commercial grade and uniform in composition and conforms to applicable state and federal regulations.
- B. For new plant material, provide packet, table, or pellet forms of slow release fertilizers, bearing the manufacturer's warranted statement of analysis. Slow release fertilizers shall contain a minimum percentage by weight of 12% nitrogen (of which 50 percent will be organic), 10% available phosphoric acid, and 10% potash.
- C. For existing trees, provide granular fertilizer bearing the manufacturer's warranted statement of analysis. Granular fertilizer shall contain a minimum percentage by weight of 12% nitrogen (of which 50 percent shall be organic), 10% available phosphoric acid, and 10% potash.

**2.8 TURF FERTILIZER**

Provide turf fertilizer that is commercial grade, free flowing, uniform in composition, and conforms to applicable state and federal regulations. Granular fertilizer shall bear the manufacturer's warranted statement of analysis. Granular fertilizer shall contain a percentage by weight of 12% nitrogen (of which 50% shall be organic), 10% available phosphoric acid, and 10% potash. Liquid starter fertilizer for use in the hydro seed slurry will be commercial type with 50 percent of the nitrogen in slow release form.

**2.9 MEMBRANES**

- A. Landscape Fabric shall be a spunbonded polyester fabric weighing 18 grams per square meter (3/4 oz per sq. yd.) and with a 9,000 liter per minute flow rate per sq. meter (225 gal. per minute flow rate per sq. ft.) woven polypropylene weighing 113 grams per square meter (4.8 oz. per

sq. yd.) and a 950 liter per minute flow rate per sq. meter (90 gal. per minute flow rate per sq. ft.).

#### **2.10 MULCH**

- A. Mulch shall be free from deleterious materials and shall be stored as to prevent inclusion of foreign material.
- B. Inert mulch materials shall be riverbank stone and shall range in size from 1-inch to 2-1/2 inches in accordance with ASTM C 136.
- C. Organic mulch materials shall be ground or shredded bark.
  - 1. Wood cellulose fiber for use with hydraulic application of grass seed and fertilizer shall consist of specially prepared wood cellulose fiber, processed to contain no growth or germination-inhibiting factors, and dyed an appropriate color to facilitate visual metering of the application of materials. On an air-dry weight basis, the wood cellulose fiber shall contain a maximum of 12% moisture, plus or minus 3% at the time of manufacture. The pH range shall be from 3.5 to 5.0. The wood cellulose fiber shall be manufactured so that:
    - a. After addition and agitation in slurry tanks with fertilizers, grass seeds, water, and other approved additives, the fibers in the material will become uniformly suspended to form a homogeneous slurry.
    - b. When hydraulically sprayed on the ground, the material will form a blotter like cover impregnated uniformly with grass seed.
    - c. The cover will allow the absorption of moisture and allow rainfall or applied water to percolate to the underlying soil.

#### **2.11 EROSION CONTROL**

- A. Erosion control blanket material shall be cellulose fiber blanket bonded to 1/4-inch square plastic net weighing 20 lbs. per 1000 sq. ft., in 50-inch wide rolls.

#### **2.12 STAKES AND GUYING WIRES (NOT APPLICABLE FOR STAKING OF TRANSPLANTED TREES)**

- A. Provide stakes for tree support of rough sawn wood, free from knots, rot, cross grain, or other defects that would impair the strength. Stakes shall be a minimum of 2 inches by 2 inches or 2-1/2 inches in diameter, by 8 feet long and pointed at one end. Galvanized steel pipe 32 mm 1-1/4 inch x 10' with cap, primed with 2 coats flat black exterior enamel
- B. Guying wire shall be 12 gauge annealed galvanized steel.
- C. Hose chafing guards shall be new or used 2-ply reinforced rubber or plastic hose of all the same color on the project.

- D. Flags to be fastened to guys shall be surveyor's plastic tape, white in color and 6 inches in length.
- E. Guying cable shall be a minimum of five strand twisted, 3/16-inch diameter steel cable
- F. Turnbuckles shall be galvanized or cadmium plated and have a 3-inch minimum lengthwise opening fitted with screw eyes.
- G. Eye bolts shall be galvanized or cadmium plated having a 1-inch diameter eye with a minimum screw length of 1-1/2 inches.
- H. Deadmen shall be 4 inch by 8 inch rectangular, or 8 inch diameter by 36 inch long sound wood.
- I. Arrow shaped or auger iron anchors shall be noncorrosive, and sized according to the manufacturer's recommendation.

### **2.13 EDGING**

- A. Metal edging shall be galvanized steel or aluminum with slots provided for stakes and shall be 5 mm thick by 100 mm deep in standard lengths. Steel edging shall be treated with a rust preventive coating and factory finished in color green or black. Anchoring stakes shall be of similar material and 16 to 18 inches long and tapered`.

### **2.14 WATER**

Water shall not contain elements toxic to plant life. It shall be obtained on site as specified in Section 01 00 00, GENERAL REQUIREMENTS, paragraph, Temporary Services at no cost to the Contractor or at a cost to be determined to the Contractor.

### **2.15 ANTIDESICANT**

Antidesicant shall be an emulsion specifically manufactured for agricultural use that will provide a protective film over plant surfaces permeable enough to permit transpiration.

### **2.16 SOD**

Sod shall be approved sod as classified in the TPI Guideline Specifications to Turfgrass Sodding. The composition of the grass species in the sod shall be as follows:

<u>Botanical and Common Name</u>	<u>Percent</u>
Poa Pratensis type Bluegrass	100 percent

Quality shall conform to ASPA Guideline Specifications for Sodding.

### **2.17 HERBICIDES**

All herbicides shall be properly labeled and registered with the U.S. Department of Agriculture. Keep all herbicides in the original labeled containers indicating the analysis and method of use.

**PART 3 - EXECUTION****3.1 LAYOUT**

Stake plant material locations and bed outlines on project site for approval by the Resident Engineer or Landscape Architect before any plant pits or beds are dug. The Resident Engineer or Landscape Architect may approve adjustments to plant material locations to meet field conditions.

**3.2 EXCAVATION FOR PLANTING**

- A. Prior to excavating for plant pits and bed, verify the location of any underground utilities. Damage to utility lines will be repaired at the Contractor's expense. Where lawns have been established prior to planting operation, cover the surrounding turf before excavations are made in a manner that will protect turf areas. Barricade existing trees, shrubbery, and beds that are to be preserved in a manner that will effectively protect them during the project construction.
- B. Remove rocks and other underground obstructions to a depth necessary to permit proper planting according to plans and specifications. Where underground utilities, construction, or solid rock ledges are encountered, the Resident Engineer may select other locations for plant material.
- C. Dig plant pits by any approved method so that they have vertical sides and flat bottoms. When pits are dug with an auger and the sides of the pits become glazed, scarify the glazed surface. Size the plant pits as shown, otherwise, the minimum allowable dimensions of plant pits shall be regardless of width, 150 mm (6 inches) deeper for shrubs and 225 mm (9 inches) deeper for trees than the depth of ball or root spread; for ball or root spread up to 600 mm (2 feet), pit diameters shall be twice the ball or root spread; for ball or root spread from 600 to 1200 mm (2 to 4 feet), pit diameters shall be 600 mm (2 feet) greater; for ball or root spread over 1200 mm (4 feet), pit diameters shall be 1-1/2 times the ball or root spread.
- D. Where ground cover and planting beds occur in existing turf areas, remove turf to a depth that will ensure the removal of the entire root system, with additional bed preparation as specified in the next paragraph.
- E. Where existing soil is to be used in place, till new ground cover and plant beds to a depth of 4 inches. Spread peat or other approved soil amendment uniformly over the bed to depth of 2 inches and thoroughly incorporate it into the existing soil to a depth of 4 inches using a rototiller or similar type of equipment to obtain a uniform and well



pulverized soil mix. Where existing soil is compacted (former roadways, parking lots, etc.) till the soil down to a depth necessary to support the growth of new planting. During tillage operations, remove all sticks, stones, roots, and other objectionable materials. Bring plant beds to a smooth and even surface conforming to established grades.

- F. In areas of new grading where existing soil is being replaced for the construction of new ground cover and plant beds, remove 4 inches of existing soil and replace with topsoil. Plant beds shall be brought to a smooth and even surface conforming to established grades. Till 2 inches of peat soil amendment into the topsoil, as specified.
- G. Using topsoil, form earth saucers or water basins for watering around plants. Basins to be 2 inches high for shrubs and 3" " high for trees.
- H. Treat plant saucers, shrub, and ground cover bed areas, prior to mulching, with an approved pre-emergent herbicide. Plant ground cover in areas to receive erosion control material through the material after material is in place.

### **3.3 SETTING PLANTS**

- A. Handle balled and burlapped and container-grown plants only by the ball or container. Remove container-grown plants in such a way to prevent damage to plants or root system. Set plants plumb and hold in position until sufficient soil has been firmly placed around the roots or ball. Set plants so that the root crown is 1" higher than the surrounding grade. Plant ground cover plants after the mulch is in place. Avoid contaminating the mulch with the planting soil. Add slow release packet, tablet or pellet fertilizer as each plant is installed as per manufacturer's recommendation for method of installation and quantity.
- B. Backfill balled and burlapped and container-grown plants with planting soil mixture as specified to approximately half the depth of the ball and then tamp and water. For balled and burlapped plants, carefully remove excess burlap and tying materials and fold back. Where plastic wrap or treated burlap is used in lieu of burlap, completely remove these materials before backfilling. Tamp and water remainder of backfill Planting Soil Mixture; then form earth saucers or water basins around isolated plants with topsoil.

### **3.4. STAKING AND GUYING**

- A. Stake and guy plants as shown on the drawings and as specified.
- B. Drive stakes vertically into the ground to a depth of 2-1/2 to 3 feet in such a manner as not to injure the ball or roots, unless otherwise shown on the drawings.

- C. Place deadmen not less than 18 inches below the surface of the ground, unless otherwise shown on the drawings.
- D. Install iron anchors according to manufacturer's recommendations.
- E. Fasten flags securely on each guy wire approximately 2/3 of the distance up from ground level.
- F. Remove stakes and guy wires after one year.

### **3.5 EDGING PLANT BEDS**

- A. Uniformly edge beds using a sharp tool to provide a clear cut division line between the planted area and the adjacent lawn.
- B. Install concrete curb edging materials in accordance with manufacturer's recommendations and as shown on the plans.

### **3.6 MULCHING PLANTS**

- A. Mulch within 48 hours after planting and applying a pre-emergent herbicide. Do not mulch in ground cover areas that shall have organic material placed before planting.
- B. Placing Inert (mineral) Material: Place polyethylene fabric sheet with edges lapped 6 to 12 inches to receive inert mulch material. Punch a grid of 1/4-inch holes for drainage in the polyethylene sheet on centers over the entire area. Spread inert mulch to a uniform thickness over the membrane as shown.
- C. Placing Organic Material: Spread a mulch of riverbank stone at base of shrubs and perennials to a uniform minimum thickness of 3 inches.
- D. Keep mulch out of the crowns of shrubs and off buildings, sidewalks, light standards, and other structures.

### **3.7 PRUNING**

- A. Prune new plant material and indicated existing plant material in the following manner: Remove dead, broken and crossing branches. Prune deciduous trees and shrubs to reduce total amount of anticipated foliage by 1/4 to 1/3 while retaining typical growth habit of individual plants with as much height and spread as is practicable. Make cuts with sharp instruments as close as possible to the branch collar. Do not make flush cuts. Do not make "Headback" cuts at right angles to line of growth. Do not pole trees or remove the leader. Remove trimmings from the site. Paint cuts 1/2-inch in diameter and larger with the specified tree wound dressing.
- B. Existing trees to be pruned are shown on the drawings. Perform tree pruning and cavity work by a licensed arborist in accordance with ANSI Z 133.1. Remove dead wood 1/2-inch or more in diameter, branches interfering with or hindering the healthy growth of the trees, and diseased branches with a clean cut made flush with the parent trunk. Cut

back or remove branches as necessary to give the trees proper shape and balance. In removing large limbs, make the initial cut on the underside at a safe distance from the trunk or lateral, to prevent ripping of bark. Ensure branches and trimmings do not endanger traffic or cause damage to property during removal. Section large branches or limbs that cannot be removed in one piece without endangering traffic or property. Lower sections by ropes. Repair any damage resulting from the Contractor's negligence during pruning. Workmen are not permitted to climb trees with climbing spurs. To promote proper healing, cut off flush stubs or limbs that have resulted from improper cuts or broken as a result of former pruning. Remove girdling roots. Clean cuts or wounds measuring 1/2-inch or more in diameter, and exposed wood and scars resulting from previous work or damage. Remove decayed wood to expose healthy tissue. Shape cavities to provide drainage.

### **3.8 FERTILIZATION OF EXISTING TREES**

Apply fertilizer to exiting trees shown on the drawings at the rate of 2 lbs. per inch caliper. Apply in 12- to 18-inch deep holes 1-1/2 to 2 inches in diameter, made by an earth auger, distributed evenly at not more than 2 feet on center throughout the outer half of the branch spread zone of each tree. Fertilize to within 4 inches of the surrounding grade. Use topsoil to bring the surface up to the surrounding grade. When using fertilizer in packet, tablet, or wedge form, apply in accordance with manufacturer's recommendation.

### **3.9 TILLAGE FOR TURF AREAS**

Thoroughly till the soil to a depth of at least 4 inches by scarifying, disking, harrowing, or other approved methods. This is particularly important in areas where heavy equipment has been used, and especially under wet soil conditions. Remove all debris and stones larger than 25 mm (one inch) remaining on the surface after tillage in preparation for finish grading. To minimize erosion, do not till areas of 3:1 slope ratio or greater. Scarify these areas to a 1-inch depth and remove debris and stones.

### **3.10 FINISH GRADING**

After tilling the soil for bonding of topsoil with the subsoil, spread the topsoil evenly to a minimum depth of 6 inches. Incorporate topsoil at least 2 to 3 inches into the subsoil to avoid soil layering. Do not spread topsoil when frozen or excessively wet or dry. Correct irregularities in finished surfaces to eliminate depressions. Protect

finished topsoil areas from damage by vehicular or pedestrian traffic.  
Complete lawn work only after areas are brought to finished grade.

### **3.11 APPLICATION OF FERTILIZER FOR TURF AREAS**

- A. As recommended in soil analysis.
- B. Incorporate fertilizers into the soil to a depth of at least 4 inches as part of the finish grading operation. Immediately restore the soil to an even condition before any turf work.

### **3.12 HYDROSEEDING**

When hydroseeding, mix the seed and slow release starter fertilizer when required, and approved wood cellulose mulch material in the required amount of water to produce a homogeneous slurry and then uniformly apply slurry under pressure at the following rate. Slurry shall consist of 35 lbs. of seed and recommended amount of turf fertilizer per 1,000 sq. ft.

When using wood cellulose mulch, incorporate it as an integral part of the slurry mix after the seed and fertilizer have been thoroughly mixed.

Apply the slurry mix at the rate of 80 lbs. per 1,000 sq. ft.

### **3.13 SODDING**

- A. Accomplish sodding in accordance with the ASPA Guideline Specifications for sodding. Lay sod at right angles to slope or the flow of water. On slope areas, start at the bottom of the slope.
- B. After completing the sodding operation, blend the edges of the sodded area smoothly into the surrounding area.

### **3.14 WATERING**

Apply water to the turf areas immediately following installation at a rate sufficient to ensure thorough wetting of the soil to a depth of at least 4 inches. Supervise watering operation to prevent run-off. Supply all pumps, hoses, pipelines, and sprinkling equipment. Repair all areas damaged by water operations.

### **3.15 PROTECTION OF TURF AREAS**

Immediately after installation of the turf areas, protect against traffic or other use by erecting barricades, as required, and placing approved signs at appropriate intervals until final acceptance.

### **3.16 EROSION CONTROL MATERIAL**

- A. Install and maintain erosion control material meeting the requirements of this specification on the designated areas as shown and specified. Prepare, fertilize and vegetate the area(s) to be covered, as specified, before the erosion material is placed. Immediately following the planting operations, lay the material evenly and smoothly and in contact

with the soil throughout. Omit the straw mulch from all seeded areas receiving the erosion control material.

- B. Staple each strip in three rows each edge and center with the center row alternately spaced with staples spaced not more than 4 feet longitudinally. When using two or more strips side by side on slopes, use a common row of staples on the adjoining strips. Staple all end strips at 1 foot intervals at the end. Firmly embed staples in the underlying soil.
- C. Maintenance shall consist of repairs made necessary by erosion, wind, or any other cause. Maintain, protect, repair, or replace the erosion control material until the Termination of the Plant and Warranty Period.

### **3.17 RESTORATION AND CLEAN-UP**

Where existing or new turf areas have been damaged or scarred during planting and construction operations, restore disturbed area to their original condition. Keep at least one paved pedestrian access route and one paved vehicular access route to each building clean at all times. In areas where planting and turf work have been completed, clear the area of all debris, spoil piles, and containers. Clear all other paved areas when work in adjacent areas is completed. Remove all debris, rubbish and excess material from the station.

### **3.18 ENVIRONMENTAL PROTECTION**

All work and Contractor operations shall comply with the requirements of Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS.

- - - E N D - - -

**SECTION 33 10 00**  
**WATER UTILITIES**

**PART 1 - GENERAL**

**1.1 DESCRIPTION:**

Underground water distribution system complete, ready for operation, including all appurtenant structures, and connections to both new building service lines and to existing water supply.

**1.2 RELATED WORK:**

- A. Maintenance of Existing Utilities: Section 01 00 00, GENERAL REQUIREMENTS.
- B. Excavation, trench widths, pipe bedding, backfill, shoring, sheeting, bracing: Section 31 20 11, EARTH MOVING (Short Form).
- C. Protection of materials and equipment: Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- D. Fire protection system connection and supervisory switch for post indicator valve: Section 21 12 00, FIRE-SUPPRESSION STANDPIPES.

**1.3 DEFINITIONS:**

- A. Water Distribution: Pipelines and appurtenances which are part of the distribution system. The distribution system comprises the network of piping located throughout building areas and other areas of water use, including hydrants, valves, and other appurtenances used to supply water for domestic and fire-fighting/fire protection purposes.
- B. Water Service Line: Pipe line connecting building piping to water distribution lines.

