FOURFRONT DESIGN INC.

FARGO VA HEALTH CARE SYSTEM

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EXPAND BUILDING 1 FOR PRIMARY CARE

Construction Documents

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VA

U.S. DEPARTMENT OF VETERANS AFFAIRS

Veterans' Health Administration

Fargo VA Health Care System

SECTION 26 05 11
REQUIREMENTS FOR ELECTRICAL INSTALLATIONS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section applies to all sections of Division 26.

B. Furnish and install electrical systems, materials, equipment, and accessories in accordance with the specifications and drawings. Capacities and ratings of motors, conductors and cable, panelboards, and other items and arrangements for the specified items are shown on the drawings.

C. Conductor ampacities specified or shown on the drawings are based on copper conductors, with the conduit and raceways sized per NEC. Aluminum conductors are prohibited.

1.2 MINIMUM REQUIREMENTS

A. The latest International Building Code (IBC), Underwriters Laboratories, Inc. (UL), Institute of Electrical and Electronics Engineers (IEEE), and National Fire Protection Association (NFPA) codes and standards are the minimum requirements for materials and installation.

B. The drawings and specifications shall govern in those instances where requirements are greater than those stated in the above codes and standards.

1.3 TEST STANDARDS

A. All materials and equipment shall be listed, labeled, or certified by a Nationally Recognized Testing Laboratory (NRTL) to meet Underwriters Laboratories, Inc. (UL), standards where test standards have been established. Materials and equipment which are not covered by UL standards will be accepted, providing that materials and equipment are listed, labeled, certified or otherwise determined to meet the safety requirements of a NRTL. Materials and equipment which no NRTL accepts, certifies, lists, labels, or determines to be safe, will be considered if inspected or tested in accordance with national industrial standards, such as ANSI, NEMA, and NETA. Evidence of compliance shall include certified test reports and definitive shop drawings.

B. Definitions:

1. Listed: Materials and equipment 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 materials and equipment or periodic evaluation of services, and whose listing states that the materials and equipment either meets appropriate designated standards or has been tested and found suitable for a specified purpose.

2. Labeled: Materials and equipment 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 materials and equipment, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.
3. Certified: Materials and equipment which:
   a. Have been tested and found by a NRTL to meet nationally recognized standards or to be safe for use in a specified manner.
   b. Are periodically inspected by a NRTL.
   c. Bear a label, tag, or other record of certification.
4. Nationally Recognized Testing Laboratory: Testing laboratory which is recognized and approved by the Secretary of Labor in accordance with OSHA regulations.

1.4 QUALIFICATIONS (PRODUCTS AND SERVICES)

A. Manufacturer’s Qualifications: The manufacturer shall regularly and currently produce, as one of the manufacturer's principal products, the materials and equipment specified for this project, and shall have manufactured the materials and equipment for at least three years.

B. Product Qualification:
   1. Manufacturer's materials and equipment shall have been in satisfactory operation, on three installations of similar size and type as this project, for at least three years.
   2. The Government reserves the right to require the Contractor to submit a list of installations where the materials and equipment 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 four hours of receipt

of notification that service is needed. Submit name and address of service organizations.

1.5 APPLICABLE PUBLICATIONS

A. Applicable publications listed in all Sections of Division 26 shall be the latest issue, unless otherwise noted.

B. Products specified in all sections of Division 26 shall comply with the applicable publications listed in each section.

1.6 MANUFACTURED PRODUCTS

A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, and for which replacement parts shall be available. Materials and equipment furnished shall be new, and shall have superior quality and freshness.

B. When more than one unit of the same class or type of materials and 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 and terminals shall be identified on the equipment being furnished and on all wiring diagrams.

E. When Factory Tests are specified, Factory Tests shall be performed in the factory by the equipment manufacturer, and witnessed by the contractor. In addition, the following requirements shall be complied with:

1. The Government shall have the option of witnessing factory tests. The Contractor shall notify the Government through the COR a minimum of forty five (45) days prior to the manufacturer’s performing of the factory tests.

2. When factory tests are successful, contractor shall furnish four (4) copies of the equipment manufacturer's certified test reports to the COR twenty one (21) days prior to shipment of the equipment, and not more than ninety (90) days after completion of the factory tests.
3. When factory tests are not successful, factory tests shall be repeated in the factory by the equipment manufacturer, and witnessed by the Contractor. The Contractor shall be liable for all additional expenses for the Government to witness factory re-testing.

1.7 VARIATIONS FROM CONTRACT REQUIREMENTS

A. Where the Government or the Contractor requests variations from the contract requirements, the connecting work and related components shall include, but not be limited to additions or changes to branch circuits, circuit protective devices, conduits, wire, feeders, controls, panels and installation methods.

1.8 MATERIALS AND EQUIPMENT PROTECTION

A. Materials and equipment shall be protected during shipment and storage against physical damage, vermin, dirt, corrosive substances, fumes, moisture, cold and rain.
1. Store materials and equipment indoors in clean dry space with uniform temperature to prevent condensation.
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 repaired or replaced, as determined by the COR.
4. Painted surfaces shall be protected with factory installed removable heavy kraft paper, sheet vinyl or equal.
5. Damaged paint on equipment shall be refinished with the same quality of paint and workmanship as used by the manufacturer so repaired areas are not obvious.

1.9 WORK PERFORMANCE

A. All electrical work shall comply with requirements of the latest NFPA 70 (NEC), NFPA 70B, NFPA 70E, NFPA 99, NFPA 110, OSHA Part 1910 subpart J – General Environmental Controls, OSHA Part 1910 subpart K – Medical

and First Aid, and OSHA Part 1910 subpart S – Electrical, in addition to other references required by contract.

B. Job site safety and worker safety is the responsibility of the Contractor.

C. Electrical work shall be accomplished with all affected circuits or equipment de-energized.

D. For work that affects existing electrical systems, arrange, phase and perform work to assure minimal interference with normal functioning of the facility. Refer to Article OPERATIONS AND STORAGE AREAS under Section 01 00 00, GENERAL REQUIREMENTS.

1. Provide temporary power during site power excavation and relocation to assure minimal interference with normal functioning of the facility.

a. Where temporary power requirements are not shown directly on construction documents contractor to verify downstream power load before ordering rental generators. Generator to be onsite prior to performing work.

E. New work shall be installed and connected to existing work neatly, safely and professionally. Disturbed or damaged work shall be replaced or repaired to its prior conditions, as required by Section 01 00 00, GENERAL REQUIREMENTS.

F. Coordinate location of equipment and conduit with other trades to minimize interference.

1.10 EQUIPMENT INSTALLATION AND REQUIREMENTS

A. Equipment location shall be as close as practical to locations shown on the drawings.

B. Working clearances shall not be less than specified in the NEC.

C. Inaccessible Equipment:

1. Where the Government determines that the Contractor has installed equipment not readily accessible for operation and maintenance, the equipment shall be removed and reinstalled as directed at no additional cost to the Government.

2. "Readily accessible" is defined as being capable of being reached quickly for operation, maintenance, or inspections without the use of ladders, or without climbing or crawling under or over obstacles such as, but not limited to, motors, pumps, belt guards, transformers, piping, ductwork, conduit and raceways.

1.11 EQUIPMENT IDENTIFICATION

A. In addition to the requirements of the NEC, install an identification sign which clearly indicates information required for use and maintenance of items such as panelboards, cabinets, motor controllers, fused and non-fused safety switches, generators, separately enclosed circuit breakers, individual breakers and controllers in switchboards, control devices and other significant equipment.
   1. Install all device labelling per site specific standards.
   2. Provide sample of all equipment labels to COR for approval prior to installation.

B. Identification signs for Normal Power System equipment shall be laminated black phenolic resin with a white core with engraved lettering. Identification signs 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 12 mm (1/2 inch) high. Identification signs 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 the latest NFPA 70E. Label shall show specific and correct information for specific equipment based on its arc flash calculations. Label shall show the followings:
   1. Nominal system voltage.
   2. Equipment/bus name, date prepared, and manufacturer name and address.
   3. Arc flash boundary.
   4. Available arc flash incident energy and the corresponding working distance.
   5. Minimum arc rating of clothing.
   6. Site-specific level of PPE.

1.12 SUBMITTALS

A. Submit to the COR in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. The Government's approval shall be obtained for all materials and equipment before delivery to the job site. Delivery, storage or

installation of materials and equipment which has not had prior approval will not be permitted.

C. All submittals shall include six copies of adequate descriptive literature, catalog cuts, shop drawings, test reports, certifications, samples, and other data necessary for the Government to ascertain that the proposed materials and equipment comply with drawing and specification requirements. Catalog cuts submitted for approval shall be legible and clearly identify specific materials and 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, manuals, pictures, nameplate data, and test reports as required.
2. Submittals are required for all equipment anchors and supports. Submittals shall include weights, dimensions, center of gravity, standard connections, manufacturer's recommendations and behavior problems (e.g., vibration, thermal expansion, etc.) associated with equipment or piping so that the proposed installation can be properly reviewed. Include sufficient fabrication information so that appropriate mounting and securing provisions may be designed and attached to the equipment.
3. 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.
4. Parts list which shall include information for replacement parts and ordering instructions, as recommended by the equipment manufacturer.

F. Maintenance and Operation Manuals:

1. Submit as required for systems and equipment specified in the technical sections. Furnish in hardcover binders or an approved equivalent.
2. Inscribe the following identification on the cover: the words "MAINTENANCE AND OPERATION MANUAL," the name and location of the system, material, equipment, building, name of Contractor, and contract name and 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 material 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.
   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 and replacement parts, and name of servicing organization.
   j. List of factory approved or qualified permanent servicing organizations for equipment repair and periodic testing and maintenance, including addresses and factory certification qualifications.

G. Approvals will be based on complete submission of shop drawings, manuals, test reports, certifications, and samples as applicable.

H. After approval and prior to installation, furnish the COR with one sample of each of the following:

1. A minimum 300 mm (12 inches) length of each type and size of wire and cable along with the tag from the coils or reels from which the sample was taken. The length of the sample shall be sufficient to show all markings provided by the manufacturer.
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, lighting control 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.

1.13 SINGULAR NUMBER

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

1.14 ACCEPTANCE CHECKS AND TESTS

A. The Contractor shall furnish the instruments, materials, and labor for tests.

B. Where systems are comprised of components specified in more than one section of Division 26, the Contractor shall coordinate the installation, testing, and adjustment of all components between various manufacturer’s representatives and technicians so that a complete, functional, and operational system is delivered to the Government.

C. When test results indicate any defects, the Contractor shall repair or replace the defective materials or equipment, and repeat the tests for the equipment. Repair, replacement, and re-testing shall be accomplished at no additional cost to the Government.

1.15 WARRANTY

A. All work performed and all equipment and material furnished under this Division 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 for the Government.

1.16 INSTRUCTION

A. Instruction to designated Government personnel shall be provided for the particular equipment or system as required in each associated technical specification section.

B. Furnish the services of competent and factory-trained instructors to give full instruction in the adjustment, operation, and maintenance of the specified equipment and system, including pertinent safety requirements. Instructors shall be thoroughly familiar with all aspects of the installation, and shall be factory-trained in operating theory as well as practical operation and maintenance procedures.

C. A training schedule shall be developed and submitted by the Contractor and approved by the COR at least 30 days prior to the planned training.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

---END---

SECTION 26 05 13
MEDIUM-VOLTAGE CABLES

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the furnishing, installation, and connection of medium-voltage cables, indicated as cable or cables in this section, and medium-voltage cable splices and terminations.

1.2 RELATED WORK

A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.

B. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.

C. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits for medium-voltage cables.

D. Section 26 05 41, UNDERGROUND ELECTRICAL CONSTRUCTION: Manholes and ducts for medium-voltage cables.

1.3 QUALITY ASSURANCE

A. Quality Assurance shall be in accordance with Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES) in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 FACTORY TESTS

A. Factory Tests shall be required.

B. Factory Tests shall be in accordance with Paragraph, MANUFACTURED PRODUCTS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirement:

1. A representative sample of Medium-voltage cables from each lot shall be factory tested per NEMA WC 74 to ensure that there are no electrical defects in that specific lot of cable.

1.5 SUBMITTALS

A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:

1. Shop Drawings:

a. Submit sufficient information to demonstrate compliance with drawings and specifications.

b. Submit the following data for approval:

1) Complete electrical ratings.
2) Installation instructions.

2. Samples:
   a. After approval of submittal and prior to installation, Contractor shall furnish sample in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
3. Certifications:
   a. Factory Test Reports: Submit certified factory production test reports for approval.
   b. Field Test Reports: Submit field test reports for approval.
   c. Compatibility: Submit a certificate from the cable manufacturer that the splices and terminations are approved for use with the cable.
   d. Two weeks prior to final inspection, submit the following.
      1) Certification by the manufacturer that the cables, splices, and terminations conform to the requirements of the drawings and specifications.
      2) Certification by the Contractor that the cables, splices, and terminations have been properly installed and tested.
      3) Certification by the Contractor that each splice and each termination were completely installed in a single continuous work period by a single qualified worker without any overnight interruption.
4. Qualified Worker Approval:
   a. Qualified workers who install cables, splices, and terminations shall have a minimum of five years of experience splicing and terminating cables, including experience with the materials in the approved splices and terminations. Qualified workers who perform cable testing shall have a minimum of five year of experience performing electrical testing of medium-voltage cables, including the ability to understand, interpret test results and develop test report.
   b. Furnish satisfactory proof of such experience for each qualified worker who splices or terminates the cables.

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. American Society for Testing and Materials (ASTM):

B3-13.....Standard Specification for Soft or Annealed Copper Wire

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

48-09.....Test Procedures and Requirements for Alternating-Current Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5 kV through 500 kV

386-06.....Separable Insulated Connector Systems for Power Distribution Systems above 600 V

400-12.....Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable Systems

400.2-13.....Guide for Field Testing of Shielded Power Cable Systems Using Very Low Frequency (VLF)

404-12.....Extruded and Laminated Dielectric Shielded Cable Joints Rated 2500 V to 500,000 V

D. National Electrical Manufacturers Association (NEMA):

WC 71-14.....Non-Shielded Cables Rated 2001-5000 Volts for Use in the Distribution of Electric Energy

WC 74-12.....5-46 KV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy

E. National Fire Protection Association (NFPA):

70-17.....National Electrical Code (NEC)

F. Underwriters Laboratories (UL):

1072-06 .....Medium-Voltage Power Cables

1.7 SHIPMENT AND STORAGE

A. Cable shall be shipped on reels such that it is protected against physical, mechanical and environmental damage. Each end of each length of cable shall be hermetically sealed with manufacturer’s end caps and securely attached to the reel.

B. Cable stored and/or cut on site shall have the ends turned down, and sealed with cable manufacturer’s standard cable end seals, or field-installed heat-shrink cable end seals.

PART 2 - PRODUCTS

2.1 CABLE

A. Cable shall be in accordance with ASTM, IEEE, NEC, NEMA and UL, and as shown on the drawings.

B. Single conductor stranded copper conforming to ASTM B3.

C. Voltage Rating:

1. 5,000 V cable shall be used on 4,160 V distribution systems.

D. Insulation:

1. Insulation level shall be 133%.
2. Types of insulation:
   a. Cable type abbreviation, EPR: Ethylene propylene rubber insulation shall be thermosetting, light and heat stabilized.
   b. Cable type abbreviation, XLP, XLPE, or TR-XLPE: cross-linked polyethylene insulation shall be thermosetting, light and heat stabilized, and chemically cross-linked.

E. Insulation shield shall be semi-conducting. Conductor shield shall be semi-conducting.

F. Insulation shall be wrapped with copper shielding tape, helically-applied over semi-conducting insulation shield.

G. Heavy duty, overall protective polyvinyl chloride jacket shall enclose every cable. The manufacturer's name, cable type and size, and other pertinent information shall be marked or molded clearly on the overall protective jacket.

H. Cable temperature ratings for continuous operation, emergency overload operation, and short circuit operation shall be not less than the NEC, NEMA WC 71, or NEMA WC 74 standard for the respective cable.

2.2 SPLICES AND TERMINATIONS

A. Materials shall be compatible with the cables being spliced and terminated, and shall be suitable for the prevailing environmental conditions.

B. In locations where moisture might be present, the splices shall be watertight. In manholes and pullboxes, the splices shall be submersible.

C. Splices:

1. Shall comply with IEEE 404. Include all components required for complete splice, with detailed instructions.

D. Terminations:

1. Shall comply with IEEE 48. Include shield ground strap for shielded cable terminations.
2. Class 1 terminations for indoor use: Kit with stress-relief tube, molded-silicone rubber insulator modules, and compression-type connector.
3. Ground metallic cable shields with a device designed for that purpose, consisting of a solderless connector enclosed in watertight rubber housing covering the entire assembly.
4. Provide insulated cable supports to relieve any strain imposed by cable weight or movement. Ground cable supports to the grounding system.

2.3 FIREPROOFING TAPE

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

PART 3 - EXECUTION

3.1 GENERAL

A. Installation shall be in accordance with the NEC, as shown on the drawings, and manufacturer’s instructions.
B. Cable shall be installed in conduit above grade and duct bank below grade.
C. All cables of a feeder shall be pulled simultaneously.
D. Conductors of different systems (e.g., 5kV and 15kV) shall not be installed in the same raceway.
E. Splice the cables only in manholes and pullboxes.
F. Ground shields in accordance with Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.
G. Cable maximum pull length, maximum pulling tension, and minimum bend radius shall conform with the recommendations of the manufacturer.
H. Use suitable lubricating compounds on the cables to prevent pulling damage. Provide compounds that are not injurious to the cable jacket and do not harden or become adhesive.
I. Seal the cable ends prior to pulling, to prevent the entry of moisture or lubricant.

3.2 PROTECTION DURING SPLICING OPERATIONS

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

3.3 PULLING CABLES IN DUCTS AND MANHOLES

A. Cables shall be pulled into ducts with equipment designed for this purpose, including power-driven winches, cable-feeding flexible tube guides, cable grips, pulling eyes, and lubricants. A sufficient number of qualified workers and equipment shall be employed to ensure the careful and proper installation of the cable.

B. Cable reels shall be set up at the side of the manhole opening and above the duct or hatch level, allowing cables to enter through the opening without reverse bending. Flexible tube guides shall be installed through the opening in a manner that will prevent cables from rubbing on the edges of any structural member.

C. Cable shall be unreeled from the top of the reel. Pay-out shall be carefully controlled. Cables to be pulled shall be attached through a swivel to the main pulling wire by means of a suitable cable grip and pulling eye.

D. Woven-wire cable grips shall be used to grip the cable end when pulling small cables and short straight lengths of heavier cables.

E. Pulling eyes shall be attached to the cable conductors to prevent damage to the cable structure.

F. Cables shall be liberally coated with a suitable lubricant as they enter the tube guide or duct. Rollers, sheaves, or tube guides around which the cable is pulled shall conform to the minimum bending radius of the cable.

G. Cables shall be pulled into ducts at a reasonable speed. Cable pulling using a vehicle shall not be permitted. Pulling operations shall be stopped immediately at any indication of binding or obstruction, and

shall not be resumed until the potential for damage to the cable is corrected. Sufficient slack shall be provided for free movement of cable due to expansion or contraction.

H. Splices in manholes shall be firmly supported on cable racks. Cable ends shall overlap at the ends of a section to provide sufficient undamaged cable for splicing.

I. Cables cut in the field shall have the cut ends immediately sealed to prevent entrance of moisture.

3.4 SPLICES AND TERMINATIONS

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

B. Installation shall be executed by qualified person trained to perform medium-voltage equipment installations. Tools shall be as recommended or provided by the manufacturer. Installation shall comply with manufacturer’s instructions.

C. Splices in manholes shall be located midway between cable racks on walls of manholes, and supported with cable arms at approximately the same elevation as the enclosing duct.

D. Where the Government determines that unsatisfactory splices and terminations have been installed, the Contractor shall replace the unsatisfactory splices and terminations with approved material at no additional cost to the Government.

3.5 FIREPROOFING

A. Cover all cable segments exposed in manholes and pullboxes with fireproofing tape.

B. Apply the tape in a single layer, wrapped in a half-lap manner, or as recommended by the manufacturer. Extend the tape not less than 25 mm (1 inch) into each duct.

C. At each end of a taped cable section, secure the fireproof tape in place with glass cloth tape.

3.6 CIRCUIT IDENTIFICATION OF FEEDERS

A. In each manhole and pullbox, install permanent identification tags on each circuit's cables to clearly designate the circuit identification and voltage. The tags shall be the embossed brass type, 40 mm (1.5 inches) in diameter and 40 mils thick. Attach tags with plastic ties.

Position the tags so they will be easy to read after the fireproofing tape is installed.

3.7 ACCEPTANCE CHECKS AND TESTS

A. General:

1. Perform tests in accordance with the latest IEEE 400 and 400.2, manufacturer's recommendations, and as specified in this specification.
2. Contractor shall make arrangements to have tests witnessed by the COR. Contractor shall proceed with tests only after obtaining approval from the COR.

B. Visual Inspection: Perform visual inspection prior to electrical tests.

1. Inspect exposed sections of cables for physical damage.
2. Inspect shield grounding, cable supports, splices, and terminations.
3. Verify that visible cable bends meet manufacturer’s minimum bending radius requirement.
4. Verify installation of fireproofing tape and identification tags.
5. At the time of final acceptance, Contractor shall provide the COR visual field inspection notes, findings, and photographs detailing accessible inspection locations.

C. Electrical Tests - New Cables: Perform preparation and tests in order shown below:

1. Preparation Prior to Testing: Splices and terminations applied to new cables shall be completed prior to testing. For renovation installation, ends of new cables intended to be spliced to existing service-aged cables shall be prepared (cut back) to allow testing without flashover or tracking. Cables shall not be connected to other equipment while under test.
2. Perform Insulation-Resistance Test. Test all cables with respect to ground and adjacent cables. All adjacent cables shall be grounded during testing.
   a. Apply test voltage for a period sufficient to stabilize output voltage and insulation resistance measurement.
   b. Test data shall include megohm, applied test voltage, and leakage current readings.

c. Further testing shall not continue unless the insulation resistance test results meet or exceed the values listed below. Test voltages and minimum acceptable resistance values shall be:

Voltage Class	Test Voltage	Min. Insulation Resistance
5kV	2,500 VDC	1,000 megohms

3. Perform Tan Delta test. Review test readings with the COR prior to proceeding with the Very Low Frequency (VLF) Withstand test
4. Perform Very Low Frequency (VLF) Withstand test. Utilize test voltages in accordance with IEEE 400.2.

D. Field Test Report: Submit a field test report to the COR that includes the following information:

1. VA Project Number, Name, Location, and Test Date.
2. Name of Technician and Company performing the test.
3. Ambient temperature and humidity at time of test.
4. Name, Model Number and Description of Test Equipment used.
5. Circuit identification, cable length, cable type and size, insulation type, cable manufacturer, service age (if any), voltage rating, description of splices or terminations.
6. Visual field inspection notes, findings, and photographs.
7. Insulation Resistance Test results:
   a. Test voltage.
   b. Measurement in Megohms.
   c. Leakage current.
8. Tan Delta results:
   a. Test voltage.
   b. Waveform (sinusoidal or cosine-rectangular).
   c. Mean Tan Delta at V_0.
   d. Stability measured by Standard Deviation at V_0.
   e. Differential Tan Delta.
   f. IEEE Condition Assessment Rating.
9. VLF Withstand results:
   a. Test voltage.
   b. Waveform (sinusoidal or cosine-rectangular).
   c. Pass/Fail Rating.
10. Conclusions. If any deficiency is discovered based on test results, provide recommendations for corrective action.

E. Final Acceptance: Final acceptance shall depend upon the satisfactory performance of the cables under test. No cable shall be put into service until all tests are successfully passed, and field test reports have been approved by the COR.

---END---

SECTION 26 05 19
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the furnishing, installation, connection, and testing of the electrical conductors and cables for use in electrical systems rated 600 V and below, indicated as cable(s), conductor(s), wire, or wiring in this section.

1.2 RELATED WORK

A. Section 07 84 00, FIRESTOPPING: Sealing around penetrations to maintain the integrity of fire-resistant rated construction.

B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections 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 for conductors and cables.

E. Section 26 05 41, UNDERGROUND ELECTRICAL CONSTRUCTION: Installation of conductors and cables in manholes and ducts.

1.3 QUALITY ASSURANCE

A. Quality Assurance shall be in accordance with Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES) in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:

1. Shop Drawings:
   a. Submit sufficient information to demonstrate compliance with drawings and specifications.
   b. Submit the following data for approval:
      1) Electrical ratings and insulation type for each conductor and cable.
      2) Splicing materials and pulling lubricant.
2. Certifications: Two weeks prior to final inspection, submit the following.

a. Certification by the manufacturer that the conductors and cables conform to the requirements of the drawings and specifications.
b. Certification by the Contractor that the conductors and cables have 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 reference in the text by designation only.

B. American Society of Testing Material (ASTM):

D2301-10.....Standard Specification for Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape

D2304-10.....Test Method for Thermal Endurance of Rigid Electrical Insulating Materials

D3005-10.....Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape

C. National Electrical Manufacturers Association (NEMA):

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

D. National Fire Protection Association (NFPA):

70-17.....National Electrical Code (NEC)

E. Underwriters Laboratories, Inc. (UL):

44-14.....Thermoset-Insulated Wires and Cables

83-14.....Thermoplastic-Insulated Wires and Cables

467-13.....Grounding and Bonding Equipment

486A-486B-13.....Wire Connectors

486C-13.....Splicing Wire Connectors

486D-15.....Sealed Wire Connector Systems

486E-15.....Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors

493-07.....Thermoplastic-Insulated Underground Feeder and Branch Circuit Cables

514B-12.....Conduit, Tubing, and Cable Fittings

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Conductors and cables shall be in accordance with ASTM, NEMA, NFPA, UL, as specified herein, and as shown on the drawings.

B. All conductors shall be copper.

C. Single Conductor and Cable:

1. No. 12 AWG: Minimum size, except where smaller sizes are specified herein or shown on the drawings.
2. No. 8 AWG and larger: Stranded.
3. No. 10 AWG and smaller: Solid; except shall be stranded for final connection to motors, transformers, and vibrating equipment.
4. Insulation: THHN-THWN.