**1.4 QUALITY ASSURANCE:**

- A. Products Criteria:
  - 1. Multiple Units: When two or more units of the same type or class of materials or equipment are required, these units shall be product of one manufacturer.
  - 2. Nameplate: Nameplate bearing manufacturer's name or identifiable trademark securely affixed in a conspicuous place on equipment or name or trademark cast integrally with equipment, stamped, or otherwise permanently marked on each item of equipment.
- B. Comply with the rules and regulations of the Public Utility having jurisdiction over the connection to Public Water lines and the extension, and/or modifications to Public Utility systems.
- C. Comply with all rules and regulations of Federal, State, and Local government, including the South Dakota Department of Environment and Natural Resources(SDDENR) having jurisdiction over the design, construction, and operation of potable water systems.

- D. All material surfaces in contact with potable water shall comply with NSF 61.

#### **1.5 SUBMITTALS:**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturers' Literature and Data (Submit all items as one package):  
(Ductile Iron Pipe and Polyvinyl Chloride (PVC) shall be in accordance with AWWA C600 and C605 respectively; and shall be provided to Resident Engineer for approval).
1. Piping.
  2. Gaskets.
  3. Valves.
  4. Fire hydrants.
  5. Valve boxes.
  6. High deflection couplings.
  7. Joint restraint.
  8. Disinfection products.
  9. Post indicator.
  10. Fittings.
- C. Testing Certifications:
1. Hydrostatic Testing.
  2. Certification of Disinfection, including free chlorine residuals, and bacteriological examinations.

#### **1.6 APPLICABLE PUBLICATIONS:**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society for Testing and Materials (ASTM):
- |               |   |
|---------------|---|
| A123-97.....  | Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products                         |
| A148M-03..... | Standard Specifications for Steel Castings  |
| A242-00.....  | Standard Specifications for High Strength Low Alloy Structural Steel AASHTO No. M161  |
| A307-02.....  | Standard Specifications for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength |
| A536-04.....  | Standard Specifications for Ductile Iron Castings                                     |
| B61-02.....   | Steam or Valve Bronze Castings  |
| B62-02.....   | Composition Bronze or Ounce Metal Castings  |
| D1784-03..... | Standard Specifications for Rigid PVC Compounds and CPVC Compounds                    |

- D3139-98.....Joints for Plastic Pressure Pipes Using Flexible  
Elastomeric Seals
- F477-02e1.....Elastomeric Seals (Gaskets) for Joining Plastic  
Pipe
- C. American Water Works Association (AWWA):
- B300-04.....Hypochlorites
- B301-04.....Liquid Chlorine
- C104-04.....Cement Mortar Lining for Ductile Iron Pipe and  
Fittings for Water
- C105-99.....Polyethylene Encasement for Gray and Ductile  
C.I. Piping for Water and Other Liquids
- C110-03.....Ductile-Iron and Gray-Iron Fittings, 80 mm (3  
Inches) Through 1200 mm (48 Inches) for Water  
and Other Liquids
- C111-01.....Rubber-Gasket Joints for Ductile-Iron and  
Gray-Iron Pressure Pipe and Fittings
- C150-02.....American National Standard for Thickness Design  
of Ductile Iron Pipe
- C151-96.....Ductile-Iron Pipe, Centrifugally Cast in Metal  
Molds or Sand-Lined Molds, for Water or Other  
Liquids
- C153-00.....Ductile-Iron Compact Fittings, 80 mm (3 inches)  
Through 300 mm (12 Inches) for Water and Other  
Liquids
- C500-02.....Gate Valves for Water and Sewerage Systems
- C502a-95.....Dry-Barrel Fire Hydrants
- C509-01.....Resilient Seated Gate Valve for Water and Sewage  
System
- C550-01.....Protective Epoxy Interior Coatings for Valves  
and Hydrants
- C600-01.....Installation for Ductile-Iron Water Mains and  
Their Appurtenances
- C605-94.....Underground Installation of Polyvinyl Chloride  
(PVC) Pressure Pipe and Fittings for Water
- C651-92.....Disinfecting Water Mains
- C800-01.....Underground Service Line Valves and Fittings
- C900-97.....Polyvinyl Chloride (PVC) Pressure Pipe, 4 Inches  
Thru 12 Inches, for Water



## D. National Fire Protection Association (NFPA):

24-95.....Installation of Private Fire Service Mains and  
Their Appurtenances

291-01.....Fire Flow Testing and Marking of Hydrants

1141-98.....Fire Protection in Planned Building Groups

## E. NSF International:

14-03.....Plastics Piping Components and Related Materials

61-02.....Drinking Water System Components-Health Effects

(Sections 1-9)

**PART 2 - PRODUCTS****2.1 POLYVINYL CHLORIDE PIPE AND FITTINGS:**

## A. Class-Rated Polyvinyl Chloride (PVC) Pipe:

1. PVC pipe and accessories 4 inches-14 inches in diameter, AWWA C900 "Polyvinyl Chloride (PVC) Pressure Pipe", Class 200, DR 14, cast iron outside diameters, unless otherwise shown or specified.
2. PVC pipe and accessories 16 inches or larger, AWWA C905, "Polyvinyl Chloride Water Transmission Pipe", Class 235, DR 18, cast iron outside diameters unless otherwise shown or specified. Pipe and accessories shall bear the NSF mark indicating pipe size, manufacturer's name, AWWA and/or ASTM Specification number, working pressure and production code. Pipe and couplings shall be made in accordance with ASTM D1784.

## B. Joints:

1. Pipe 3 inches and Greater in Diameter: Push-on type with factory installed solid cross section elastomeric ring meeting the requirements of ASTM F-477.

## C. Fittings:

1. Class-Rated Pipe 3 inches in Diameter and Greater: Ductile iron with mechanical joints conforming to the requirements of AWWA C153.

**2.2 VALVES:**

## A. Asbestos packing is not allowed.

## B. Post Indicator Valve:

1. The post indicator shall conform to NFPA 24, and shall be fully compatible with the valve and all the supervisory switches.

## C. Gate Valves:

1. 3 inches and Larger: Resilient seated, ductile iron body, bronze mounted, inclined seats, non-rising stem type turning counter-clockwise to open, 200 pound WOG. AWWA C509. The resilient seat shall be fastened to the gate with stainless steel fasteners or vulcanizing methods. The interior and exterior shall be coated with thermo-setting or fusion epoxy coating in accordance with AWWA C550.

2. Operator:

- a. Underground: Except for use with post indicators, furnish valves with 2 inch nut for socket wrench operation. Post indicator shall comply with the requirements of NFPA 24 and shall be fully compatible with the valve provided.
- 3. Joints: Ends of valves shall accommodate, or be adapted to, pipe installed.

**2.3 VALVE BOX:**

Cast iron extension box with screw or slide-type adjustment and flared base. Minimum thickness of metal shall be 3/16-inch. Box shall be adapted, without full extension, to depth of cover required over pipe at valve location. Cast the word "WATER" in cover.

**2.4 FIRE HYDRANTS:**

- A. Size of main valve opening of each hydrant shall be 5 inches, minimum.
- B. Hydrant shall be type AWWA C502, heavy construction, of proper length to connect pipe without extra fittings, and shall be the traffic type with safety flange on barrel and safety couplings on the valve stem with the following features:
  - 1. Interior removable without digging up hydrant; can be packed under pressure; 6-inch bell connection; one steamer nozzle and two hose nozzles with nozzle caps securely chained to barrel; suitable drainage device; single rubber or leather-faced valve in base; nozzles, stuffing boxes, wedge nuts, seat rings, clamp plates, etc. Threaded joints or spindles shall be bronze. Upper and lower barrels shall be of equal diameters. Upper barrel shall be of sufficient length to permit setting hydrant with barrel flange not more than 2 inches above finished grade. All fire hydrants shall have 6-inch bottom connection.
  - 2. Hydrant shall be Mueller Super Centurion with 5-inch Pumper Nozzle NST.

**2.5 POTABLE WATER:**

Water used for filling, flushing, and disinfection of water mains and appurtenances shall conform to Safe Drinking Water Act.

**2.6 DISINFECTION CHLORINE:**

- A. Liquid chlorine shall conform to AWWA B301 and AWWA C651.
- B. Sodium hypochlorite shall conform to AWWA B300 with 5 percent to 15 percent available chlorine.
- C. Calcium hypochlorite shall conform to AWWA B300 supplied in granular form or 5.g tablets, and shall contain 65 percent chlorine by weight.

**2.7 WARNING TAPE**

Standard, 4-Mil polyethylene 3-inch wide tape, detectable type, blue with black letters, and imprinted with "CAUTION BURIED WATER LINE BELOW".

**PART 3 - EXECUTION****3.1 BUILDING SERVICE LINES:**

Install water service lines to point of connection within approximately 1500 mm (5 feet) outside of buildings to which such service is to be connected and make connections thereto. If building services have not been installed provide temporary caps.

**3.2 REGRADING:**

Raise or lower existing valve and curb stop boxes and fire hydrants to finish grade in areas being graded.

**3.3 PIPE LAYING, GENERAL:**

- A. Care shall be taken in loading, transporting, and unloading to prevent injury to the pipe or coatings. Pipe or fittings shall not be dropped. All pipe or fittings shall be examined before laying, and no piece shall be installed which is found to be defective. Any damage to the pipe coatings shall be repaired as directed by the Resident Engineer.
- B. All pipe and fittings shall be subjected to a careful inspection just prior to being laid or installed. If any defective piping is discovered after it has been laid, it shall be removed and replaced with a sound pipe in a satisfactory manner at no additional expense to the Government. All pipe and fittings shall be thoroughly cleaned before laying, shall be kept clean until they are used in the work, and when installed or laid, shall conform to the lines and grades required.
- C. All buried piping shall be installed to the lines and grades as shown on the drawings. All underground piping shall slope uniformly between joints where elevations are shown.
- D. Contractor shall exercise extreme care when installing piping to shore up and protect from damage all existing underground water line and power lines, and all existing structures.
- E. Do not lay pipe on unstable material, in wet trench, or when trench or weather conditions are unsuitable.
- F. Do not lay pipe in same trench with other pipes or utilities unless shown otherwise on drawings.
- G. Hold pipe securely in place while joint is being made.
- H. Do not walk on pipes in trenches until covered by layers of earth well tamped in place to a depth of 12 inches over pipe.

- I. Full length of each section of pipe shall rest solidly upon pipe bed with recesses excavated to accommodate bells or joints. Do not lay pipes on wood blocking.
- J. Tees, plugs, caps, bends and hydrants on pipe installed underground shall be anchored. See section 3.5 "RESTRAINED JOINTS".
- K. Close pipe openings with caps or plugs during installation. Tightly cover and protect equipment against dirt, water and chemical, or mechanical injury. At completion of all work, thoroughly clean exposed materials and equipment.
- L. Good alignment shall be preserved in laying. The deflection at joints shall not exceed that recommended by the manufacturer.
- M. Warning tape shall be continuously placed 12 inches above buried water pipes.

#### **3.4 PVC PIPE:**

- A. PVC piping shall be installed in strict accordance with the manufacturer's instructions and AWWA 605. Place selected material and thoroughly compacted to one foot above the top of the pipe and thereafter back filled as specified in Section 31 20 11, EARTH MOVING.
- B. Copper Tracer Wire: Copper tracer wire consisting of No. 14 AWG solid, single conductor, insulated copper wire shall be installed in the trench with all piping to permit location of the pipe with electronic detectors. The wire shall not be spiraled around the pipe nor taped to the pipe. Wire connections are to be made by stripping the insulation from the wire and soldering with rosin core solder. Solder joints shall be wrapped with rubber tape and electrical tape. At least every 1000 feet, provide a 5 pound magnesium anode attached to the main tracer wire by solder. The solder joint shall be wrapped with rubber tape and with electrical tape. An anode shall be attached at the end of each line.
- C. Magnetic markers may be used in lieu of copper tracer wire to aid in future pipe locating. Generally, install markers on 20 foot centers. If pipe is in a congested piping area, install on 10 foot centers. Prepare as-built drawing indicating exact location of magnetic markers.

#### **3.5 RESTRAINED JOINTS:**

- A. Sections of piping requiring restrained joints shall be constructed using pipe and fittings with restrained "locked-type" joints and the joints shall be capable of holding against withdrawal for line pressures 50 percent above the normal working pressure but not less than 1375 kPa (200 psi). The pipe and fittings shall be restrained push-on joints or restrained mechanical joints.
- B. The minimum number of restrained joints required for resisting force at fittings and changes in direction of pipe shall be determined from the

length of retained pipe on each side of fittings and changes in direction necessary to develop adequate resisting friction with the soil. Restrained pipe length shall be as shown on the drawings.

- C. Restrained joint assemblies with ductile iron mechanical joint pipe shall be "Flex-Ring", "Lok-Ring", or mechanical joint coupled as manufactured by American Cast Iron Pipe Company, "Mega-Lug" or approved equal.
- D. Ductile iron pipe bell and spigot joints shall be restrained with EBBA Iron Sales, Inc. Series 800 Coverall or approved equal.
- E. Ductile iron mechanical joint fittings shall be restrained with EBBA Iron Sales, Inc. Series 1200 Restrainer. The restraining device shall be designed to fit standard mechanical joint bells with standard T head bolts conforming to AWWA C111 and AWWA C153. Glands shall be manufactured of ductile iron conforming to ASTM A536. Set screws shall be hardened ductile iron and require the same torque in all sizes. Steel set screws not permitted. These devices shall have the stated pressure rating with a minimum safety factor of 2:1. Glands shall be listed with Underwriters Laboratories and/or approved by Factory Mutual.
- F. Thrust blocks shall not be permitted, unless approved by the Resident Engineer.
- G. PVC pipe bell and spigot joints shall be restrained with the Uni-Flange Corp. Series 1350 Restrainer or approved equal. The restraining device and Tee head bolts shall be manufactured of high strength ductile iron meeting ASTM A536. Clamping bolts and nuts shall be manufactured of corrosion resistant high strength, low alloy steel meeting the requirements of ASTM A242.
- H. Ductile iron mechanical joint fittings used with PVC pipe shall be restrained with UNI-Flange Corp. Series 1300 Restrainer, EBBA Iron, Inc, Series 2000PV Mechanical Joint Restrainer Gland, or approved equal. The restraining device and Tee head bolts shall be manufactured of high strength ductile iron meeting ASTM A-536. Clamping bolts and nuts shall be manufactured of corrosion resistant high strength, low alloy steel meeting the requirements of ASTM A242.

### **3.6 PIPE SEPARATION:**

- A. Horizontal Separation-Water Mains and Sewers:
  - 1. Water mains shall be located at least 10 feet horizontally from any proposed drain, storm sewer, sanitary or sewer service connection.
  - 2. Water mains may be located closer than 10 feet to a sewer line when:
    - a. Local conditions prevent a lateral separation of 10 feet; and
    - b. The water main invert is at least 18 inches above the crown of the sewer; and

- c. The water main is either in a separate trench or in the same trench on an undisturbed earth shelf located one side of the sewer.
- 3. When it is impossible to meet (1) or (2) above, both the water main and drain or sewer shall be constructed of mechanical joint ductile iron pipe. Ductile iron pipe shall comply with the requirements listed in this specification section. The drain or sewer shall be pressure tested to the maximum expected surcharge head before back filling.
- B. Vertical Separation-Water Mains and Sewers:
  - 1. A water main shall be separated from a sewer so that its invert is a minimum of 18 inches above the crown of the drain or sewer whenever water mains cross storm sewers, sanitary sewers or sewer service connections. The vertical separation shall be maintained for that portion of the water main located within 10 feet horizontally of any sewer or drain crossed. A length of water main pipe shall be centered over the sewer to be crossed with joints equidistant from the sewer or drain.
  - 2. Both the water main and sewer shall be constructed of slip-on or mechanical joint ductile iron pipe or PVC pipe equivalent to water main standards of construction when:
    - a. It is impossible to obtain the proper vertical separations described in (1) above; or
    - b. The water main passes under a sewer or drain.
  - 3. A vertical separation of 18 inches between the invert of the sewer or drain and the crown of the water main shall be maintained where a water main crosses under a sewer. Support the sewer or drain lines to prevent settling and breaking the water main.
  - 4. Construction shall extend on each side of the crossing until the perpendicular distance from the water main to the sewer or drain line is at least 10 feet.

### **3.7 SETTING OF VALVES AND BOXES:**

- A. Provide a surface concrete pad 18 by 18 by 6 inches to protect valve box when valve is not located below pavement.
- B. Clean valve interior before installation.
- C. Set valve box cover flush with finished grade.
- D. Valves shall be installed plumb and level and in accordance with manufacturer's recommendations.

### **3.8 SETTING OF FIRE HYDRANTS:**

- A. Set center of each hydrant not less than 2 feet nor more than 6 feet back of edge of road or face of curb. Fire apparatus connection shall

face road with center of nozzle 18 inches above finished grade. Set barrel flange not more than 2 inches above finished grade.

- B. Set each hydrant on a slab of stone or concrete not less than 4 inches thick and 15 inches square. The service line to the hydrant, between the tee and the shoe of the hydrant, shall be fully restrained.
- C. Set bases in not less than 1/2 cubic yard of crushed rock or gravel placed entirely below hydrant drainage device.
- D. Clean interiors of hydrants of all foreign matter before installation.

### 3.9 FLUSHING AND DISINFECTING:

- A. Flush and disinfect new water lines in accordance with AWWA C651 and WYDEQ requirements.
- B. Initial flushing shall obtain a minimum velocity in the main of 2.5 feet per second at 40 PSI residual pressure in water main. The duration of the flushing shall be adequate to remove all particles from the line.

Pipe Diameter		Flow Required to Produce 2.5 ft/sec(approx.) Velocity in Main		Number of Hydrant Outlets			
				Size of Tap. in. (mm)			
				1(25)	1 1/2 in (38)	2(51)	2 1/2-in (64 mm)
In	(mm)	gpm	(L/sec)	Number of taps on pipe			
4	(100)	100	(6.3)	1	--	--	1
6	(150)	200	(12.6)	--	1	--	1
8	(200)	400	(25.2)	--	2	1	1
10	(250)	600	(37.9)	--	3	2	1
12	(300)	900	(56.8)	--	--	3	2
16	(400)	1,600	(100.9)	--	--	4	2

The backflow preventers shall not be in place during the flushing.

- C. The Contractor shall be responsible to provide the water source for filling, flushing, and disinfecting the lines. Only potable water shall be used, and the Contractor shall provide all required temporary pumps, storage facilities required to complete the specified flushing, and disinfection operations.
- D. The Contractor shall be responsible for the disposal of all water used to flush and disinfect the system in accordance with all governing rules and regulations. The discharge water shall not be allowed to create a nuisance for activities occurring on or adjacent to the site.
- E. The bacteriological test specified in AWWA C651 shall be performed by a laboratory approved by the WYDEQ.
- F. Re-disinfection and bacteriological testing of failed sections of the system shall be the sole responsibility of the Contractor.

- G. Before backflow preventers are installed, all upstream piping shall be thoroughly flushed.

**3.10 HYDROSTATIC TESTING:**

- A. Hydrostatic testing of the system shall occur prior to disinfecting the system.
- B. After new system is installed, except for connections to existing system and building, backfill at least 12 inches above pipe barrel, leaving joints exposed. The depth of the backfill shall be adequate to prevent the horizontal and vertical movement of the pipe during testing.
- C. Prior to pressurizing the line, all joint restraints shall be completely installed and inspected.
- D. If the system is tested in sections, and at the temporary caps at connections to the existing system and buildings, the Contractor shall provide and install all required temporary thrust restraints required to safely conduct the test.
- E. The Contractor shall install corporation stops in the line as required to purge the air out of the system. At the completion of the test, all corporation stops shall be capped.
- F. The Contractor shall perform pressure and leakage tests for the new system for 2 hours to 200 psi. Leakage shall not exceed the following requirements.
  - 1. Polyvinyl Chloride (PVC) AWWA C605. Provide to Resident Engineer office.

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**SECTION 33 30 00**  
**SANITARY SEWERAGE UTILITIES**

**PART 1 - GENERAL**

**1.1 DESCRIPTION:**

Outside, underground sanitary sewer system, complete, ready for operation, including all gravity flow lines, manholes, cleanouts, frames, covers, structures, appurtenances, and connections to new building and structure, service lines, existing sanitary sewer lines, and existing sanitary structures, and all other incidentals.

**1.2 RELATED WORK:**

- A. Maintenance of Existing Utilities: Section 01 00 00, GENERAL REQUIREMENTS.
- B. Excavation, Trench Widths, Pipe Bedding, Backfill, Shoring, Sheeting, Bracing: Section 31 20 11, EARTH MOVING (short form). Dewatering: Section 31 23 19, DEWATERING.
- C. Concrete Work Reinforcing, Placement and Finishing; Section 03 30 53, MISCELLANEOUS CAST-IN-PLACE CONCRETE.

**1.3 QUALITY ASSURANCE:**

- A. Products Criteria:
  - 1. Multiple Units: When two or more units of the same type or class of materials or equipment are required, these units shall be products of one manufacturer.
  - 2. Nameplates: Nameplate bearing manufacturer's name, or identifiable trademark, including model number, securely affixed in a conspicuous place on equipment, or name or trademark, including model number cast integrally with equipment, stamped, or otherwise permanently marked on each item of equipment.
- B. Comply with the rules and regulations of the Public Utility having jurisdiction over the connection to Public Sanitary Sewer lines and the extension, and/or modifications to Public Utility Systems.

**1.4 SUBMITTALS:**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturers' Literature and Data: Submit the following as one package:
  - 1. Pipe, Fittings, and, Appurtenances.
  - 2. Jointing Material.
  - 3. Manhole and Structure Material.
  - 4. Frames and Covers.

**1.5 APPLICABLE PUBLICATIONS:**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society for Testing and Materials (ASTM):
- A48/A48M-03.....Gray Iron Castings
  - A536-84(2004).....Ductile Iron Castings
  - A615/A615M-06.....Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
  - C150-05.....Portland Cement
  - C478-06a/C478M-06a.....Precast Reinforced Concrete Manhole Sections
  - C857-95(2001).....Minimum Structural Design Loading for Underground Precast Concrete Utility Structures
  - D698-00a e1.....Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup> (600 kN-m/m<sup>3</sup>))
  - D2321-05.....Underground Installation of Thermoplastic Pipes for Sewers and Other Gravity-Flow Applications
  - D2412-02.....Determination of External Loading Characteristics of Plastic Pipe by Parallel- Plate Loading
  - D2992-01.....Practice for Obtaining Hydrostatic or Pressure Design Basis for Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Fittings
  - D3034-04a.....Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
  - D3212-96a (2003) e1.....Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
  - F477-02e1.....Elastomeric Seals (Gaskets) for Joining Plastic Pipe
- C. American Water Works Association (AWWA):
- C115-99.....Flanged Ductile-Iron Pipe with Threaded Flanges
- D. Uni-Bell PVC Pipe Association:
- Uni-B-6-98.....Recommended Practice Low Pressure Air Testing of Installed Sewer Pipe

**PART 2 - PRODUCTS****2.1 PIPING:**

- A. Gravity Flow Lines (Pipe and Fittings):
1. Polyvinyl Chloride (PVC):
    - a. Pipe and Fittings, 100 to 375 mm (4 to 15 inches) in diameter, shall conform to ASTM D3034, Type PSM, SDR 35. Pipe and fittings

shall have elastomeric gasket joints providing a watertight seal when tested in accordance with ASTM D3212. Gaskets shall conform to ASTM F477. Solvent welded joints shall not be permitted.

## **2.2 JOINTING MATERIAL:**

### **A. Gravity Flow Lines:**

1. Polyvinyl Chloride (PVC) Pipe (Gravity Use): Joints, ASTM D3212. Elastomeric gasket, ASTM F477.

## **2.3 MANHOLES AND CATCH BASINS:**

### **A. Manholes and vaults shall be constructed of precast reinforced concrete rings, and precast reinforced sections**

1. The manholes shall be in accordance with the details shown on the drawings. The Contractor shall furnish shop drawings for each product listed below.
2. Precast Reinforced Concrete Rings: Rings or sections shall have an inside diameter as indicated on the drawings, and shall be not less than 1200 mm (48 inches) in diameter. Wall thickness shall conform to requirements of ASTM C76, except that lengths of the sections may be shorter as conditions require. Tops shall conform to ASTM C478. Top section shall be eccentric cone type. Steps on inside wall shall be in the same plane from bottom of structure to manhole cover.
3. Precast Reinforced Concrete Manhole Risers and Tops: Design, material and installation shall conform to requirements of ASTM C478. Top sections shall be eccentric. Steps on inside wall shall be in the same plane from bottom of structure to manhole cover.
4. Mortar:
  - a. Precast Reinforced Concrete Ring and Riser Structures: By volume, 1 part of Portland cement and 2 parts sand. Water in mixture shall produce a stiff, workable mortar, but shall not exceed 21 L (5-1/2 gallons) per sack of cement.
5. Flexible sealing compound shall be packaged in extruded preformed shape, sized to completely fill the joint between precast sections, and form permanently flexible watertight seal. The sealing compound shall be non-shrink and meet AASHTO M198.
6. Frames and covers shall be gray cast iron conforming to ASTM A48. The frame and cover shall be rated for HS20-44 loading, have a studded pattern on the cover, and the words "sanitary sewer". The studs and the lettering shall be raised 8 mm (5/16-inch). The cover shall be a minimum of 600 mm (24 inches) in diameter and shall have four 19 mm (3/4-inch) vent holes and two lifting slots. The bearing surface of

the frame and cover shall be machine finished. The cover shall fit firmly on the frame without movement when subject to traffic.

#### **2.4 CONCRETE:**

Concrete shall have a minimum compressive strength of 20 MPa (3000 psi) at 28 days. The cement shall be Type III conforming to ASTM C150. Concrete shall conform with the provisions of Division 03 of these specifications.

#### **2.5 REINFORCING STEEL:**

Reinforcing steel shall be deformed bars, ASTM A615, Grade 40 unless otherwise noted.

#### **2.6 CLEANOUT FRAMES AND COVERS:**

Frames and covers shall be gray iron casting conforming to ASTM C48. The frame and cover shall be rated for HS20-44 wheel loading, have a studded pattern on its cover, vent holes, and lifting slots. The cover shall fit firmly on the frame without movement when subject to vehicular traffic. The word "SEWER" shall be cast on the cover.

#### **2.7 WARNING TAPE:**

Standard, .1mm (4Mil) polyethylene 76 mm (3-inch) wide tape detectable type, green with black letters and imprinted with "CAUTION BURIED SEWER LINE BELOW".

### **PART 3 - EXECUTION**

#### **3.1 BUILDING SERVICE LINES:**

- A. Install sanitary sewer service lines to point of connection within approximately 1500 mm (5 feet) outside of buildings where service is required and make connections. Coordinate the invert and location of the service line with the Contractor installing the building lines.
- B. Connections of service line to building piping shall be made after the new sanitary sewer system has been constructed, tested, and accepted for operation by the Resident Engineer. The Contractor shall install all temporary caps or plugs required for testing.
- C. When building services have not been installed at the time when the sanitary sewer system is complete, provide temporary plugs or caps at the ends of all service lines. Mark the location and depth of the service lines with continuous warning tape placed 300 mm (12 inches) above service lines.
- D. Piping under and within 1500 mm (10 feet) of building areas shall be completely removed.
- E. Piping outside of building areas shall have all ends of the piping at the limit of the abandonment and within structures and manholes, plugged with concrete, and abandoned in-place.

- F. The Contractor shall comply with all OSHA confined space requirements while working within existing manholes and structures.
- G. When the limit of the abandonment terminates in an existing manhole to remain, the flow line in the bench of the manhole to the abandoned line shall be filled with concrete and shaped to maintain the flowline of the lines to remain.

### **3.2 REGRADING:**

- A. Raise or lower existing manholes and structures frames and covers, cleanout frames and covers and valve boxes in regraded areas to finish grade. Carefully remove, clean and salvage cast iron frames and covers. Adjust the elevation of the top of the manhole or structure as detailed on the drawings. Adjust the elevation of the cleanout pipe riser, and reinstall the cap or plug. Reset cast iron frame and cover, grouting below and around the frame. Install concrete collar around reset frame and cover as specified for new construction.
- B. During periods when work is progressing on adjusting manholes or structures cover elevations, the Contractor shall install a temporary cover above the bench of the structure or manhole. The temporary cover shall be installed above the high flow elevation within the structure, and shall prevent debris from entering the wastewater stream.
- C. The Contractor shall comply with all OSHA confined space requirements when working within existing structures.

### **3.3 CONNECTIONS TO EXISTING VA OWNED SANITARY MAINS OR MANHOLES:**

- A. During construction of new connections to existing main, it shall be the sole responsibility of the Contractor to maintain continued sanitary sewer service to all buildings and users upstream. The contractor shall provide, install, and maintain all pumping, conveyance system, dams, weirs, etc. required to maintain the continuous flow of sewage. All temporary measures required to meet this requirement shall be subject to the review of the Resident Engineer.

### **3.4 PIPE SEPARATION:**

- A. Horizontal Separation - Water Mains and Sewers:
  - 1. Existing and proposed water mains shall be at least 3 meters (10 feet) horizontally from any proposed gravity flow and pressure (force main) sanitary sewer or sewer service connection.
  - 2. Gravity flow mains and pressure (force) mains may be located closer than 3 meters (10 feet) but not closer than 1.8 m (6 feet) to a water main when:
    - a. Local conditions prevent a lateral separation of ten feet; and

- b. The water main invert is at least 450 mm (18 inches) above the crown of the gravity sewer or 600 mm (24 inches) above the crown of the pressure (force) main; and
  - c. The water main is in a separate trench separated by undisturbed earth.
- 3. When it is impossible to meet (1) or (2) above, both the water main and sanitary sewer main shall be constructed of push-on or mechanical joint ductile iron pipe. The pipe for the sanitary sewer main shall comply with the specifications for pressure (force) mains, and the water main material shall comply with Section 33 10 00, WATER UTILITIES. The sewer shall be pressure tested as specified for pressure (force) mains before backfilling.
- B. Vertical Separation - Water Mains and Sewers at Crossings:
  - 1. Water mains shall be separated from sewer mains so that the invert of the water main is a minimum of 600 mm (24 inches) above the crown of gravity flow sewer or 1200 mm (48 inches) above the crown of pressure (force) mains. The vertical separation shall be maintained within 3 meters (10 feet) horizontally of the sewer and water crossing. When these vertical separations are met, no additional protection is required.
  - 2. When it is impossible to meet (1) above, the gravity flow sewer may be installed 450 mm (18 inches) above or 300 mm (12 inches) below the water main, provided that the water main is encased in flowable fill as per the drawings. Piping for the water main shall conform to Section 33 10 00, WATER UTILITIES.
  - 3. The required vertical separation between the sewer and the water main shall extend on each side of the crossing until the perpendicular distance from the water main to the sewer line is at least 3 meters (10 feet).

### **3.5 GENERAL PIPING INSTALLATION:**

- A. Lay pipes true to line and grade. Gravity flow sewer shall be laid with bells facing upgrade. Pressure (force) mains shall have the bells facing the direction of flow.
- B. Do not lay pipe on unstable material, in wet trench or when trench and weather conditions are unsuitable for the work.
- C. Support pipe on compacted bedding material. Excavate bell holes only large enough to properly make the joint.
- D. Inspect pipes and fittings, for defects before installation. Defective materials shall be plainly marked and removed from the site. Cut pipe shall have smooth regular ends at right angles to axis of pipe.

- E. Clean interior of all pipe thoroughly before installation. When work is not in progress, open ends of pipe shall be closed securely to prevent entrance of storm water, dirt or other substances.
- F. Lower pipe into trench carefully and bring to proper line, grade, and joint. After jointing, interior of each pipe shall be thoroughly wiped or swabbed to remove any dirt, trash or excess jointing materials.
- G. Do not lay sewer pipe in same trench with another pipe or utility. Sanitary sewers shall cross at least 600 mm (2 feet) below water lines.
- H. Do not walk on pipe in trenches until covered by layers of bedding or backfill material to a depth of 300 mm (12 inches) over the crown of the pipe.
- I. Warning tape shall be continuously placed 300 mm (12 inches) above sewer pipe
- J. Install gravity sewer line in accordance with the provisions of these specifications and the following standards:
  - 1. Polyvinyl Chloride (PVC) Piping: ASTM D2321.

### **3.6 MANHOLES:**

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

##### **1. Circular Structures:**

- a. Precast reinforced concrete rings shall be installed true and plumb. The joints between rings and between rings and the base and top, shall be sealed with a preform flexible gasket material specifically manufactured for this type of application. Adjust the length of the rings so that the eccentric conical top section will be at the required elevation. Cutting the conical top section is not acceptable.
- b. Precast reinforced concrete manhole risers and tops. Install as specified for precast reinforced concrete rings.
- 2. Do not build structures when air temperature is 0 degrees C (32 degrees F), or below.
- 3. Invert channels shall be smooth and semicircular in shape conforming to inside of adjacent sewer section. Make changes in direction of flow with a smooth curve of as large a radius as size of structure will permit. Make changes in size and grade of channels gradually and evenly. Construct invert channels by one of the listed methods:
  - a. Forming directly in concrete base of structure.
  - b. Building up with brick and mortar.
- 4. Floor of structure outside the channels shall be smooth and slope toward channels not less than 1:12 (1-inch per foot) nor more than 1:6 (2 inches per foot). Bottom slab and benches shall be concrete.



5. The wall that support access rungs or ladder shall be 90 degrees vertical from the floor of structure to manhole cover.
6. Install manhole frames and covers on a mortar bed, and flush with the finish pavement. Frames and covers shall not move when subject to vehicular traffic. Install a concrete collar around the frame to protect the frame from moving until the adjacent pavement is placed. In unpaved areas, the rim elevation shall be 50 mm (2 inches) above the adjacent finish grade. Install a 200 mm (8 inches) thick, by 300 mm (12 inches) concrete collar around the perimeter of the frame. Slope the top of the collar away from the frame.

### **3.7 CLEANOUTS:**

- A. 150 millimeters (6 inches) in diameter and consisting of a PVC 45 degree fitting on end of run, or combination Y fitting and 1/8 bend in the run with PVC pipe extension, water tight plug or cap and cast frame and cover flush with finished grade. See detail on drawings.
- B. The top of the cleanout assembly shall be 50 mm (2 inches) below the bottom of the cover to prevent loads being transferred from the frame and cover to the piping.

### **3.8 INSPECTION OF SEWERS:**

- A. Inspect and obtain the Resident Engineer's approval. Thoroughly flush out before inspection. Lamp test between structures and show full bore indicating sewer is true to line and grade. Lip at joints on the inside of gravity sewer lines is not acceptable.

### **3.9 TESTING OF SANITARY SEWERS:**

- A. Gravity Sewers and Manholes (Select one of the following):
  1. Air Test: PVC Pipe, Uni-Bell Uni-B-6. Clean and isolate the section of sewer line to be tested. Plug or cap the ends of all branches, laterals, tees, wyes, and stubs to be included in the test to prevent air leakage. The line shall be pressurized to 28 kPa (4 psi) and allowed to stabilize. After pressure stabilization, the pressure shall be dropped to 24 kPa (3.5 psi) greater than the average back-pressure of any groundwater above the sewer. The minimum test time shall be as specified in Uni-Bell Uni-B-6.

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**SECTION 33 40 00  
STORM SEWER UTILITIES**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

This section specifies materials and procedures for construction of outside, underground storm sewer and roof drain systems that are complete and ready for operation. This includes piping, structures and all other incidentals.

**1.2 RELATED WORK**

- A. Excavation, Trench Widths, Pipe Bedding, Backfill, Shoring, Sheeting, Bracing: Section 31 20 00, EARTH MOVING (Short Form).
- B. Concrete Work, Reinforcing, Placement and Finishing: Section 32 05 23 CEMENT AND CONCRETE FOR EXTERIOR IMPROVEMENTS.
- C. General plumbing, protection of Materials and Equipment, and quality assurance: Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- D. Materials and Testing Report Submittals: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.
- E. Erosion and Sediment Control: Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS.

**1.3 DELIVERY, STORAGE, AND HANDLING**

- A. Do not store pipe and fittings in direct sunlight.
- B. Handle manholes and stormwater inlets according to manufacturer's written rigging instructions.

**1.4 COORDINATION**

- A. Coordinate connection to storm sewer main with the Owner.
- B. Coordinate exterior utility lines and connections to building services up to the actual extent of building wall.

**1.5 QUALITY ASSURANCE:**

- A. Products Criteria:
  - 1. When two or more units of the same type or class of materials or equipment are required, these units shall be products of one manufacturer.
  - 2. A nameplate bearing manufacturer's name or trademark, including model number, shall be securely affixed in a conspicuous place on equipment. In addition, the model number shall be either cast integrally with equipment, stamped, or otherwise permanently marked on each item of equipment.

**1.6 SUBMITTALS**

A. Manufacturer's Literature and Data: Submit the following as one package:

1. Piping and fittings.
2. Jointing material.
3. Frames and covers.
4. Steps.
5. Resilient connectors and downspout boots.
6. Frames and grates.