D. Color Code:

1. No. 10 AWG and smaller: Solid color insulation or solid color coating.
2. No. 8 AWG and larger: 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.
   c. Color using 19 mm (0.75 inches) wide tape.
4. For modifications and additions to existing wiring systems, color coding shall conform to the existing wiring system.
5. Conductors shall be color-coded as follows:

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

6. Lighting circuit “switch legs”, and 3-way and 4-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 COR.

2.2 SPLICES

A. Splices shall be in accordance with NEC and UL.

B. Above Ground Splices for No. 10 AWG and Smaller:
   1. Solderless, screw-on, reusable pressure cable type, with integral insulation, approved for copper conductors.
   2. The integral insulator shall have a skirt to completely cover the stripped conductors.
   3. The number, size, and combination of conductors used with the connector, as listed on the manufacturer's packaging, shall be strictly followed.

C. Above Ground Splices for No. 8 AWG to No. 4/0 AWG:
   1. Compression, hex screw, or bolt clamp-type of high conductivity and corrosion-resistant material, listed for use with copper conductors.
   2. Insulate with materials approved for the particular use, location, voltage, and temperature. Insulation level shall be not less than the insulation level of the conductors being joined.
   3. Splice and insulation shall be product of the same manufacturer.
   4. All bolts, nuts, and washers used with splices shall be zinc-plated steel.

D. Above Ground Splices for 250 kcmil and Larger:
   1. Long barrel “butt-splice” or “sleeve” type compression connectors, with minimum of two compression indents per wire, listed for use with copper conductors.
   2. Insulate with materials approved for the particular use, location, voltage, and temperature. Insulation level shall be not less than the insulation level of the conductors being joined.
   3. Splice and insulation shall be product of the same manufacturer.

E. Underground Splices for No. 10 AWG and Smaller:
   1. Solderless, screw-on, reusable pressure cable type, with integral insulation. Listed for wet locations, and approved for copper conductors.
   2. The integral insulator shall have a skirt to completely cover the stripped conductors.
   3. The number, size, and combination of conductors used with the connector, as listed on the manufacturer's packaging, shall be strictly followed.

F. Underground Splices for No. 8 AWG and Larger:

1. Mechanical type, of high conductivity and corrosion-resistant material. Listed for wet locations, and approved for copper conductors.
2. Insulate with materials approved for the particular use, location, voltage, and temperature. Insulation level shall be not less than the insulation level of the conductors being joined.
3. Splice and insulation shall be product of the same manufacturer.

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

2.3 CONNECTORS AND TERMINATIONS

A. Mechanical type of high conductivity and corrosion-resistant material, listed for use with copper conductors.

B. Long barrel compression type of high conductivity and corrosion-resistant material, with minimum of two compression indents per wire, listed for use with copper conductors.

C. All bolts, nuts, and washers used to connect connections and terminations to bus bars or other termination points shall be zinc-plated steel.

2.4 CONTROL WIRING

A. Unless otherwise specified elsewhere in these specifications, control wiring shall be as specified herein, except that the minimum size shall be not less than No. 14 AWG.

B. Control wiring shall be sized such that the voltage drop under in-rush conditions does not adversely affect operation of the controls.

2.5 WIRE LUBRICATING COMPOUND

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

PART 3 - EXECUTION

3.1 GENERAL

A. Installation shall be in accordance with the NEC, as shown on the drawings, and manufacturer’s instructions.

B. Install all conductors in raceway systems.

C. Splice conductors only in outlet boxes, junction boxes, pullboxes, manholes, or handholes.

D. Conductors of different systems (e.g., 120 V and 277 V) shall not be installed in the same raceway.

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. In panelboards, cabinets, wireways, switches, enclosures, and equipment assemblies, neatly form, train, and tie the conductors with non-metallic ties.

G. For connections to motors, transformers, and vibrating equipment, stranded conductors shall be used only from the last fixed point of connection to the motors, transformers, or vibrating equipment.

H. Use non-hardening duct-seal to seal conduits entering a building, after installation of conductors.

I. Conductor and Cable Pulling:

1. Provide installation equipment that will prevent the cutting or abrasion of insulation during pulling. Use lubricants approved for the cable.
2. Use nonmetallic pull ropes.
3. Attach pull ropes by means of either woven basket grips or pulling eyes attached directly to the conductors.
4. All conductors in a single conduit shall be pulled simultaneously.
5. Do not exceed manufacturer’s recommended maximum pulling tensions and sidewall pressure values.

J. No more than three branch circuits shall be installed in any one conduit.

K. When stripping stranded conductors, use a tool that does not damage the conductor or remove conductor strands.

3.2 INSTALLATION IN MANHOLES

A. Train the cables around the manhole walls, but do not bend to a radius less than six times the overall cable diameter.

B. Fireproofing:

1. Install fireproofing on low-voltage conductors where the low-voltage conductors are installed in the same manholes with medium-voltage conductors.
2. Use fireproofing tape as specified in Section 26 05 13, MEDIUM-VOLTAGE CABLES, and apply the tape in a single layer, half-lapped, or as recommended by the manufacturer. Install the tape with the coated side towards the cable and extend it not less than 25 mm (1 inch) into each duct.

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

3.3 SPLICE AND TERMINATION INSTALLATION

A. Splices and terminations shall be mechanically and electrically secure, and tightened to manufacturer's published torque values using a torque screwdriver or wrench.

B. Where the Government determines that unsatisfactory splices or terminations have been installed, replace the splices or terminations at no additional cost to the Government.

3.4 CONDUCTOR IDENTIFICATION

A. When using colored tape to identify phase, neutral, and ground conductors larger than No. 8 AWG, apply tape in half-overlapping turns for a minimum of 75 mm (3 inches) from terminal points, and in junction boxes, pullboxes, 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.

3.5 FEEDER CONDUCTOR IDENTIFICATION

A. In each interior pullbox and each underground manhole and handhole, install brass tags on all feeder conductors to clearly designate their circuit identification and voltage. The tags shall be the embossed type, 40 mm (1-1/2 inches) in diameter and 40 mils thick. Attach tags with plastic ties.

3.6 EXISTING CONDUCTORS

A. Unless specifically indicated on the plans, existing conductors shall not be reused.

3.7 CONTROL WIRING INSTALLATION

A. Unless otherwise specified in other sections, install control wiring and connect to equipment to perform the required functions as specified or as shown on the drawings.

B. Install a separate power supply circuit for each system, except where otherwise shown on the drawings.

3.8 CONTROL 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.

3.9 ACCEPTANCE CHECKS AND TESTS

A. Perform in accordance with the manufacturer's recommendations. In addition, include the following:

1. Visual Inspection and Tests: Inspect physical condition.
2. Electrical tests:
   a. After installation but before connection to utilization devices, such as fixtures, motors, or appliances, test conductors phase-to-phase and phase-to-ground resistance with an insulation resistance tester. Existing conductors to be reused shall also be tested.
   b. Applied voltage shall be 500 V DC for 300 V rated cable, and 1000 V DC for 600 V 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 V rated cable and 100 megohms for 600 V rated cable.
   c. Perform phase rotation test on all three-phase circuits.
   d. Contractor to provide photos of the manhole interior showing completed work for future use. A record of work performed under the construction contract shall be provided.

---END---

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the furnishing, installation, connection, and testing of grounding and bonding equipment, indicated as grounding equipment in this section.

B. "Grounding electrode system" refers to grounding electrode conductors and all electrodes required or allowed by NEC, as well as made, supplementary, and lightning protection system grounding electrodes.

C. The terms "connect" and "bond" are used interchangeably in this section and have the same meaning.

1.2 RELATED WORK

A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.

B. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Low-voltage conductors.

C. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduit and boxes.

D. Section 26 24 16, PANELBOARDS: Low-voltage panelboards.

1.3 QUALITY ASSURANCE

A. Quality Assurance shall be in accordance with Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES) in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:

1. Shop Drawings:
   a. Submit sufficient information to demonstrate compliance with drawings and specifications.
   b. Submit plans showing the location of system grounding electrodes and connections, and the routing of aboveground and underground grounding electrode conductors.
2. Test Reports:
   a. Two weeks prior to the final inspection, submit ground resistance field test reports to the COTR.

3. Certifications:
   a. Certification by the Contractor that the grounding equipment 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. American Society for Testing and Materials (ASTM):

B1-13.....Standard Specification for Hard-Drawn Copper Wire

B3-13.....Standard Specification for Soft or Annealed Copper Wire

B8-11.....Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

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

81-12.....IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System Part 1: Normal Measurements

D. National Fire Protection Association (NFPA):

70-17.....National Electrical Code (NEC)

70E-15.....National Electrical Safety Code

99-15.....Health Care Facilities

E. Underwriters Laboratories, Inc. (UL):

44-14 .....Thermoset-Insulated Wires and Cables

83-14 .....Thermoplastic-Insulated Wires and Cables

467-13 .....Grounding and Bonding Equipment

PART 2 - PRODUCTS

2.1 GROUNDING AND BONDING CONDUCTORS

A. Equipment grounding conductors shall be insulated stranded copper, except that sizes No. 10 AWG and smaller shall be solid copper. Insulation color shall be continuous green for all equipment grounding conductors, except that wire sizes No. 4 AWG and larger shall be identified per NEC.

B. Bonding conductors shall be bare stranded copper, except that sizes No. 10 AWG and smaller shall be bare solid copper. Bonding conductors

shall be stranded for final connection to motors, transformers, and vibrating equipment.

C. Conductor sizes shall not be less than shown on the drawings, or not less than required by the NEC, whichever is greater.

D. Insulation: THHN-THWN.

2.2 GROUND CONNECTIONS

A. Above Grade:

1. Bonding Jumpers: Listed for use with copper conductors. For wire sizes No. 8 AWG and larger, use compression-type connectors. For wire sizes smaller than No. 8 AWG, use mechanical type lugs. Connectors or lugs shall use zinc-plated steel bolts, nuts, and washers. Bolts shall be torqued to the values recommended by the manufacturer.
2. Connection to Building Steel: Exothermic-welded type connectors.
3. Connection to Grounding Bus Bars: Listed for use with copper conductors. Use mechanical type lugs, with zinc-plated steel bolts, nuts, and washers. Bolts shall be torqued to the values recommended by the manufacturer.
4. Connection to Equipment Rack and Cabinet Ground Bars: Listed for use with copper conductors. Use mechanical type lugs, with zinc-plated steel bolts, nuts, and washers. Bolts shall be torqued to the values recommended by the manufacturer.

2.3 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. Ground bars shall have minimum dimensions of 6.3 mm (0.25 inch) thick x 19 mm (0.75 inch) wide, with length as required or as shown on the drawings. Provide insulators and mounting brackets.

2.4 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 mechanical type lugs, with zinc-plated steel bolts, nuts, and washers. Bolts shall be torqued to the values recommended by the manufacturer.

2.5 GROUNDING BUS BAR

A. Pre-drilled rectangular copper bar with stand-off insulators, minimum 6.3 mm (0.25 inch) thick x 100 mm (4 inches) high in cross-section, length as shown on the drawings, with hole size, quantity, and spacing

per detail shown on the drawings. Provide insulators and mounting brackets.

PART 3 - EXECUTION

3.1 GENERAL

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

B. System Grounding:

1. Secondary service neutrals: Ground at the supply side of the secondary disconnecting means and at the related transformer.
2. Separately derived systems (transformers downstream from the service entrance): Ground the secondary neutral.

C. Equipment Grounding: Metallic piping, building structural steel, electrical 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. For patient care area electrical power system grounding, conform to the latest NFPA 70 and 99.

3.2 INACCESSIBLE GROUNDING CONNECTIONS

A. Make grounding connections, which are normally buried or otherwise inaccessible, by exothermic weld.

3.3 MEDIUM-VOLTAGE EQUIPMENT AND CIRCUITS

A. Duct Banks and Manholes: Provide an insulated equipment grounding conductor in each duct containing medium-voltage conductors, sized per NEC except that minimum size shall be No. 2 AWG. Bond the equipment grounding conductors to the switchgear ground bus, to all manhole grounding provisions and hardware, to the cable shield grounding provisions of medium-voltage cable splices and terminations, and to equipment enclosures.

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 Structural 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 structural steel, and supplemental or made electrodes. Provide jumpers across insulating joints in the metallic piping.

2. Provide a supplemental ground electrode as shown on the drawings and bond to the grounding electrode system.

C. Panelboards, Motor Control Centers, and other electrical equipment:
1. Connect the equipment grounding conductors to the ground bus.
2. Connect metallic conduits by grounding bushings and equipment grounding conductor to the equipment ground bus.

3.5 RACEWAY

A. Conduit Systems:
1. Ground all metallic conduit systems. All metallic conduit systems shall contain an equipment grounding conductor.
2. Non-metallic conduit systems, except non-metallic feeder conduits that carry a grounded conductor from exterior transformers to interior or building-mounted service entrance equipment, shall contain an equipment grounding conductor.
3. Metallic 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 an equipment 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.
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 electrical continuity throughout the wireway system, by connecting a No. 6 AWG bonding jumper at all intermediate metallic enclosures and across all section junctions.

2. Install insulated No. 6 AWG bonding jumpers between the wireway system, bonded as required above, and the closest building ground at each end and approximately every 16 M (50 feet).
3. Use insulated No. 6 AWG 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 bonding jumpers to ground cable tray to column-mounted building ground plates (pads) at each end and approximately every 15 M (49 feet).

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. 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, installed in rigid metal conduit.

3.6 CORROSION INHIBITORS

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

3.7 CONDUCTIVE PIPING

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

3.8 EXTERIOR LIGHT POLES

A. Provide 6.1 M (20 feet) of No. 4 AWG bare copper coiled at bottom of pole base excavation prior to pour, plus additional un-spliced length in and above foundation as required to reach pole ground stud.

3.9 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. Grounding system resistance shall comply with the electric utility company ground resistance requirements.

3.10 ACCEPTANCE CHECKS AND TESTS

A. 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 or connected to the electric utility company ground system, and shall be made in normally dry conditions not fewer than 48 hours after the last rainfall.

B. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.

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

---END---

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 00, EARTHWORK: Bedding of conduits.

1.3 QUALITY ASSURANCE

A. Quality Assurance shall be in accordance with Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES) in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:

1. Shop Drawings:
   a. Size and location of main feeders.
   b. Size and location of panels and pull-boxes.
   c. Layout of required conduit penetrations. Penetrations through structural elements will not be allowed.
   d. Submit the following data for approval:
      1) Raceway types and sizes.
      2) Conduit bodies, connectors and fittings.
      3) Junction and pull boxes, types and sizes.
2. Certifications: Two weeks prior to final inspection, submit the following:
   a. Certification by the manufacturer that raceways, conduits, conduit bodies, connectors, fittings, junction and pull boxes, and all related equipment conform to the requirements of the drawings and specifications.
   b. Certification by the Contractor that raceways, conduits, conduit bodies, connectors, fittings, junction and pull boxes, and all related equipment have 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 Iron and Steel Institute (AISI):

S100-12.....North American Specification for the Design of Cold-Formed Steel Structural Members

C. National Electrical Manufacturers Association (NEMA):

C80.1-15.....Electrical Rigid Steel Conduit

C80.3-15.....Steel Electrical Metal Tubing

C80.6-05.....Electrical Intermediate Metal Conduit

FB1-14.....Fittings, Cast Metal Boxes and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable

FB2.10-13.....Selection and Installation Guidelines for Fittings for use with Non-Flexible Conduit or Tubing (Rigid Metal Conduit, Intermediate Metallic Conduit, and Electrical Metallic Tubing)

FB2.20-14.....Selection and Installation Guidelines for Fittings for use with Flexible Electrical Conduit and Cable

TC-2-13.....Electrical Polyvinyl Chloride (PVC) Tubing and Conduit

TC-3-13.....PVC Fittings for Use with Rigid PVC Conduit and Tubing

D. National Fire Protection Association (NFPA):

70-17.....National Electrical Code (NEC)

E. Underwriters Laboratories, Inc. (UL):

1-05.....Flexible Metal Conduit

5-16.....Surface Metal Raceway and Fittings

6-07.....Electrical Rigid Metal Conduit - Steel

50-15.....Enclosures for Electrical Equipment

360-13.....Liquid-Tight Flexible Steel Conduit

467-13.....Grounding and Bonding Equipment

514A-13.....Metallic Outlet Boxes

514B-12.....Conduit, Tubing, and Cable Fittings

514C-14.....Nonmetallic Outlet Boxes, Flush-Device Boxes and Covers

651-11.....Schedule 40 and 80 Rigid PVC Conduit and Fittings

651A-11.....Type EB and A Rigid PVC Conduit and HDPE Conduit

797-07.....Electrical Metallic Tubing

1242-14.....Electrical Intermediate Metal Conduit - Steel

PART 2 - PRODUCTS

2.1 MATERIAL

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

B. Conduit:

1. Size: In accordance with the NEC, but not less than 3/4-inch.

2. Rigid Steel Conduit (RMC): Shall conform to UL 6 and NEMA C80.1.
3. Rigid Intermediate Steel Conduit (IMC): Shall conform to UL 1242 and NEMA C80.6.
4. Electrical Metallic Tubing (EMT): Shall conform to UL 797 and NEMA C80.3. Maximum size not to exceed 105 mm (4 inches) and shall be permitted only with cable rated 600 V or less.
5. Flexible Metal Conduit: Shall conform to UL 1.
   a. Flexible conduit shall only be allowed on a case by case basis and will require COR approval prior to ordering or installation.
   b. Flexible conduit shall be limited to lengths of 6 ft unprotected by rigid conduit.
6. Liquid-tight Flexible Metal Conduit: Shall conform to UL 360.
   a. Flexible conduit shall only be allowed on a case by case basis and will require COR approval prior to ordering or installation.
   b. Flexible conduit shall be limited to lengths of 6 ft unprotected by rigid conduit.
7. Surface Metal Raceway: Shall conform to UL 5.
   a. Surface mounted raceway shall only be allowed on a case by case basis and will require COR approval prior to ordering or installation.

C. Conduit Fittings:
1. Rigid Steel and Intermediate Metallic 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. Integral retractable type IMC couplings are also acceptable.
   c. Locknuts: Bonding type with sharp edges for digging into the metal wall of an enclosure.
   d. Bushings: Metallic insulating type, consisting of an insulating insert, molded or locked into the metallic body of the fitting. Bushings made entirely of metal or nonmetallic material are not permitted.
   e. Set Screw Type Couplings: Approved for use in concrete are permitted for use to complete a conduit run where conduit is installed in concrete. Use set screws of case-hardened steel with hex head and cup point to firmly seat in conduit wall for

positive ground. Tightening of set screws with pliers is prohibited.

f. Sealing Fittings: Threaded cast iron type. Use continuous drain-type sealing fittings to prevent passage of water vapor. In concealed work, install fittings in flush steel boxes with blank cover plates having the same finishes as that of other electrical plates in the room.

2. Electrical Metallic Tubing Fittings:
   a. Fittings and conduit bodies shall meet the requirements of UL 514B, NEMA C80.3, and NEMA FB1.
   b. Only steel or malleable iron materials are acceptable.
   c. Couplings and Connectors: Concrete-tight and rain-tight.
   d. Setscrew Couplings and Connectors: Use setscrews of case-hardened steel with hex head and cup point, to firmly seat in wall of conduit for positive grounding.
   e. Indent-type connectors or couplings are prohibited.
   f. Die-cast or pressure-cast zinc-alloy fittings or fittings made of "pot metal" are prohibited.
3. Flexible Metal Conduit Fittings:
   a. Conform to UL 514B. Only steel or malleable iron materials are acceptable.
   b. Clamp-type, with insulated throat.
4. Liquid-tight Flexible Metal Conduit Fittings:
   a. Fittings shall meet the requirements of UL 514B and NEMA FB1.
   b. Only steel or malleable iron materials are acceptable.
   c. Fittings must incorporate a threaded grounding cone, a steel compression ring, and a gland for tightening.
5. Surface Metal Raceway Fittings: As recommended by the raceway manufacturer. Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, conduit entry fittings, accessories, and other fittings as required for complete system.

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 38 mm x 38 mm (1.5 x 1.5 inches), 12-gauge steel, cold-formed, lipped channels; with not less than 9 mm (0.375-inch) 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. Comply with UL-50 and UL-514A.
2. Rustproof cast metal where required by the NEC or shown on drawings.
3. Sheet Metal Boxes: Galvanized steel, except where shown on drawings.
4. Support boxes on 2 sides or from behind to prevent movement.

F. Metal Wireways: Equip with hinged covers, except as shown on drawings. 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.
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 when permitted by the COR where working space is limited.

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

C. Waterproofing: At floor, exterior wall, and roof conduit penetrations, completely seal the gap around conduit to render it watertight, as specified in Section 07 92 00, JOINT SEALANTS.

3.2 INSTALLATION, GENERAL

A. In accordance with NEC, NEMA, UL, as shown on drawings, and as specified herein.

B. Raceway systems used for Essential Electrical Systems (EES) shall be entirely independent of other raceway systems.

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 conduits.
4. Assure conduit installation does not encroach into the ceiling height head room, walkways, or doorways.
5. Cut conduits square, ream, remove burrs, and draw up tight.
6. Independently support conduit at 2.4 M (8 feet) on centers with specified materials and as shown on drawings.
7. Do not use suspended ceilings, suspended ceiling supporting members, lighting fixtures, other conduits, cable tray, boxes, piping, or ducts to support conduits and conduit runs.
8. Support within 300 mm (12 inches) of changes of direction, and within 300 mm (12 inches) of each enclosure to which connected.
9. Close ends of empty conduits with plugs or caps at the rough-in stage until wires are pulled in, to prevent entry of debris.
10. Conduit installations under fume and vent hoods are prohibited.
11. Secure conduits to cabinets, junction boxes, pull-boxes, and outlet boxes with bonding type locknuts. For rigid steel 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.
12. Flashing of penetrations of the roof membrane is specified in Section 07 60 00, FLASHING AND SHEET METAL.
13. 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 and approved by the COR.

3.3 CONCEALED WORK INSTALLATION

A. In Concrete:

1. Conduit: Rigid steel, IMC, 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. Installation of conduit in concrete that is less than 75 mm (3 inches) 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 19 mm (0.75-inch) of concrete around the conduits.
4. 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 in the same system is prohibited.
2. Conduit for Conductors 600 V and Below: Rigid steel, IMC, or EMT. Mixing different types of conduits 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 1.8 M (6 feet) of flexible metal conduit extending from a junction box to the fixture.
5. Tightening set screws with pliers is prohibited.
6. For conduits running through metal studs, limit field cut holes to no more than 70% of web depth. Spacing between holes shall be at least 457 mm (18 inches). Cuts or notches in flanges or return lips shall not be permitted.

3.4 EXPOSED WORK INSTALLATION

A. Unless otherwise indicated on 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 in the system is prohibited.

C. Conduit for Conductors 600 V and Below: Rigid steel, IMC, or EMT. Mixing different types of conduits 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 2.4 M (8 feet) intervals.

G. Surface Metal Raceways: Surface metal raceways are not allowed unless approved by the VA COR and will be evaluated on a case-by-case basis.

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 50 mm (2 inch) high black numerals and letters, showing the cable voltage rating. Provide legends where conduits pass through walls and floors and at maximum 6 M (20 feet) intervals in between.

3.5 WET OR DAMP LOCATIONS

A. Use rigid steel or IMC conduits unless as shown on drawings.

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. Use rigid steel or IMC conduit within 1.5 M (5 feet) of the exterior and below concrete building slabs in contact with soil, gravel, or vapor barriers, unless as shown on drawings. Conduit shall be half-lapped with 10 mil PVC tape before installation. After installation, completely recoat or retape any damaged areas of coating.

D. Conduits shall not be run on roof.

3.6 MOTORS AND VIBRATING EQUIPMENT

A. Use flexible metal conduit for connections to motors and other electrical equipment subject to movement, vibration, misalignment, cramped quarters, or noise transmission.

B. Use liquid-tight flexible metal conduit for installation in exterior locations, moisture or humidity laden atmosphere, corrosive atmosphere, water or spray wash-down operations, inside airstream of HVAC units, and locations subject to seepage or dripping of oil, grease, or water.
C. Provide a green equipment grounding conductor with flexible and liquid-tight flexible metal conduit.

3.7 CONDUIT SUPPORTS

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. Caddy style supports are not allowed.
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 an additional 90 kg (200 lbs). 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 6 mm (0.25-inch) bolt size and not less than 28 mm (1.125 inch) in embedment.
      b. Power set fasteners not less than 6 mm (0.25-inch) diameter with depth of penetration not less than 75 mm (3 inch).
      c. Use vibration and shock-resistant anchors and fasteners for attaching to concrete ceilings.
F. Hollow Masonry: Toggle bolts.
G. Bolts supported only by plaster or gypsum wallboard are not acceptable.
H. Metal Structures: Use machine screw fasteners or other devices specifically designed and approved for the application.
I. Attachment by wood plugs, rawl plug, plastic, lead or soft metal anchors, or wood blocking and bolts supported only by plaster is prohibited.
J. Chain, wire, or perforated strap shall not be used to support or fasten conduit.

K. Spring steel type supports or fasteners are prohibited for all uses except horizontal and vertical supports/fasteners within walls.

L. 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.

3.8 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 or where more than the equivalent of 4-90 degree bends are necessary.

C. Locate pullboxes so that covers are accessible and easily removed. Coordinate locations with piping and ductwork where installed above ceilings.

D. Remove only knockouts as required. Plug unused openings. Use threaded plugs for cast metal boxes and snap-in metal covers for sheet metal boxes.

E. Outlet boxes mounted back-to-back in the same wall are prohibited. A minimum 600 mm (24 inch) center-to-center lateral spacing shall be maintained between boxes.

F. 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.

G. Minimum size of outlet boxes for ground fault circuit interrupter (GFCI) receptacles is 100 mm (4 inches) square x 55 mm (2.125 inches) deep, with device covers for the wall material and thickness involved.

H. Stencil or install phenolic nameplates on covers of the boxes identified on riser diagrams; for example "SIG-FA JB No. 1."