**1.7 APPLICABLE PUBLICATIONS**

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

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

- A185/A185M-07.....Steel Welded Wire Reinforcement, Plain, for  
Concrete
- A536-84(2009).....Ductile Iron Castings
- A615/A615M-09b.....Deformed and Plain Carbon-Steel Bars for  
Concrete Reinforcement
- C33/C33M-08.....Concrete Aggregates
- C76-11.....Reinforced Concrete Culvert, Storm Drain, and  
Sewer Pipe
- C150/C150M-11.....Portland Cement
- C443-10.....Joints for Concrete Pipe and Manholes, Using  
Rubber Gaskets
- C478-09.....Precast Reinforced Concrete Manhole Sections
- C506-10b.....Reinforced Concrete Arch Culvert, Storm Drain,  
and Sewer Pipe
- C507-10b.....Reinforced Concrete Elliptical Culvert, Storm  
Drain, and Sewer Pipe
- C655-09.....Reinforced Concrete D-Load Culvert, Storm  
Drain, and Sewer Pipe
- C857-07.....Minimum Structural Design Loading for  
Underground Precast Concrete Utility Structures

- C891-09.....Installation of Underground Precast Concrete  
Utility Structures
- C913-08.....Precast Concrete Water and Wastewater  
Structures
- C923-08.....Resilient Connectors Between Reinforced  
Concrete Manhole Structures, Pipes, and  
Laterals
- C924-02 (2009).....Testing Concrete Pipe Sewer Lines by Low-  
Pressure Air Test Method
- C990-09.....Joints for Concrete Pipe, Manholes, and Precast  
Box Sections Using Preformed Flexible Joint  
Sealants
- C1103-03 (2009).....Joint Acceptance Testing of Installed Precast  
Concrete Pipe Sewer Lines
- C1173-08.....Flexible Transition Couplings for Underground  
Piping Systems
- C1433-10.....Precast Reinforced Concrete Monolithic Box  
Sections for Culverts, Storm Drains, and Sewers
- C1479-10.....Installation of Precast Concrete Sewer, Storm  
Drain, and Culvert Pipe Using Standard  
Installations
- D448-08.....Sizes of Aggregate for Road and Bridge  
Construction
- D698-07e1.....Laboratory Compaction Characteristics of Soil  
Using Standard Effort (12 400 ft-lbf/ft<sup>3</sup> (600  
kN-m/m<sup>3</sup>))
- D1056-07.....Flexible Cellular Materials—Sponge or Expanded  
Rubber
- D1785-06.....Poly(Vinyl Chloride) (PVC) Plastic Pipe,  
Schedules 40, 80, and 120
- D2321-11.....Underground Installation of Thermoplastic Pipe  
for Sewers and Other Gravity-Flow Applications

- D2751-05.....Acrylonitrile-Butadiene-Styrene (ABS) Sewer  
Pipe and Fittings
- D2774-08.....Underground Installation of Thermoplastic  
Pressure Piping
- D3034-08.....Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe  
and Fittings
- D3350-10.....Polyethylene Plastics Pipe and Fittings  
Materials
- D5926-09.....Poly (Vinyl Chloride) (PVC) Gaskets for Drain,  
Waste, and Vent (DWV), Sewer, Sanitary, and  
Storm Plumbing Systems
- F477-10.....Elastomeric Seals (Gaskets) for Joining Plastic  
Pipe
- F679-08.....Poly(Vinyl Chloride) (PVC) Large-Diameter  
Plastic Gravity Sewer Pipe and Fittings
- F794-03(2009).....Poly(Vinyl Chloride) (PVC) Profile Gravity  
Sewer Pipe and Fittings Based on Controlled  
Inside Diameter
- F1417-11.....Installation Acceptance of Plastic Gravity  
Sewer Lines Using Low-Pressure Air
- F1668-08.....Construction Procedures for Buried Plastic Pipe
- C. American Association of State Highway and Transportation Officials  
(AASHTO):
- M190-04.....Bituminous-Coated Corrugated Metal Culvert Pipe  
and Pipe Arches
- M198-10.....Joints for Concrete Pipe, Manholes, and Precast  
Box Sections Using Preformed Flexible Joint  
Sealants

### **1.8 WARRANTY**

The Contractor shall remedy any defect due to faulty material or workmanship and pay for any damage to other work resulting therefrom within a period of one year two years from final acceptance. Further, the Contractor will furnish all manufacturers' and suppliers' written

guarantees and warranties covering materials and equipment furnished under this Contract.

## **PART 2 - PRODUCTS**

### **2.1 FACTORY-ASSEMBLED PRODUCTS**

A. Standardization of components shall be maximized to reduce spare part requirements. The Contractor shall guarantee performance of assemblies of components, and shall repair or replace elements of the assemblies as required to deliver specified performance of the complete assembly.

### **2.2 PVC PIPE AND FITTINGS**

#### **A. PVC Pipe And Fittings**

1. PVC Cellular-Core Pipe And Fittings: ASTM F891, Sewer and Drain Series, PS 50 minimum stiffness, PVC cellular-core pipe with plain ends for solvent-cemented joints.
2. Fittings: ASTM D3034, SDR 35.

#### **B. PVC Type PSM Sewer Piping**

1. Pipe: ASTM D3034, SDR 35 Insert SDR, PVC Type PSM sewer pipe with bell-and-spigot ends.
2. Fittings: ASTM D3034, PVC with bell ends.
3. Gaskets: ASTM F477, elastomeric seals.

### **2.3 CONCRETE PIPE AND FITTINGS**

A. Reinforced-Concrete sewer pipe and fittings shall be ASTM C76 or ASTM C655.

1. Bell-and-spigot gasketed sealant joints with ASTM C990, bitumen or butyl-rubber sealant.
2. Class III: Wall B.

### **2.4 NONPRESSURE TRANSITION COUPLINGS**

A. Comply with ASTM C1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground non-pressure piping. Include ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

#### **B. Sleeve Materials**

1. For concrete pipes: ASTM C443, rubber.
2. For plastic pipes: ASTM F477, elastomeric seal or ASTM D5926, PVC.
3. For dissimilar pipes: ASTM D5926, PVC or other material compatible with pipe materials being joined.

- C. Unshielded, Flexible Couplings: Couplings shall be an elastomeric sleeve with corrosion-resistant-metal tension band and tightening mechanism on each end.

## **2.5 CLEANOUTS**

- A. 150 mm (6 inches) in diameter and consisting of a PVC 45 degree fitting on end of run, or combination Y fitting and 1/8 bend in the run with PVC pipe extension, water tight plug or cap and cast frame and cover flush with finished grade. See detail on drawings.
- B. The top of the cleanout assembly shall be 50 mm (2 inches) below the bottom of the cleanout assembly shall be 50 mm (2 inches) below the bottom of the cover to prevent loads being transferred from the frame and cover to the piping.

## **2.6 MANHOLES AND CATCH BASINS**

- A. Standard Precast Concrete Manholes:
1. Description: ASTM C478 (ASTM C478M), precast, reinforced concrete, of depth indicated, with provision for sealant joints.
  2. Diameter: 48 inches (1200 mm) minimum unless otherwise indicated.
  3. Ballast: Increase thickness of precast concrete sections or add concrete to base section as required to prevent flotation.
  4. Base Section: 6 inch (150 mm) minimum thickness for floor slab and 4-inch (102 mm) minimum thickness for walls and base riser section, and separate base slab or base section with integral floor. See drawings.
  5. Riser Sections: 4 inch (102 mm) minimum thickness, and lengths to provide depth indicated. See drawings.
  6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated, and top of cone of size that matches grade rings.
  7. Joint Sealant: ASTM C990 (ASTM C990M), bitumen or butyl rubber.
  8. Resilient Pipe Connectors: ASTM C923 (ASTM C923M), cast or fitted into manhole walls, for each pipe connection.
  9. Steps: If total depth from floor of manhole to finished grade is greater than 60 inches (1500 mm). ASTM A615, deformed, 1/2 inch (13 mm) steel reinforcing rods encased in ASTM D4101, PP, width of 16 inches (400 mm) minimum, spaced at 12 to 16 inch (300 to 400 mm) intervals.
  10. Adjusting Rings: Reinforced-concrete rings, 6 to 9 inch (150 to 225 mm) total thickness, to match diameter of manhole frame and cover,

and height as required to adjust manhole frame and cover to indicated elevation and slope.

**B. Designed Precast Concrete Manholes:**

1. Description: ASTM C913; designed for A-16 (AASHTO HS20-44), heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for sealant joints.
2. Ballast: Increase thickness of one or more precast concrete sections or add concrete to manhole as required to prevent flotation.
3. Joint Sealant: ASTM C990 (ASTM C990M), bitumen or butyl rubber.
4. Resilient Pipe Connectors: ASTM C923 (ASTM C923M), cast or fitted into manhole walls, for each pipe connection.
5. Steps: If total depth from floor of manhole to finished grade is greater than 60 inches (1500 mm). // Individual FRP steps or FRP ladder // Individual FRP steps; FRP ladder; or ASTM A615, deformed, 1/2 inch (13 mm) steel reinforcing rods encased in ASTM D4101, PP // ASTM A615 deformed, 1/2 inch (13 mm) steel reinforcing rods encased in ASTM D 4101, PP //, width of 16 inches (400 mm) minimum, spaced at 12 to 16 inch (300 to 400 mm) intervals.
6. Adjusting Rings: Reinforced-concrete rings, 6 to 9 inch (150 to 225 mm) total thickness, to match diameter of manhole frame and cover, and height as required to adjust manhole frame and cover to indicated elevation and slope.

**C. Manhole Frames and Covers:**

1. Description: Ferrous; 24 inch (610 mm) ID by 7 to 9 inch (175 to 225 mm) riser with 4 inch (102 mm) minimum width flange and 26-inch (600 mm) diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."
2. Material: ASTM A48/A48M, Class 35 gray iron unless otherwise indicated.

**2.7 CONCRETE FOR MANHOLES AND CATCH BASINS**

**A. General:** Cast-in-place concrete according to ACI 318, ACI 350/350R, and the following:

1. Cement: ASTM C150, Type II.
2. Fine Aggregate: ASTM C33, sand.
3. Coarse Aggregate: ASTM C33, crushed gravel.
4. Water: Potable.

**B. Concrete Design Mix:** 4000 psi (27.6 MPa) minimum, compressive strength in 28 days.



1. Reinforcing Fabric: ASTM A185, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A615, Grade 60 (420 MPa) deformed steel.

## **2.8 WARNING TAPE**

SPEC WRITER NOTE: Use non-detectable type  
for cemeteries only.

- A. Standard, 4-Mil polyethylene 3 inch (76 mm) wide tape detectable type, purple with black letters, and imprinted with "CAUTION BURIED STORM SEWER BELOW".

## **PART 3 - EXECUTION**

### **3.1 PIPE BEDDING**

- A. The bedding surface of the pipe shall provide a firm foundation of uniform density throughout the entire length of pipe. Concrete pipe requirements are such that when no bedding class is specified, concrete pipe shall be bedded in a soil foundation accurately shaped and rounded to conform with the lowest one-fourth of the outside portion of circular pipe. When necessary, the bedding shall be tamped. Bell holes and depressions for joints shall not be more than the length, depth, and width required for properly making the particular type of joint.
- B. The bedding surface of the pipe shall provide a firm foundation of uniform density throughout the entire length of pipe. Plastic pipe bedding requirements shall be Type I Bedding Material.

### **3.2 PIPING INSTALLATION**

- A. Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install piping with minimum cover as shown on the Drawings.
- C. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
  1. Do not lay pipe on unstable material, in wet trench or when trench and weather conditions are unsuitable for the work.
  2. Support pipe on compacted bedding material. Excavate bell holes only large enough to properly make the joint.

3. Inspect pipes and fittings, for defects before installation.  
Defective materials shall be plainly marked and removed from the site. Cut pipe shall have smooth regular ends at right angles to axis of pipe.
4. Clean interior of all pipe thoroughly before installation. When work is not in progress, open ends of pipe shall be closed securely to prevent entrance of storm water, dirt or other substances.
5. Lower pipe into trench carefully and bring to proper line, grade, and joint. After jointing, interior of each pipe shall be thoroughly wiped or swabbed to remove any dirt, trash or excess jointing materials.
6. Do not walk on pipe in trenches until covered by layers of shading to a depth of 12 inches (300 mm) over the crown of the pipe.
7. Warning tape shall be continuously placed 12 inches (300 mm) above storm sewer piping.
- D. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
- E. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- F. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.
- G. Install gravity-flow, nonpressure drainage piping according to the following:
  1. Install piping pitched down in direction of flow.
  2. Install PVC cellular-core piping, PVC sewer piping, and PVC profile gravity sewer piping, according to ASTM D2321 and ASTM F1668.
  3. Install reinforced concrete sewer piping according to ASTM C1479.

### **3.3 REGRADING**

- A. Raise or lower existing manholes and structures frames and covers in regraded areas to finish grade. Carefully remove, clean and salvage cast iron frames and covers. Adjust the elevation of the top of the manhole or structure as detailed on the drawings. Reset cast iron frame and cover, grouting below and around the frame. Install concrete collar around reset frame and cover as specified for new construction.
- B. During periods when work is progressing on adjusting manholes or structures cover elevations, the Contractor shall install a temporary

cover above the bench of the structure or manhole. The temporary cover shall be installed above the high flow elevation within the structure, and shall prevent debris from entering the wastewater stream.

### **3.4 CONNECTIONS TO EXISTING VA-OWNED MANHOLES**

- A. Make pipe connections and alterations to existing manholes so that finished work will conform as nearly as practicable to the applicable requirements specified for new manholes, including concrete and masonry work, cutting, and shaping.

### **3.5 CONNECTIONS TO EXISTING PUBLIC UTILITY MANHOLES**

- A. Comply with all rules and regulations of the public utility.
- B. Install horizontal-type backwater valves combination horizontal and manual gate-valve terminal-type backwater valves in piping where indicated.
- C. Cleanout Installation
  - 1. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast iron soil pipe fittings in sewer pipes at branches for cleanouts and cast iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
    - a. Use Light-Duty, top-loading classification cleanouts in // earth or unpaved foot-traffic // Insert other // areas.
    - b. Use Medium-Duty, top-loading classification cleanouts in // paved foot-traffic // Insert other // areas.
    - c. Use Heavy-Duty, top-loading classification cleanouts in // vehicle-traffic service // Insert other // areas.
    - d. Use Extra-Heavy-Duty, top-loading classification cleanouts in // roads // Insert area //.
  - 2. Set cleanout frames and covers in earth in cast in-place concrete block, // 18 by 18 by 12 inches (450 by 450 by 300 mm) // Insert dimensions // deep. Set with tops // 1 inch (25 mm) // Insert dimension // above surrounding earth grade.
- D. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

### **3.6 MANHOLE INSTALLATION**

- A. Install manholes, complete with appurtenances and accessories indicated. Install precast concrete manhole sections with sealants according to ASTM C891.

B. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 2 inches (76 mm) above finished surface elsewhere unless otherwise indicated.

C. Circular Structures:

1. Precast reinforced concrete rings shall be installed true and plumb. The joints between rings and between rings and the base and top shall be sealed with a preform flexible gasket material specifically manufactured for this type of application. Adjust the length of the rings so that the eccentric conical top section will be at the required elevation. Cutting the conical top section is not acceptable.
2. Precast reinforced concrete manhole risers and tops. Install as specified for precast reinforced concrete rings.

D. Rectangular Structures:

1. Invert channels shall be level and semicircular in shape conforming to inside of adjacent sewer section. Make changes in direction of flow with a smooth curve of as large a radius as size of structure will permit. Make changes in size and grade of channels gradually and evenly. Construct invert channels by one of the listed methods:
  - a. Forming directly in concrete base of structure.
  - b. Building up with brick and mortar.
2. Floor of structure outside the channels shall be smooth and slope toward channels not less than 1 to 12 or more than 1 to 6. Bottom slab and benches shall be concrete.
3. The wall that supports access rungs or ladder shall be 90 deg vertical from the floor of structure to manhole cover.
4. Install steps and ladders per the manufacturer's recommendations. Steps and ladders shall not move or flex when used. All loose steps and ladders shall be replaced by the Contractor.
5. Install manhole frames and covers on a mortar bed, and flush with the finish pavement. Frames and covers shall not move when subject to vehicular traffic. Install a concrete collar around the frame to protect the frame from moving until the adjacent pavement is placed. In unpaved areas, the rim elevation shall be 2 inches (50 mm) above the adjacent finish grade. Install an 8 inch (203 mm) thick, by 12 inch (300 mm) concrete collar around the perimeter of the frame. Slope the top of the collar away from the frame.

### 3.7 CATCH BASIN INSTALLATION

- A. Construct catch basins to sizes and shapes indicated.
- B. Set frames and grates to elevations indicated.

### 3.8 CONNECTIONS

- A. Connect nonpressure, gravity-flow drainage piping in building's storm building drains specified in Division 22 Section FACILITY STORM DRAINAGE PIPING.
- B. Encase entire connection fitting, plus 6 inch (150 mm) overlap, with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).
- C. Make connections to existing piping and underground manholes.
  - 1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping.
  - 2. Make branch connections from side into existing piping, NPS 4 to NPS 20 (DN 100 to DN 500). Remove section of existing pipe, install wye fitting into existing piping.
  - 3. Make branch connections from side into existing piping, NPS 21 (DN 525) or larger, or to underground manholes and structures by cutting into existing unit and creating an opening large enough to allow 3 inches (76 mm) of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe, manhole, or structure wall, use epoxy-bonding compound as interface between new and existing concrete and piping materials.
  - 4. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.
- D. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
  - 1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.
    - a. Unshielded Shielded flexible couplings for same or minor difference OD pipes.
    - b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.

- c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

### **3.9 CLOSING ABANDONED STORM DRAINAGE SYSTEMS**

- A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:
  - 1. Close open ends of piping with at least 12 inch concrete.
  - 2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.
- B. Abandoned Manholes and Structures: Excavate around manholes and structures as required and use one procedure below:
  - 1. Remove manhole or structure and close open ends of remaining piping.

### **3.10 IDENTIFICATION**

- A. Install green warning tape directly over piping and at outside edge of underground structures.

### **3.11 FIELD QUALITY CONTROL**

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Prior to final acceptance, provide a video record of all piping from the building to the municipal connection to show the lines are free from obstructions, properly sloped and joined.
  - 1. Submit separate reports for each system inspection.
  - 2. Defects requiring correction include the following:
    - a. Damage: Crushed, broken, cracked, or otherwise damaged piping.
    - b. Infiltration: Water leakage into piping.
    - c. Exfiltration: Water leakage from or around piping.
  - 3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
  - 4. Reinspect and repeat procedure until results are satisfactory.

### **3.12 TESTING OF STORM SEWERS:**

- A. Submit separate report for each test.
- B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
  - 1. Do not enclose, cover, or put into service before inspection and approval.

2. Test completed piping systems according to requirements of authorities having jurisdiction.
  3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours advance notice.
  4. Submit separate report for each test.
  5. Air test gravity sewers. Concrete Pipes conform to ASTM C924, Plastic Pipes conform to ASTM F1417, all other pipe material conform to ASTM C828 or C924, after consulting with pipe manufacturer. Testing of individual joints shall conform to ASTM C1103.
- C. Leaks and loss in test pressure constitute defects that must be repaired. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

### **3.13 CLEANING**

- A. Clean interior of piping of dirt and superfluous materials. Flush with water.

--- E N D ---

**SECTION 33 46 13**  
**FOUNDATION DRAINAGE**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

This section specifies materials and procedures for construction of foundation drainage systems, including installation, backfill, and cleanout, to a point of connection to storm sewer.

**1.2 RELATED WORK**

- A. Excavation, Trench Widths, Pipe Bedding, Backfill, Shoring, Sheeting, Bracing: Section 31 20 11, EARTH MOVING (Short Form).
- B. Materials testing and inspection during construction: Section 01 45 29, TESTING LABORATORY SERVICES.
- C. General plumbing, protection of Materials and Equipment, and quality assurance: Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- D. Submittals: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.

**1.3 DEFINITIONS**

Underdrain: Foundation drainage system that collects and removes subsurface or seepage water from building foundation from building to storm water system.

**1.4 DELIVERY, STORAGE, AND HANDLING**

- A. Do not store plastic, pipe, and fittings in direct sunlight.
- B. Protect pipe, pipe fittings, and seals from dirt and damage.

**1.5 COORDINATION**

- A. Coordinate exterior utility lines and connections to foundation building drain.

**1.6 QUALITY ASSURANCE:**

- A. Products Criteria:
  - 1. When two or more units of the same type or class of materials or equipment are required, these units shall be products of one manufacturer.
  - 2. A nameplate bearing manufacturer's name or trademark, including model number, shall be securely affixed in a conspicuous place on equipment. In addition, the model number shall be either cast integrally with equipment, stamped, or otherwise permanently marked on each item of equipment.



- B. Comply with the rules and regulations of the Public Agency having jurisdiction over the connection to public storm sewer lines or the requirements for discharge of subsurface drainage.

#### **1.7 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred in the text by basic designation only.

- B. American Society for Testing and Materials (ASTM):

D2321-11.....Underground Installation of Thermoplastic Pipe  
for Sewers and Other Gravity-Flow Applications

D3034-08.....Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe  
and Fittings

D4491-99a(2009).....Test Methods for Water Permeability of  
Geotextiles by Permittivity

D4716-08.....Test Method for Determining the (In-plane) Flow  
Rate per Unit Width and Hydraulic  
Transmissivity of a Geosynthetic Using a  
Constant Head

D5926-09.....Poly (Vinyl Chloride) (PVC) Gaskets for Drain,  
Waste, and Vent (DWV), Sewer, Sanitary, and  
Storm Plumbing Systems

D6707-06 (2011).....Circular-Knit Geotextile for Use in Subsurface  
Drainage Applications

F405-05.....Corrugated Polyethylene (PE) Pipe and Fittings

F477-10.....Elastomeric Seals (Gaskets) for Joining Plastic  
Pipe

F667-06.....Larger Diameter Corrugated Polyethylene Pipe  
and Fittings

F2648-10.....2 to 60 Inch Annular Corrugated Profile Wall  
Polyethylene (PE) Pipe and Fittings for Land  
Drainage Applications

#### **1.8 WARRANTY**

The Contractor shall remedy any defect due to faulty material or workmanship and pay for any damage to other work resulting therefrom

within a period of one year from final acceptance. Further, the Contractor will furnish all manufacturer's and supplier's written guarantees and warranties covering materials and equipment furnished under this Contract.

## **PART 2 - PRODUCTS**

### **2.1 FACTORY-ASSEMBLED PRODUCTS**

- A. Standardization of components shall be maximized to reduce spare part requirements.
- B. Contractor shall guarantee performance of assemblies of components, and shall repair or replace elements of the assemblies as required to deliver specified performance of the complete assembly.

### **2.2 COMPATIBILITY OF RELATED EQUIPMENT**

Equipment and materials installed shall be compatible in all respects with other items being furnished and with existing items so that the result will be a complete and fully operational system that conforms to contract requirements.

### **2.3 PERFORATED-WALL PIPES AND FITTINGS FOR VAULTS OR MANHOLES**

- A. Perforated PVC Sewer Pipe and Fittings shall be ASTM D3034.

### **2.4 SOLID-WALL PIPES AND FITTINGS**

- A. PVC Sewer Pipe and Fittings: ASTM D3034.
  - 1. Gaskets: ASTM F477.

### **2.5 SPECIAL PIPE COUPLINGS**

- A. Comply with ASTM C1173 for joining underground non-pressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant metal tension band and tightening mechanism on each end.
  - 1. Sleeve Materials:
    - a. For Dissimilar Pipes: ASTM D5926, PVC or other material compatible with pipe materials being joined.
  - 2. Unshielded Flexible Couplings: Elastomeric sleeve with corrosion-resistant metal tension band and tightening mechanism on each end.

### **2.6 CLEANOUTS**

- A. Cleanout PVC Extension shall conform to ASTM D3034. PVC extensions shall have watertight joints and long sweep elbow fittings. PVC cleanout shall be as per the drawings.

### **2.7 DRAINAGE CONDUITS**

- A. Smooth PVC Drainage Conduits shall have perforated fittings and couplings complying with ASTM D3034.

1. Nominal size shall be 8 inches (200 mm).
  - a. Minimum flow rate equal to a NPS 4 (DN 100) pipe.
2. Fittings shall be as per manufacturer.

## **2.8 SOIL MATERIALS**

### **A. Drainage Material**

1. Bedding: Type 1 Bedding, see Section 31 20 11 EARTH MOVING (Short Form).
2. Fill to 1 foot (300 mm) above pipe shall be Crushed stone, 3/4 inch (20 mm) to No. 4 per ASTM D448, at a minimum or as per geotechnical recommendations.

### **B. Concrete Sand shall be ASTM C33.**

## **2.9 GEOTEXTILE FILTER FABRICS**

- A. Geotextile fabric shall conform to ASTM 6707. Elongation will be greater than 50 percent and the flow rate shall range from 110 to 330 gpm/sq. ft. (4480 to 13440 L/min. per sq. m).
  1. Structure Type shall be Nonwoven, needle-punched continuous filament.
  2. Style(s) shall be flat.
- B. Manufacturer: Linq Industrial Fabrics, 130 EX, Trevira Spunbond 1114, Mirafi N40, or equal.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine surfaces and areas for suitable conditions where subdrainage systems are to be installed.
- B. If subdrainage is required for landscaping, locate and mark existing utilities, underground structures, and aboveground obstructions before beginning installation and avoid disruption and damage of services.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PIPING APPLICATIONS**

- A. Underground Subdrainage Piping shall be:
  1. Perforated PVC sewer pipe and fittings for loose, bell-and-spigot joints.
- B. Header Piping shall be:
  1. PVC sewer pipe and fittings, couplings, and coupled joints.

### **3.3 CLEANOUT APPLICATIONS**

- A. In Underground Subdrainage Piping:

1. At Grade in Earth shall be PVC cleanouts with casting as per drawings.
2. At Grade in Paved Areas shall be PVC cleanouts with casting as per drawings.

### **3.4 FOUNDATION DRAINAGE INSTALLATION**

- A. Place impervious fill material on subgrade adjacent to bottom of footing after concrete footing forms have been removed. Place and compact impervious fill to dimensions indicated, but not less than 6 inches (150 mm) deep and 12 inches (300 mm) wide.
- B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.
- C. Place supporting layer of bedding course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches (100 mm).
- D. Add drainage course to width of at least 6 inches (150 mm) on side away from wall and to top of pipe to perform tests.
- E. After satisfactory testing, cover drainage piping to width of at least 6 inches (150 mm) on side away from footing and above top of pipe a minimum of 12 inches above the bottom of the footing to within 12 inches (300 mm) of finish grade.
- F. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.
- G. Wrap flat-style geotextile filter fabric over top of drainage course, overlapping edges at least 4 inches (100 mm).

### **3.5 PIPING INSTALLATION**

- A. Install piping beginning at low points of system, true to grades and alignment indicated, with unbroken continuity of invert. Bed piping with full bearing in filtering material. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions and other requirements indicated.
  1. Foundation Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 0.5 percent and with a minimum cover of 48 inches and as indicated on drawings.
  2. Lay perforated pipe with perforations down.
  3. Excavate recesses in trench bottom for bell ends of pipe. Lay pipe with bells facing upslope and with spigot end entered fully into adjacent bell.

B. Use increasers, reducers, and couplings made for different sizes or materials of pipes and fittings being connected. Reduction of pipe size in direction of flow is prohibited.

C. Install PVC piping according to ASTM D2321.

### **3.6 PIPE JOINT CONSTRUCTION**

A. Join PVC pipe and fittings according to ASTM D2729.

B. Join perforated PVC pipe and fittings according to ASTM D2729.

### **3.7 CLEANOUT INSTALLATION**

A. Cleanouts for Foundation Subdrainage:

1. Install cleanouts from piping to grade. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping. See details on drawings.

### **3.8 CONNECTIONS**

A. Connect low elevations of subdrainage system to solid-wall-piping storm drainage system.

### **3.9 IDENTIFICATION**

A. Install detectable warning tape over nonferrous piping and over edges of underground structures.

### **3.10 FIELD QUALITY CONTROL**

Testing: After installing drainage course to top of piping, test drain piping with water to ensure free flow before backfilling. Remove obstructions, replace damaged components, and repeat test until results are satisfactory.

### **3.11 CLEANING**

Clear interior of installed piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of each day or when work stops.

--- E N D ---

# Geotechnical Engineering Report

Proposed VA Surgery Tower/Wing Addition

Ft. Meade VA Hospital

Ft. Meade, South Dakota

April 30, 2012

Terracon Project No. B4125017



**Prepared for:**

FourFront Design, Inc.  
Rapid City, South Dakota

**Prepared by:**

Terracon Consultants, Inc.  
Rapid City, South Dakota

Offices Nationwide  
Employee-Owned

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# Terracon

Geotechnical   ■   Environmental   ■   Construction Materials   ■   Facilities



April 30, 2012

Mr. David Jolly  
FourFront Design, Inc.  
517 Seventh Street  
Rapid City, South Dakota 57701

**Subject:       Geotechnical Engineering Report  
Proposed VA Surgery Tower/Wing Addition  
Ft. Meade VA Hospital  
Ft. Meade, South Dakota  
Terracon Project No. B4125017**

Dear Mr. Jolly,

Terracon has completed the geotechnical engineering services for the proposed VA Surgery Tower/Wing to be constructed on the north side of the existing hospital building. This study was performed in general accordance with Terracon's proposal No. GB412049, dated March 21, 2012, and the written authorization to proceed provided by Mr. Curt Huus, FourFront Design, Inc.

The results of our engineering study, including the boring location diagram, laboratory test results, boring logs, and the geotechnical recommendations needed to aid in the design of foundations and other earth connected phases of this project, are attached.

We appreciate being of service to you in the geotechnical engineering phase of this project and are prepared to assist you during the construction phases as well. If you have any questions concerning this report, please contact us at your convenience.

Sincerely,  
**Terracon Consultants, Inc.**

Teresa Serie, E.I.  
Staff Professional

Walt Feeger, P.E.  
Office Manager

Copies:       Client (3 bound, 1 via e-mail)  
File (1)



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**Geotechnical**



**Environmental**



**Construction Materials**



**Facilities**

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## **EXECUTIVE SUMMARY**

A geotechnical engineering report has been completed for the proposed VA Surgery Tower/Wing addition to be constructed on the north side of the existing Ft. Meade Hospital building in Ft. Meade, South Dakota. Three (3) soil borings, designated B-1 through B-3, were performed to depths of approximately 20½ feet below existing grades within the proposed building addition footprint. This report addresses the recommendations for the proposed project.

Based on the information obtained from our subsurface exploration, the site can be developed for the proposed project. The following geotechnical considerations were identified:

- In general, within Borings B-1 and B-2, the subsurface soils consisted of approximately 1½ to 3 feet of medium stiff to very stiff lean clay soils overlying about 11 to 11½ feet of dense to very dense sand and gravel soils. Within Boring B-3, approximately 3 feet of stiff to medium stiff lean clay soils were encountered overlying about 15 feet of dense to very dense silty gravels. The soils are underlain by weathered shale bedrock which extended to the total depths explored within each of the borings. Groundwater was encountered within the borings at depths of approximately 14 to 15½ feet below existing grade.
- Based on the soils encountered within the borings, the proposed structure can be supported on a conventional spread footing foundation system bearing on the site sand and gravel soils.
- The lower level (basement) concrete-slab on grade floor system may be constructed on the reconditioned granular site soils. We recommend the main level floor slab be constructed on at least 12-inches of compacted granular engineered fill.
- Earthwork on the project should be observed and evaluated by Terracon. The evaluation of earthwork should include observation and testing of engineered fill, subgrade preparation, foundation bearing soils, and other geotechnical conditions involved with construction of the project.
- This summary should be used in conjunction with the entire report for design purposes. It should be recognized that details were not included or fully developed in this section, and the report must be read in its entirety for a comprehensive understanding of the items contained herein. The section titled **GENERAL COMMENTS** should be read for an understanding of the report limitations.

# **GEOTECHNICAL ENGINEERING REPORT**

## **PROPOSED VA SURGERY TOWER/WING ADDITION**

### **FT. MEADE VA HOSPITAL**

### **FT. MEADE, SOUTH DAKOTA**

**Terracon Project No. B4125017**  
**April 30, 2012**

## **1.0 INTRODUCTION**

A geotechnical engineering report has been completed for the proposed VA Surgery Tower/Wing addition to be constructed on the north side of the existing hospital building located at the Ft. Meade VA Hospital in Ft. Meade, South Dakota. Three (3) soil borings, designated B-1 through B-3, were advanced to depths of approximately 20½ feet below existing grades within the proposed building addition footprint. This report specifically addresses the recommendations for the proposed building addition. Logs of the borings along with a boring location diagram are included in Appendix A of this report.

The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- subsurface soil conditions
- groundwater conditions
- earthwork
- site drainage requirements
- site and subgrade preparation
- foundation design and construction
- seismic classification

## **2.0 PROJECT INFORMATION**

### **2.1 Project Description**

<b>ITEM</b>	<b>DESCRIPTION</b>
<b>Site layout</b>	See Appendix A, Figure 1, Boring Location Diagram
<b>Building Construction</b>	Two-story building addition with a basement level within a portion of the structure.
<b>Finished floor elevation, feet</b>	96.0 feet (assumed as referenced to our project datum)
<b>Maximum loads</b>	Columns: 75 kips maximum (assumed) Walls: 3 klf maximum (assumed) Floor Slab: 150 psf (assumed)
<b>Maximum allowable total settlement</b>	Columns: 1-inch (assumed) Walls: 1-inch (assumed)
<b>Grading within Building Footprint</b>	Cut and fill balances on the order of about 1 to 3 feet based on assumed finished floor elevation of 96.0 feet

## 2.2 Site Location and Description

ITEM	DESCRIPTION
<b>Location</b>	The location of the proposed addition is on the north side of the existing hospital building at the Ft. Meade VA Hospital in Ft. Meade, South Dakota.
<b>Current use</b>	The site is currently being utilized both as a landscaped area around the existing hospital building as well as an asphalt paved parking lot and associated access drives.
<b>Existing topography</b>	Overall, the site slopes slightly downward to the north with and elevation differences of about 4 feet noted between the boring locations.

## 3.0 SUBSURFACE CONDITIONS

### 3.1 Typical Profile

In general, within Borings B-1 and B-2, the subsurface soils consisted of approximately 1½ to 3 feet of medium stiff to very stiff lean clay soils overlying about 11 to 11½ feet of dense to very dense sand and gravel soils. Within Boring B-3, approximately 3 feet of stiff to medium stiff lean clay soils were encountered overlying about 15 feet of dense to very dense silty gravels. The soils are underlain by weathered shale bedrock which extended to the total depths explored within each of the borings.

Conditions encountered at each boring location are indicated on the individual boring logs. Stratification boundaries on the boring logs represent the approximate location of changes in soil types; in-situ, the transition between materials may be gradual. Details for each of the borings can be found on the boring logs in Appendix A of this report.

### 3.2 Groundwater

The boreholes were observed while drilling and after completion for the presence and level of groundwater. Measurable groundwater was encountered within Borings B-1 and B-3 at depths of approximately 14 to 15½ feet below existing grade, respectively. Borings were backfilled with auger cuttings once groundwater measurements were made.

Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff, local irrigation practices, and other factors not evident at the time the borings were performed. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project. Evaluation of the factors that affect groundwater fluctuations is beyond the scope of this report.

## **4.0 RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION**

### **4.1 Earthwork**

Earthwork on the project should be observed and evaluated by Terracon. The evaluation of earthwork should include observation and testing of engineered fill, subgrade preparation, foundation bearing soils, and other geotechnical conditions involved with construction of the project.

#### **4.1.1 Site Preparation**

At this time it is anticipated that the main level floor of the proposed addition will match that of the existing building. Based on an assumed finished floor elevation of 96.0 feet as referenced to our project datum, cut and fill balances on the order of about 1 to 3 feet will be required within the proposed building addition footprint in order to reach the desired construction elevations.

Existing utilities (if encountered), topsoil, vegetation, man-made debris and other unsuitable materials should be removed in their entirety from within the proposed building footprint and areas to receive pavement. Once completed and where required, excavations should continue to the desired construction elevations and to allow for the placement of at least 12-inches of compacted imported granular material below the main level concrete-slab-on-grade floor. Care should be taken to not undermine the footings of the existing building.

Conventional earth moving equipment, such as large tracked excavators, should be able to perform the required excavations within the site soils. Possible cobble to boulder sized material may be encountered within the site soils which may make excavation difficult where encountered.

The excavated granular soils, cleaned of all topsoil, organics, unsuitable materials, and gravel greater than 3 inches in nominal size, may be stockpiled on-site and reused as engineered fill, utility trench backfill, overlot fill, and wall backfill. Excavated clay soils should be used within landscape areas only and as a wall backfill cap in non-structural areas.