I. On all branch circuit junction box covers, identify the circuits with black marker.

- - - E N D - - -

SECTION 26 05 41
UNDERGROUND ELECTRICAL CONSTRUCTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the furnishing, installation, and connection of underground ducts and raceways, and precast manholes and pullboxes to form a complete underground electrical raceway system.

B. The terms "duct" and "conduit" are used interchangeably in this section.

1.2 RELATED WORK

A. Section 07 92 00, JOINT SEALANTS: Sealing of conduit penetrations.

B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections 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 31 20 00, EARTHWORK: Trenching, backfill, and compaction.

1.3 QUALITY ASSURANCE

A. Quality Assurance shall be in accordance with Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES) in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

B. Coordinate layout and installation of ducts, manholes, and pullboxes with final arrangement of other utilities, site grading, and surface features.

1.4 SUBMITTALS

A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:

1. Shop Drawings:

a. Submit sufficient information to demonstrate compliance with drawings and specifications.

b. Submit information on manholes, pullboxes, ducts, and hardware. Submit manhole plan and elevation drawings, showing openings, pulling irons, cable supports, cover, ladder, sump, and other accessories.

c. Proposed deviations from the drawings shall be clearly marked on the submittals. If it is necessary to locate manholes, pullboxes,

or duct banks at locations other than shown on the drawings, show the proposed locations accurately on scaled site drawings, and submit to the COR for approval prior to construction.

2. Certifications: Two weeks prior to the final inspection, submit the following.
   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.

1.5 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
318-14/318M-14.....Building Code Requirements for Structural Concrete & Commentary
SP-66-04.....ACI Detailing Manual

C. American National Standards Institute (ANSI):
77-14.....Underground Enclosure Integrity

D. American Society for Testing and Materials (ASTM):
C478 REV A-15.....Standard Specification for Precast Reinforced Concrete Manhole Sections
C858-10.....Underground Precast Concrete Utility Structures
C990-09.....Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants.

E. National Electrical Manufacturers Association (NEMA):
TC 2-13.....Electrical Polyvinyl Chloride (PVC) Conduit
TC 3-15.....Polyvinyl Chloride (PVC) Fittings for Use With Rigid PVC Conduit And Tubing
TC 6 & 8-13.....Polyvinyl Chloride (PVC) Plastic Utilities Duct For Underground Installations
TC 9-04.....Fittings For Polyvinyl Chloride (PVC) Plastic Utilities Duct For Underground Installation

F. National Fire Protection Association (NFPA):

70-17.....National Electrical Code (NEC)

70E-15.....National Electrical Safety Code

G. Underwriters Laboratories, Inc. (UL):

6-07.....Electrical Rigid Metal Conduit-Steel

467-13.....Grounding and Bonding Equipment

651-11.....Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings

651A-11.....Schedule 40 and 80 High Density Polyethylene (HDPE) Conduit

PART 2 - PRODUCTS

2.1 PRE-CAST CONCRETE MANHOLES AND HARDWARE

A. Structure: Factory-fabricated, reinforced-concrete, monolithically-poured walls and bottom. Frame and cover shall form top of manhole.

B. Cable Supports:

1. Cable stanchions shall be hot-rolled, heavy duty, hot-dipped galvanized "T" section steel, 56 mm (2.25 inches) x 6 mm (0.25 inch) in size, and punched with 14 holes on 38 mm (1.5 inches) centers for attaching cable arms.
2. Cable arms shall be 5 mm (0.1875 inch) gauge, hot-rolled, hot-dipped galvanized sheet steel, pressed to channel shape. Arms shall be approximately 63 mm (2.5 inches) wide x 350 mm (14 inches) long.
3. Insulators for cable supports shall be porcelain, and shall be saddle type or type that completely encircles the cable.
4. Equip each cable stanchion with one spare cable arm, with three spare insulators for future use.

C. Ladder: Aluminum with 12 inch rung spacing. Provide securely-mounted ladder for every manhole over 1.2 M (4 feet) deep.

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

E. Sump: Provide 305 mm x 305 mm (12 inches x 12 inches) covered sump frame and grated cover.

2.2 DUCTS

A. Number and sizes shall be as shown on the drawings.

B. Ducts (concrete-encased):

1. Plastic Duct:

a. UL 651 and 651A Schedule 40 PVC conduit.

b. Duct shall be suitable for use with 90˚ C (194˚ F) rated conductors.

2. Conduit Spacers: Prefabricated plastic.

2.3 GROUNDING

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

2.4 WARNING TAPE

A. 4-mil polyethylene 75 mm (3 inches) wide detectable tape, red with black letters, imprinted with "CAUTION - BURIED ELECTRIC CABLE BELOW" or similar.

2.5 PULL ROPE FOR SPARE DUCTS

A. Plastic with 890 N (200 lb) minimum tensile strength.

PART 3 - EXECUTION

3.1 MANHOLE AND PULLBOX INSTALLATION

A. Assembly and installation shall be per the requirements of the manufacturer.

1. Install manholes and pullboxes level and plumb.
2. Units shall be installed on a 300 mm (12 inches) thick level bed of 90% compacted granular fill, well-graded from the 25 mm (1 inch) sieve to the No. 4 sieve. Granular fill shall be compacted with a minimum of four passes with a plate compactor.

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

C. Grounding in Manholes:

1. Ground Rods in Manholes: Drive a ground rod into the earth, through the floor sleeve, after the manhole is set in place. Fill the sleeve with sealant to make a watertight seal. Rods shall protrude approximately 100 mm (4 inches) above the manhole floor.
2. Install a No. 3/0 AWG bare copper ring grounding conductor around the inside perimeter of the manhole and anchor to the walls with metallic cable clips.
3. Connect the ring grounding conductor to the ground rod by an exothermic welding process.
4. Bond the ring grounding conductor to the duct bank equipment grounding conductors, the exposed non-current carrying metal parts of racks, sump covers, and like items in the manholes with a minimum No. 6 AWG bare copper jumper using an exothermic welding process.

D. Sump Pump: Provide 120V cord and plug connected sump pump complete with float switch, thermal overload protection, and GFCI receptacle mounted in NEMA 3R boxes in manhole. Provide dedicated 20 mm (0.75 inch) direct-buried conduit and conductors to nearest electrical panelboard.

3.2 TRENCHING

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

B. Before performing trenching work at existing facilities:

1. A Ground Penetrating Radar Survey shall be carefully performed by a certified technician to reveal all existing underground ducts, conduits, cables, and other utility systems.
2. Obtain a digging permit from COR.

C. Work with extreme care near existing ducts, conduits, and other utilities to avoid damaging them.

D. Cut the trenches neatly and uniformly.

E. Concrete-Encased Ducts:

1. After excavation of the trench, stakes shall be driven in the bottom of the trench at 1.2 M (4 feet) 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 the 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. Individual conduits to be installed under existing paved areas and roads that cannot be disturbed shall be jacked into place using rigid metal conduit, or bored using plastic utilities duct or PVC conduit, as approved by the COR.

3.3 DUCT INSTALLATION

A. General Requirements:

1. Ducts shall be in accordance with the NEC, as shown on the drawings, and as specified.

2. Join and terminate ducts with fittings recommended by the manufacturer.
3. Slope ducts to drain towards manholes and pullboxes, and away from building and equipment entrances. Pitch not less than 100 mm (4 inches) in 30 M (100 feet).
4. Underground conduit stub-ups and sweeps to equipment inside of buildings shall be galvanized rigid metal conduit half-lap wrapped with PVC tape, and shall extend a minimum of 1.5 M (5 feet) outside the building foundation. Tops of conduits below building slab shall be minimum 610 mm (24 inches) below bottom of slab.
5. Stub-ups and sweeps to equipment mounted on outdoor concrete slabs shall be galvanized rigid metal conduit half-lap wrapped with PVC tape, and shall extend a minimum of 1.5 M (5 feet) away from the edge of slab.
6. Install insulated grounding bushings on the conduit terminations.
7. Radius for sweeps shall be sufficient to accomplish pulls without damage. Minimum radius shall be six times conduit diameter.
8. All multiple conduit runs shall have conduit spacers. Spacers shall securely support and maintain uniform spacing of the duct assembly a minimum of 75 mm (3 inches) above the bottom of the trench during the concrete pour. Spacer spacing shall not exceed 1.5 M (5 feet). Secure spacers to ducts and earth to prevent floating during concrete pour. Provide nonferrous tie wires to prevent displacement of the ducts during concrete pour. Tie wires shall not act as substitute for spacers.
9. Duct lines shall be installed no less than 300 mm (12 inches) from other utility systems, such as water, sewer, chilled water.
10. Clearances between individual ducts:
    a. For similar services, not less than 75 mm (3 inches).
    b. For power and signal services, not less than 150 mm (6 inches).
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. Spare Ducts: 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.
15. Duct Identification: Place continuous strip of warning tape approximately 300 mm (12 inches) above ducts before backfilling trenches. Warning tape shall be preprinted with proper identification.
16. Duct Sealing: Seal ducts, including spare ducts, at building entrances and at outdoor terminations for equipment, with a suitable non-hardening compound to prevent the entrance of foreign objects and material, moisture, and gases.
17. Use plastic ties to secure cables to insulators on cable arms. Use minimum two ties per cable per insulator.

B. Concrete-Encased Ducts:
   1. Install concrete-encased ducts for medium-voltage systems, low-voltage systems, and signal systems, unless otherwise shown on the drawings.
   2. Duct banks shall be 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 600 mm (24 inches) and not less than shown on the drawings, below finished grade.
      b. Not less than 750 mm (30 inches) and not less than shown on the drawings, below roads and other paved surfaces.
      c. Additional burial depth shall be required in order to accomplish NEC-required minimum bend radius of ducts.
      d. Conduits crossing under grade slab construction joints shall be installed a minimum of 1.2 M (4 feet) below slab.
   4. Extend the concrete envelope encasing the ducts not less than 75 mm (3 inches) beyond the outside walls of the outer ducts.
   5. Within 3 M (10 feet} of building and manhole 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 and concrete envelopes are to be joined to existing manholes, pullboxes, ducts, and concrete envelopes, make the joints with the proper fittings and fabricate the concrete envelopes to ensure smooth durable transitions.
8. Duct joints in concrete may be placed side by side horizontally, but shall be staggered at least 150 mm (6 inches) 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 19 mm (0.75 inch) reinforcing rod dowels extending 450 mm (18 inches) 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 COR.

B. Connections to Manholes: Ducts connecting to manholes shall be flared to have an enlarged cross-section to provide additional shear strength. Dimensions of the flared cross-section shall be larger than the corresponding manhole opening dimensions by no less than 300 mm (12 inches) in each direction. Perimeter of the duct bank opening in the manhole shall be flared toward the inside or keyed to provide a positive interlock between the duct and the wall of the manhole. Use vibrators when this portion of the encasement is poured to ensure a seal between the envelope and the wall of the structure.

C. Connections to Existing Manholes: For duct connections to existing manholes, break the structure wall out to the dimensions required and preserve the steel in the structure wall. Cut steel and extend into the duct bank envelope. Chip the perimeter surface of the duct bank opening to form a key or flared surface, providing a positive connection with the duct bank envelope.

D. Connections to Existing Ducts: Where connections to existing ducts are indicated, excavate around the ducts 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.

E. Partially-Completed Ducts: 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 plugs. Fit concrete envelope of a partially completed ducts with reinforcing steel extending a

minimum of 600 mm (2 feet) back into the envelope and a minimum of 600 mm (2 feet) beyond the end of the envelope. Provide one No. 4 bar in each corner, 75 mm (3 inches) from the edge of the envelope. Secure corner bars with two No. 3 ties, spaced approximately 300 mm (12 inches) apart. Restrain reinforcing assembly from moving during pouring of concrete.

3.4 ACCEPTANCE CHECKS AND TESTS

A. Duct Testing and 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, and to test for out-of-round conditions.
2. The mandrel shall be not less than 300 mm (12 inches) long, and shall have a diameter not less than 13 mm (0.5 inch) 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.
3. If testing reveals obstructions or out-of-round conditions, the Contractor shall replace affected section(s) of duct and retest to the satisfaction of the COR.
4. Mandrel pulls shall be witnessed by the COR.

---END---

SECTION 26 08 00

COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. The requirements of this Section apply to all sections of Division 26.

B. This project will have selected building systems commissioned. The complete list of equipment and systems to be commissioned is specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. The commissioning process, which the Contractor is responsible to execute, is defined in Section 01 91 00 GENERAL COMMISSIONING REQUIRMENTS. A Commissioning Agent (CxA) appointed by the VA will manage the commissioning process.

1.2 RELATED WORK

A. Section 01 00 00 GENERAL REQUIREMENTS.

B. Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

C. Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

1.3 SUMMARY

A. This Section includes requirements for commissioning the Facility electrical systems, related subsystems and related equipment. This Section supplements the general requirements specified in Section 01 91 00 General Commissioning Requirements.

B. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for more details regarding processes and procedures as well as roles and responsibilities for all Commissioning Team members.

1.4 DEFINITIONS

A. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for definitions.

1.5 COMMISSIONED SYSTEMS

A. Commissioning of a system or systems specified in Division 26 is part of the construction process. Documentation and testing of these systems, as well as training of the VA’s Operation and Maintenance personnel in accordance with the requirements of Section 01 91 00 and of Division 26, is required in cooperation with the VA and the Commissioning Agent.

B. The Facility electrical systems commissioning will include the systems listed in Section 01 91 00 General Commissioning Requirements:

1.6 SUBMITTALS

A. The commissioning process requires review of selected Submittals that pertain to the systems to be commissioned. The Commissioning Agent will provide a list of submittals that will be reviewed by the Commissioning Agent. This list will be reviewed and approved by the VA prior to forwarding to the Contractor. Refer to Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, and SAMPLES for further details.

B. The commissioning process requires Submittal review simultaneously with engineering review. Specific submittal requirements related to the commissioning process are specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 CONSTRUCTION INSPECTIONS

A. Commissioning of Electrical systems will require inspection of individual elements of the electrical systems construction throughout the construction period. The Contractor shall coordinate with the Commissioning Agent in accordance with Section 01 91 00 and the Commissioning plan to schedule electrical systems inspections as required to support the Commissioning Process.

3.2 PRE-FUNCTIONAL CHECKLISTS

A. The Contractor shall complete Pre-Functional Checklists to verify systems, subsystems, and equipment installation is complete and systems are ready for Systems Functional Performance Testing. The Commissioning Agent will prepare Pre-Functional Checklists to be used to document equipment installation. The Contractor shall complete the checklists. Completed checklists shall be submitted to the VA and to the Commissioning Agent for review. The Commissioning Agent may spot check a sample of completed checklists. If the Commissioning Agent determines that the information provided on the checklist is not accurate, the Commissioning Agent will return the marked-up checklist to the Contractor for correction and resubmission. If the Commissioning Agent determines that a significant number of completed checklists for similar equipment are not accurate, the Commissioning Agent will select a broader sample of checklists for review. If the Commissioning Agent determines that a significant number of the broader sample of checklists is also inaccurate, all the checklists for the type of equipment will be returned to the Contractor for correction and

resubmission. Refer to SECTION 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for submittal requirements for Pre-Functional Checklists, Equipment Startup Reports, and other commissioning documents.

3.3 CONTRACTORS TESTS

A. Contractor tests as required by other sections of Division 26 shall be scheduled and documented in accordance with Section 01 00 00 GENERAL REQUIREMENTS. All testing shall be incorporated into the project schedule. Contractor shall provide no less than 7 calendar days' notice of testing. The Commissioning Agent will witness selected Contractor tests at the sole discretion of the Commissioning Agent. Contractor tests shall be completed prior to scheduling Systems Functional Performance Testing.

3.4 SYSTEMS FUNCTIONAL PERFORMANCE TESTING

A. The Commissioning Process includes Systems Functional Performance Testing that is intended to test systems functional performance under steady state conditions, to test system reaction to changes in operating conditions, and system performance under emergency conditions. The Commissioning Agent will prepare detailed Systems Functional Performance Test procedures for review and approval by the Resident Engineer. The Contractor shall review and comment on the tests prior to approval. The Contractor shall provide the required labor, materials, and test equipment identified in the test procedure to perform the tests. The Commissioning Agent will witness and document the testing. The Contractor shall sign the test reports to verify tests were performed. See Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS, for additional details.

3.5 TRAINING OF VA PERSONNEL

A. Training of the VA operation and maintenance personnel is required in cooperation with the Resident Engineer and Commissioning Agent. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems. Contractor shall submit training agendas and trainer resumes in accordance with the requirements of Section 01 91 00. The instruction shall be scheduled in coordination with the VA Resident Engineer after submission and approval of formal training plans. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS and Division 26 Sections for additional Contractor training requirements.

----- END -----

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

B. Section 26 05 19, 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 24 16, PANELBOARDS: Panelboard enclosure and interior bussing used for lighting control panels.

E. Section 26 27 26, WIRING DEVICES: Wiring devices used for control of the lighting systems.

F. Section 26 51 00, INTERIOR LIGHTING: Luminaire ballast and drivers used in control of lighting systems.

1.3 QUALITY ASSURANCE

A. Quality Assurance shall be in accordance with Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES) in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:

1. Shop Drawings:
   a. Submit the following information for each type of lighting controls.
   b. Material and construction details.
   c. Physical dimensions and description.
   d. Wiring schematic and connection diagram.
   e. Installation details.
2. Manuals:

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

b. If changes have been made to the maintenance and operating manuals originally submitted, submit updated maintenance and operating manuals two weeks prior to the final inspection.

3. Certifications: Two weeks prior to final inspection, submit the following.

a. Certification by the Contractor that the lighting control systems have 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. National Electrical Manufacturer's Association (NEMA):

C136.10-10.....American National Standard for Roadway and Area Lighting Equipment—Locking-Type Photocontrol Devices and Mating Receptacles—Physical and Electrical Interchangeability and Testing

ICS-1-15.....Standard for Industrial Control and Systems General Requirements

ICS-2-05.....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-6-16.....Standard for Industrial Controls and Systems Enclosures

C. National Fire Protection Association (NFPA):

70-17.....National Electrical Code (NEC)

D. Underwriters Laboratories, Inc. (UL):

20-10.....Standard for General-Use Snap Switches

98-16.....Enclosed and Dead-Front Switches

773-16.....Standard for Plug-In Locking Type Photocontrols for Use with Area Lighting

773A-16.....Nonindustrial Photoelectric Switches for Lighting Control

916-15.....Standard for Energy Management Equipment Systems

917-06.....Clock Operated Switches

924-16.....Emergency Lighting and Power Equipment (for use when controlling emergency circuits).

PART 2 - PRODUCTS

2.1 INDOOR OCCUPANCY SENSORS

A. 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 30 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 120 volt and 277 volt, for 13A tungsten at 120 volt, and for 1 hp at 120 volt.
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: Provide single pole double throw toggle switch with center off for full bypass of automatic controls. Label three positions of switch as:
   a. Top: On.
   b. Center: Off.
   c. Bottom: Auto.
7. Manual/automatic selector switch.
8. Automatic Light-Level Sensor: Adjustable from 21.5 to 2152 lx (2 to 200 fc); 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 150 mm (6-inch) minimum movement of any portion of a human body that presents a target of not less than 232 sq. cm (36 sq. in), and detect a person of average size and weight moving not less than 305 mm (12 inches) in either a horizontal or a vertical manner at an approximate speed of 305 mm/s (12 inches/s).

C. Detection Coverage: Shall be sufficient to provide coverage as required by sensor locations shown on drawing.

2.2 INDOOR VACANCY SENSOR SWITCH

A. Wall mounting, solid-state units with integral sensor and switch.
   1. Operation: Manually turn lights on with switch and sensor detects vacancy to turn lights off.
   2. Switch Rating: 120/277 volt, 1200 watts at 277 volt, 800 watts at 120 volt unit.
   3. Mounting:
      a. Sensor: Suitable for mounting in a standard switch box.
      b. Time-Delay and Sensitivity Adjustments: Integral with switch and accessible for reprogramming without removing switch.
   4. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
   5. Switch: Manual operation to turn lights on and override lights off.
   6. Faceplate: Refer to wall plate material and color requirements for toggle switches, as specified in Section 26 27 26, WIRING DEVICES.

PART 3 - EXECUTION

3.1 INSTALLATION

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

C. Aiming for wall-mounted and ceiling-mounted, occupancy or vacancy sensor switches shall be per manufacturer’s recommendations.

D. Set occupancy or vacancy sensor "on" duration to 30 minutes.

E. Locate photoelectric sensors as indicated and in accordance with the manufacturer's recommendations. Adjust sensor for the available light level at the typical work plane for that area.

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.

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 in the presence of COR.

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SECTION 26 24 16
PANELBOARDS

PART 1 - GENERAL

1.1 DESCRIPTION

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

1.2 RELATED WORK

A. Section 09 91 00, PAINTING: Painting of panelboards.

B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.

C. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Low-voltage conductors.

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.

F.

1.3 QUALITY ASSURANCE

A. Quality Assurance shall be in accordance with Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES) in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:

1. Shop Drawings:
    a. Submit sufficient information to demonstrate compliance with drawings and specifications.
    b. Include electrical ratings, dimensions, mounting details, materials, required clearances, terminations, weight, circuit breakers, wiring and connection diagrams, accessories, and nameplate data.
2. Manuals:
    a. Submit, simultaneously with the shop drawings, complete maintenance and operating manuals including technical data sheets, wiring diagrams, and information for ordering circuit breakers and replacement parts.

1) Include schematic diagrams, with all terminals identified, matching terminal identification in the panelboards.
2) Include information for testing, repair, troubleshooting, assembly, and disassembly.

b. If changes have been made to the maintenance and operating manuals originally submitted, submit updated maintenance and operating manuals two weeks prior to the final inspection.

3. Certifications: Two weeks prior to final inspection, submit the following.

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

b. Certification by the Contractor that the panelboards have 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. International Code Council (ICC):

IBC-15.....International Building Code

C. National Electrical Manufacturers Association (NEMA):

PB 1-11.....Panelboards

250-14.....Enclosures for Electrical Equipment (1,000V Maximum)

D. National Fire Protection Association (NFPA):

70-17.....National Electrical Code (NEC)

70E-18.....Standard for Electrical Safety in the Workplace

E. Underwriters Laboratories, Inc. (UL):

50-15.....Enclosures for Electrical Equipment

67-09.....Panelboards

489-16.....Molded Case Circuit Breakers and Circuit Breaker Enclosures

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Panelboards shall be in accordance with NEC, NEMA, UL, as specified, and as shown on the drawings.

B. Panelboards shall have main breaker or main lugs, bus size, voltage, phases, number of circuit breaker mounting spaces, top or bottom feed, flush or surface mounting, branch circuit breakers, and accessories as shown on the drawings.
C. Panelboards shall be completely factory-assembled with molded case circuit breakers and integral accessories as shown on the drawings or specified herein.
D. Non-reduced size copper bus bars, rigidly supported on molded insulators, and fabricated for bolt-on type circuit breakers.
E. Bus bar connections to the branch circuit breakers shall be the "distributed phase" or "phase sequence" type.
F. Mechanical lugs furnished with panelboards shall be cast, stamped, or machined metal alloys listed for use with the conductors to which they will be connected.
G. Neutral bus shall be 100% rated, mounted on insulated supports.
H. Grounding bus bar shall be equipped with screws or lugs for the connection of equipment grounding conductors.
I. Bus bars shall be braced for the available short-circuit current as shown on the drawings, but not be less than 10,000 A symmetrical for 120/208 V and 120/240 V panelboards, and 14,000 A symmetrical for 277/480 V panelboards.
J. Series-rated panelboards are not permitted.

2.2 ENCLOSURES AND TRIMS

A. Enclosures:
   1. Provide galvanized steel enclosures, with NEMA rating as shown on the drawings or as required for the environmental conditions in which installed.
   2. Enclosures shall not have ventilating openings.
   3. Enclosures may be of one-piece formed steel or of formed sheet steel with end and side panels welded, riveted, or bolted as required.
   4. Provide manufacturer's standard option for prepunched knockouts on top and bottom endwalls.
   5. Include removable inner dead front cover, independent of the panelboard cover.
B. Trims:
   1. Hinged "door-in-door" type Keyed to Square D 251.

2. Interior hinged door with hand-operated latch or latches, as required to provide access only to circuit breaker operating handles, not to energized parts.
3. Outer hinged door shall be securely mounted to the panelboard enclosure with factory bolts, screws, clips, or other fasteners, requiring a key or tool for entry. Hand-operated latches are not acceptable.
4. Inner and outer doors shall open left to right.
5. Trims shall be flush or surface type as shown on the drawings.

2.3 MOLDED CASE CIRCUIT BREAKERS

A. Circuit breakers shall be per UL, NEC, as shown on the drawings, and as specified.
B. Circuit breakers shall be bolt-on type.
C. Circuit breakers shall have minimum interrupting rating as required to withstand the available fault current, but not less than:
   1. 120/208 V Panelboard: 10,000 A symmetrical.
   2. 120/240 V Panelboard: 10,000 A symmetrical.
   3. 277/480 V Panelboard: 14,000 A symmetrical.
D. Circuit breakers shall have automatic, trip free, non-adjustable, inverse time, and instantaneous magnetic trips for less than 400 A frame. Circuit breakers with 400 A frames and above shall have magnetic trip, adjustable from 5x to 10x.
E. Circuit 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 closed, tripped, and open positions.
   8. An overload on one pole of a multi-pole 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 shown on the drawings.

10. For circuit breakers being added to existing panelboards, coordinate the breaker type with existing panelboards. Modify the panel directory accordingly.

PART 3 - EXECUTION

3.1 INSTALLATION

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

B. Locate panelboards so that the present and future conduits can be conveniently connected.

C. Install a printed schedule of circuits in each panelboard after approval by the COR. Schedules shall reflect final load descriptions, room numbers, and room names connected to each circuit breaker. Schedules shall be printed on the panelboard directory cards and be installed in the appropriate panelboards.

D. Install panel label of engraved plastic on exterior surface of panelboard. Label shall be black with white lettering for normal power. Label shall be red with white engraved lettering for emergency power.

E. Arc lash label will be placed on cover of each panelboard.

F. Mount panelboards such that the maximum height of the top circuit breaker above the finished floor shall not exceed 1980 mm (78 inches).