Although evidence of underground facilities, such as foundation elements, septic tanks, cesspools, basements were not observed during the field exploration, such features could be encountered during construction. If unexpected underground facilities and utilities are encountered, such features should be removed and the excavation thoroughly cleaned prior to backfill placement and/or construction.

Prior to the placement of engineered fill (where required) and structural elements, we recommend that the subgrade soils be scarified to a depth of at least 8 inches, the moisture content adjusted to near optimum, and the soils re-compacted to at least 95 percent of the maximum dry density, as determined by ASTM D 698 (Standard Proctor). All exposed surfaces should be free of mounds and depressions which could prevent uniform compaction.

This process will help to delineate soft or disturbed areas. Unstable areas identified during scarification and recompaction should either be stabilized or undercut to expose stable material. If isolated soft or unstable areas are encountered, it may be necessary to place a layer of crushed stone to stabilize the subgrade and help expedite construction.

If extensive soft or unstable conditions are encountered during site preparation, additional mechanical or chemical stabilization of the soils may be required. Terracon can assist with developing appropriate stabilization procedures based on conditions encountered during construction if required.

Groundwater was encountered during our site explorations. Depending on the time of year construction takes place, groundwater may be encountered within the excavations performed at this site, especially within excavations performed for utilities and the basement level. We recommend that, if encountered during excavations, the groundwater be promptly removed using a de-watering technique that lowers and keeps the groundwater surface at least 2 feet below the bottom of excavations.

A potential side effect of any de-watering effort is settlement (consolidation) of the soils, resulting in surface settlements, which can adversely impact existing structures, pavements or underground facilities. The contractors working on the project should select de-watering systems that will limit the cone of groundwater depression to the immediate construction area.

Due to the potential of encountering groundwater, we recommend that contractors bidding and working on this project be made aware of the groundwater potential and include an itemization in their bid for dewatering. Additionally, the subgrade soils may require mitigation through the use of additional over-excavation and replacement with granular engineered fill and/or a geo-grid or stabilization fabric in order to build a solid platform for placing engineered fill material or foundations. Contractors should also provide an itemization in their bid for such remediation.

#### **4.1.2 Engineered Fill Material Requirements**

Engineered fill should meet the following material property requirements:

<b>Fill Type<sup>1</sup></b>	<b>USCS Classification</b>	<b>Acceptable Location for Placement</b>
Granular <sup>2</sup>	GM, GC, SM, SC	Below foundations, concrete slabs-on-grade, interior/exterior wall backfill
On-Site Soils <sup>3</sup>	SM, GM, CL	Cohesionless (Sand & Gravel) - Engineered fill, utility trench backfill, wall backfill, and overlot fill. Cohesive (Lean Clay) - Utility trench backfill, and overlot fill.

## Geotechnical Engineering Report

Proposed VA Surgery Tower/Wing Addition ■ Ft. Meade, South Dakota

April 30, 2012 ■ Terracon Project No. B4125017



Engineered fill should consist of approved materials that are free of organic matter and debris. Frozen material should not be used, and fill should not be placed on a frozen subgrade. Each proposed fill material type should be sampled and evaluated by the geotechnical engineer prior to its delivery and/or use.

Imported granular engineered fill required below foundations, columns, interior/exterior concrete slabs and for exterior wall backfill should consist of a granular pit run material, or conform to the following criteria.

Additionally, the material should be submitted to the project geotechnical engineer for review and approval.

<u>Gradation</u>	<u>Percent finer by weight (ASTM C136)</u>
3" .....	100
No. 4 Sieve .....	40-85
No. 200 Sieve .....	20-35
Liquid Limit .....	30 (max)
Plasticity Index .....	10 (max)

Moisture conditioning and processing of the site soils will be required in order to maintain moisture control during placement

### 4.1.3 Engineered Fill Compaction Requirements

Item	Description
<b>Fill Lift Thickness</b>	8 inches or less in loose thickness when heavy, self-propelled compaction equipment is used.  4 to 6 inches in loose thickness when hand-guided equipment (i.e. jumping jack or plate compactor) is used.
<b>Minimum Compaction Requirement (ASTM D698 Standard Proctor)</b>	<b>Engineered fill:</b> 97% <b>Scarified subgrade soils:</b> 95% <b>Aggregate base (beneath paving and slabs):</b> 95% <b>Wall/Trench backfill:</b> 95% <b>Miscellaneous backfill (non-structural areas):</b> 90%
<b>Moisture Content (ASTM D698)</b>	<b>Granular Engineered Fill:</b> $\pm 3\%$ of optimum <b>Site Sand/Gravel Soils:</b> $\pm 3\%$ of optimum <b>Site Clay Soils:</b> -1 to +3 percent of optimum

We recommend that each lift of engineered fill and backfill be tested by Terracon for moisture content and compaction prior to the placement of additional engineered fill or concrete. Should the results of the in-place density tests indicate the specified moisture or compaction limits have not been met, the area represented by the test should be reworked and retested as required until the specified moisture and compaction requirements are achieved.

#### **4.1.4 Utility Trench Excavations and Backfill**

All trench excavations should be made with sufficient working space to permit construction including backfill placement and compaction. Utility trenches are a common source of water infiltration and migration. All utility trenches that penetrate beneath the building should be effectively sealed to restrict water intrusion and flow through the trenches that could migrate below the building. We recommend constructing an effective clay “trench plug” that extends at least 5 feet out from the face of the building exterior. The plug material should consist of clay compacted at a water content at or above the soil's optimum water content. The clay fill should be placed to completely surround the utility line and compacted in accordance with recommendations in this report.

As previously noted, groundwater was encountered during our field work, and depending on the time of year construction takes place groundwater or surface runoff accumulation may be encountered within site excavations. Contractors working on the project should anticipate dewatering the excavations and have equipment on-site that will lower and maintain the groundwater level below the base of the excavations if encountered.

It is anticipated that excavations for the proposed construction can be accomplished with conventional earthmoving equipment such as large tracked excavators. The individual contractor's competent person should be made responsible for designing and constructing stable, temporary excavations, as required, to maintain stability of both the excavation sides and bottom. Excavations should be sloped or shored in the interest of safety following local and federal regulations, including current OSHA excavation and trench safety standards. In our opinion, the clay soils encountered at the site can be classified as Type B with maximum allowable slopes of 1H:1V for excavations less than 20 feet in depth. The site sand and gravel soils should be classified as Type C soils with a maximum allowable slope of 1½H:1V for excavations less than 20 feet in depth.

Depending on the depths of excavations and subsurface soil and groundwater conditions, the use of temporary shoring and/or trench boxes may be required. As a safety measure, vehicles and stockpiles should be kept away from the excavation crest a distance at least equal to the slope height. Where practical, the exposed slope face should be protected against the elements.



#### **4.1.5 Grading and Drainage**

Positive drainage should be provided during construction and maintained throughout the life of the proposed project. Infiltration of water into utility or foundation excavations must be prevented during construction.

All grades must provide effective drainage away from the building during and after construction. Water permitted to pond next to the building can result in greater soil movements than those discussed in this report. These greater movements can result in unacceptable differential floor slab movements, cracked slabs and walls, and roof leaks. Estimated movements described in this report are based on effective drainage for the life of the structure and cannot be relied upon if effective drainage is not maintained.

In areas where sidewalks or paving do not immediately adjoin the structure, we recommend that protective slopes be provided with a minimum grade of approximately 10 percent for at least 10 feet from perimeter walls. Backfill against footings, exterior walls, and in utility and sprinkler line trenches should be well compacted and free of all construction debris to reduce the possibility of moisture infiltration.

Downspouts, roof drains or scuppers should discharge into splash blocks or extensions when the ground surface beneath such features is not protected by exterior slabs or paving. Sprinkler systems should not be installed within 10 feet of foundation walls. Landscaped irrigation adjacent to the foundation system should be minimized or eliminated.

#### **4.1.6 Construction Considerations**

Although the exposed subgrade is anticipated to be relatively stable upon initial exposure, unstable subgrade conditions could develop during general construction operations, particularly if the soils are wetted and/or subjected to repetitive construction traffic. The use of light construction equipment would aid in reducing subgrade disturbance. The use of remotely operated equipment, such as a backhoe, would be beneficial to perform cuts and reduce subgrade disturbance. Should unstable subgrade conditions develop, stabilization measures will need to be employed.

Upon completion of filling and grading, care should be taken to maintain the subgrade moisture content prior to construction of floor slabs and pavements. Construction traffic over the completed subgrade should be avoided to the extent practical. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. If the subgrade should become frozen, desiccated, saturated, or disturbed, the affected material should be removed or these materials should be scarified, moisture conditioned, and recompacted prior to floor slab and pavement construction.



As a minimum, all temporary excavations should be sloped or braced as required by Occupational Health and Safety Administration (OSHA) regulations to provide stability and safe working conditions. Temporary excavations will probably be required during grading operations. The grading contractor, by his contract, is usually responsible for designing and constructing stable, temporary excavations and should shore, slope or bench the sides of the excavations, as required, to maintain stability of both the excavation sides and bottom. All excavations should comply with applicable local, state, and federal safety regulations, including the current OSHA Excavation and Trench Safety Standards.

The geotechnical engineer and/or their representative should be retained during the construction phase of the project to observe/test earthwork and to perform necessary tests and observations during subgrade preparation; proof-rolling; placement and compaction of controlled compacted fills; backfilling of excavations into the completed subgrade, and just prior to construction of building floor slabs.

## **4.2 Foundations**

In our opinion, the proposed building addition can be supported on a shallow spread footing foundation system bearing on the re-compacted and approved granular site soils and/or on newly placed and compacted granular engineered fill as required by site grading. Design recommendations for shallow foundations for the proposed structure are presented in the following paragraphs.

### **4.2.1 Design Recommendations**

<b>DESCRIPTION</b>	<b><u>Column</u></b>	<b><u>Wall</u></b>
<b>Allowable bearing pressure <sup>1</sup></b>	3,500 psf	3,500 psf
<b>Minimum dimensions</b>	30 inches	18 inches
<b>Minimum embedment below finished grade for frost protection <sup>2</sup></b>	48 inches	48 inches
<b>Approximate total movement <sup>3</sup></b>	1 inch	1 inch

1. The recommended allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. Assumes any unsuitable material or soft/loose soils, if encountered, will be undercut and replaced with suitable engineered fill.
2. For exterior foundations beneath continuously heated structures, depth below the lowest adjacent exterior grade. The minimum depth for interior footings of continuously heated structures is 12 inches.
3. The foundation movement will depend upon the variations within the subsurface soil profile, the structural loading conditions, the embedment depth of the footings, the thickness of compacted fill, drainage, and the quality of the earthwork operations. If positive drainage around the structure cannot be maintained, the movement estimates provided cannot be relied upon.

The design bearing pressures apply to dead loads plus the design live load conditions. The design bearing pressures may be increased by one-third when considering total loads that include wind or seismic conditions.

#### **4.2.2 Construction Considerations**

The base of all foundation excavations should be free of water and loose or soft soil prior to placing concrete. Concrete should be placed soon after excavating to reduce bearing soil disturbance. If the soils at bearing level become excessively dry, disturbed or saturated, or frozen, the affected soil should be removed prior to placing concrete.

It is recommended that the geotechnical engineer be retained to observe the soil foundation bearing materials. If unsuitable bearing soils are encountered in footing excavations, the excavation should be extended deeper to suitable soils and the footing bear directly on these soils at the lower elevation or on properly compacted structural backfill extending down to the suitable soils.

#### **4.3 Seismic Considerations**

<b>Code Used</b>	<b>Site Classification</b>
2009 International Building Code (IBC) <sup>1</sup>	C <sup>2</sup>

1. In general accordance with the *2009 International Building Code*, Table 1613.5.2.
2. The 2009 International Building Code (IBC) requires a site soil profile determination extending a depth of 100 feet for seismic site classification. The current scope requested does not include the required 100 foot soil profile determination.

Borings for the project extended to maximum depths of approximately 20½ feet below grade, and this seismic site class definition considers that shale bedrock continues below the maximum depth of the subsurface exploration. Additional exploration to deeper depths could be performed to confirm the conditions below the current depth of exploration. Alternatively, a geophysical exploration could be utilized in order to attempt to justify a higher seismic site class if required.

#### **4.4 Concrete Slab-on-Grade**

##### **4.4.1 Interior Slab-On-Grade**

Based on the soils encountered within the borings, lean clay soils will likely be present at the anticipated main level floor slab elevation. Because low plasticity clay soils shrink and swell to some extent with normal variations in moisture content, some movements normally occur and should be anticipated. However, to reduce the potential for movement related distress to the floor slab, we recommend the concrete floor slab bear on at least 12-inches of compacted granular engineered fill. The leveling course, typically 4 to 6 inches of base course material provided below the concrete, slab may be included in the 12-inch thickness of granular engineered fill placed below the slab. The basement level slab-on-grade floor may be placed on the reconditioned site granular soils.

ITEM	DESCRIPTION
<b>Floor slab support</b>	Main Level - 12-inches of compacted imported granular engineered fill. Basement Level – Reconditioned granular site soils.
<b>Modulus of subgrade reaction</b>	Imported granular engineered fill – 250 pounds per square inch per inch (psi/in) for point loading conditions. Site granular soils – 200 psi/in for point loading conditions
<b>Aggregate base course/capillary break <sup>2</sup></b>	4-6 inches of free draining granular material

1. Floor slabs should be structurally independent of any building footings or walls to reduce the possibility of floor slab cracking caused by differential movements between the slab and foundation.
2. The floor slab design should include a capillary break, comprised of free-draining, compacted, granular material at least 4-6 inches thick.

Additional floor slab design and construction recommendations are as follows:

- Positive separations and/or isolation joints should be provided between slabs and all foundations, columns or utility lines to allow independent movement.
- Contraction joints should be provided in slabs to control the location and extent of cracking.
- The use of a vapor retarder should be considered beneath concrete slabs-on-grade that will be covered with wood, tile, carpet or other moisture sensitive or impervious coverings, or when the slab will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder, the slab designer and slab contractor should refer to ACI 302 for procedures and cautions regarding the use and placement of a vapor retarder.
- Floor slabs should not be constructed on frozen subgrade.
- Other design and construction considerations, as outlined in Section 302.1R of the *ACI Design Manual*, are recommended.

#### 4.4.2 Exterior Slab Construction Considerations

Exterior slabs-on-grade founded on the site clay soils could experience movement exceeding one-inch due to the volume change of the clay material. This movement may lead to loss of positive drainage away from the building and could present a tripping hazard where slab sections move independently.

Potential movement could be reduced by:

- Placing slabs on a minimum of one (1) foot of imported granular engineered fill as specified in this report,
- Minimizing moisture increases in the subgrade,
- Controlling moisture-density during placement,
- Using designs which allow vertical movement between the exterior features and adjoining structural elements, and
- Placing effective control joints on relatively close centers.

#### **4.5 Basement Construction Considerations**

As indicated, groundwater was encountered in the borings at depths of approximately 14 to 15½ feet below existing grades. Based on this information, the lower (basement) level should be above the anticipated groundwater levels at this site. However, the following recommendations should be considered during the design and construction of the lower structural level in the event the groundwater levels rise due to seasonal variations.

To intercept the potential for water infiltration from impacting the foundation bearing stratum and entering the lower level, an exterior perimeter drain is recommended. The exterior drainage system should be constructed around the exterior perimeter of the basement foundation, and sloped at a minimum 1/8 inch per foot to a suitable outlet, such as the storm sewer or a sump and pump system. The new system could also be tied into the existing drain system, if present, around the existing building.

The exterior drainage system should consist of a properly sized perforated pipe, embedded in free-draining gravel, and placed along the exterior edge of the footing. Gravel should extend a minimum of 3 inches beneath the bottom of the pipe, and at least 1 foot above the bottom of the foundation wall. The gravel should be covered with drainage fabric prior to placement of foundation backfill.

**Lateral Earth Pressures:** For soils above any free water surface, recommended equivalent fluid pressures for unrestrained foundation elements are:

- Active:
  - Site granular soils ..... 50 psf
  - Imported granular backfill ..... 35 psf
- Passive:
  - Site granular soils ..... 320 psf
  - Imported granular backfill ..... 520 psf

- Where the design includes restrained elements, the following equivalent fluid pressures are recommended:
- At rest:
  - Site granular soils ..... 70 psf
  - Imported granular backfill ..... 55 psf

The lateral earth pressures herein do not include any factor of safety and are not applicable for submerged soils/hydrostatic loading. Additional recommendations may be necessary if submerged conditions are to be included in the design.

Fill against basement walls should be compacted to densities specified in the “Earthwork” section of this report. Compaction within 5 feet of basement walls should be accomplished with hand-operated tampers or other lightweight compactors. Overcompaction may cause excessive lateral earth pressures which could result in cracking and/or wall movement.

## **5.0 GENERAL COMMENTS**

Terracon should be retained to review the final design plans and specifications so comments can be made regarding interpretation and implementation of our geotechnical recommendations in the design and specifications. Terracon also should be retained to provide observation and testing services during grading, excavation, foundation construction, and other earth-related construction phases of the project.

The analysis and recommendations presented in this report are based upon the data obtained from the borings performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between borings, across the site, or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided.

The scope of services for this project does not include, either specifically or by implication, any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either expressed or implied, are intended or made.

**Geotechnical Engineering Report**

Proposed VA Surgery Tower/Wing Addition ■ Ft. Meade, South Dakota  
April 30, 2012 ■ Terracon Project No. B4125017



Site safety, excavation support, and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project, as outlined in this report, are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Terracon reviews the changes and either verifies or modifies the conclusions of this report in writing.

# **APPENDIX A**

## **FIELD EXPLORATION**







# LOG OF BORING NO. B- 1

Page 1 of 1

OWNER		Ft. Meade VA Hospital		ARCHITECT		FourFront Design, Inc.							
SITE		Ft. Meade VA Hospital Ft. Meade, South Dakota		PROJECT		Proposed VA Surgery Tower/Wing Addition							
GRAPHIC LOG	Boring Location: Proposed Building Addition			DEPTH, ft.	USCS SYMBOL	SAMPLES			TESTS				
	DESCRIPTION					NUMBER	TYPE	RECOVERY, ft.	SPT - N BLOWS / ft.	WATER CONTENT, %	DRY UNIT WT pcf	UNCONFINED STRENGTH, psf	
	Approx. Surface Elev.: 94.9 ft												
	0.5	<u>TOPSOIL/VEGETATIVE LAYER</u>											94.4
	<u>SANDY LEAN CLAY</u> , brown, very stiff (CL)												
	2.5												92.4
	<u>SILTY SAND with GRAVEL</u> , brown, very dense possible cobbles present (SM)												
14	<u>SANDY CLAY with GRAVEL</u> , brown, very stiff (CL)		80.9										
19.5			75.4										
<u>WEATHERED SHALE</u> , dark grey, stiff													
20.5			74.4										
End of Boring													

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

## WATER DEPTH OBSERVATIONS, ft

WD	▽ 14	4/3/12	▽
WD	▽		▽
WD			

# Terracon

BORING STARTED		4-3-12	
BORING COMPLETED		4-3-12	
RIG	CME-55	FOREMAN	BC
LOGGED	GR	JOB #	B4125017

# LOG OF BORING NO. B-2

Page 1 of 1

OWNER		Ft. Meade VA Hospital		ARCHITECT		FourFront Design, Inc.						
SITE		Ft. Meade VA Hospital Ft. Meade, South Dakota		PROJECT		Proposed VA Surgery Tower/Wing Addition						
GRAPHIC LOG	Boring Location: Proposed Building Addition			DEPTH, ft.	USCS SYMBOL	SAMPLES			TESTS			
	DESCRIPTION					NUMBER	TYPE	RECOVERY, ft.	SPT - N BLOWS / ft.	WATER CONTENT, %	DRY UNIT WT pcf	UNCONFINED STRENGTH, psf
	Approx. Surface Elev.: 96.2 ft											
	0.3	CONCRETE	95.9									
	0.5	AGGREGATE BASE COURSE	95.7									
	2	SANDY LEAN CLAY, brown, very stiff (CL)	94.2									
	SILTY SAND with GRAVEL, brown, very dense, possible cobbles present (SM)											
14	SANDY CLAY with GRAVEL, brown, hard (CL)	82.2										
18	WEATHERED SHALE, dark grey, very stiff	78.2										
20.5		75.7										
End of Boring												

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

## WATER DEPTH OBSERVATIONS, ft

WD	None	4/3/12	▼
WD	▼		▼
WD			

# Terracon

BORING STARTED		4-3-12	
BORING COMPLETED		4-3-12	
RIG	CME-55	FOREMAN	BC
LOGGED	GR	JOB #	B4125017

# LOG OF BORING NO. B- 3

Page 1 of 1

OWNER		Ft. Meade VA Hospital		ARCHITECT		FourFront Design, Inc.							
SITE		Ft. Meade VA Hospital Ft. Meade, South Dakota		PROJECT		Proposed VA Surgery Tower/Wing Addition							
GRAPHIC LOG	Boring Location: Proposed Building Addition			DEPTH, ft.	USCS SYMBOL	SAMPLES			TESTS				
	DESCRIPTION					NUMBER	TYPE	RECOVERY, ft.	SPT - N BLOWS / ft.	WATER CONTENT, %	DRY UNIT WT pcf	UNCONFINED STRENGTH, psf	
	Approx. Surface Elev.: 98.8 ft												
	0.5	<u>TOPSOIL/VEGETATIVE LAYER</u>											98.3
	<u>SANDY LEAN CLAY</u> , brown, stiff to medium stiff, gravel present (CL)												
	3.5												95.3
	<u>SILTY GRAVEL with SAND</u> , brown, dense to very dense, possible cobbles present (GM)												

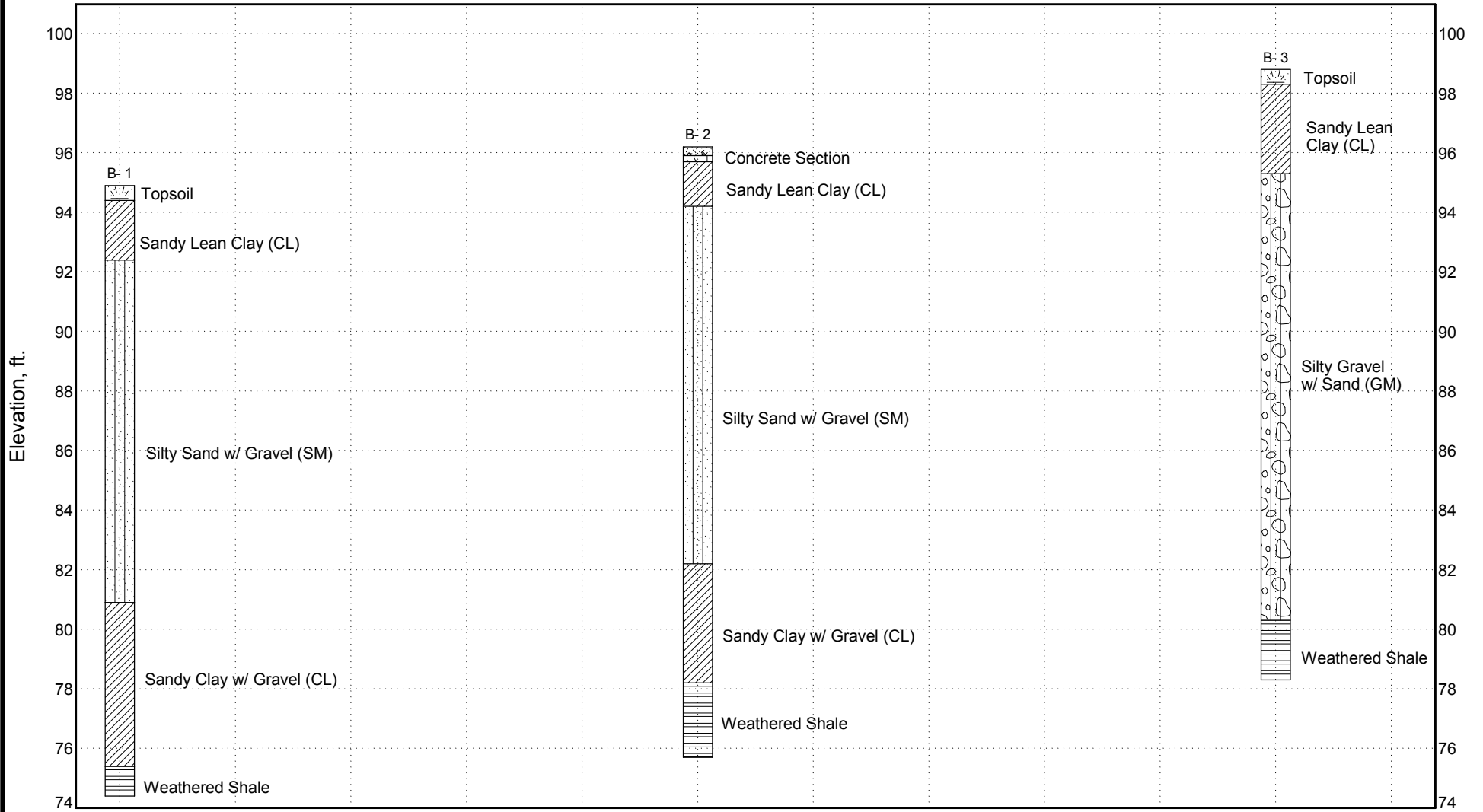
The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

## WATER DEPTH OBSERVATIONS, ft

WD	▽ 15.5	4/3/12	▽
WD	▽		▽
WD			

# Terracon

BORING STARTED		4-3-12	
BORING COMPLETED		4-3-12	
RIG	DME-55	FOREMAN	BC
LOGGED	GR	JOB #	B4125017



Project: Proposed VA Surgery Tower/Wing Addition  
 Site: Ft. Meade VA Hospital Ft. Meade, South Dakota  
 Job #: B4125017  
 Date: 4-30-12

## SUBSURFACE DIAGRAM

## **Geotechnical Engineering Report**

Proposed VA Surgery Tower/Wing Addition ■ Ft. Meade, South Dakota

April 30, 2012 ■ Terracon Project No. B4125017



### **Field Exploration Description**

The boring locations were selected and staked in the field by Terracon. The approximate boring locations are indicated on the attached Boring Location Diagram. The ground surface elevations indicated on the boring logs were referenced to a Temporary Benchmark (TBM). The TBM selected for this project was the finished main floor of the existing hospital building. The locations and elevations of the borings should be considered accurate only to the degree implied by the means and methods used to define them.

The borings were drilled with a CME-55 rotary drill rig using solid-stem augers to advance the boreholes. Samples of the soil encountered in the borings were obtained using split spoon and California Barrel samplers.

In the split-barrel sampling procedure, the number of blows required to advance a standard 2-inch O.D. split-barrel sampler the last 12 inches of the typical total 18-inch penetration by means of a 140-pound C.M.E. auto-hammer with a free fall of 30 inches, is the standard penetration resistance value (SPT-N). This value is used to estimate the in-situ relative density of cohesionless soils and consistency of cohesive soils.

Penetration resistance values for the California barrel sampler were recorded in a manner similar to the standard penetration test (SPT). This test consists of driving the sampler into the ground with a 140-pound hammer free-falling through a distance of 30 inches. The number of blows required to advance the California barrel sampler 18 inches, is recorded and can be correlated to the standard penetration resistance value (N-value). The blow count values are indicated on the boring log at the respective sample depths.

The samples were tagged for identification, sealed to reduce moisture loss, and taken to our laboratory for further examination, testing, and classification. Information provided on the boring logs attached to this report includes soil descriptions, consistency evaluations, boring depths, sampling intervals, and groundwater conditions. The borings were backfilled with auger cuttings in the follow days once follow-up groundwater measurements were recorded.

A field log of each boring was prepared by the field engineer. These logs included visual classifications of the materials encountered during drilling as well as the engineer's interpretation of the subsurface conditions between samples. Final boring logs included with this report represent the engineer's interpretation of the field logs and include modifications based on laboratory observation and tests of the samples.

## **APPENDIX B**

### **LABORATORY TESTING**

**Geotechnical Engineering Report**

Proposed VA Surgery Tower/Wing Addition ■ Ft. Meade, South Dakota  
April 30, 2012 ■ Terracon Project No. B4125017

**Laboratory Testing**

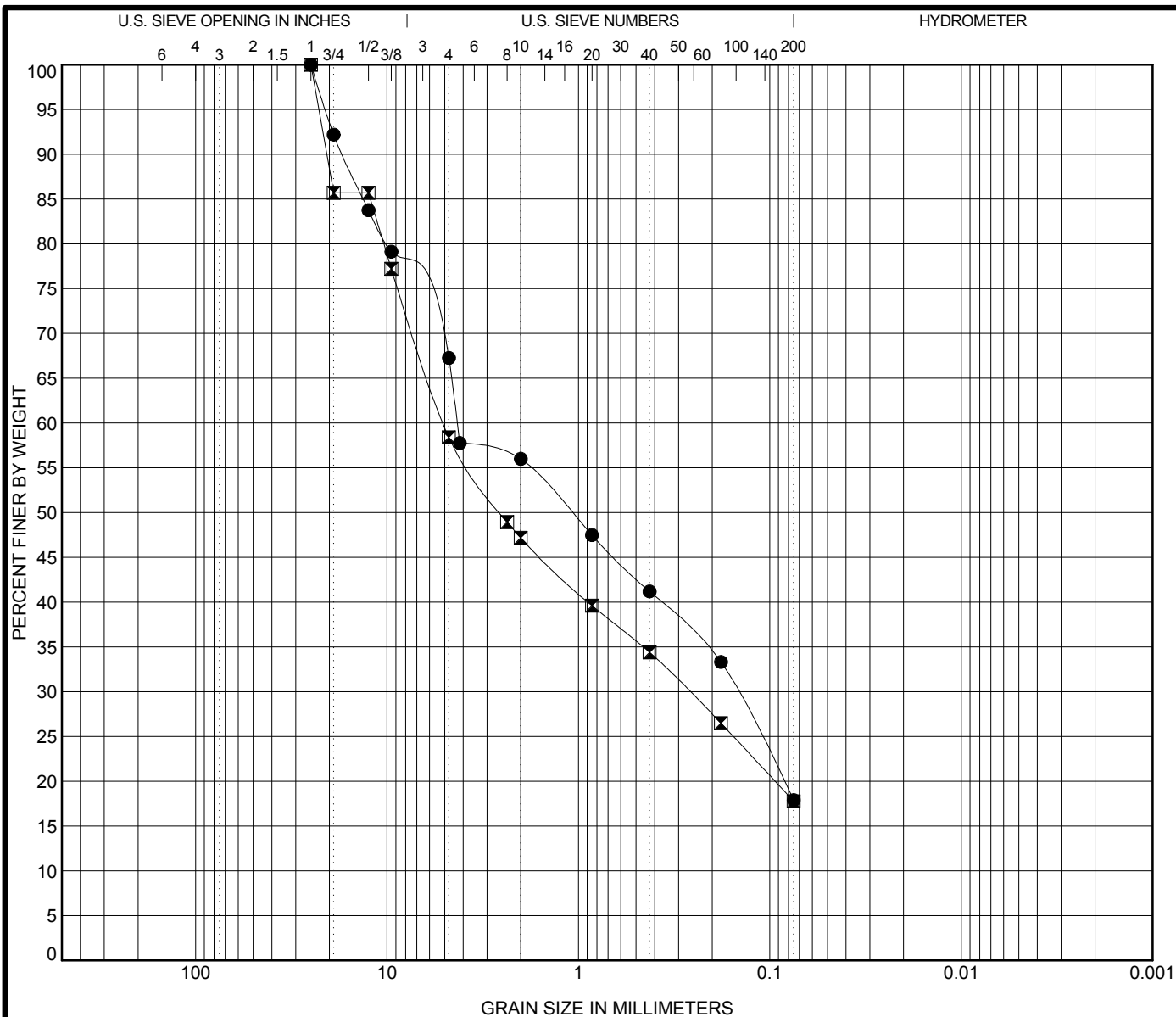
As a part of the laboratory testing program, the soil samples were classified in the laboratory based on visual observation, texture, plasticity, and the laboratory testing performed as noted below. The soil descriptions presented on the boring logs for native soils are in accordance with our enclosed General Notes and Unified Soil Classification System (USCS). The estimated group symbol for the USCS is also shown on the boring logs, and a brief description of the Unified System is included in this report. Results of the laboratory tests are presented on the boring logs and/or included herein.

Selected soil samples were tested for the following properties:

- Water Content
- Grain Size Distribution
- Atterberg Limits







COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification			LL	PL	PI	Cc	Cu
●	B- 1	4ft	SILTY SAND with GRAVEL(SM)			20	14	6		
☒	B- 3	7.5ft	SILTY GRAVEL with SAND(GM)			NP	NP	NP		
Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B- 1	4ft	25	4.3	0.149		33	49	18	
☒	B- 3	7.5ft	25	5.042	0.264		42	41	18	

**Terracon**

### GRAIN SIZE DISTRIBUTION

Project: Proposed VA Surgery Tower/Wing Addition  
 Site: Ft. Meade VA Hospital Ft. Meade, South Dakota  
 Job #: B4125017  
 Date: 4-30-12

**APPENDIX C**  
**SUPPORTING DOCUMENTS**

# GENERAL NOTES

## DRILLING & SAMPLING SYMBOLS:

SS:	Split Spoon - 1-3/8" I.D., 2" O.D., unless otherwise noted	HS:	Hollow Stem Auger
ST:	Thin-Walled Tube - 2" O.D., unless otherwise noted	PA:	Power Auger
CS:	Ring Sampler - 2" I.D., 2½" O.D., unless otherwise noted	HA:	Hand Auger
DB:	Diamond Bit Coring - 4", N, B	RB:	Rock Bit
BS:	Bulk Sample or Auger Sample	WB:	Wash Boring or Mud Rotary

The number of blows required to advance a split-spoon sampler (SS) the last 12 inches of the total 18-inch penetration with a 140-pound hammer falling 30 inches is considered the "Standard Penetration" or "N-value".

## WATER LEVEL MEASUREMENT SYMBOLS:

WL:	Water Level	WS:	While Sampling
WCI:	Wet Cave in	WD:	While Drilling
DCI:	Dry Cave in	BCR:	Before Casing Removal
AB:	After Boring	ACR:	After Casing Removal

Water levels indicated on the boring logs are the levels measured in the borings at the times indicated. Groundwater levels at other times and other locations across the site could vary. In pervious soils, the indicated levels may reflect the location of groundwater. In low permeability soils, the accurate determination of groundwater levels may not be possible with only short-term observations.