G. Provide blank cover for each unused circuit breaker mounting space.

H. Rust and scale shall be removed from the inside of existing enclosures where new interior components are to be installed. Paint inside of enclosures with rust-preventive paint before the new interior components are installed. Provide new trim. Trim shall fit tight to the enclosure.

I. Panelboard enclosures shall not be used for conductors feeding through, spliced, or tapping off to other enclosures or devices.

3.2 ACCEPTANCE CHECKS AND TESTS

A. Perform in accordance with the manufacturer's recommendations. In addition, include the following:

1. Visual Inspection and Tests:

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. Vacuum-clean enclosure interior. Clean enclosure exterior.

3.3 FOLLOW-UP VERIFICATION

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

---END---

SECTION 26 27 26
WIRING DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the furnishing, installation, connection, and testing 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 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: 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 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduit and boxes.

E. Section 26 51 00, INTERIOR LIGHTING: Fluorescent ballasts and LED drivers for use with manual dimming controls.

1.3 QUALITY ASSURANCE

A. Quality Assurance shall be in accordance with Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES) in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:

1. Shop Drawings:
   a. Submit sufficient information to demonstrate compliance with drawings and specifications.
   b. Include electrical ratings, dimensions, mounting details, construction materials, grade, and termination information.
2. Manuals:
   a. Submit, simultaneously with the shop drawings, companion copies of complete maintenance and operating manuals, including technical data sheets and information for ordering replacement parts.

b. If changes have been made to the maintenance and operating manuals originally submitted, submit updated maintenance and operating manuals two weeks prior to the final inspection.

3. Certifications: Two weeks prior to final inspection, submit the following.
   a. Certification by the manufacturer that the wiring devices conform to the requirements of the drawings and specifications.
   b. Certification by the Contractor that the wiring devices have been properly installed and adjusted.

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 Electrical Manufacturers Association (NEMA):
WD 1-99(R2015).....General Color Requirements for Wiring Devices
WD 6-16 .....Wiring Devices – Dimensional Specifications

C. National Fire Protection Association (NFPA):
70-17.....National Electrical Code (NEC)
99-18.....Health Care Facilities

D. Underwriter’s Laboratories, Inc. (UL):
5-16.....Surface Metal Raceways and Fittings
20-10.....General-Use Snap Switches
231-16.....Power Outlets
467-13.....Grounding and Bonding Equipment
498-17.....Attachment Plugs and Receptacles
943-16.....Ground-Fault Circuit-Interrupters
1449-14.....Surge Protective Devices
1472-15.....Solid State Dimming Controls

PART 2 - PRODUCTS

2.1 RECEPTACLES

A. General: All receptacles shall comply with NEMA, NFPA, UL, and as shown on the drawings.

1. Mounting straps shall be nickel plated brass, brass, nickel plated steel or galvanize 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 minimum) and side wiring from four captively held binding screws.

B. Duplex Receptacles - Hospital-grade: shall be listed for hospital grade, single phase, 20 ampere, 120 volts, 2-pole, 3-wire, NEMA 5-20R, with break-off feature for two-circuit operation.
   1. Bodies shall be ivory in color for receptacles on normal power.
   2. Switched duplex receptacles shall be wired so that only the top receptacle is switched. The lower receptacle shall be unswitched.
   3. Duplex Receptacles on Emergency Circuit:
      a. Bodies shall be red in color for receptacles on emergency power.
      b. In rooms without emergency powered general lighting, the emergency receptacles shall be of the self-illuminated type.
   4. Ground Fault Current Interrupter (GFCI) Duplex Receptacles: Shall be an integral unit, hospital-grade, suitable for mounting in a standard outlet box, with end-of-life indication and provisions to isolate the face due to improper wiring. GFCI receptacles shall be self-test receptacles in accordance with UL 943.
      a. Ground fault interrupter shall consist of a differential current transformer, self-test, solid state sensing circuitry and a circuit interrupter switch. Device shall have nominal sensitivity to ground leakage current of 4-6 milliamperes and shall function to interrupt the current supply for any value of ground leakage current above five milliamperes (+ or – 1 milliampere) on the load side of the device. Device shall have a minimum nominal tripping time of 0.025 second.
      b. Self-test function shall be automatically initiated within 5 seconds after power is activated to the receptacles. Self-test function shall be periodically and automatically performed every 3 hours or less.
      c. End-of-life indicator light shall be a persistent flashing or blinking light to indicate that the GFCI receptacle is no longer in service.
   5. Tamper-Resistant Duplex Receptacles:
      a. Bodies shall be ivory for receptacles on normal power and shall be red in color for receptacles on emergency power.

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.

b. Tamper proof receptacles shall be installed in office spaces, waiting rooms, reception, patient toilets, corridors, and exam rooms in accordance with NEC 406.12.

C. Duplex Receptacles – Non-hospital Grade: shall not be allowed on this project.

D. Receptacles - 20, 30, and 50 ampere, 250 Volts: Shall be complete with appropriate cord grip plug.

E. Weatherproof Receptacles: Shall consist of a duplex receptacle, mounted in box with a gasketed, weatherproof, cast metal cover plate and cap over each receptacle opening. The cap shall be permanently attached to the cover plate by a spring-hinged flap. The weatherproof integrity shall not be affected when heavy duty specification or hospital grade attachment plug caps are inserted. Cover plates on outlet boxes mounted flush in the wall shall be gasketed to the wall in a watertight manner.

2.2 TOGGLE SWITCHES

A. Toggle switches shall be totally enclosed tumbler type with nylon bodies. Handles shall be ivory in color unless otherwise specified or shown on the drawings.

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 plasters ears and provisions for back wiring with separate metal wiring clamps and side wiring with captively held binding screws.
3. Switches shall be rated 20 amperes at 120-277 Volts AC.

2.3 MANUAL DIMMING CONTROL

A. Electronic full-wave manual slide dimmer with on/off switch and audible frequency and EMI/RFI suppression filters.

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

C. Provide single-pole, three-way or four-way, as shown on the drawings.

D. Manual dimming control and faceplates shall be ivory in color unless otherwise specified.

2.4 WALL PLATES

A. Wall plates for switches and receptacles shall be type 302 stainless steel. Oversize plates are not acceptable.

B. For receptacles or switches mounted adjacent to each other, wall plates shall be common for each group of receptacles or switches.

C. Duplex Receptacles on Emergency Circuit: Wall plates shall be red nylon with the word "EMERGENCY" engraved in 6 mm (1/4 inch) white letters, or may be 302 stainless steel with the word "EMERGENCY" engraved in 6 mm (1/4 inch) red letters.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be in accordance with the NEC and as shown as on the drawings.

B. Install wiring devices after wall construction and painting is complete.

C. The ground terminal of each wiring device shall be bonded to the outlet box with an approved green bonding jumper, and also connected to the branch circuit equipment grounding conductor.

D. Outlet boxes for toggle switches and manual dimming controls shall be mounted on the strike side of doors.

E. Provide barriers in multi-gang outlet boxes to comply with the NEC.

F. 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.

G. 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.

H. Coordinate installation location and height of outlets in exam rooms with the using staff through the VA COR.

I. Install wall switches 1.2 M (48 inches) above floor, with the toggle OFF position down.

J. Install wall dimmers 1.2 M (48 inches) above floor.

K. Install receptacles 450 mm (18 inches) above floor, and 152 mm (6 inches) above counter backsplash or workbenches. Install specific-use receptacles at heights shown on the drawings.

L. Install horizontally mounted receptacles with the ground pin to the right.

M. When required or recommended by the manufacturer, use a torque screwdriver. Tighten unused terminal screws.

N. Label device plates with a permanent adhesive label listing panel and circuit feeding the wiring device.

3.2 ACCEPTANCE CHECKS AND TESTS

A. Perform manufacturer’s required field checks in accordance with the manufacturer's recommendations, and the latest NFPA 99. In addition, include the following:

1. Visual Inspection and Tests:
   a. Inspect physical and electrical conditions.
   b. Vacuum-clean surface metal raceway interior. Clean metal raceway exterior.
   c. 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.
   d. Test GFCI receptacles.
2. Receptacle testing such as retention force of the grounding blade of each receptacle, shall comply with the latest NFPA 99.

---END---

SECTION 26 29 11
MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the furnishing, installation, connection, and testing of motor controllers, including all low- and medium-voltage motor controllers and manual motor controllers, indicated as motor controllers in this section, and low-voltage variable speed motor controllers.

B. Motor controllers, whether furnished with the equipment specified in other sections or otherwise shall meet this specification and all related specifications.

1.2 RELATED WORK

A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.

B. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Low-voltage conductors.

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.

1.3 QUALITY ASSURANCE

A. Quality Assurance shall be in accordance with Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES) in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:

1. Shop Drawings:
   a. Submit sufficient information to demonstrate compliance with drawings and specifications.
   b. Include electrical ratings, dimensions, weights, mounting details, materials, overcurrent protection devices, overload relays, sizes of enclosures, wiring diagrams, starting characteristics, interlocking, and accessories.

c. Certification from the manufacturer that representative motor controllers have been seismically tested to International Building Code requirements. Certification shall be based upon simulated seismic forces on a shake table or by analytical methods, but not by experience data or other methods.

2. Manuals:

a. 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.

1) Wiring diagrams shall have their terminals identified to facilitate installation, maintenance, and operation.

2) Wiring diagrams shall indicate internal wiring for each item of equipment and interconnections between the items of equipment.

3) Elementary schematic diagrams shall be provided for clarity of operation.

4) Include the catalog numbers for the correct sizes of overload relays for the motor controllers.

b. If changes have been made to the maintenance and operating manuals originally submitted, submit updated maintenance and operating manuals two weeks prior to the final inspection.

3. Certifications: Two weeks prior to final inspection, submit the following.

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

b. Certification by the Contractor that the motor controllers have 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 basic designation only.

B. Institute of Electrical and Electronic Engineers (IEEE):

519-14.....Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems

C37.90.1-12.....Standard Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus

C. International Code Council (ICC):

IBC-15.....International Building Code

D. National Electrical Manufacturers Association (NEMA):

ICS 1-00(R2015).....Industrial Control and Systems: General Requirements

ICS 1.1-84(R2015).....Safety Guidelines for the Application, Installation and Maintenance of Solid State Control

ICS 2-00(R2005).....Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 Volts

ICS 4-15.....Industrial Control and Systems: Terminal Blocks

ICS 6-93(R2016).....Industrial Control and Systems: Enclosures

ICS 7-14.....Industrial Control and Systems: Adjustable-Speed Drives

ICS 7.1-14.....Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable-Speed Drive Systems

E. National Fire Protection Association (NFPA):

70-17.....National Electrical Code (NEC)

F. Underwriters Laboratories Inc. (UL):

508A-13.....Industrial Control Panels

508C-16.....Power Conversion Equipment

1449-14.....Surge Protective Devices

PART 2 - PRODUCTS

2.1 MOTOR CONTROLLERS

A. Motor controllers shall comply with IEEE, NEMA, NFPA, UL, and as shown on the drawings.

B. Motor controllers shall be separately enclosed, unless part of another assembly. For installation in motor control centers, provide plug-in, draw-out type motor controllers up through NEMA size 4. NEMA size 5 and above require bolted connections.

C. Motor controllers shall be combination type, with magnetic controller per Paragraph 2.3 below and with fused switch disconnecting means, with

external operating handle with lock-open padlocking positions and ON-OFF position indicator.

1. Fused Switches:
   a. Quick-make, quick-break type.
   b. Minimum duty rating shall be NEMA classification General Duty (GD) for 240 Volts and NEMA classification Heavy Duty (HD) for 480 Volts.
   c. Horsepower rated, and shall have the following features:
      1) Copper blades, visible in the OFF position.
      2) An arc chute for each pole.
      3) Fuse holders for the sizes and types of fuses specified or as shown on the drawings.

D. Enclosures:
   1. Enclosures shall be NEMA-type rated 1, 3R, or 12 as indicated on the drawings or as required per the installed environment.
   2. Enclosure doors shall be interlocked to prevent opening unless the disconnecting means is open. A "defeater" mechanism shall allow for inspection by qualified personnel with the disconnect means closed. Provide padlocking provisions.
   3. All metal surfaces shall be thoroughly cleaned, phosphatized, and factory primed prior to applying light gray baked enamel finish.

E. Motor control circuits:
   1. Shall operate at not more than 120 Volts.
   2. Shall be grounded, except where the equipment manufacturer recommends that the control circuits be isolated.
   3. For each motor operating over 120 Volts, incorporate a separate, heavy duty, control transformer within each motor controller enclosure.
   4. Incorporate primary and secondary overcurrent protection for the control power transformers.

F. Overload relays:
   1. Thermal type. Devices shall be NEMA type.
   2. One for each pole.
   3. External overload relay reset pushbutton on the door of each motor controller enclosure.

4. Overload relays shall be matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
5. Thermal overload relays shall be tamperproof, not affected by vibration, manual reset, sensitive to single-phasing, and shall have selectable trip classes of 10, 20 and 30.

G. Hand-Off-Automatic (H-O-A) switch is required unless specifically stated on the drawings as not required for a particular controller. H-O-A switch shall be operable without opening enclosure door. H-O-A switch is not required for manual motor controllers.

H. Incorporate into each control circuit a 120 Volt, electronic 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.

I. Unless noted otherwise, equip each motor controller with not less than two normally open (N.O.) and two normally closed (N.C.) auxiliary contacts.

J. Provide green (RUN) and red (STOP) pilot lights.

K. Motor controllers incorporated within equipment assemblies shall also be designed for the specific requirements of the assemblies.

L. Additional requirements for specific motor controllers, as indicated in other specification sections, shall also apply.

2.2 MANUAL MOTOR CONTROLLERS

A. Shall be in accordance with applicable requirements of 2.1 above.

B. Manual motor controllers shall have the following features:
1. Controllers shall be general-purpose Class A, manually operated type with full voltage controller for induction motors, rated in horsepower.
2. Units shall include thermal overload relays, on-off operator, pilot light, normally open and normally closed auxiliary contacts.

C. Fractional horsepower manual motor controllers shall have the following features:
1. Controllers shall be general-purpose Class A, manually operated type with full voltage controller for fractional horsepower induction motors.
2. Units shall include thermal overload relays, red pilot light, and toggle operator.

2.3 MAGNETIC MOTOR CONTROLLERS

A. Shall be in accordance with applicable requirements of 2.1 above.

B. Controllers shall be general-purpose, Class A magnetic controllers for induction motors rated in horsepower. Minimum NEMA size 0.

C. Where combination motor controllers are used, combine controller with protective or disconnect device in a common enclosure.

D. Provide phase loss protection for each controller, with contacts to de-energize the controller 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 or variable speed controllers as shown on the drawings. Equip controllers with 120 VAC coils and individual control transformer unless otherwise noted.

2.4 LOW-VOLTAGE VARIABLE SPEED MOTOR CONTROLLERS (VSMC)

A. VSMC shall be in accordance with applicable portions of 2.1 above.

B. VSMC shall be electronic, with adjustable frequency and voltage, three phase output, capable of driving standard NEMA B three-phase induction motors at full rated speed. The control technique shall be pulse width modulation (PWM), where the VSMC utilizes a full wave bridge design incorporating diode rectifier circuitry. Silicon controlled rectifiers or other control techniques are not acceptable.

C. VSMC shall be suitable for 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.

D. VSMC shall be capable of operating within voltage parameters of plus 10 to minus 15 percent of line voltage, and be suitably rated for the full load amps of the maximum watts (HP) within its class.

E. Minimum efficiency shall be 95 percent at 100 percent speed and 85 percent at 50 percent speed.

F. The displacement power factor of the VSMC shall not be less than 95 percent under any speed or load condition.

G. VSMC current and voltage harmonic distortion shall not exceed the values allowed by IEEE 519.

H. Operating and Design Conditions:

1. Elevation: 899 feet Above Mean Sea Level (AMSL)

2. Temperatures: Maximum +89°F Minimum -18°F

3. Relative Humidity: 50%
4. VSMC Location: Air conditioned space.

I. VSMC shall have the following features:

1. Isolated power for control circuits.
2. Manually resettable 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 2000 seconds. Set timers to the equipment manufacturer's recommended time in the above range.
5. Control input circuitry that will accept 4 to 20 mA current or 0-10 VDC voltage control signals from an external source.
6. Automatic frequency adjustment from 1 Hz to 300 Hz.
7. Circuitry to initiate an orderly shutdown when any of the conditions listed below occur. The VSMC shall not be damaged by any of these electrical disturbances and shall automatically restart when the conditions are corrected. The VSMC 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. Overvoltage in excess of 10 percent.
   d. Undervoltage in excess of 15 percent.
   e. Running overcurrent above 110 percent (VSMC shall not automatically reset for this condition.)
   f. Instantaneous overcurrent above 150 percent (VSMC shall not automatically reset for this condition).
   g. 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 VSMC fault or on return of power after an interruption and before shutting down for manual reset or fault correction, with 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 VSMC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to VSMC, motor, or load.

J. VSMC shall include an input circuit breaker which will disconnect all input power, interlocked with the door so that the door cannot be opened with the circuit breaker in the closed position.

K. VSMC shall include a 5% line reactor and a RFI/EMI filter.

L. Surge Suppression: Provide three-phase protection against damage from supply voltage surges in accordance with UL 1449.

M. VSMC shall include front-accessible operator station, with sealed keypad and digital display, which allows complete programming, operating, monitoring, and diagnostic capabilities.
   1. Typical control functions shall include but not be limited to:
      a. HAND-OFF-AUTOMATIC-RESET, with manual speed control in HAND mode.
      b. NORMAL-BYPASS.
      c. NORMAL-TEST, which allows testing and adjusting of the VSMC while in bypass mode.
   2. Typical monitoring functions shall include but not be limited to:
      a. Output frequency (Hz).
      b. Motor speed and status (run, stop, fault).
      c. Output voltage and current.
   3. Typical fault and alarm functions shall include but not be limited to:
      a. Loss of input signal, under- and over-voltage, inverter overcurrent, motor overload, critical frequency rejection with selectable and adjustable deadbands, instantaneous line-to-line and line-to-ground overcurrent, loss-of-phase, reverse-phase, and short circuit.
      b. System protection indicators indicating that the system has shutdown and will not automatically restart.

N. VSMC shall include two N.O. and two N.C. dry contacts rated 120 Volts, 10 amperes, 60 Hz.

O. Hardware, software, network interfaces, gateways, and programming to control and monitor the VSMC by control systems specified in other specification sections, including but not limited to Divisions 22 and 23.

P. Network communications ports: As required for connectivity to control systems specified in other specification sections, including but not limited to Divisions 22 and 23.

Q. Communications protocols: As required for communications with control systems specified in other specification sections, including but not limited to Divisions 22 and 23.

R. Bypass controller: Provide contactor-style bypass, arranged to bypass the inverter.

1. Inverter Output Contactor and Bypass Contactor: Load-break NEMA-rated contactor.
2. Motor overload relays.
3. HAND-OFF-AUTOMATIC bypass control.

S. Bypass operation: Transfers motor between inverter output and bypass circuit, manually, automatically, or both. VSMC shall be capable of stable operation (starting, stopping, and running), and control by fire alarm and detection systems, with motor completely disconnected from the inverter output. Transfer between inverter and bypass contactor and retransfer shall only be allowed with the motor at zero speed.

T. Inverter Isolating Switch: Provide non-load-break switch arranged to isolate inverter and permit safe troubleshooting and testing of the inverter, both energized and de-energized, while motor is operating in bypass mode. Include padlockable, door-mounted handle mechanism.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install motor controllers in accordance with the NEC, as shown on the drawings, and as recommended by the manufacturer.

C. Install manual motor controllers in flush enclosures in finished areas.

D. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and electronic overload relay pickup and trip ranges.

E. Program variable speed motor controllers per the manufacturer’s instructions and in coordination with other trades so that a complete and functional system is delivered.

F. Adjust trip settings of circuit breakers and motor circuit protectors 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 Efficiency motors if required). Where these maximum settings do not allow starting of a motor, notify COR before increasing settings.

3.2 ACCEPTANCE CHECKS AND TESTS

A. Perform manufacturer's required field tests in accordance with the manufacturer's recommendations. In addition, include the following:

1. Visual Inspection and Tests:
   a. Compare equipment nameplate data with specifications and approved shop drawings.
   b. Inspect physical, electrical, and mechanical condition.
   c. Verify appropriate anchorage, required area clearances, and correct alignment.
   d. Verify that circuit breaker, motor circuit protector, and fuse sizes and types correspond to approved shop drawings.
   e. Verify overload relay ratings are correct.
   f. Vacuum-clean enclosure interior. Clean enclosure exterior.
   g. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
   h. Test all control and safety features of the motor controllers.
   i. For low-voltage variable speed motor controllers, final programming and connections 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.

3.3 FOLLOW-UP VERIFICATION

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

3.4 SPARE PARTS

A. Two weeks prior to the final inspection, provide one complete set of spare fuses for each motor controller.

3.5 INSTRUCTION

A. Furnish the services of a factory-trained technician for two 4-hour training periods for instructing personnel in the maintenance and operation of the motor controllers, on the dates requested by the COR.

---END---

SECTION 26 29 21
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the furnishing, installation, and connection of fused and unfused disconnect switches (indicated as switches in this section), and separately-enclosed circuit breakers for use in electrical systems rated 600 V and below.

1.2 RELATED WORK

A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.

B. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Low-voltage conductors.

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.

E. Section 26 24 16, PANELBOARDS: Molded-case circuit breakers.

1.3 QUALITY ASSURANCE

A. Quality Assurance shall be in accordance with Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES) in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:

1. Shop Drawings:
   a. Submit sufficient information to demonstrate compliance with drawings and specifications.
   b. Submit the following data for approval:
      1) Electrical ratings, dimensions, mounting details, materials, required clearances, terminations, weight, fuses, circuit breakers, wiring and connection diagrams, accessories, and device nameplate data.
   c. Certification from the manufacturer that representative enclosed switches and circuit breakers have been seismically tested to International Building Code requirements. Certification shall be

based upon simulated seismic forces on a shake table or by analytical methods, but not by experience data or other methods.

2. Manuals:
   a. Submit complete maintenance and operating manuals including technical data sheets, wiring diagrams, and information for ordering fuses, circuit breakers, and replacement parts.
      1) Include schematic diagrams, with all terminals identified, matching terminal identification in the enclosed switches and circuit breakers.
      2) Include information for testing, repair, troubleshooting, assembly, and disassembly.
   b. If changes have been made to the maintenance and operating manuals originally submitted, submit updated maintenance and operating manuals two weeks prior to the final inspection.
3. Certifications: Two weeks prior to final inspection, submit the following.
   a. Certification by the manufacturer that the enclosed switches and circuit breakers conform to the requirements of the drawings and specifications.
   b. Certification by the Contractor that the enclosed switches and circuit breakers have 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. International Code Council (ICC):
   IBC-15.....International Building Code

C. National Electrical Manufacturers Association (NEMA):
   FU l-12.....Low Voltage Cartridge Fuses
   KS l-13.....Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum)

D. National Fire Protection Association (NFPA):
   70-17.....National Electrical Code (NEC)

E. Underwriters Laboratories, Inc. (UL):
   98-16.....Enclosed and Dead-Front Switches
   248 1-11.....Low Voltage Fuses

489-13.....Molded Case Circuit Breakers and Circuit Breaker Enclosures

PART 2 - PRODUCTS

2.1 FUSED SWITCHES RATED 600 AMPERES AND LESS

A. Switches shall be in accordance with NEMA, NEC, UL, as specified, and as shown on the drawings.

B. Shall be NEMA classified General Duty (GD) for 240 V switches, and NEMA classified Heavy Duty (HD) for 480 V switches.

C. Shall be horsepower (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 open position.
3. An arc chute for each pole.
4. External operating handle shall indicate open and closed positions, and have lock-open padlocking provisions.
5. Mechanical interlock shall permit opening of the door only when the switch is in the open 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.
   b. Where the types of switch enclosures are not shown, they shall be the NEMA types most suitable for the ambient environmental conditions.
   c. Shall be finished with manufacturer’s standard gray baked enamel paint over pretreated steel.

2.2 UNFUSED SWITCHES RATED 600 AMPERES AND LESS

A. Shall be the same as fused switches, but without provisions for fuses.

2.3 MOTOR RATED TOGGLE SWITCHES

A. Type 1, general purpose for single-phase motors rated up to 1 horsepower.

B. Quick-make, quick-break toggle switch with external reset button and thermal overload protection matched to nameplate full-load current of actual protected motor.

2.4 CARTRIDGE FUSES

A. Shall be in accordance with NEMA FU 1.

B. Service Entrance: Class RK1, time delay.

C. Feeders: Class RK1, time delay or Class RK5, time delay.

D. Motor Branch Circuits: Class RK1 or Class RK5, time delay.

E. Other Branch Circuits: Class RK1, time delay or Class RK5, time delay.

F. Control Circuits: Class CC, time delay.

2.5 SEPARATELY-ENCLOSED CIRCUIT BREAKERS

A. Provide circuit breakers in accordance with the applicable requirements in Section 26 24 16, PANELBOARDS.

B. Enclosures shall be the NEMA types shown on the drawings. Where the types are not shown, they shall be the NEMA type most suitable for the ambient environmental conditions.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be in accordance with the NEC, as shown on the drawings, and manufacturer’s instructions.

B. Fused switches shall be furnished complete with fuses. Arrange fuses such that rating information is readable without removing the fuses.

3.2 ACCEPTANCE CHECKS AND TESTS

A. Perform in accordance with the manufacturer's recommendations. In addition, include the following:

1. Visual Inspection and Tests:

a. Compare equipment nameplate data with specifications and approved shop drawings.

b. Inspect physical, electrical, and mechanical condition.

c. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method.

d. Vacuum-clean enclosure interior. Clean enclosure exterior.

3.3 SPARE PARTS

A. Two weeks prior to the final inspection, furnish one complete set of spare fuses for each fused disconnect switch installed on the project. Deliver the spare fuses to the COR.

---END---

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. The terms "lighting fixture," "fixture," and "luminaire" are used interchangeably.