**DESCRIPTIVE SOIL CLASSIFICATION:** Soil classification is based on the Unified Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

### FINE-GRAINED SOILS

<u>(RS)</u> <u>Blows/Ft.</u>	<u>(SS)</u> <u>Blows/Ft.</u>	<u>Consistency</u>
< 3	0-2	Very Soft
3-4	3-4	Soft
5-9	5-8	Medium Stiff
10-18	9-15	Stiff
19-42	16-30	Very Stiff
> 42	> 30	Hard

### COARSE-GRAINED SOILS

<u>(RS)</u> <u>Blows/Ft.</u>	<u>(SS)</u> <u>Blows/Ft.</u>	<u>Relative</u> <u>Density</u>
0-6	< 3	Very Loose
7-18	4-9	Loose
19-58	10-29	Medium Dense
59-98	30-50	Dense
> 98	> 50	Very Dense

### BEDROCK

<u>(RS)</u> <u>Blows/Ft.</u>	<u>(SS)</u> <u>Blows/Ft.</u>	<u>Consistency</u>
< 30	< 20	Weathered
30-49	20-29	Firm
50-89	30-49	Medium Hard
90-119	50-79	Hard
> 119	> 79	Very Hard

### RELATIVE PROPORTIONS OF SAND AND GRAVEL

<u>Descriptive Terms of</u> <u>Other Constituents</u>	<u>Percent of</u> <u>Dry Weight</u>
Trace	< 15
With	15 – 29
Modifier	> 30

### GRAIN SIZE TERMINOLOGY

<u>Major Component</u> <u>of Sample</u>	<u>Particle Size</u>
Boulders	Over 12 in. (300mm)
Cobbles	12 in. to 3 in. (300mm to 75 mm)
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)
Sand	#4 to #200 sieve (4.75mm to 0.075mm)
Silt or Clay	Passing #200 Sieve (0.075mm)

### RELATIVE PROPORTIONS OF FINES

<u>Descriptive Terms of</u> <u>Other Constituents</u>	<u>Percent of</u> <u>Dry Weight</u>
Trace	< 5
With	5 – 12
Modifiers	> 12

### PLASTICITY DESCRIPTION

<u>Term</u>	<u>Plasticity Index</u>
Non-plastic	0
Low	1-10
Medium	11-30
High	30+

# UNIFIED SOIL CLASSIFICATION SYSTEM

## Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests					Soil Classification	
					Group Symbol	Group Name <sup>B</sup>
Coarse Grained Soils  More than 50% retained on No. 200 sieve	Gravels  More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels	Cu ≥ 4 and 1 ≤ Cc ≤ 3 <sup>E</sup>	GW	Well graded gravel <sup>F</sup>	
		Less than 5% fines <sup>C</sup>	Cu < 4 and/or 1 > Cc > 3 <sup>E</sup>	GP	Poorly graded gravel <sup>F</sup>	
	Gravels with Fines More than 12% fines <sup>C</sup>	Fines classify as ML or MH	GM	Silty gravel <sup>F,G,H</sup>		
		Fines classify as CL or CH	GC	Clayey gravel <sup>F,G,H</sup>		
	Sands  50% or more of coarse fraction passes No. 4 sieve	Clean Sands	Cu ≥ 6 and 1 ≤ Cc ≤ 3 <sup>E</sup>	SW	Well graded sand <sup>I</sup>	
		Less than 5% fines <sup>D</sup>	Cu < 6 and/or 1 > Cc > 3 <sup>E</sup>	SP	Poorly graded sand <sup>I</sup>	
		Sands with Fines More than 12% fines <sup>D</sup>	Fines classify as ML or MH	SM	Silty sand <sup>G,H,I</sup>	
			Fines classify as CL or CH	SC	Clayey sand <sup>G,H,I</sup>	
Fine-Grained Soils  50% or more passes the No. 200 sieve	Silts and Clays  Liquid limit less than 50	Inorganic	PI > 7 and plots on or above “A” line <sup>J</sup>	CL	Lean clay <sup>K,L,M</sup>	
			PI < 4 or plots below “A” line <sup>J</sup>	ML	Silt <sup>K,L,M</sup>	
		Organic	Liquid limit - oven dried	< 0.75	OL	Organic clay <sup>K,L,M,N</sup>
			Liquid limit - not dried		Organic silt <sup>K,L,M,O</sup>	
	Silts and Clays  Liquid limit 50 or more	Inorganic	PI plots on or above “A” line	CH	Fat clay <sup>K,L,M</sup>	
			PI plots below “A” line	MH	Elastic silt <sup>K,L,M</sup>	
		Organic	Liquid limit - oven dried	< 0.75	OH	Organic clay <sup>K,L,M,P</sup>
			Liquid limit - not dried		Organic silt <sup>K,L,M,Q</sup>	
Highly organic soils	Primarily organic matter, dark in color, and organic odor			PT	Peat	

<sup>A</sup> Based on the material passing the 3-in. (75-mm) sieve

<sup>B</sup> If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

<sup>C</sup> Gravels with 5 to 12% fines require dual symbols: GW-GM well graded gravel with silt, GW-GC well graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

<sup>D</sup> Sands with 5 to 12% fines require dual symbols: SW-SM well graded sand with silt, SW-SC well graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

$$^E Cu = D_{60}/D_{10} \quad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$$

<sup>F</sup> If soil contains  $\geq 15\%$  sand, add "with sand" to group name.

<sup>G</sup> If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

<sup>H</sup> If fines are organic, add "with organic fines" to group name.

<sup>I</sup> If soil contains  $\geq 15\%$  gravel, add "with gravel" to group name.

<sup>J</sup> If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

<sup>K</sup> If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

<sup>L</sup> If soil contains  $\geq 30\%$  plus No. 200 predominantly sand, add "sandy" to group name.

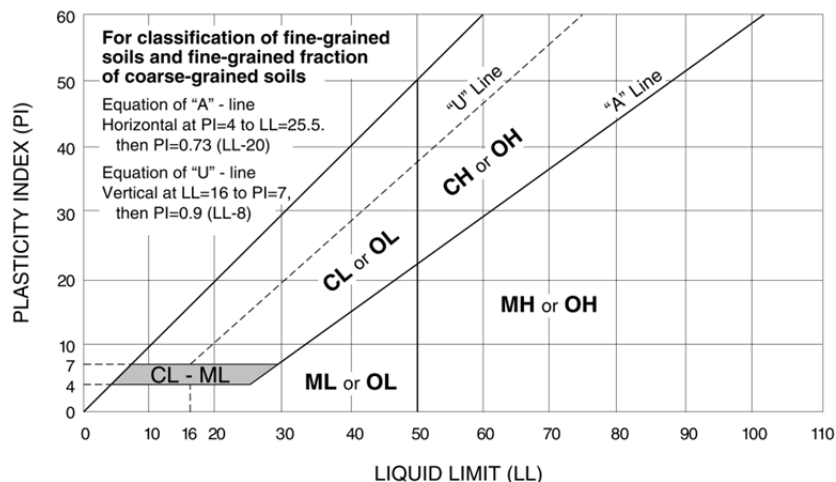
<sup>M</sup> If soil contains  $\geq 30\%$  plus No. 200, predominantly gravel, add "gravelly" to group name.

<sup>N</sup>  $PI \geq 4$  and plots on or above "A" line.

<sup>O</sup>  $PI < 4$  or plots below "A" line.

<sup>P</sup> PI plots on or above "A" line.

<sup>Q</sup> PI plots below "A" line.



**LABORATORY TEST  
SIGNIFICANCE AND PURPOSE**

<b>TEST</b>	<b>SIGNIFICANCE</b>	<b>PURPOSE</b>
<b><i>California Bearing Ratio</i></b>	Used to evaluate the potential strength of subgrade soil, subbase, and base course material, including recycled materials for use in road and airfield pavements.	<b><i>Pavement Thickness Design</i></b>
<b><i>Consolidation</i></b>	Used to develop an estimate of both the rate and amount of both differential and total settlement of a structure.	<b><i>Foundation Design</i></b>
<b><i>Direct Shear</i></b>	Used to determine the consolidated drained shear strength of soil or rock.	<b><i>Bearing Capacity, Foundation Design, and Slope Stability</i></b>
<b><i>Dry Density</i></b>	Used to determine the in-place density of natural, inorganic, fine-grained soils.	<b><i>Index Property Soil Behavior</i></b>
<b><i>Expansion</i></b>	Used to measure the expansive potential of fine-grained soil and to provide a basis for swell potential classification.	<b><i>Foundation and Slab Design</i></b>
<b><i>Gradation</i></b>	Used for the quantitative determination of the distribution of particle sizes in soil.	<b><i>Soil Classification</i></b>
<b><i>Liquid &amp; Plastic Limit, Plasticity Index</i></b>	Used as an integral part of engineering classification systems to characterize the fine-grained fraction of soils, and to specify the fine-grained fraction of construction materials.	<b><i>Soil Classification</i></b>
<b><i>Permeability</i></b>	Used to determine the capacity of soil or rock to conduct a liquid or gas.	<b><i>Groundwater Flow Analysis</i></b>
<b><i>pH</i></b>	Used to determine the degree of acidity or alkalinity of a soil.	<b><i>Corrosion Potential</i></b>
<b><i>Resistivity</i></b>	Used to indicate the relative ability of a soil medium to carry electrical currents.	<b><i>Corrosion Potential</i></b>
<b><i>R-Value</i></b>	Used to evaluate the potential strength of subgrade soil, subbase, and base course material, including recycled materials for use in road and airfield pavements.	<b><i>Pavement Thickness Design</i></b>
<b><i>Soluble Sulphate</i></b>	Used to determine the quantitative amount of soluble sulfates within a soil mass.	<b><i>Corrosion Potential</i></b>
<b><i>Unconfined Compression</i></b>	To obtain the approximate compressive strength of soils that possess sufficient cohesion to permit testing in the unconfined state.	<b><i>Bearing Capacity Analysis for Foundations</i></b>
<b><i>Water Content</i></b>	Used to determine the quantitative amount of water in a soil mass.	<b><i>Index Property Soil Behavior</i></b>

## REPORT TERMINOLOGY (Based on ASTM D653)

<b><i>Allowable Soil Bearing Capacity</i></b>	The recommended maximum contact stress developed at the interface of the foundation element and the supporting material.
<b><i>Alluvium</i></b>	Soil, the constituents of which have been transported in suspension by flowing water and subsequently deposited by sedimentation.
<b><i>Aggregate Base Course</i></b>	A layer of specified material placed on a subgrade or subbase usually beneath slabs or pavements.
<b><i>Backfill</i></b>	A specified material placed and compacted in a confined area.
<b><i>Bedrock</i></b>	A natural aggregate of mineral grains connected by strong and permanent cohesive forces. Usually requires drilling, wedging, blasting or other methods of extraordinary force for excavation.
<b><i>Bench</i></b>	A horizontal surface in a sloped deposit.
<b><i>Caisson (Drilled Pier or Shaft)</i></b>	A concrete foundation element cast in a circular excavation which may have an enlarged base. Sometimes referred to as a cast-in-place pier or drilled shaft.
<b><i>Coefficient of Friction</i></b>	A constant proportionality factor relating normal stress and the corresponding shear stress at which sliding starts between the two surfaces.
<b><i>Colluvium</i></b>	Soil, the constituents of which have been deposited chiefly by gravity such as at the foot of a slope or cliff.
<b><i>Compaction</i></b>	The densification of a soil by means of mechanical manipulation
<b><i>Concrete Slab-on-Grade</i></b>	A concrete surface layer cast directly upon a base, subbase or subgrade, and typically used as a floor system.
<b><i>Differential Movement</i></b>	Unequal settlement or heave between, or within foundation elements of structure.
<b><i>Earth Pressure</i></b>	The pressure exerted by soil on any boundary such as a foundation wall.
<b><i>ESAL</i></b>	Equivalent Single Axle Load, a criteria used to convert traffic to a uniform standard, (18,000 pound axle loads).
<b><i>Engineered Fill</i></b>	Specified material placed and compacted to specified density and/or moisture conditions under observations of a representative of a geotechnical engineer.
<b><i>Equivalent Fluid</i></b>	A hypothetical fluid having a unit weight such that it will produce a pressure against a lateral support presumed to be equivalent to that produced by the actual soil. This simplified approach is valid only when deformation conditions are such that the pressure increases linearly with depth and the wall friction is neglected.
<b><i>Existing Fill (or Man-Made Fill)</i></b>	Materials deposited throughout the action of man prior to exploration of the site.
<b><i>Existing Grade</i></b>	The ground surface at the time of field exploration.

## REPORT TERMINOLOGY (Based on ASTM D653)

<b>Expansive Potential</b>	The potential of a soil to expand (increase in volume) due to absorption of moisture.
<b>Finished Grade</b>	The final grade created as a part of the project.
<b>Footing</b>	A portion of the foundation of a structure that transmits loads directly to the soil.
<b>Foundation</b>	The lower part of a structure that transmits the loads to the soil or bedrock.
<b>Frost Depth</b>	The depth at which the ground becomes frozen during the winter season.
<b>Grade Beam</b>	A foundation element or wall, typically constructed of reinforced concrete, used to span between other foundation elements such as drilled piers.
<b>Groundwater</b>	Subsurface water found in the zone of saturation of soils or within fractures in bedrock.
<b>Heave</b>	Upward movement.
<b>Lithologic</b>	The characteristics which describe the composition and texture of soil and rock by observation.
<b>Native Grade</b>	The naturally occurring ground surface.
<b>Native Soil</b>	Naturally occurring on-site soil, sometimes referred to as natural soil.
<b>Optimum Moisture Content</b>	The water content at which a soil can be compacted to a maximum dry unit weight by a given compactive effort.
<b>Perched Water</b>	Groundwater, usually of limited area maintained above a normal water elevation by the presence of an intervening relatively impervious continuous stratum.
<b>Scarify</b>	To mechanically loosen soil or break down existing soil structure.
<b>Settlement</b>	Downward movement.
<b>Skin Friction (Side Shear)</b>	The frictional resistance developed between soil and an element of the structure such as a drilled pier.
<b>Soil (Earth)</b>	Sediments or other unconsolidated accumulations of solid particles produced by the physical and chemical disintegration of rocks, and which may or may not contain organic matter.
<b>Strain</b>	The change in length per unit of length in a given direction.
<b>Stress</b>	The force per unit area acting within a soil mass.
<b>Strip</b>	To remove from present location.
<b>Subbase</b>	A layer of specified material in a pavement system between the subgrade and base course.
<b>Subgrade</b>	The soil prepared and compacted to support a structure, slab or pavement system.



May 2, 2012

Mr. David Jolly  
FourFront Design, Inc.  
517 Seventh Street  
Rapid City, South Dakota 57701

**Subject:      Pavement Design Recommendations  
Proposed VA Surgery Tower/Wing Addition  
Ft. Meade VA Hospital  
Ft. Meade, South Dakota  
Terracon Project No. B4125017**

Dear Mr. Jolly,

As you are aware, Terracon Consultants, Inc. (Terracon) recently provided the geotechnical services for the proposed VA Surgery Tower/Wing addition and submitted our findings and recommendations in a report dated April 30, 2012. This letter transmits additional recommendations with respect to flexible (asphalt) and rigid (concrete) pavement sections for the project.

### **Pavement Design Considerations**

The pavement section alternatives for this project were designed based on the procedures outlined in the 1993 Guideline for Design of Pavement Structures by the American Association of State Highway and Transportation Officials (AASHTO).

Detailed traffic loads and frequencies were not available for use in the pavement design analysis. However, it is anticipated that traffic will consist primarily of passenger vehicles (cars and pickup trucks) in the proposed parking areas and passenger vehicles combined with delivery trucks and occasional semi-tractor trailer delivery trucks along the proposed new access drives. Based on this information, an Equivalent Single Axle Load (ESAL) of 35,000 was used for the general use parking lot pavement section and 75,000 for the access drive.

Additionally, for purposes of this design analysis, a terminal serviceability index of 2.0, an inherent reliability of 85 percent, and a subgrade drainage coefficient of 0.9 were used. Based on previously geotechnical work, it is anticipated that pavement subgrade soils will predominately consists of clay soils which are typically considered fair to poor materials for pavement support. Based on our correlation to laboratory index values, a California Bearing Ratio (CBR) value of 3.0 was used in the pavement design analysis utilizing clay soils as the subgrade material. Please notify us if any of the parameters used in the pavement design do not adequately define the anticipated conditions.



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**Geotechnical**



**Environmental**



**Construction Materials**



**Facilities**



## Pavement Recommendations

Proposed VA Surgery Tower/Wing Addition ■ Ft. Meade, South Dakota

May 2, 2012 ■ Terracon Project No. B4125017



Select from the following pavement alternatives, or a Terracon approved equivalent.

Recommended Pavement Section Thickness (inches)				
Traffic Area	Flexible (Asphalt), in.	Rigid (Concrete), in	Aggregate Base Course, in.	Total, in.
Parking Areas	4	---	6	10
	---	5	4	9
Access Drives	5	--	6	11
	--	6	4	10

For areas subject to concentrated and repetitive loading conditions, such as dumpster pads, semi-truck delivery access lanes/docks, and ingress/egress aprons, we recommend using a Portland Cement concrete pavement with a thickness of at least 7 inches underlain by at least 6 inches of aggregate base course.

Asphalt concrete should be composed of a mixture of aggregate, filler and additives, if required, and approved bituminous material. The asphalt concrete should conform to approved mix designs stating the Marshall properties, optimum asphalt content, job mix formula and recommended mixing and placing temperatures.

We recommend the asphalt be obtained from an approved mix design conforming to the South Dakota Department of Transportation (SDDOT) Class E Specifications as defined in the "Standard Specifications for Road and Bridges, 2004 edition.

Aggregate used in the asphalt and concrete should meet SDDOT specifications under Section 880 "Aggregates for Asphalt Concrete" for quality and gradation. Mix designs should be submitted prior to construction to verify their adequacy. Asphalt material should be placed in maximum 3-inch lifts and should be compacted to the minimum standards outlined in the SDDOT Specifications.

Where rigid pavements are used, the concrete should be obtained from an approved mix design conforming to Section 380 "Portland Cement Concrete Pavement" and Section 460 "Structural Concrete" of the SDDOT Specifications, including the following minimum properties:

- |                                  |                    |
|----------------------------------|--------------------|
| ■ Compressive Strength @ 28 days | 4,000 psi minimum  |
| ■ Entrained Air Content          | 5% to 7.5%         |
| ■ Cement Type                    | Type I-II Portland |

## **Pavement Recommendations**

Proposed VA Surgery Tower/Wing Addition ■ Ft. Meade, South Dakota  
May 2, 2012 ■ Terracon Project No. B4125017



Longitudinal and transverse joints should be provided as needed in concrete pavements for expansion/contraction and isolation. The location and extent of joints should be based upon the final pavement geometry. Sawed joints should be cut within 24-hours of concrete placement. All joints should be sealed to prevent entry of foreign material and dowelled where necessary for load transfer.

Aggregate base course should meet the requirements as outlined in Section 882 "Aggregates for Granular Bases and Surfacing" of the SDDOT specifications. Aggregate base course should be compacted to a minimum of 95 percent of the maximum dry density, as determined by ASTM D698 (Standard Proctor).

The pavement sections presented are based on design parameters selected by Terracon based on experience with similar projects and soil conditions. Design parameters such as design ESAL's, average daily traffic (ADT), terminal serviceability index, and inherent reliability may vary with specific projects. Variation of these parameters may change the thickness of the pavement sections presented.

### **Construction Considerations**

Prior to placement of the base course, the exposed subgrade should be scarified to a depth of 8 inches below existing grade, moisture conditioned to near optimum and re-compacted to at least 95 percent of maximum density, as determined by ASTM D698.

The prepared subgrade should be proof-rolled by a tandem axle dump truck or water truck loaded to its capacity. The proof-rolling should be observed by our geotechnical engineer to identify areas of soft subgrade.

Any areas that become unstable or "pump" under the loaded truck should be excavated to a depth to be determined by the geotechnical engineer and replaced with granular engineered fill to stabilize the subgrade. Once the subgrade has been proof-rolled and approved by the geotechnical engineer, base course may be placed. Additionally, a geo-grid or geotextile separation fabric may be required to stabilize soft subgrade soils, if encountered.

Upon completion of filling and grading, care should be taken to maintain the subgrade moisture content prior to construction. Construction traffic over the completed subgrade should be avoided to the extent practical. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations.

If the subgrade should become frozen, desiccated, saturated, or disturbed, the affected material should be removed or these materials should be scarified, moisture conditioned, and recompacted prior to pavement construction.

**Pavement Recommendations**

Proposed VA Surgery Tower/Wing Addition ■ Ft. Meade, South Dakota  
May 2, 2012 ■ Terracon Project No. B4125017

**Closing**

This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either expressed or implied, are intended or made.

If you have any questions concerning the information contained herein or need additional information please contact our office at your convenience.

Sincerely,  
**Terracon Consultants, Inc.**

A handwritten signature in blue ink, appearing to read "Walt Feeger".

Walt Feeger, PE  
Office Manager