1.2 RELATED WORK

A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.

B. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Low-voltage conductors.

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. Quality Assurance shall be in accordance with Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES) in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:

1. Shop Drawings:
   a. Submit the following information for each type of lighting fixture designated on the LIGHTING FIXTURE SCHEDULE, arranged in order of lighting fixture designation.
   b. Material and construction details, include information on housing and optics system.
   c. Physical dimensions and description.
   d. Wiring schematic and connection diagram.
   e. Installation details.
   f. Energy efficiency data.
   g. Photometric data based on laboratory tests complying with IES Lighting Measurements testing and calculation guides.

h. Lamp data including lumen output (initial and mean), color rendition index (CRI), rated life (hours), and color temperature (degrees Kelvin).

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

j. For LED lighting fixtures, submit US DOE LED Lighting Facts label, and IES L70 rated life.

2. Manuals:

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

b. If changes have been made to the maintenance and operating manuals originally submitted, submit updated maintenance and operating manuals two weeks prior to the final inspection.

3. Certifications: Two weeks prior to final inspection, submit the following.

a. Certification by the Contractor that the interior lighting systems have 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. American Society for Testing and Materials (ASTM):

C635/C635M REV A-13.....Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings

C. Environmental Protection Agency (EPA):

40 CFR 261.....Identification and Listing of Hazardous Waste

D. Federal Communications Commission (FCC):

CFR Title 47, Part 15...Radio Frequency Devices

CFR Title 47, Part 18...Industrial, Scientific, and Medical Equipment

E. Illuminating Engineering Society of North America (IESNA):

LM-79-08.....Electrical and Photometric Measurements of Solid-State Lighting Products

LM-80-15.....Measuring Lumen Maintenance of LED Light Sources

LM-82-12.....Characterization of LED Light Engines and LED Lamps for Electrical and Photometric Properties as a Function of Temperature

F. Institute of Electrical and Electronic Engineers (IEEE):

C62.41-91(R1995).....Surge Voltages in Low Voltage AC Power Circuits

G. International Code Council (ICC):

IBC-15.....International Building Code

H. National Electrical Manufacturer's Association (NEMA):

C78.376-14.....Chromaticity of Fluorescent Lamps

C82.1-04(R2015).....Lamp Ballasts – Line Frequency Fluorescent Lamp Ballasts

C82.2-02(R2016).....Method of Measurement of Fluorescent Lamp Ballasts

C82.4-17.....Lamp Ballasts - Ballasts for High-Intensity Discharge and Low-Pressure Sodium (LPS) Lamps (Multiple-Supply Type)

C82.11-17.....Lamp Ballasts - High Frequency Fluorescent Lamp Ballasts

LL 9-11.....Dimming of T8 Fluorescent Lighting Systems

SSL 1-16.....Electronic Drivers for LED Devices, Arrays, or Systems

I. National Fire Protection Association (NFPA):

70-17.....National Electrical Code (NEC)

101-18.....Life Safety Code

J. Underwriters Laboratories, Inc. (UL):

496-17.....Lampholders

542-05.....Fluorescent Lamp Starters

844-12.....Luminaires for Use in Hazardous (Classified) Locations

924-16.....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

1598-08.....Luminaires

1574-04.....Track Lighting Systems
2108-15.....Low-Voltage Lighting Systems
8750-15.....Light Emitting Diode (LED) Light Sources for Use in Lighting Products

PART 2 - PRODUCTS

2.1 LED EXIT LIGHT FIXTURES

A. Exit light fixtures shall meet applicable requirements of NFPA and UL.
B. Housing and door shall be die-cast aluminum.
C. For general purpose exit light fixtures, door frame shall be hinged, with latch.
D. Finish shall be satin or fine-grain brushed aluminum.
E. There shall be no radioactive material used in the fixtures.
F. Fixtures:
   1. Inscription panels shall be cast or stamped aluminum a minimum of 2.25 mm (0.090 inch) thick, stenciled with 150 mm (6 inch) 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.
   2. Double-Faced Fixtures: Provide double-faced fixtures where required or as shown on drawings.
   3. 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. Voltage: Multi-voltage (120 – 277V).

2.2 LED LIGHT FIXTURES

A. General:
   1. LED light fixtures shall be in accordance with IES, NFPA, UL, as shown on the drawings, and as specified.
   2. LED light fixtures shall be Reduction of Hazardous Substances (RoHS)-compliant.
   3. LED drivers shall include the following features unless otherwise indicated:
      a. Minimum efficiency: 85% at full load.
      b. Minimum Operating Ambient Temperature: -20˚ C. (-4˚ F.)
      c. Input Voltage: 120 - 277V (±10%) at 60 Hz.
      d. Integral short circuit, open circuit, and overload protection.

e. Power Factor: ≥ 0.95.

f. Total Harmonic Distortion: ≤ 20%.

g. Comply with FCC 47 CFR Part 15.

4. LED modules shall include the following features unless otherwise indicated:

a. Comply with IES LM-79 and LM-80 requirements.

b. Minimum CRI 80 and color temperature 3000˚ K unless otherwise specified in LIGHTING FIXTURE SCHEDULE.

c. Minimum Rated Life: 50,000 hours per IES L70.

d. Light output lumens as indicated in the LIGHTING FIXTURE SCHEDULE.

B. LED Downlights:

1. Housing, LED driver, and LED module shall be products of the same manufacturer.

C. LED Troffers:

1. LED drivers, modules, and reflector shall be accessible, serviceable, and replaceable from below the ceiling.

2. Housing, LED driver, and LED module shall be products of the same manufacturer.

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. Wall-mounted fixtures shall be attached to the studs in the walls, or to a 20 gauge metal backing plate that is attached to the studs in the walls. Lighting fixtures shall not be attached directly to gypsum board.

D. Lighting Fixture Supports:

1. Shall provide support for all of the fixtures. Supports may be anchored to channels of the ceiling construction, to the structural slab or to structural members within a partition, or above a suspended ceiling.

2. Shall maintain the fixture positions after cleaning and relamping.

3. Shall support the lighting fixtures without causing the ceiling or partition to deflect.

4. Hardware for recessed lighting fixtures:

a. All fixture mounting devices connecting fixtures to the ceiling system or building structure shall have a capacity for a horizontal force of 100 percent of the fixture weight and a vertical force of 400 percent of the fixture weight.
b. Mounting devices shall clamp the fixture to the ceiling system structure (main grid runners or fixture framing cross runners) at four points in such a manner as to resist spreading of these supporting members. Each support point device shall utilize a screw or approved hardware to "lock" the fixture housing to the ceiling system, restraining the fixture from movement in any direction relative to the ceiling. The screw (size No. 10 minimum) or approved hardware shall pass through the ceiling member (T-bar, channel or spline), or it may extend over the inside of the flange of the channel (or spline) that faces away from the fixture, in a manner that prevents any fixture movement.
c. In addition to the above, the following is required for fixtures exceeding 9 kg (20 pounds) in weight.
    1) Where fixtures mounted in ASTM Standard C635 "Intermediate Duty" and "Heavy Duty" ceilings and weigh between 9 kg and 25 kg (20 pounds and 56 pounds), provide two 12 gauge safety hangers hung slack between diagonal corners of the fixture and the building structure.
    2) Where fixtures weigh over 25 kg (56 pounds), they shall be independently supported from the building structure by approved hangers. Two-way angular bracing of hangers shall be provided to prevent lateral motion.
d. Where ceiling cross runners are installed for support of lighting fixtures, they must have a carrying capacity equal to that of the main ceiling runners and be rigidly secured to the main runners.

5. Surface mounted lighting fixtures:
    a. Fixtures shall be bolted against the ceiling independent of the outlet box at four points spaced near the corners of each unit. The bolts (or stud-clips) shall be minimum 6 mm (1/4 inch) bolt, secured to main ceiling runners and/or secured to cross runners. Non-turning studs may be attached to the main ceiling runners and cross runners with special non-friction clip devices designed for the purpose, provided they bolt through the runner, or are also

secured to the building structure by 12 gauge safety hangers. Studs or bolts securing fixtures weighing in excess of 25 kg (56 pounds) shall be supported directly from the building structure.

b. Where ceiling cross runners are installed for support of lighting fixtures, they must have a carrying capacity equal to that of the main ceiling runners and be rigidly secured to the main runners.

c. Fixtures mounted in open construction shall be secured directly to the building structure with approved bolting and clamping devices.

E. Furnish and install the new lamps as specified for all lighting fixtures installed under this project.

F. The electrical and ceiling trades shall coordinate to ascertain that approved lighting fixtures are furnished in the proper sizes and installed with the proper devices (hangers, clips, trim frames, flanges, etc.), to match the ceiling system being installed.

G. Bond lighting fixtures to the grounding system as specified in Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.

H. At completion of project, replace all defective components of the lighting fixtures at no cost to the Government.

3.2 ACCEPTANCE CHECKS AND TESTS

A. Perform the following:

1. Visual Inspection:

a. Verify proper operation by operating the lighting controls.

b. Visually inspect for damage to fixtures, lenses, reflectors, diffusers, and louvers. Clean fixtures, lenses, reflectors, diffusers, and louvers that have accumulated dust, dirt, or fingerprints during construction.

2. Electrical tests:

a. Exercise dimming components of the lighting fixtures over full range of dimming capability by operating the control devices(s) in the presence of the COR. Observe for visually detectable flicker over full dimming range, and replace defective components at no cost to the Government.

b. 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 specifically recommended otherwise by

the lamp manufacturer. Replace any lamps and ballasts which fail during burn-in.

3.3 FOLLOW-UP VERIFICATION

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

---END---

SECTION 26 56 00
EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the furnishing, installation, and connection of exterior fixtures, poles, and supports. The terms "lighting fixtures", "fixture" and "luminaire" are used interchangeably.

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 19, 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. Quality Assurance shall be in accordance with Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES) in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:

1. Shop Drawings:

a. Submit the following information for each type of lighting fixture designated on the LIGHTING FIXTURE SCHEDULE, arranged in order of lighting fixture designation.

b. Material and construction details, include information on housing and optics system.

c. Physical dimensions and description.
d. Wiring schematic and connection diagram.
e. Installation details.
f. Energy efficiency data.
g. Photometric data based on laboratory tests complying with IES Lighting Measurements testing and calculation guides.
h. Lamp data including lumen output (initial and mean), color rendition index (CRI), rated life (hours), and color temperature (degrees Kelvin).
i. Ballast data including ballast type, starting method, ambient temperature, ballast factor, sound rating, system watts, and total harmonic distortion (THD).
j. For LED lighting fixtures, submit US DOE LED Lighting Facts label, and IES L70 rated life.
k. Submit site plan showing all exterior lighting fixtures with fixture tags consistent with Lighting Fixture Schedule as shown on drawings. Site plan shall show computer generated point-by-point illumination calculations. Include lamp lumen and light loss factors used in calculations.

2. Manuals:
a. Submit, simultaneously with the shop drawings, complete maintenance and operating manuals, including technical data sheets, wiring diagrams, and information for ordering replacement parts.
b. If changes have been made to the maintenance and operating manuals originally submitted, submit updated maintenance and operating manuals two weeks prior to the final inspection.

3. Certifications: Two weeks prior to final inspection, submit the following.
a. Certification by the Contractor that the exterior lighting systems have 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. American Association of State Highway and Transportation Officials (AASHTO):

LRFDLTS-17.....Structural Supports for Highway Signs, Luminaires and Traffic Signals

C. American Concrete Institute (ACI):

318-14 .....Building Code Requirements for Structural Concrete

D. American National Standards Institute (ANSI):

H35.1/H35 1M-17.....American National Standard Alloy and Temper Designation Systems for Aluminum

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

A123/A123M-17 .....Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

A153/A153M-16.....Zinc Coating (Hot-Dip) on Iron and Steel Hardware

B108/B108M-15 .....Aluminum-Alloy Permanent Mold Castings

C1089-13 .....Spun Cast Prestressed Concrete Poles

F. Federal Aviation Administration (FAA):

AC 70/7460-IL-15.....Obstruction Lighting and Marking

AC 150/5345-43H-16.....Obstruction Lighting Equipment

G. Illuminating Engineering Society of North America (IESNA):

HB-9-00.....Lighting Handbook

RP-8-14.....Roadway Lighting

LM-52-03.....Photometric Measurements of Roadway Sign Installations

LM-72-97(R2010).....Directional Positioning of Photometric Data

LM-79-08.....Approved Method for the Electrical and Photometric Measurements of Solid-Sate Lighting Products

LM-80-15.....Approved Method for Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays and Modules

TM-15-11.....Luminaire Classification System for Outdoor Luminaires

H. National Electrical Manufacturers Association (NEMA):

C78.41-16.....Electric Lamps – Guidelines for Low-Pressure Sodium Lamps

C78.42-09(R2016) .....Electric Lamps – Guidelines for High-Pressure Sodium Lamps
C78.43-13 .....Electric Lamps – Single-Ended Metal-Halide Lamps
C78.1381-98.....Electric Lamps – 70-Watt M85 Double-Ended Metal-Halide Lamps
C81.61-17 .....Electrical Lamp Bases – Specifications for Bases (Caps) for Electric Lamps
C82.4-17 .....Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type)
C136.3-14 .....For Roadway and Area Lighting Equipment – Luminaire Attachments
C136.17-05(R2010)(S2017) 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(R2016) .....Enclosures

I. National Fire Protection Association (NFPA):
70-17 .....National Electrical Code (NEC)
101-18.....Life Safety Code

J. Underwriters Laboratories, Inc. (UL):
496-17 .....Lampholders
773-16.....Plug-In, Locking Type Photocontrols for Use with Area Lighting
773A-16 .....Nonindustrial Photoelectric Switches for Lighting Control
1029-94.....High-Intensity-Discharge Lamp Ballasts
1598-08 .....Luminaires
8750-15.....Light Emitting Diode (LED) Equipment 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 305 mm (12 inches) above

ground level and growing vegetation. Do not remove factory-applied pole wrappings until just before installing pole.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

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

2.2 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 6 mm (0.25-inch) 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 tiewire to stirrups.

F. Prior to concrete pour, install electrode per Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.

2.3 LUMINAIRES

A. 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. Illumination distribution patterns, BUG ratings and cutoff types as defined by the IESNA 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. Pre-wire internal components to terminal strips at the factory.

F. Bracket-mounted luminaires shall have leveling provisions and clamp-type adjustable slip-fitters with locking screws.

G. Materials shall be rustproof. Latches and fittings shall be non-ferrous metal.

H. 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.

I. Luminaires shall carry factory labels, showing complete, specific lamp and ballast information.

2.3 LAMPS

A. Install the proper lamps in every luminaire installed and every existing luminaire relocated or reinstalled as shown on the drawings.

B. Lamps shall be general-service, outdoor lighting types.

C. LED sources shall meet the following requirements:

1. Operating temperature rating shall be between -40 degrees C (-40 degrees F) and 50 degrees C (120 degrees F).
2. Correlated Color Temperature (CCT): 3000K.
3. Color Rendering Index (CRI): ≥ 80.
4. The manufacturer shall have performed reliability tests on the LEDs luminaires complying with Illuminating Engineering Society (IES) LM79 for photometric performance and LM80 for lumen maintenance and L70 life.

D. Mercury vapor lamps shall not be used.

2.4 LED DRIVERS

A. LED drivers shall meet the following requirements:

1. Drivers shall have a minimum efficiency of 85%.
2. Starting Temperature: -40 degrees C (-40 degrees F).
3. Input Voltage: 120 to 480 (±10%) volt.
4. Power Supplies: Class I or II output.
5. Surge Protection: The system must survive 250 repetitive strikes of "C Low" (C Low: 6kV/1.2 x 50 µs, 10kA/8 x 20 µs) waveforms at 1-minute intervals with less than 10% degradation in clamping voltage. "C Low" waveforms are as defined in IEEE/ASNI C62.41.2-2002, Scenario 1 Location Category C.
6. Power Factor (PF): ≥ 0.90.
7. Total Harmonic Distortion (THD): ≤ 20%.

8. Comply with FCC Title 47 CFR Part 18 Non-consumer RFI/EMI Standards.
9. Drivers shall be reduction of hazardous substances (ROHS)-compliant.

2.5 EXISTING LIGHTING SYSTEMS

A. For modifications or additions to existing lighting systems, the new components shall be compatible with the existing systems.

B. New poles and luminaires shall have approximately the same configurations, dimensions, lamping and reflector type 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 9 mm (0.375-inch) 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 includes common requirements to communications installations and applies to all sections of Division 27 and Division 28.

B. Provide completely functioning communications systems.

C. Comply with VAAR 852.236.91 and FAR clause 52.236-21 in circumstance of a need for additional detail or conflict between drawings, specifications, reference standards or code.

1.2 REFERENCES

A. Abbreviations and Acronyms

1. Refer to http://www.cfm.va.gov/til/sdetail.asp for Division 00, ARCHITECTURAL ABBREVIATIONS.

2. Additional Abbreviations and Acronyms:

A	Ampere
AC	Alternating Current
AE	Architect and Engineer
AFF	Above Finished Floor
AHJ	Authority Having Jurisdiction
ANSI	American National Standards Institute
AWG	American Wire Gauge (refer to STP and UTP)
AWS	Advanced Wireless Services
BCT	Bonding Conductor for Telecommunications (also Telecommunications Bonding Conductor (TBC))
BDA	Bi-Directional Amplifier
BICSI	Building Industry Consulting Service International
BIM	Building Information Modeling
BOM	Bill of Materials
BTU	British Thermal Units
BUCR	Back-up Computer Room
BTS	Base Transceiver Station
CAD	AutoCAD
CBOPC	Community Based Out Patient Clinic

CBC	Coupled Bonding Conductor
CBOC	Community Based Out Patient Clinic (refer to CBOPC, OPC, VAMC)
CCS	TIP's Cross Connection System (refer to VCCS and HCCS)
CFE	Contractor Furnished Equipment
CFM	US Department of Veterans Affairs Office of Construction and Facilities Management
CFR	Consolidated Federal Regulations
CIO	Communication Information Officer (Facility, VISN or Region)
cm	Centimeters
CO	Central Office
COR	Contracting Officer Representative
CPU	Central Processing Unit
CSU	Customer Service Unit
CUP	Conditional Use Permit(s) – Federal/GSA for VA
dB	Decibel
dBm	Decibel Measured
dBmV	Decibel per milli-Volt
DC	Direct Current
DEA	United States Drug Enforcement Administration
DSU	Data Service Unit
EBC	Equipment Bonding Conductor
ECC	Engineering Control Center (refer to DCR, EMCR)
EDGE	Enhanced Data (Rates) for GSM Evolution
EDM	Electrical Design Manual
EMCR	Emergency Management Control Room (refer to DCR, ECC)
EMI	Electromagnetic Interference (refer to RFI)
EMS	Emergency Medical Service
EMT	Electrical Metallic Tubing or thin wall conduit
ENTR	Utilities Entrance Location (refer to DEMARC, POTS, LEC)

EPBX	Electronic Digital Private Branch Exchange
ESR	Vendor's Engineering Service Report
FA	Fire Alarm
FAR	Federal Acquisition Regulations in Chapter 1 of Title 48 of Code of Federal Regulations
FMS	VA's Headquarters or Medical Center Facility's Management Service
FR	Frequency (refer to RF)
FTS	Federal Telephone Service
GFE	Government Furnished Equipment
GPS	Global Positioning System
GRC	Galvanized Rigid Metal Conduit
GSM	Global System (Station) for Mobile
HCCS	TIP's Horizontal Cross Connection System (refer to CCS & VCCS)
HDPE	High Density Polyethylene Conduit
HDTV	Advanced Television Standards Committee High-Definition Digital Television
HEC	Head End Cabinets(refer to HEIC, PA)
HEIC	Head End Interface Cabinets(refer to HEC, PA)
HF	High Frequency (Radio Band; Re FR, RF, VHF & UHF)
HSPA	High Speed Packet Access
HZ	Hertz
IBT	Intersystem Bonding Termination (NEC 250.94)
IC	Intercom
ICRA	Infectious Control Risk Assessment
IDEN	Integrated Digital Enhanced Network
IDC	Insulation Displacement Contact
IDF	Intermediate Distribution Frame
ILSM	Interim Life Safety Measures
IMC	Rigid Intermediate Steel Conduit
IRM	Department of Veterans Affairs Office of Information Resources Management

ISDN	Integrated Services Digital Network
ISM	Industrial, Scientific, Medical
IWS	Intra-Building Wireless System
LAN	Local Area Network
LBS	Location Based Services, Leased Based Systems
LEC	Local Exchange Carrier (refer to DEMARC, PBX & POTS)
LED	Light Emitting Diode
LMR	Land Mobile Radio
LTE	Long Term Evolution, or 4G Standard for Wireless Data Communications Technology
M	Meter
MAS	Medical Administration Service
MATV	Master Antenna Television
MCR	Main Computer Room
MCOR	Main Computer Operators Room
MDF	Main Distribution Frame
MH	Manholes or Maintenance Holes
MHz	Megaherts (10^6 Hz)
mm	Millimeter
MOU	Memorandum of Understanding
MW	Microwave (RF Band, Equipment or Services)
NID	Network Interface Device (refer to DEMARC)
NEC	National Electric Code
NOR	Network Operations Room
NRTL	OSHA Nationally Recognized Testing Laboratory
NS	Nurse Stations
NTIA	U.S. Department of Commerce National Telecommunications and Information Administration
OEM	Original Equipment Manufacturer
OI&T	Office of Information and Technology
OPC	VA’s Outpatient Clinic (refer to CBOC, VAMC)
OSH	Department of Veterans Affairs Office of Occupational Safety and Health

OSHA	United States Department of Labor Occupational Safety and Health Administration
OTDR	Optical Time-Domain Reflectometer
PA	Public Address System (refer to HE, HEIC, RPEC)
PBX	Private Branch Exchange (refer to DEMARC, LEC, POTS)
PCR	Police Control Room (refer to SPCC, could be designated SCC)
PCS	Personal Communications Service (refer to UPCS)
PE	Professional Engineer
PM	Project Manager
PoE	Power over Ethernet
POTS	Plain Old Telephone Service (refer to DEMARC, LEC, PBX)
PSTN	Public Switched Telephone Network
PSRAS	Public Safety Radio Amplification Systems
PTS	Pay Telephone Station
PVC	Poly-Vinyl Chloride
PWR	Power (in Watts)
RAN	Radio Access Network
RBB	Rack Bonding Busbar
RE	Resident Engineer or Senior Resident Engineer
RF	Radio Frequency (refer to FR)
RFI	Radio Frequency Interference (refer to EMI)
RFID	RF Identification (Equipment, System or Personnel)
RMC	Rigid Metal Conduit
RMU	Rack Mounting Unit
RPEC	Radio Paging Equipment Cabinets(refer to HEC, HEIC, PA)
RTLS	Real Time Location Service or System
RUS	Rural Utilities Service
SCC	Security Control Console (refer to PCR, SPCC)
SMCS	Spectrum Management and Communications Security (COMSEC)

SFO	Solicitation for Offers
SME	Subject Matter Experts (refer to AHJ)
SMR	Specialized Mobile Radio
SMS	Security Management System
SNMP	Simple Network Management Protocol
SPCC	Security Police Control Center (refer to PCR, SMS)
STP	Shielded Balanced Twisted Pair (refer to UTP)
STR	Stacked Telecommunications Room
TAC	VA's Technology Acquisition Center, Austin, Texas
TCO	Telecommunications Outlet
TER	Telephone Equipment Room
TGB	Telecommunications Grounding Busbar (also Secondary Bonding Busbar (SBB))
TIP	Telecommunications Infrastructure Plant
TMGB	Telecommunications Main Grounding Busbar (also Primary Bonding Busbar (PBB))
TMS	Traffic Management System
TOR	Telephone Operators Room
TP	Balanced Twisted Pair (refer to STP and UTP)
TR	Telecommunications Room (refer to STR)
TWP	Twisted Pair
UHF	Ultra High Frequency (Radio)
UMTS	Universal Mobile Telecommunications System
UPCS	Unlicensed Personal Communications Service (refer to PCS)
UPS	Uninterruptible Power Supply
USC	United States Code
UTP	Unshielded Balanced Twisted Pair (refer to TP and STP)
UV	Ultraviolet
V	Volts
VAAR	Veterans Affairs Acquisition Regulation
VACO	Veterans Affairs Central Office

VAMC	VA Medical Center (refer to CBOC, OPC, VACO)
VCCS	TIP's Vertical Cross Connection System (refer to CCS and HCCS)
VHF	Very High Frequency (Radio)
VISN	Veterans Integrated Services Network (refers to geographical region)
VSWR	Voltage Standing Wave Radio
W	Watts
WEB	World Electronic Broadcast
WiMAX	Worldwide Interoperability (for MW Access)
WI-FI	Wireless Fidelity
WMTS	Wireless Medical Telemetry Service
WSP	Wireless Service Providers

B. Definitions:

1. Access Floor: Pathway system of removable floor panels supported on adjustable pedestals to allow cable placement in area below.
2. BNC Connector (BNC): United States Military Standard MIL-C-39012/21 bayonet-type coaxial connector with quick twist mating/unmating, and two lugs preventing accidental disconnection from pulling forces on cable.
3. Bond: Permanent joining of metallic parts to form an electrically conductive path to ensure electrical continuity and capacity to safely conduct any currents likely to be imposed to earth ground.
4. Bundled Microducts: All forms of jacketed microducts.
5. Conduit: Includes all raceway types specified.
6. Conveniently Accessible: Capable of being reached without use of ladders, or without climbing or crawling under or over obstacles such as, motors, pumps, belt guards, transformers, piping, ductwork, conduit and raceways.
7. Distributed (in house) Antenna System (DAS): An Emergency Radio Communications System installed for Emergency Responder (or first responders and Government personnel) use while inside facility to maintain contact with each respective control point; refer to Section 27 53 19, DISTRIBUTED RADIO ANTENNA (WITHIN BUILDING) EQUIPMENT AND SYSTEMS.

8. DEMARC, Extended DMARC or ENTR: Service provider's main point of demarcation owned by LEC or service provider and establishes a physical point where service provider's responsibilities for service and maintenance end. This point is called NID, in data networks.
9. Effectively Grounded: Intentionally bonded to earth through connections of low impedance having current carrying capacity to prevent buildup of currents and voltages resulting in hazard to equipment or persons.
10. Electrical Supervision: Analyzing a system’s function and components (i.e. cable breaks / shorts, inoperative stations, lights, LEDs and states of change, from primary to backup) on a 24/7/365 basis; provide aural and visual emergency notification signals to minimum two remote designated or accepted monitoring stations.
11. Electrostatic Interference (ESI) or Electrostatic Discharge Interference: Refer to EMI and RFI.
12. Emergency Call Systems: Wall units (in parking garages and stairwells) and pedestal mounts (in parking lots) typically provided with a strobe, camera and two-way audio communication functions.
13. Project 25 (2014) (P25 (TIA-102 Series)): Set of standards for local, state and Federal public safety organizations and agencies digital LMR services. P25 is applicable to LMR equipment authorized or licensed under the US Department of Commerce National Telecommunications and Information Administration or FCC rules and regulations, and is a required standard capability for all LMR equipment and systems.
14. Grounding Electrode Conductor: (GEC) Conductor connected to earth grounding electrode.
15. Grounding Electrode System: Electrodes through which an effective connection to earth is established, including supplementary, communications system grounding electrodes and GEC.
16. Grounding Equalizer or Backbone Bonding Conductor (BBC): Conductor that interconnects elements of telecommunications grounding infrastructure.
17. Head End (HE): Equipment, hardware and software, or a master facility at originating point in a communications system designed for centralized communications control, signal processing, and distribution that acts as a common point of connection between equipment and devices connected to a network of interconnected

equipment, possessing greatest authority for allowing information to be exchanged, with whom other equipment is subordinate.

18. Microducts: All forms of air blown fiber pathways.
19. Ohm: A unit of restive measurement.
20. Received Signal Strength Indication (RSSI): A measurement of power present in a received RF signal.
21. Service Provider Demarcation Point (SPDP): Not owned by LEC or service provider, but designated by Government as point within facility considered the DEMARC.
22. Sound (SND): Changing air pressure to audible signals over given time span.
23. System: Specific hardware, firmware, and software, functioning together as a unit, performing task for which it was designed.
24. Telecommunications Bonding Backbone (TBB): Conductors of appropriate size (minimum 53.49 mm2 [1/0 AWG]) stranded copper wire, that connect to Grounding Electrode System and route to telecommunications main grounding busbar (TMGB) and circulate to interconnect various TGBs and other locations shown on drawings.
25. Voice over Internet Protocol (VoIP): A telephone system in which voice signals are converted to packets and transmitted over LAN network using Transmission Control Protocol (TCP)/Internet Protocol (IP). VA'S VoIP is not listed or coded for life and public safety, critical, emergency or other protection functions. When VoIP system or equipment is provided instead of PBX system or equipment, each TR (STR) and DEMARC requires increased AC power provided to compensate for loss of PBX's telephone instrument line power; and, to compensate for absence of PBX's UPS capability.
26. Wide Area Network (WAN): A digital network that transcends localized LANs within a given geographic location. VA'S WAN/LAN is not nationally listed or coded for life and public safety, critical, emergency or other safety functions.

1.3 APPLICABLE PUBLICATIONS

A. Applicability of Standards: Unless documents include more stringent requirements, applicable construction industry standards have same force and effect as if bound or copied directly into the documents to extent referenced. Such standards are made a part of these documents by reference.

1. Each entity engaged in construction must be familiar with industry standards applicable to its construction activity.
2. Obtain standards directly from publication source, where copies of standards are needed to perform a required construction activity.

B. Government Codes, Standards and Executive Orders: Refer to http://www.cfm.va.gov/TIL/cPro.asp:

1. Federal Communications Commission, (FCC) CFR, Title 47:

Part 15	Restrictions of use for Part 15 listed RF Equipment in Safety of Life Emergency Functions and Equipment Locations
Part 47	Chapter A, Paragraphs 6.1-6.23, Access to Telecommunications Service, Telecommunications Equipment and Customer Premises Equipment
Part 58	Television Broadcast Service
Part 73	Radio and Television Broadcast Rules
Part 90	Rules and Regulations, Appendix C
Form 854	Antenna Structure Registration
Chapter XXIII	National Telecommunications and Information Administration (NTIA, P/O Commerce, Chapter XXIII) the 'Red Book'– Chapters 7, 8 & 9 compliments CFR, Title 47, FCC Part 15, RF Restriction of Use and Compliance in "Safety of Life" Functions & Locations

2. US Department of Agriculture, (Title 7, USC, Chapter 55, Sections 2201, 2202 & 2203:RUS 1755 Telecommunications Standards and Specifications for Materials, Equipment and Construction:

RUS Bull 1751F-630	Design of Aerial Cable Plants
RUS Bull 1751F-640	Design of Buried Cable Plant, Physical Considerations
RUS Bull 1751F-643	Underground Plant Design
RUS Bull 1751F-815	Electrical Protection of Outside Plants,
RUS Bull 1753F-201	Acceptance Tests of Telecommunications Plants (PC-4)
RUS Bull 1753F-401	Splicing Copper and Fiber Optic Cables (PC-2)
RUS Bull 345-50	Trunk Carrier Systems (PE-60)
RUS Bull 345-65	Shield Bonding Connectors (PE-65)
RUS Bull 345-72	Filled Splice Closures (PE-74)
RUS Bull 345-83	Gas Tube Surge Arrestors (PE-80)

3. US Department of Commerce/National Institute of Standards Technology,(NIST):

FIPS PUB 1-1	Telecommunications Information Exchange
FIPS PUB 100/1	Interface between Data Terminal Equipment (DTE) Circuit Terminating Equipment for operation with Packet Switched Networks, or Between Two DTEs, by Dedicated Circuit
FIPS PUB 140/2	Telecommunications Information Security Algorithms
FIPS PUB 143	General Purpose 37 Position Interface between DTE and Data Circuit Terminating Equipment
FIPS 160/2	Electronic Data Interchange (EDI),
FIPS 175	Federal Building Standard for Telecommunications Pathway and Spaces
FIPS 191	Guideline for the Analysis of Local Area Network Security
FIPS 197	Advanced Encryption Standard (AES)
FIPS 199	Standards for Security Categorization of Federal Information and Information Systems

4. US Department of Defense, (DoD):

MIL-STD-188-110	Interoperability and Performance Standards for Data Modems
MIL-STD-188-114	Electrical Characteristics of Digital Interface Circuits
MIL-STD-188-115	Communications Timing and Synchronizations Subsystems
MIL-C-28883	Advanced Narrowband Digital Voice Terminals
MIL-C-39012/21	Connectors, Receptacle, Electrical, Coaxial, Radio Frequency, (Series BNC (Uncabled), Socket Contact, Jam Nut Mounted, Class 2)

5. US Department of Health and Human Services:
   The Health Insurance Portability and Accountability Act of 1996 (HIPAA) Privacy, Security and Breach Notification Rules
6. US Department of Justice:
   2010 Americans with Disabilities Act Standards for Accessible Design (ADAAD).

7. US Department of Labor, (DoL) - Public Law 426-62 – CFR, Title 29, Part 1910, Chapter XVII - Occupational Safety and Health Administration (OSHA), Occupational Safety and Health Standards):

Subpart 7	Approved NRTLs; obtain a copy at https://www.osha.gov/dts/otpca/nrtl/nrtllist.html
Subpart 35	Compliance with NFPA 101, Life Safety Code
Subpart 36	Design and Construction Requirements for Exit Routes
Subpart 268	Telecommunications
Subpart 305	Wiring Methods, Components, and Equipment for General Use
Subpart 508	Americans with Disabilities Act Accessibility Guidelines; technical requirement for accessibility to buildings and facilities by individuals with disabilities

8. US Department of Transportation, (DoT):
   a. Public Law 85-625, CFR, Title 49, Part 1, Subpart C – Federal Aviation Administration (FAA):AC 110/460-ID & AC 707 / 460-2E – Advisory Circulars Standards for Construction of Antenna Towers, and 7450 and 7460-2 – Antenna Construction Registration Forms.
9. US Department of Veterans Affairs (VA): Office of Telecommunications (OI&T), MP-6, PART VIII, TELECOMMUNICATIONS, CHAPTER 5, AUDIO, RADIO AND TELEVISION (and COMSEC) COMMUNICATIONS SYSTEMS: Spectrum Management and COMSEC Service (SMCS), AHJ for:
   a. CoG, “Continuance of Government” communications guidelines and compliance.
   b. COMSEC,“VA wide coordination and control of security classified communication assets.”
   c. COOP, “Continuance of Operations” emergency communications guidelines and compliance.
   d. FAA, FCC, and US Department of Commerce National Telecommunications and Information Administration, “VA wide RF Co-ordination, Compliance and Licensing.”
   e. Handbook 6100 – Telecommunications: Cyber and Information Security Office of Cyber and Information Security, and Handbook 6500 – Information Security Program.

f. Low Voltage Special Communications Systems "Design, Engineering, Construction Contract Specifications and Drawings Conformity, Proof of Performance Testing, VA Compliance and Life Safety Certifications for CFM and VA Facility Low Voltage Special Communications Projects (except Fire Alarm, Telephone and Data Systems)."

g. SATCOM, "Satellite Communications" guidelines and compliance, and Security and Law Enforcement Systems – "Coordinates the Design, Engineering, Construction Contract Specifications and Drawings Conformity, Proof of Performance Testing, VA Compliance, DEA and Public Safety Certification(s) for CFM and VA Facility Security Low Voltage Special Communications and Physical Security Projects.

h. VHA's National Center for Patient Safety – Veterans Health Administration (VHA) Warning System, Failure of Medical Alarm Systems using Paging Technology to Notify Clinical Staff, July 2004.

i. VA's CEOSH, concurrence with warning identified in VA Directive 7700.

j. Wireless and Handheld Devices, "Guidelines and Compliance,"

k. Office of Security and Law Enforcement: VA Directive 0730 and Health Special Presidential Directive (HSPD)-12.

C. NRTL Standards: Refer to https://www.osha.gov/laws-regs/regulations/standardnumber/1926

1. Canadian Standards Association (CSA); same tests as presented by UL
2. Communications Certifications Laboratory (CEL); same tests as presented by UL.
3. Intertek Testing Services NA, Inc., (ITSNA), formerly Edison Testing Laboratory (ETL) same tests as presented by UL).
4. Underwriters Laboratory (UL):

1-2005	Flexible Metal Conduit
5-2011	Surface Metal Raceway and Fittings
6-2007	Rigid Metal Conduit
44-010	Thermoset-Insulated Wires and Cables
50-1995	Enclosures for Electrical Equipment
65-2010	Wired Cabinets
83-2008	Thermoplastic-Insulated Wires and Cables
96-2005	Lightning Protection Components

96A-2007	Installation Requirements for Lightning Protection Systems
360-2013	Liquid-Tight Flexible Steel Conduit
444-2008	Communications Cables
467-2013	Grounding and Bonding Equipment
486A-486B-2013	Wire Connectors
486C-2013	Splicing Wire Connectors
486D-2005	Sealed Wire Connector Systems
486E-2009	Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors
493-2007	Thermoplastic-Insulated Underground Feeder and Branch Circuit Cable
497/497A/497B/497C	
497D/497E	Protectors for Paired Conductors/Communications Circuits/Data Communications and Fire Alarm Circuits/coaxial circuits/voltage protections/Antenna Lead In
510-2005	Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape
514A-2013	Metallic Outlet Boxes
514B-2012	Fittings for Cable and Conduit
514C-1996	Nonmetallic Outlet Boxes, Flush-Device Boxes and Covers
651-2011	Schedule 40 and 80 Rigid PVC Conduit
651A-2011	Type EB and A Rigid PVC Conduit and HDPE Conduit
797-2007	Electrical Metallic Tubing
884-2011	Underfloor Raceways and Fittings
1069-2007	Hospital Signaling and Nurse Call Equipment
1242-2006	Intermediate Metal Conduit
1449-2006	Standard for Transient Voltage Surge Suppressors
1479-2003	Fire Tests of Through-Penetration Fire Stops
1480-2003	Speaker Standards for Fire Alarm, Emergency, Commercial and Professional use
1666-2007	Standard for Wire/Cable Vertical (Riser) Tray Flame Tests

1685-2007	Vertical Tray Fire Protection and Smoke Release Test for Electrical and Fiber Optic Cables
1861-2012	Communication Circuit Accessories
1863-2013	Standard for Safety, communications Circuits Accessories
1865-2007	Standard for Safety for Vertical-Tray Fire Protection and Smoke-Release Test for Electrical and Optical-Fiber Cables
2024-2011	Standard for Optical Fiber Raceways
2024-2014	Standard for Cable Routing Assemblies and Communications Raceways
2196-2001	Standard for Test of Fire Resistive Cable
60950-1 ed. 2-2014	Information Technology Equipment Safety

D. Industry Standards:

1. Advanced Television Systems Committee (ATSC):

A/53 Part 1: 2013	ATSC Digital Television Standard, Part 1, Digital Television System
A/53 Part 2: 2011	ATSC Digital Television Standard, Part 2, RF/Transmission System Characteristics
A/53 Part 3: 2013	ATSC Digital Television Standard, Part 3, Service Multiplex and Transport System Characteristics
A/53 Part 4: 2009	ATSC Digital Television Standard, Part 4, MPEG-2 Video System Characteristics
A/53 Part 5: 2014	ATSC Digital Television Standard, Part 5, AC-3 Audio System Characteristics
A/53 Part 6: 2014	ATSC digital Television Standard, Part 6, Enhanced AC-3 Audio System Characteristics

2. American Institute of Architects (AIA): 2006 Guidelines for Design & Construction of Health Care Facilities.

3. American Society of Mechanical Engineers (ASME):

A17.1 (2013)	Safety Code for Elevators and Escalators Includes Requirements for Elevators, Escalators, Dumbwaiters, Moving Walks, Material Lifts, and Dumbwaiters with Automatic Transfer Devices
17.3 (2011)	Safety Code for Existing Elevators and Escalators

17.4 (2009) Guide for Emergency Personnel

17.5 (2011) Elevator and Escalator Electrical Equipment

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

B1 (2001) Standard Specification for Hard-Drawn Copper Wire

B8 (2004) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

D1557 (2012) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort 56,000 ft-lbf/ft3 (2,700 kN-m/m3)

D2301 (2004) Standard Specification for Vinyl Chloride Plastic Pressure Sensitive Electrical Insulating Tape

B258-02 (2008) Standard Specification for Standard Nominal Diameters and Cross-Sectional Areas of AWG Sizes of Solid Round Wires Used as Electrical Conductors

D709-01(2007) Standard Specification for Laminated Thermosetting Materials

D4566 (2008) Standard Test Methods for Electrical Performance Properties of Insulations and Jackets for Telecommunications Wire and Cable

5. American Telephone and Telegraph Corporation (AT&T) - Obtain following AT&T Publications at https://ebiznet.sbc.com/sbcnebs/

ATT-TP-76200 (2013) Network Equipment and Power Grounding, Environmental, and Physical Design Requirements

ATT-TP-76300(2012) Merged AT&T Affiliate Companies Installation Requirements

ATT-TP-76305 (2013) Common Systems Cable and Wire Installation and Removal Requirements - Cable Racks and Raceways

ATT-TP-76306 (2009) Electrostatic Discharge Control

ATT-TP-76400 (2012) Detail Engineering Requirements

ATT-TP-76402 (2013) AT&T Raised Access Floor Engineering and Installation Requirements

ATT-TP-76405 (2011) Technical Requirements for Supplemental Cooling Systems in Network Equipment Environments

ATT-TP-76416 (2011) Grounding and Bonding Requirements for Network Facilities
ATT-TP-76440 (2005) Ethernet Specification
ATT-TP-76450 (2013) Common Systems Equipment Interconnection Standards for AT&T Network Equipment Spaces
ATT-TP-76461 (2008) Fiber Optic Cleaning
ATT-TP-76900 (2010) AT&T Installation Testing Requirement
ATT-TP-76911 (1999) AT&T LEC Technical Publication Notice

6. British Standards Institution (BSI):
BS EN 50109-2 Hand Crimping Tools - Tools for The Crimp Termination of Electric Cables and Wires for Low Frequency and Radio Frequency Applications – All Parts & Sections. October 1997

7. Building Industry Consulting Service International(BICSI):
ANSI/BICSI 002-2011 Data Center Design and Implementation Best Practices
ANSI/BICSI 004-2012 Information Technology Systems Design and Implementation Best Practices for Healthcare Institutions and Facilities
ANSI/NECA/BICSI 568-2006 Standard for Installing Commercial Building Telecommunications Cabling
NECA/BICSI 607-2011 Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings
ANSI/BICSI 005-2013 Electronic Safety and Security (ESS) System Design and Implementation Best Practices

8. Electronic Components Assemblies and Materials Association,(ECA).
ECA EIA/RS-270 (1973)Tools, Crimping, Solderless Wiring Devices – Recommended Procedures for User Certification
EIA/ECA 310-E (2005) Cabinets, and Associated Equipment

9. Facility Guidelines Institute: 2010 Guidelines for Design and Construction of Health Care Facilities.

10. Insulated Cable Engineers Association (ICEA):
ANSI/ICEA S-80-576-2002 Category 1 & 2 Individually Unshielded Twisted-Pair Indoor Cables for Use in Communications Wiring Systems

ANSI/ICEA S-84-608-2010	Telecommunications Cable, Filled Polyolefin Insulated Copper Conductor, S-87-640(2011) Optical Fiber Outside Plant Communications Cable
ANSI/ICEA S-90-661-2012	Category 3, 5, & 5e Individually Unshielded Twisted-Pair Indoor Cable for Use in General Purpose and LAN Communication Wiring Systems
S-98-688 (2012)	Broadband Twisted Pair Cable Aircore, Polyolefin Insulated, Copper Conductors
S-99-689 (2012)	Broadband Twisted Pair Cable Filled, Polyolefin Insulated, Copper Conductors
ICEA S-102-700 (2004)	Category 6 Individually Unshielded Twisted Pair Indoor Cables (With or Without an Overall Shield) for use in Communications Wiring Systems Technical Requirements

11. Institute of Electrical and Electronics Engineers (IEEE):

ISSN 0739-5175	March-April 2008 Engineering in Medicine and Biology Magazine, IEEE (Volume: 27, Issue:2) Medical Grade-Mission Critical-Wireless Networks
IEEE C2-2012	National Electrical Safety Code (NESC)
C62.41.2-2002/ Cor 1-2012 IEEE	Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits 4)
C62.45-2002	IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits
81-2012 IEEE	Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System
100-1992	IEEE the New IEEE Standards Dictionary of Electrical and Electronics Terms
602-2007	IEEE Recommended Practice for Electric Systems in Health Care Facilities

1100-2005 IEEE Recommended Practice for Powering and Grounding Electronic Equipment

12. International Code Council:

AC193 (2014) Mechanical Anchors in Concrete Elements

13. International Organization for Standardization (ISO):

ISO/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

14. National Electrical Manufacturers Association (NEMA):

NEMA 250 (2008) Enclosures for Electrical Equipment (1,000V Maximum)

ANSI C62.61 (1993) American National Standard for Gas Tube Surge Arresters on Wire Line Telephone Circuits

ANSI/NEMA FB 1 (2012) Fittings, Cast Metal Boxes and Conduit Bodies for Conduit, Electrical Metallic Tubing EMT) and Cable

ANSI/NEMA OS 1 (2009) Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports

NEMA SB 19 (R2007) NEMA Installation Guide for Nurse Call Systems

TC 3 (2004) Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing

NEMA VE 2 (2006) Cable Tray Installation Guidelines

15. National Fire Protection Association (NFPA):

70E-2015 Standard for Electrical Safety in the Workplace

70-2014 National Electrical Code (NEC)

72-2013 National Fire Alarm Code

75-2013 Standard for the Fire Protection of Information Technological Equipment

76-2012 Recommended Practice for the Fire Protection of Telecommunications Facilities

77-2014 Recommended Practice on Static Electricity

90A-2015 Standard for the Installation of Air Conditioning and Ventilating Systems

99-2015 Health Care Facilities Code

101-2015 Life Safety Code

241	Safeguarding construction, alternation and Demolition Operations
255-2006	Standard Method of Test of Surface Burning Characteristics of Building Materials
262 - 2011	Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces
780-2014	Standard for the Installation of Lightning Protection Systems
1221-2013	Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems
5000-2015	Building Construction and Safety Code

16. Society for Protective Coatings (SSPC):
    SSPC SP 6/NACE No.3 (2007) Commercial Blast Cleaning
17. Society of Cable Telecommunications Engineers (SCTE):

ANSI/SCTE 15 2006	Specification for Trunk, Feeder and Distribution Coaxial Cable

18. Telecommunications Industry Association (TIA):

TIA-120 Series	Telecommunications Land Mobile communications (APCO/Project 25) (January 2014)
TIA TSB-140	Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fiber Cabling Systems (2004)
TIA-155	Guidelines for the Assessment and Mitigation of Installed Category 6 Cabling to Support 10GBASE-T (2010)
TIA TSB-162-A	Telecommunications Cabling Guidelines for Wireless Access Points (2013)
TIA-222-G	Structural Standard for Antenna Supporting Structures and Antennas (2014)
TIA/EIA-423-B	Electrical Characteristics of Unbalanced Voltage Digital Interface Circuits (2012)
TIA-455-C	General Requirements for Standard Test Procedures for Optical Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and other Fiber Optic Components (August 2014)

TIA-455-53-A	FOTP-53 Attenuation by Substitution Measurements for Multimode Graded-Index Optical Fibers in Fiber Assemblies (Long Length) (September 2001)
TIA-455-61-A	FOTP-61 Measurement of Fiber of Cable Attenuation Using an OTDR (July 2003)
TIA-472D000-B	Fiber Optic Communications Cable for Outside Plant Use (July 2007)
ANSI/TIA-492-B	62.5-µ Core Diameter/125-um Cladding Diameter Class 1a Graded-Index Multimode Optical Fibers (November 2009)
ANSI/TIA-492AAAB-A	50-um Core Diameter/125-um Cladding Diameter Class IA Graded-Index Multimode Optically Optimized American Standard Fibers (November 2009
TIA-492CAAA	Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers (September 2002)
TIA-492E000	Sectional Specification for Class IVd Nonzero-Dispersion Single-Mode Optical Fibers for the 1,550 nm Window (September 2002)
TIA-526-7-B	Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant – OFSTP-7 (December 2008)
TIA-526.14-A	Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant – SFSTP-14 (August 1998)
TIA-568	Revision/Edition: C Commercial Building Telecommunications Cabling Standard Set: (TIA-568-C.0-2 Generic Telecommunications Cabling for Customer Premises (2012), TIA-568-C.1-1 Commercial Building Telecommunications Cabling Standard Part 1: General Requirements (2012), TIA-568-C.2 Commercial Building Telecommunications Cabling Standard—Part 2: Balanced Twisted Pair Cabling Components (2009), TIA-568-C.3-1 Optical Fiber Cabling Components Standard, (2011) AND TIA-568-C.4

	Broadband Coaxial Cabling and Components Standard (2011) with addendums and erratas
TIA-569	Revision/Edition C Telecommunications Pathways and Spaces (March 2013)
TIA-574	Position Non-Synchronous Interface between Data Terminal equipment and Data Circuit Terminating Equipment Employing Serial Binary Interchange (May 2003)
TIA/EIA-590-A	Standard for Physical Location and Protection of Below Ground Fiber Optic Cable Plant (July 2001)
TIA-598-D	Optical Fiber Cable Color Coding (January 2005)
TIA-604-10-B	Fiber Optic Connector Intermateablility Standard (August 2008)
ANSI/TIA-606-B	Administration Standard for Telecommunications Infrastructure (2012)
TIA-607-B	Generic Telecommunications Bonding and Grounding (Earthing) For Customer Premises (January 2013)
TIA-613	High Speed Serial Interface for Data Terminal Equipment and Data Circuit Terminal Equipment (September 2005)
ANSI/TIA-758-B	Customer-owned Outside Plant Telecommunications Infrastructure Standard (April 2012)
ANSI/TIA-854	A Full Duplex Ethernet Specification for 1000 Mb/s (1000BASE-TX) Operating over Category 6 Balanced Twisted-Pair Cabling (2001)
ANSI/TIA-862-A	Building Automation Systems Cabling Standard (April 2011)
TIA-942-A	Telecommunications Infrastructure Standard for Data Centers (March 2014)
TIA-1152	Requirements for Field Testing Instruments and Measurements for Balanced Twisted Pair Cabling (September 2009)
TIA-1179	Healthcare Facility Telecommunications Infrastructure Standard (July 2010)

1.4 SINGULAR NUMBER

A. Where any device or part of equipment is referred in singular number (such as " rack"), reference applies to as many such devices as are required to complete installation.

1.5 RELATED WORK

A. Specification Order of Precedence: FAR Clause 52.236-21, VAAR Clause 852.236-71.

1. Field Cutting and Patching: Section 09 91 00, PAINTING.
2. Additional submittal requirements: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.
3. Control of environmental pollution and damage for air, water, and land resources: Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS.
4. Requirements for non-hazardous building construction and demolition waste: Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
5. Closures of openings in walls, floors, and roof decks against penetration of flame, heat, and smoke or gases in fire resistant rated construction: Section 07 84 00, FIRESTOPPING.
6. Sealant and caulking materials and their application: Section 07 92 00, JOINT SEALANTS.
7. General electrical requirements that are common to more than one section of Division 26: Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
8. Electrical conductors and cables in electrical systems rated 600 V and below: Section 26 05 21, LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW).
9. Requirements for personnel safety and to provide a low impedance path to ground for possible ground fault currents: Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.
10. Conduit and boxes: Section 26 05 33, RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS.
11. Wiring devices: Section 26 27 26, WIRING DEVICES.
12. Physical Access Control System field-installed controllers connected by data transmission network: Section 28 13 00, PHYSICAL ACCESS DETECTION.
13. Alarm initiating devices, alarm notification appliances, control units, fire safety control devices, annunciators, power supplies, and wiring: Section 28 31 00, FIRE DETECTION AND ALARM.

1.6 ADMINISTRATIVE REQUIREMENTS

A. Assign a single communications project manager to serve as point of contact for Government, contractor, and design professional.

B. Be proactive in scheduling work.

1. Use of premises is restricted at times directed by COR.
2. Movement of materials: Unload materials and equipment delivered to site. Pay costs for rigging, hoisting, lowering and moving equipment on and around site, in building or on roof.
3. Coordinate installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
4. Sequence, coordinate, and integrate installations of materials and equipment for efficient flow of Work.
5. Coordinate connection of materials, equipment, and systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies; provide required connection for each service.
6. Initiate and maintain discussion regarding schedule for ceiling construction and install cables to meet that schedule.

C. Communications Project Manager Responsibilities:

1. Assume responsibility for overall telecommunications system integration and coordination of work among trades, subcontractors, and authorized system installers.
2. Coordinate with related work indicated on drawings or specified.
3. Manage work related to telecommunications system installation in a manner approved by manufacturer.

1.7 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Provide parts list including quantity of spare parts.

C. Provide manufacturer product information. Government reserves the right to require a list of installations where products have been in operation.

D. Provide Source Quality Control Submittal:

1. Submit written certification from OEM indicating that proposed supervisor of installation and proposed provider of warranty maintenance are authorized representatives of OEM. Include

individual's legal name, contact information and OEM credentials in certification.

2. Submit written certification from OEM that wiring and connection diagrams meet Government Life Safety Guidelines, NFPA, NEC, NRTL, these specifications, and Joint Commission requirements and instructions, requirements, recommendations, and guidance set forth by OEM for the proper performance of system.
3. Pre-acceptance Certification: Certification in accordance with procedure outlined in Section 01 00 00, GENERAL REQUIREMENTS and specific Division 27 qualification documentation.

E. Installer Qualifications: Submit three installations of similar size and complexity furnished and installed by installer; include:
1. Installation location and name.
2. Owner’s name and contact information including, address, telephone and email.
3. Date of project start and date of final acceptance.
4. System project number.
5. Three paragraph description of each system related to this project; include function, operation, and installation.

F. Provide delegated design submittals (e.g. seismic support design).

G. Submittals are required for all equipment anchors and supports. Include weights, dimensions, center of gravity, standard connections, manufacturer's recommendations and behavior problems (e.g., vibration, thermal expansion,) associated with equipment or conduit. Anchors and supports to resist seismic load based on seismic design categories per section 4.0 of VA seismic design requirements H-18-8 dated August, 2013.

H. Test Equipment List:
1. Supply test equipment of accuracy better than parameters to be tested.
2. Submit test equipment list including make and model number:
a. ANSI/TIA-1152 Level IIIe twisted pair cabling test instrument.
b. Optical time domain reflectometer (OTDR).
c. Volt-Ohm meter.
3. Supply only test equipment with a calibration tag from Government-accepted calibration service dated not more than 12 months prior to test.
4. Provide sample test and evaluation reports.

I. Submittal Drawings:

1. Access Panel Schedule on Submittal Drawings: Coordinate and prepare a location, size, and function schedule of access panels required to fully service equipment.

J. Provide sustainable design submittals.

K. Furnish electronic certified test reports to COR prior to final inspection and not more than 90 days after completion of tests.

1.8 CLOSEOUT SUBMITTALS

A. Provide following closeout submittals prior to project closeout date:

1. Warranty certificate.
2. Evidence of compliance with requirements such as low voltage certificate of inspection.
3. Project record documents.
4. Instruction manuals and software that are a part of system.

B. Maintenance and Operation Manuals: Submit in accordance with Section 01 00 00, GENERAL REQUIREMENTS.

1. Prepare a manual for each system and equipment specified.
2. Furnish on portable storage drive in PDF format or equivalent accepted by COR.
3. Furnish complete manual as specified in specification section, fifteen days prior to performance of systems or equipment test.
4. Furnish remaining manuals prior to final completion.
5. Identify storage drive "MAINTENANCE AND OPERATION MANUAL" and system name.
6. Include name, contact information and emergency service numbers of each subcontractor installing system or equipment and local representatives for system or equipment.
7. Provide a Table of Contents and assemble files to conform to Table of Contents.
8. Operation and Maintenance Data includes:
   a. Approved shop drawing for each item of equipment.
   b. Internal and interconnecting wiring and control diagrams with data to explain detailed operation and control of equipment.
   c. A control sequence describing start-up, operation, and shutdown.
   d. Description of function of each principal item of equipment.
   e. Installation and maintenance instructions.
   f. Safety precautions.
   g. Diagrams and illustrations.

h. Test Results and testing methods.

i. Performance data.

j. Pictorial "exploded" parts list with part numbers. Emphasis to be placed on use of special tools and instruments. Indicate sources of supply, recommended spare parts, and name of servicing organization.

k. Warranty documentation indicating end date and equipment protected under warranty.

l. Appendix; list qualified permanent servicing organizations for support of equipment, including addresses and certified personnel qualifications.

C. Record Wiring Diagrams:

1. Red Line Drawings: Keep one E1 size 76.2 cm x 106.7 cm (30 inches x 42 inches) set of floor plans, on site during work hours, showing installation progress marked and backbone cable labels noted. Make these drawings available for examination during construction meetings or field inspections.

2. General Drawing Specifications: Detail and elevation drawings to be E1 size 30 inches x 42 inches with a minimum scale of 1/4 inch = 12 inches. ER, TR and other enlarged detail floor plan drawings to be E1 size 30 inches x 42 inches with a minimum scale of 1/4 inch = 12 inches. Building composite floor plan drawings to be E1 size 30 inches x 42 inches with a minimum scale of 1/8 inch = 1’ 0 inch.

3. Building Composite Floor Plans: Provide building floor plans showing work area outlet locations and configuration, types of jacks, distance for each cable, and cable routing locations.

4. Floor plans to include:

a. Final room numbers and actual backbone cabling and pathway locations and labeling.

b. Inputs and outputs of equipment identified according to labels installed on cables and equipment

c. Device locations with labels.

d. Conduit.

e. Head-end equipment.

f. Wiring diagram.

g. Labeling and administration documentation.

5. Submit Record Wiring Diagrams within five business days after final cable testing.

6. Deliver Record Wiring Diagrams as CAD files in .dwg formats as determined by COR.
7. Deliver four complete sets of electronic record wiring diagrams to COR on compact disc.

D. Service Qualifications: Submit name and contact information of service organizations providing service to this installation within four hours of receipt of notification service is needed.

1.9 MAINTENANCE MATERIAL SUBMITTALS

A. After approval and prior to installation, furnish COR with the following:
1. A 300 mm (12 inch) length of each type and size of wire and cable along with tag from coils of reels from which samples were taken.
2. One coupling, bushing and termination fitting for each type of conduit.
3. Samples of each hanger, clamp and supports for conduit and pathways.
4. Duct sealing compound.

1.10 QUALITY ASSURANCE

A. Manufacturer’s Qualifications: Manufacturer must produce, as a principal product, the equipment and material specified for this project, and have manufactured item for at least three years.

B. Product and System Qualification:
1. OEM must have three installations of equipment submitted presently in operation of similar size and type as this project, that have continuously operated for a minimum of three years.
2. Government reserves the right to require a list of installations where products have been in operation before approval.
3. Authorized representative of OEM must be responsible for design, satisfactory operation of installed system, and certification.

C. Trade Contractor Qualifications: Trade contractor must have completed three or more installations of similar systems of comparable size and complexity with regards to coordinating, engineering, testing, certifying, supervising, training, and documentation. Identify these installations as a part of submittal.

D. System Supplier Qualifications: System supplier must be authorized by OEM to warranty installed equipment.

E. Telecommunications technicians assigned to system must be trained, and certified by OEM on installation and testing of system; provide written evidence of current OEM certifications for installers.

F. Manufactured Products:

1. Comply with FAR clause 52.236-5 for material and workmanship.
2. When more than one unit of same class of equipment is required, units must be product of a single manufacturer.
3. Equipment Assemblies and Components:
   a. Components of an assembled unit need not be products of same manufacturer.
   b. Manufacturers of equipment assemblies, which include components made by others, to assume complete responsibility for final assembled unit.
   c. Provide compatible components for assembly and intended service.
   d. Constituent parts which are similar must be product of a single manufacturer.
4. Identify factory wiring on equipment being furnished and on wiring diagrams.

G. Testing Agencies: Government reserves the option of witnessing factory tests. Notify COR minimum 21 working days prior to manufacturer performing the factory tests.

1. When equipment fails to meet factory test and re-inspection is required, contractor is liable for additional expenses, including expenses of Government.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Government's approval of submittals must be obtained for equipment and material before delivery to job site.
2. Deliver and store materials to job site in OEM's original unopened containers, clearly labeled with OEM's name and equipment catalog numbers, model and serial identification numbers for COR to inventory cable, patch panels, and related equipment.

B. Storage and Handling Requirements:

1. Equipment and materials must be protected during shipment and storage against physical damage, dirt, moisture, cold and rain:
   a. Store and protect equipment in a manner that precludes damage or loss, including theft.
   b. Protect painted surfaces with factory installed removable heavy kraft paper, sheet vinyl or equivalent.
   c. Protect enclosures, equipment, controls, controllers, circuit protective devices, and other like items, against entry of

foreign matter during installation; vacuum clean both inside and outside before testing and operating.

C. Coordinate storage.

1.12 FIELD CONDITIONS

A. Where variations from documents are requested in accordance with GENERAL CONDITIONS and Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, connecting work and related components must include additions or changes to branch circuits, circuit protective devices, conduits, wire, feeders, controls, panels and installation methods.

B. A contract adjustment or additional time will not be granted because of field conditions pursuant to FAR 52.236-2 and FAR 52.236-3; a contract adjustment or additional time will not be granted for additional work required for complete and usable construction and systems pursuant to FAR 52.246-12.

1.13 WARRANTY

A. Comply with FAR clause 52.246-21.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA

A. Provide communications spaces and pathways conforming to TIA 569, at a minimum.

2.2 EQUIPMENT IDENTIFICATION

A. Provide laminated black phenolic resin with a white core nameplates with minimum 6 mm (1/4 inch) high engraved lettering.

B. Nameplates furnished by manufacturer as standard catalog items, unless other method of identification is indicated.

2.3 WIRE LUBRICATING COMPOUND

A. Provide non-hardening or forming adhesive coating cable lubricants suitable for cable jacket material and raceway.

2.4 FIREPROOFING TAPE

A. Provide flexible, conformable fabric tape of organic composition and coated one side with flame-retardant elastomer.

B. Tape must be self-extinguishing and cannot support combustion; arc-proof and fireproof.

C. Tape cannot deteriorate when subjected to water, gases, salt water, sewage, or fungus; and tape must be resistant to sunlight and ultraviolet light.

D. Application must withstand a 200-ampere arc for minimum 30 seconds.

E. Securing Tape: Glass cloth electrical tape minimum 0.18 mm (7 mils) thick and 19 mm (3/4 inch) wide.

2.5 ACCESS PANELS

A. Panels: 304 mm x 304 mm (12 inches by 12 inches), or size allowed by location to provide optimum access to equipment for maintenance and service.

B. Provide access panels and doors as required to allow service of materials and equipment that require inspection, replacement, repair or service.

C. Provide access panels where items installed require access and are concealed in floor, wall, furred space or above ceiling; ceilings consisting of lay-in or removable splined tiles do not require access panels.

D. Provide access panels with same fire rating classification as surface penetrated.

PART 3 - EXECUTION

3.1 PREPARATION

A. Penetrations and Sleeves:

1. Lay out penetration and sleeve openings in advance, to permit provision in work.
2. Set sleeves in forms before concrete is poured.
3. Set sleeves prior to installation of structure for passage of pipes, conduit, ducts, etc.
4. Provide sleeves and packing materials at penetrations of foundations, walls, slabs, partitions, and floors.
5. Make sleeves that penetrate outside walls, basement slabs, footings, and beams waterproof.
6. Fill slots, sleeves and other openings in floors or walls if not used.
   a. Fill spaces in openings after installation of conduit or cable.
   b. Provide fill for floor penetrations to prevent passage of water, smoke, fire, and fumes.
   c. Provide fire resistant fill in floors and walls, to prevent passage of air, smoke and fumes.
7. Install sleeves through floors watertight and extend minimum 50.8 mm (2 inches) above floor surface.

8. Match and set sleeves flush with adjoining floor, ceiling, and wall finishes where raceways passing through openings are exposed in finished rooms.
9. Annular space between conduit and sleeve must be minimum 6 mm (1/4 inch).
10. Do not provide sleeves for slabs-on-grade, unless specified or indicated otherwise.
11. Comply with requirements for firestopping, for sleeves through walls and floors.
12. Do not support piping risers or conduit on sleeves.
13. Identify unused sleeves and slots for future installation.
14. Provide core drilling if walls are poured or otherwise constructed without sleeves and wall penetration is required; do not penetrate structural members.

B. Core Drilling:
1. Avoid core drilling whenever possible.
2. Coordinate openings with other trades and utilities, and prevent damage to structural reinforcement.
3. Investigate existing conditions in vicinity of required opening prior to coring, including an x-ray of floor if determined necessary by competent person or COR.
4. Protect areas from damage.

C. Verification of In-Place Conditions:
1. Verify location, use and status of all material, equipment, and utilities that are specified, indicated, or determined necessary for removal.
   a. Verify materials, equipment, and utilities to be removed are inactive, not required, or in use after completion of project.
   b. Replace with equivalent any material, equipment and utilities that were removed by contractor that are required to be left in place.
2. Existing Utilities: Do not interrupt utilities serving facilities occupied by Government or others unless permitted under following conditions and then only after arranging to provide temporary utility services, according to requirements indicated:
   a. Notify COR in writing at least 21 days in advance of proposed utility interruptions.

b. Do not proceed with utility interruptions without Government’s written permission.

D. Provide suspended platforms, strap hangers, brackets, shelves, stands or legs for floor, wall and ceiling mounting of equipment as required.

E. Provide steel supports and hardware for installation of hangers, anchors, guides, and other support hardware.

F. Obtain and analyze catalog data, weights, and other pertinent data required for coordination of equipment support provisions and installation.

G. Verify site conditions and dimensions of equipment to ensure access for proper installation of equipment without disassembly that would void warranty.

3.2 INSTALLATION - GENERAL

A. Coordinate systems, equipment, and materials installation with other building components.

B. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings.

C. Conform to VAAR 852.236.91 arrangements indicated, recognizing that work may be shown in diagrammatic form or have been impracticable to detail all items because of variances in manufacturers’ methods of achieving specified results.

D. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed in both exposed and un-exposed spaces.

E. Install equipment according to manufacturers' written instructions.

F. Install wiring and cabling between equipment and related devices.

G. Install cabling, wiring, and equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. Connect equipment for ease of disconnecting, with minimum interference of adjacent other installations.

H. Provide access panel or doors where units are concealed behind finished surfaces.

I. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for wiring, cabling, and equipment installations.

J. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide maximum headroom and access for service and maintenance as possible.

K. Install systems, materials, and equipment giving priority to systems required to be installed at a specified slope.

L. Avoid interference with structure and with work or other trades, preserving adequate headroom and clearing doors and passageways to satisfaction of COR and code requirements.

M. Install equipment and cabling to distribute equipment loads on building structural members provided for equipment support under other sections; install and support roof-mounted equipment on structural steel or roof curbs as appropriate.

N. Provide supplementary or miscellaneous items, appurtenances, devices and materials for a complete installation.

3.3 EQUIPMENT INSTALLATION

A. Locate equipment as close as practical to locations shown on drawings.

B. Note locations of equipment requiring access on record drawings.

C. Access and Access Panels: Verify access panel locations and construction with COR.

D. Inaccessible Equipment:

1. Where Government determines that contractor has installed equipment not conveniently accessible for operation and maintenance, equipment must be removed and reinstalled as directed and without additional cost to Government.

E. EQUIPMENT IDENTIFICATION

1. Install an identification sign which clearly indicates information required for use and maintenance of equipment.
2. Secure identification signs with screws.

3.4 CUTTING AND PATCHING

A. Perform cutting and patching according to contract general requirements and as follows:

1. Remove samples of installed work as specified for testing.
2. Perform cutting, fitting, and patching of equipment and materials required to uncover existing infrastructure in order to provide access for correction of improperly installed existing or new work.
3. Remove and replace defective work.
4. Remove and replace non-conforming work.

B. Cut, remove, and legally dispose of selected equipment, components, and materials, including removal of material, equipment, devices, and other items indicated to be removed and items made obsolete by new work.

C. Provide and maintain temporary partitions or dust barriers adequate to prevent spread of dust and dirt to adjacent areas.
D. Protect adjacent installations during cutting and patching operations.
E. Protect structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
F. Patch finished surfaces and building components using new materials specified for original installation and experienced installers.

3.5 FIELD QUALITY CONTROL

A. Provide work according to VAAR 852.236.91 and FAR clause 52.236-5.
B. Provide minimum clearances and work required for compliance with NFPA 70, National Electrical Code (NEC), and manufacturers' instructions; comply with additional requirements indicated for access and clearances.
C. Verify all field conditions and dimensions that affect selection and provision of materials and equipment, and provide any disassembly, reassembly, relocation, demolition, cutting and patching required to provide work specified or indicated, including relocation and reinstallation of existing wiring and equipment.
   1. Protect facility, equipment, and wiring from damage.
D. Submit written notice that:
   1. Project has been inspected for compliance with documents.
   2. Work has been completed in accordance with documents.
E. Non-Conforming Work: Conduct project acceptance inspections, final completion inspections, substantial completion inspections, and acceptance testing and demonstrations after verification of system operation and completeness by Contractor.
F. Tests:
   1. Interim inspection is required at approximately 50 percent of installation.
   2. Request inspection 21 working days prior to interim inspection start date by notifying COR in writing; this inspection must verify equipment and system being provided adheres to installation, mechanical and technical requirements of construction documents.
   3. Inspection to be conducted by OEM and factory-certified contractor representative, and witnessed by COR, and facility.
   4. Check each item of installed equipment to ensure appropriate NRTL listing labels and markings are fixed in place.

5. Verify cabling terminations in DEMARC, MCR, TER, SCC, ECC, TRs and head end rooms, workstation locations and TCO adhere to color code for T568A pin assignments and cabling connections are in compliance with TIA standards.
6. Visually confirm minimum Category 6 cable marking at TCOs, CCSs locations, patch cords and origination locations.
7. Review cable tray, conduit and path/wire way installation practice.
8. OEM and contractor to perform:
   a. Baseband cable field inspection tests via attenuation measurements on factory reels and provide results along with OEM certification for factory reel tests.
9. Relocate failed cable reels to a secured location for inventory, as directed by COR, and then remove from project site within two working days; provide COR with written confirmation of defective cable reels removal from project site.
10. Provide results of interim inspections to COR.
11. If major or multiple deficiencies are discovered, additional interim inspections could be required until deficiencies are corrected, before permitting further system installation.
    a. Additional inspections are scheduled at direction of COR.
    b. Re-inspection of deficiencies noted during interim inspections, must be part of system’s Final Acceptance Proof of Performance Test.
    c. The interim inspection cannot affect the system’s completion date unless directed by COR.
12. Contractor will ensure test documents become a part of system’s official documentation package.

G. Pretesting: Re-align, re-balance, sweep, re-adjust and clean entire system and leave system working for a “break-in” period, upon completing installation of system and prior to Final Acceptance Proof of Performance Test. System RF transmitting equipment must not be connected to keying or control lines during “break-in” period.
   1. Pretesting Procedure:
      a. Verify systems are fully operational and meet performance requirements, utilizing accepted test equipment and spectrum analyzer.
      b. Pretest and verify system functions and performance requirements conform to construction documents and, that no unwanted physical,

aural and electronic effects, such as signal distortion, noise pulses, glitches, audio hum, poling noise are present.

2. Measure and record signal, aural and control carrier levels of each DAS RF, voice and data channel, at each of the following minimum points in system:
   a. System interfaces in locations listed herein.
   b. HE interconnections.
   c. Each general floor areas.
3. Provide recorded system pretest measurements and certification that the system is ready for formal acceptance test to COR.

H. Acceptance Test:
1. Schedule an acceptance test date after system has been pretested, and pretest results and certification submitted to COR.
2. Give COR 21 working days written notice prior to date test is expected to begin; include expected duration of time for test in notification.
3. Test in the presence of the following:
   a. COR.
   b. OEM representatives.
   c. Facility:
      1) FMS Service Chief, Bio-Medical Engineering and facility representatives.
      2) OI&T Service Chief and OI&T representatives.
4. Test system utilizing accepted test equipment to certify proof of performance and Life and Public Safety compliance, FCC, NRTL, NFPA and OSHA compliance.
   a. Rate system as acceptable or unacceptable at conclusion of test; make only minor adjustments and connections required to show proof of performance.
      1) Demonstrate and verify that system complies with performance requirements under operating conditions.
      2) Failure of any part of system that precludes completion of system testing, and which cannot be repaired within four hours, terminates acceptance test of that portion of system.
      3) Repeated failures that result in a cumulative time of eight hours to affect repairs is cause for entire system to be declared unacceptable.

4) If system is declared unacceptable, retesting must be rescheduled at convenience of Government and costs borne by the contractor.

I. Acceptance Test Procedure:

1. Physical and Mechanical Inspection: The test team representatives must tour major areas to determine system and sub-systems are completely and properly installed and are ready for acceptance testing.
2. A system inventory including available spare parts must be taken at this time.
3. Each item of installed equipment must be re-checked to ensure appropriate NRTL (i.e. UL) certification listing labels are affixed.
4. Confirm that deficiencies reported during Interim Inspections and Pretesting are corrected prior to start of Acceptance Test.
5. Inventory system diagrams, record drawings, equipment manuals, pretest results.
6. Failure of system to meet installation requirements of specifications is grounds for terminating testing and to schedule re-testing.

J. Operational Test:

1. Government’s Condition of Acceptance of System Language:
   a. Without Acceptance: Until system fully meets conditions of construction documents, system’s ownership, use, operation and warranty commences at Government’s final acceptance date.
   b. With Conditional Acceptance: Stating conditions that need to be addressed by contractor or OEM and stating system’s use and operation to commence immediately while its warranty commences only at Government’s agreed final extended acceptance date.
   c. With Full Acceptance: Stating system’s ownership, use, operation and warranty to immediately commence at Government’s agreed to date of final acceptance.

K. Acceptance Test Conclusion: Reschedule testing on deficiencies and shortages with COR. Perform retesting to comply with these specifications at contractor's expense.

L. Final acceptance shall not begin until the entire addition and remodeled space is turned over to VA for use when all trades have completed their work and the construction contract may be closed out.

M. Proof of Performance Certification:

1. If system is declared acceptable, AHJ) provides COR notice stating system processes to required operating standards and functions and is Government accepted for use by facility.
2. Validate items with COR needing to be provided to complete project contract (i.e. charts & diagrams, manuals, spare parts, system warranty documents executed, etc.).
3. If system is declared unacceptable without conditions, rescheduled testing expenses are to be borne by contractor.

3.6 CLEANING

A. Remove debris, rubbish, waste material, tools, construction equipment, machinery and surplus materials from project site and clean work area, prior to final inspection and acceptance of work.
B. Put building and premises in neat and clean condition.
C. Remove debris on a daily basis.
D. Remove unused material, during progress of work.
E. Perform cleaning and washing required to provide acceptable appearance and operation of equipment to satisfaction of COR.
F. Clean exterior surface of all equipment, including concrete residue, dirt, and paint residue, after completion of project.
G. Perform final cleaning prior to project acceptance by COR.
H. Remove paint splatters and other spots, dirt, and debris; touch up scratches and mars of finish to match original finish.
I. Clean devices internally using methods and materials recommended by manufacturer.
J. Tighten wiring connectors, terminals, bus joints, and mountings, to include lugs, screws and bolts according to equipment manufacturer’s published torque tightening values for equipment connectors. In absence of published connection or terminal torque values, comply with torque values specified in UL 486A-486B.

3.7 TRAINING

A. Provide training in accordance with subsection, INSTRUCTIONS, of Section 01 00 00, GENERAL REQUIREMENTS.
B. Provide training for equipment or system as required in each associated specification.
C. Develop and submit training schedule for approval by COR, at least 30 days prior to planned training.

3.8 PROTECTION

A. Protection of Fireproofing:

1. Install clips, hangers, clamps, supports and other attachments to surfaces to be fireproofed, if possible, prior to start of spray fireproofing work.
2. Install conduits and other items that would interfere with proper application of fireproofing after completion of spray fire proofing work.
3. Patch and repair fireproofing damaged due to cutting or course of work must be performed by installer of fireproofing and paid for by trade responsible for damage.

B. Maintain equipment and systems until final acceptance.

C. Ensure adequate protection of equipment and material during installation and shutdown and during delays pending final test of systems and equipment because of seasonal conditions.

- - - E N D - - -

SECTION 27 05 33
RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies conduit, fittings, and boxes to form complete, coordinated, raceway systems. Raceways are required for communications cabling unless shown or specified otherwise.

1.2 RELATED WORK

A. Sealing around penetrations to maintain integrity of fire rated construction: Section 07 84 00, FIRESTOPPING.

B. Sealing around conduit penetrations through building envelope to prevent moisture migration into building: Section 07 92 00, JOINT SEALANTS.

C. Identification and painting of conduit and other devices: Section 09 91 00, PAINTING.

1.3 SUBMITTALS

A. In accordance with Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS, submit the following:

1. Size and location of cabinets, splice boxes and pull boxes.
2. Layout of required conduit penetrations through structural elements.
3. Catalog cuts marked with specific item proposed and area of application identified.

B. Certification: Provide letter prior to final inspection, certifying material is in accordance with construction documents and properly installed.

PART 2 - PRODUCTS

2.1 MATERIAL

A. Minimum Conduit Size: 19 mm (3/4 inch).

B. Conduit:

1. Rigid Galvanized Steel: Conform to UL 6, ANSI C80.1.
2. Rigid Intermediate Steel Conduit (IMC): Conform to UL 1242, ANSI C80.6.
3. Conduit color will correspond to the wiring system contained within as follows:
   a. Voice communication wiring: Conduit to be white in color.
   b. Date system wiring: Conduit to be yellow in color.
   c. Overhead paging system wiring: Conduit to be orange in color.
   d. Fire alarm system wiring: Conduit to be red in color.

e. Control system wiring: Conduit to be blue in color.

4. Electrical Metallic Tubing (EMT):
   a. Maximum Size: 105 mm (4 inches).
   b. Install only for cable rated 600 volts or less.
   c. Conform to UL 797, ANSI C80.3.
5. Flexible Galvanized Steel Conduit: Conform to UL 1.
   a. Flexible conduit shall only be allowed on a case by case basis and will require COR approval prior to ordering or installation.
   b. Flexible conduit shall be limited to lengths of 6 ft unprotected by rigid conduit.
6. Liquid-tight Flexible Metal Conduit: Conform to UL 360.
   a. Flexible conduit shall only be allowed on a case by case basis and will require COR approval prior to ordering or installation.
   b. Flexible conduit shall be limited to lengths of 6 ft unprotected by rigid conduit.
7. Wireway, Approved “Basket”: Provide "Telecommunications Service” rated with approved length way partitions and cable straps to prevent wires and cables from changing from one partitioned pathway to another.

C. Conduit Fittings:
1. Rigid Galvanized Steel and Rigid Intermediate Steel Conduit Fittings:
   a. Provide fittings meeting requirements of UL 514B and ANSI/ NEMA FB 1.
   b. Sealing: Provide threaded cast iron type. Use continuous drain type sealing fittings to prevent passage of water and vapor. In concealed work, install sealing fittings in flush steel boxes with blank cover plates having same finishes as other electrical plates in room.
   c. Standard Threaded Couplings, Locknuts, Bushings, and Elbows: Only steel or malleable iron materials are acceptable. Integral retractable type IMC couplings are also acceptable.
   d. Locknuts: Bonding type with sharp edges for digging into metal wall of an enclosure.
   e. Bushings: Metallic insulating type, consisting of an insulating insert molded or locked into metallic body of fitting. Bushings made entirely of metal or nonmetallic material are not permitted.
   f. Set Screw Type Couplings:

1) Couplings listed for use in concrete are permitted for use to complete a conduit run.
2) Use set screws of case hardened steel with hex head and cup point to seat in conduit wall for positive ground. Tightening of set screws with pliers is prohibited.

g. Provide OEM approved fittings.

2. Electrical Metallic Tubing Fittings:
   a. Conform to UL 514B and ANSI/ NEMA FB1; only steel or malleable iron materials are acceptable.
   b. Couplings and Connectors:
      1) Use set screw type couplings with four set screws each for conduit sizes over 50 mm (2 inches).
      2) Use set screws of case-hardened steel with hex head and cup point to seat in wall of conduit for positive grounding.
   c. Indent type connectors or couplings are not permitted.
   d. Die-cast or pressure-cast zinc-alloy fittings or fittings made of "pot metal" are not permitted.
   e. Provide OEM approved fittings.
3. Flexible Steel Conduit Fittings:
   a. Conform to UL 514B; only steel or malleable iron materials are acceptable.
   b. Provide clamp type, with insulated throat.
   c. Provide OEM approved fittings.
4. Liquid-tight Flexible Metal Conduit Fittings:
   a. Conform to UL 514B and ANSI/ NEMA FB1; only steel or malleable iron materials are acceptable.
   b. Fittings must incorporate a threaded grounding cone, a steel or plastic compression ring, and a gland for tightening.
   c. Provide connectors with insulated throats to prevent damage to cable jacket.
   d. Provide OEM approved fittings.
5. Wireway Fittings: As recommended by wireway OEM.

D. Conduit Supports:
   1. Parts and Hardware: Provide zinc-coat or 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: Minimum 38 mm by 38 mm (1-1/2 by 1-1/2 inch), 2.78 mm (12 gage) steel, cold formed, lipped channels; with minimum 9 mm (3/8 inch) diameter steel hanger rods.
4. Solid Masonry and Concrete Anchors: Self-drilling expansion shields, or machine bolt expansion.
5. Caddy style supports will not be accepted for use.

E. Outlet, Splice, and Pull Boxes:
1. Conform to UL-50 and UL-514A.
2. Cast metal where required by NEC or shown, and equipped with rustproof boxes.
3. Sheet Metal Boxes: Galvanized steel, except where otherwise shown.
4. Install flush mounted wall or ceiling boxes with raised covers so that front face of raised cover is flush with wall.
5. Install surface mounted wall or ceiling boxes with surface style flat or raised covers.

F. Warning Tape: Standard, 4-Mil polyethylene 76 mm (3 inch) wide tape detectable type, red with black letters, and imprinted with “CAUTION BURIED COMMUNICATIONS CABLE BELOW”.

G. Flexible Nonmetallic Communications Raceway (Innerduct) and Fittings:
1. General: Provide UL 910 listed plenum, riser, and general purpose corrugated pliable communications raceway for optical fiber cables and communications cable applications; select in accordance with provisions of NEC Articles 770 and 800.
2. Provide Communications Raceway with a factory installed 567 kg (1250 lb.) tensile pre-lubricated pull tape.
3. Use only metallic straps, hangers and fittings to support raceway from building structure. Cable ties are not permitted for securing raceway to building structure.
4. Provide fittings to be installed in spaces used for environmental air made of materials that do not exceed flammability, smoke generation, ignitibility, and toxicity requirements of environmental air space.
5. Size: Metric Designator 53 (trade size 2) or smaller.
6. Outside Plant: Plenum-rated where each interduct is 75 mm (3 inches) and larger.
7. Inside Plant: Listed and marked for installation in plenum airspaces and minimum 25 mm (1 inch) inside diameter.
8. Plenum: Non-metallic communications raceway.

a. Constructed of low smoke emission, flame retardant PVC with corrugated construction.
b. UL 94 V-O rating for flame spreading limitation.

9. Provide innerduct reel lengths as necessary to ensure ducts are continuous; one piece runs from ENTR to MH; MH to MH; DEMARC to MCR/TER; TR to TR. Innerduct connectors are not permitted between rooms.
10. Provide pulling accessories used for innerduct including but not limited to, inner duct lubricants, spreaders, applicators, grips, swivels, harnesses, and line missiles (blown air) compatible with materials being pulled.

H. Outlet Boxes:
1. Flush wall mounted minimum 11.9 cm (4-11/16 inches) square, 9.2 cm (3-5/8 inches) deep pressed galvanized steel.
2. 2-Gang Tile Box:
a. Flush backbox type for installation in block walls.
b. Minimum 92 mm (3-5/8 inches) deep.

I. Weatherproof Outlet Boxes: Surface mount two gang, 67 mm (2-5/8 inches) deep weatherproof cast aluminum with powder coated finish internal threads on hubs 19 mm (3/4 inch) minimum.

J. Cable Tray:
1. Provide wire basket type of sizes indicated; with all required splicing and mounting hardware.
2. Materials and Finishes:
a. Electro-plated zinc galvanized (post plated) made from carbon steel and plated to ASTM B 633, Type III, SC-1.
b. Remove soot, manufacturing residue/oils, or metallic particles after fabrication.
c. Rounded edges and smooth surfaces.
3. Provide continuous welded top side wire to protect cable insulation and installers.
4. High strength steel wires formed into a 50 x 100 mm (2 inches by 4 inches) wire mesh pattern with intersecting wires welded together.
5. Wire Basket Sizes:
a. Wire Diameter: 5 mm (0.195 inch) minimum on all mesh sections.
b. Usable Loading Depth: 105 mm (4 inch).
c. Width: 300 mm (12 inches).

6. Fittings: Field-formed, from straight sections, in accordance with manufacturer's instructions.
7. Provide accessories to protect, support and install wire basket tray system.

K. Cable Duct: Equip with hinged covers, except where removable covers are accepted by COR.

L. Cable Duct Fittings: As recommended by cable duct OEM.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION AND REQUIREMENTS

A. Raceways typically required for cabling systems unless otherwise indicated:

System	Specification Section	Installed Method
Control, Communication and Signal Wiring	27 10 00	Complete Conduit Allowed in Non-Partitioned Cable Tray or Cable Ladders
Communications Structured Cabling	27 15 00	Conduit to Cable Tray Partitioned Cable Tray
Public Address and Mass Notification Systems	27 51 16	Complete conduit
Physical Access Control System	28 13 00	Conduit to Cable Tray Partitioned Cable Tray
Fire Detection and Alarm	28 31 00	Complete Conduit

B. Penetrations:

1. Cutting or Holes:
   a. Locate holes in advance of installation.
   b. Make holes through concrete and masonry in new and existing structures with a diamond core drill or concrete saw. Pneumatic hammer, impact electric, hand or manual hammer type drills are not permitted; COR may grant limited permission by request, in condition of limited working space.
   c. Fire Stop: Where conduits, wireways, and other communications raceways pass through walls or floors, install a fire stop that provides an effective barrier against spread of fire, smoke and gases as specified in Section 07 84 00, FIRESTOPPING.
      1) Fill and seal clearances between raceways and openings with fire stop material.

2) Install only retrofittable, non-hardening, and reusable firestop material that can be removed and reinstalled to seal around cables inside conduits.

C. Conduit Installation:

1. Minimum conduit size of 19 mm (3/4 inch), but not less than size required for 40 percent fill.
2. Install insulated bushings on all conduit ends.
3. Install pull boxes after every 180 degrees of bends (two 90 degree bends). Size boxes per TIA 569.
4. Extend vertical conduits/sleeves through floors minimum 75 mm (3 inches) above floor and minimum 75 mm (3 inches) below ceiling of floor below.
5. Terminate conduit runs to and from a backboard in a closet or interstitial space at top or bottom of backboard. Install conduits to enter telecommunication rooms next to wall and flush with backboard.
6. Where drilling is necessary for vertical conduits, locate holes so as not to affect structural sections.
7. Seal empty conduits located in telecommunications rooms or on backboards with fire stop/caulk to prevent entrance of moisture and gases and to meet fire resistance requirements.
8. Minimum radius of communication conduit bends:

Sizes of Conduit Trade Size	Radius of Conduit Bends mm, Inches
3/4	150 (6)
1	230 (9)
1-1/4	350 (14)
1-1/2	430 (17)
2	525 (21)
2-1/2	635 (25)
3	775 (31)
3-1/2	900 (36)
4	1125 (45)

9. Provide pull wire in all empty conduits; sleeves through floor are exceptions.

10. Complete each entire conduit run installation before pulling in cables.
11. Flattened, dented, or deformed conduit is not permitted.
12. Ensure conduit installation does not encroach into ceiling height head room, walkways, or doorways.
13. Cut conduit square with a hacksaw, ream, remove burrs, and draw tight.
14. Install conduit mechanically continuous.
15. Independently support conduit at 2.44 m (8 feet) on center; do not use other supports (i.e., suspended ceilings, suspended ceiling supporting members, luminaires, conduits, mechanical piping, or mechanical ducts).
16. Support conduit within 300 mm (1 foot) of changes of direction, and within 300 mm (1 foot) of each enclosure to which connected.
17. Close ends of empty conduit with plugs or caps to prevent entry of debris, until cables are pulled in.
18. Attach conduits to cabinets, splice cases, pull boxes and outlet boxes with bonding type locknuts. For rigid and IMC conduit installations, provide a locknut on inside of enclosure, made up wrench tight. Do not make conduit connections to box covers.
19. Unless otherwise indicated on drawings or specified herein, conceal conduits within finished walls, floors and ceilings.
20. Conduit Bends:
    a. Make bends with standard conduit bending machines; observe minimum bend radius for cable type and outside diameter.
    b. Conduit hickey is permitted only for slight offsets, and for straightening stubbed conduits.
    c. Bending of conduits with a pipe tee or vise is not permitted.
21. Layout and Homeruns - Deviations: Make only where necessary to avoid interferences and only after drawings showing proposed deviations have been submitted and approved by COR.

D. Furred or Suspended Ceilings and in Walls:
1. Rigid steel, IMC, or EMT. Different type conduits mixed indiscriminately in same system is not permitted.
2. Align and run conduit parallel or perpendicular to building lines.
3. Tightening set screws with pliers is not permitted.

E. Exposed Work Installation:

1. Unless otherwise indicated on drawings, exposed conduit is only permitted in telecommunications rooms.
   a. Provide rigid steel, IMC, or EMT.
   b. Different type of conduits mixed indiscriminately in system is not permitted.
2. Align and run conduit parallel or perpendicular to building lines.
3. Install horizontal runs close to ceiling or beams and secure with conduit straps.
4. Support horizontal or vertical runs at not over 2400 mm (96 inches) intervals.
5. Surface Metal Raceways: Use only where shown on drawings.
6. Painting:
   a. Paint exposed conduit as specified in Section 09 91 00, PAINTING.
   b. Refer to Section 09 91 00, PAINTING for preparation, paint type, and exact color.
   c. Provide labels where conduits pass through walls and floors and at maximum 6000 mm (20 foot) intervals in between.

F. Conduit Supports, Installation:
1. Select AC193 code listed mechanical anchors or fastening devices with safe working load not to exceed 1/4 of proof test load.
2. Use pipe straps or individual conduit hangers for supporting individual conduits. Maximum distance between supports is 2.5 m (8 foot) on center.
3. Support multiple conduit runs with trapeze hangers. Use trapeze hangers designed to support a load equal or greater than sum of the weights of the conduits, wires, hanger itself, and 90 kg (200 pounds). Attach each conduit with U-bolts or other accepted fasteners.
4. Support conduit independent of pull boxes, luminaires, suspended ceiling components, angle supports, duct work, and similar items.
5. Fastenings and Supports in Solid Masonry and Concrete:
   a. New Construction: Use steel or malleable iron concrete inserts set in place prior to placing concrete.
   b. Existing Construction:
      1) Code AC193 listed wedge type steel expansion anchors minimum 6 mm (1/4 inch) bolt size and minimum 28 mm (1-1/8 inch) embedment.

2) Power set fasteners minimum 6 mm (1/4 inch) diameter with depth of penetration minimum 75 mm (3 inches).
3) Use vibration and shock resistant anchors and fasteners for attaching to concrete ceilings.

6. Fastening to Hollow Masonry: Toggle bolts are permitted.
7. Fastening to Metal Structures: Use machine screw fasteners or other devices designed and accepted for application.
8. Bolts supported only by plaster or gypsum wallboard are not acceptable.
9. Attachment by wood plugs, rawl plug, plastic, lead or soft metal anchors, or wood blocking and bolts supported only by plaster is prohibited.
10. Do not support conduit from chain, wire, or perforated strap.
11. Spring steel type supports or fasteners are not permitted except horizontal and vertical supports/fasteners within walls.
12. Vertical Supports:
    a. Install riser clamps and supports for vertical conduit runs in accordance with NEC.
    b. Provide supports for cable and wire with fittings that include internal wedges and retaining collars.

G. Box Installation:
1. Boxes for Concealed Conduits:
    a. Flush mounted.
    b. Provide raised covers for boxes to suit wall or ceiling, construction and finish.
2. In addition to boxes shown, install additional boxes where needed to prevent damage to cables during pulling.
3. 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.
4. Stencil or install phenolic nameplates on covers of boxes identified on riser diagrams; for example "SIG-FA JB No. 1".
5. Outlet boxes mounted back-to-back in same wall are not permitted. A minimum 600 mm (24 inches) center-to-center lateral spacing must be maintained between boxes.

3.2 TESTING

A. Examine fittings and locknuts for secureness.
B. Test RMC, IMC and EMT systems for electrical continuity.

C. Perform simple continuity test after cable installation.

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SECTION 27 08 00
COMMISSIONING OF COMMUNICATIONS SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

A. This section includes requirements for commissioning facility communications systems, related subsystems and related equipment. This Section supplements general requirements specified in Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.

B. Complete list of equipment and systems to be commissioned is specified in Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS and Specification 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.

C. Commissioned Systems:

1. Commissioning of systems specified in Division 27 and 28 is part of project's construction process including documentation and proof of performance testing of these systems, as well as training of VA's Operation and Maintenance personnel in accordance with requirements of Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS and Division 27, in cooperation with Government and Commissioning Agent.
2. The facility exterior closure systems commissioning includes communications systems listed in Section 01 91 00 GENERAL COMMISSIONING REQUIRMENTS and 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.

1.2 RELATED WORK

A. System tests: Section 01 00 00, GENERAL REQUIREMENTS.

B. Commissioning process requires review of selected submittals that pertain to systems to be commissioned: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.

C. Construction phase commissioning process and procedures including roles and responsibilities of commissioning team members and user training: Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.

1.3 COORDINATION

A. Commissioning Agent will provide a list of submittals that must be reviewed by Commissioning Agent simultaneously with engineering review; do not proceed with work of sections identified without engineering and Commissioning Agent's review completed.

B. Commissioning of communications systems require inspection of individual elements of communications system construction throughout construction period. Coordinate with Commissioning Agent in accordance

with Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS and commissioning plan to schedule communications systems inspections as required to support the commissioning process.

1.4 CLOSEOUT SUBMITTALS

A. Refer to Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS for submittal requirements for pre-functional checklists, equipment startup reports, and other commissioning documents.

B. Pre-Functional Checklists:

1. Complete pre-functional checklists provided by commissioning agent to verify systems, subsystems, and equipment installation is complete and systems are ready for Systems Functional Performance Testing.
2. Submit completed checklists to COR and to Commissioning Agent. Commissioning Agent can spot check a sample of completed checklists. If Commissioning Agent determines that information provided on the checklist is not accurate, Commissioning Agent then returns the marked-up checklist to Contractor for correction and resubmission.
3. If Commissioning Agent determines that a significant number of completed checklists for similar equipment are not accurate, Commissioning Agent can select a broader sample of checklists for review.
4. If Commissioning Agent determines that a significant number of broader sample of checklists is also inaccurate, all checklists for the type of equipment will be returned to Contractor for correction and resubmission.

C. Submit training agendas and trainer resumes in accordance with requirements of Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. Contractor's Tests:

1. Scheduled tests required by other sections of Division 27 must be documented in accordance with Section 01 00 00, GENERAL REQUIREMENTS.
2. Incorporate all testing into project schedule. Provide minimum seven calendar days' notice of testing for Commissioning Agent to witness selected Contractor tests at sole discretion of Commissioning Agent.

3. Complete tests prior to scheduling Systems Functional Performance Testing.

B. Systems Functional Performance Testing:

1. Commissioning process includes Systems Functional Performance Testing that is intended to test systems functional performance under steady state conditions, to test system reaction to changes in operating conditions, and system performance under emergency conditions.
2. Commissioning Agent prepares detailed Systems Functional Performance Test procedures for review and acceptance by COR.
3. Provide required labor, materials, and test equipment identified in test procedure to perform tests.
4. Commissioning Agent must witness and document the testing.
   a. Provide test reports to Commissioning Agent. Commissioning Agent will sign test reports to verify tests were performed.

3.2 TRAINING

A. Training of Government's operation and maintenance personnel is required in cooperation with COR and Commissioning Agent.

B. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning location, operation, and troubleshooting of installed systems.

C. Schedule instruction in coordination with COR after submission and approval of formal training plans.

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SECTION 27 10 00
CONTROL, COMMUNICATION AND SIGNAL WIRING

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section includes control, communication and signal wiring for a comprehensive systems infrastructure.

B. This section applies to all sections of Divisions 27 and 28.

1.2 RELATED WORK

A. Sealing around penetrations to maintain integrity of time rated construction: Section 07 84 00, FIRESTOPPING.

B. General electrical requirements that are common to more than one section in Division 27: Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.

C. Conduits for cables and wiring: Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS.

1.3 SUBMITTALS

A. Submit in accordance with Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.

B. Submit written certification from OEM:

1. Indicate wiring and connection diagrams meet National and Government Life Safety Guidelines, NFPA, NEC, NRTL, Joint Commission, OEM, this section and Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.
2. Include instructions, requirements, recommendations, and guidance for proper performance of system as described herein.
3. Government will not approve any submittal without this certification.

C. Identify environmental specifications on technical submittals; identify requirements for installation.

1. Minimum floor space and ceiling heights.
2. Minimum size of doors for cable reel passage.

D. Power: Provide specific voltage, amperage, phases, and quantities of circuits.

E. Provide conduit size requirements.

F. Closeout Submittals:

1. Provide contact information for maintenance personnel to contact contractor for emergency maintenance and logistic assistance, and

assistance in resolving technical problems at any time during warranty period.

2. Provide certified OEM sweep test tags from each cable reel to COR.
3. Furnish spare or unused wire and cable with appropriate connectors (female types) for installation in appropriate punch blocks, barrier strips, patch, or bulkhead connector panels.
4. Turn over unused and opened installation kit boxes, coaxial, fiber optic, and twisted pair cable reels, conduit, cable tray, cable duct bundles, wire rolls, physical installation hardware to COR.
5. Documentation: Include any item or quantity of items, as installed drawings, equipment, maintenance, and operation manuals, and OEM materials needed to completely and correctly provide system documentation required herein.

PART 2 - PRODUCTS

2.1 CONTROL WIRING

A. Provide control wiring large enough so voltage drop under in-rush conditions does not adversely affect operation of controls.

B. Provide cable meeting specifications for type of cable.

C. Outside Location (i.e. above ground, underground in conduit, ducts, pathways, etc.): Provide cables filled with a waterproofing compound between outside jacket (not touching any provided armor) and inter conductors to seal punctures in jacket and protect conductors from moisture.

D. Remote Control Cable:

1. Multi-conductor with stranded conductors able to handle power and voltage required to control specified system equipment, from a remote location.
2. NRTL listed and pass VW-1 vertical wire flame test (UL 83) (formerly FR-1).
3. Color-coded Conductors: Combined multi-conductor and coaxial cables are acceptable for this installation, on condition system performance standards are met.
4. Technical Characteristics:
   a. Length: As required, in 1K (3,000 ft.) reels minimum.
   b. Connectors: As required by system design.
   c. Size:
      1) 18 AWG, minimum, Outside.
      2) 20 AWG, minimum, Inside.

d. Color Coding: Required, EIA industry standard.

e. Bend Radius: 10 times cable outside diameter.

f. Impedance: As required.

g. Shield Coverage: As required by OEM specification.

h. Attenuation:

Frequency in MHz	dB per 305 Meter (1,000 feet), maximum
0.7	5.2
1.0	6.5
4.0	14.0
8.0	19.0
16.0	26.0
20.0	29.0
25.0	33.0
31.0	36.0
50.0	52.0

E. Distribution System Signal Wires and Cables:

1. Provide in same manner, and use construction practices, as Fire Protective and other Emergency Systems identified and defined in NFPA 101, Life Safety Code, Chapters 7, 12, and 13, NFPA 70, National Electrical Code, Chapter 7, Special Conditions.
2. Provide system able to withstand adverse environmental conditions without deterioration, in their respective location.
3. Provide entering of each equipment enclosure, console, cabinet or rack in such a manner that all doors or access panels can be opened and closed without removal or disruption of cables.
4. Terminate on an item of equipment by direct connection.

2.2 COMMUNICATION AND SIGNAL WIRING

A. Provide communications and signal wiring conforming to recommendations of manufacturers of systems; provide not less than TIA Performance Category 6a.

B. Wiring shown is for typical systems; provide wiring as required for systems being provided.

C. Provide color-coded conductor insulation for multi-conductor cables.

D. Connectors:

1. Provide connectors for transmission lines, and signal extensions to maintain uninterupted continuity, ensure effective connection, and preserve uniform polarity between all points in system.

a. Provide AC barrier strips with a protective cover to prevent accidental contact with wires carrying live AC current.
b. Provide punch blocks for signal connection, not AC power. AC power twist-on wire connectors are not permitted for signal wire terminations.

2. Cables: Provide connectors designed for specific size cable and conductors being installed with OEM's approved installation tool. Typical system cable connectors include:
   a. Audio spade lug.
   b. Punch block.
   c. Wirewrap.

2.3 INSTALLATION KIT

A. Include 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, cable tray, etc., required to accomplish a neat and secure installation.

B. Terminate conductors in a spade lug and barrier strip, wire wrap terminal or punch block, so there are no unfinished or unlabeled wire connections.

C. Minimum required installation sub-kits:
   1. Wire and Cable: Provide connectors and terminals, punch blocks, tie wraps, hangers, clamps, labels, etc. required to accomplish termination in an orderly installation.
   2. Conduit, Cable Duct, and Cable Tray: Provide conduit, duct, trays, junction boxes, back boxes, cover plates, feed through nipples, hangers, clamps, other hardware required to accomplish a neat and secure conduit, cable duct, cable tray installation in accordance with NEC and documents.
   3. Equipment Interface: Provide any items or quantity of equipment, cable, mounting hardware and materials to interface systems with identified sub-systems, according to OEM requirements and construction documents.
   4. Labels: Provide any item or quantity of labels, tools, stencils, and materials to label each subsystem according to OEM requirements, as-installed drawings, and construction documents.

D. Cross-Connection System (CCS) Equipment Breakout, Termination Connector (or Bulkhead), and Patch Panels:

1. Connector Panels: Flat smooth 3.175 mm (1/8 inch) thick solid aluminum, custom designed, fitted and installed in cabinet. Install bulkhead equipment connectors on panel to enable cabinet equipment's signal, control, and coaxial cables to be connected through panel. Match panel color to cabinet installed.
   a. Voice (or Telephone):
      1) Provide industry standard Type 110 (minimum) punch blocks for voice or telephone, and control wiring instead of patch panels, each being certified for category 6a.
      2) IDC punch blocks (with internal RJ45 jacks) are acceptable for use in CCS when designed for Category 6a and the size and type of cable used.
      3) Secure punch block strips to OEM designed physical anchoring unit on a wall location in TRS; console, cabinet, rail, panel, etc. mounting is permitted at OEM recommendation and as accepted by COR. Punch blocks are not permitted for Class II or 120 VAC power wiring.
      4) Technical Characteristics:
         a) Number of Horizontal Rows: Minimum 100.
         b) Number of Terminals per Row: Minimum 4.
         c) Terminal Protector: Required for each used or unused terminal.
         d) Insulation Splicing: Required between each row of terminals.
   b. Digital or High Speed Data:
      1) Provide 480 mm (19 inches) horizontal EIA/ECA 310 rack mountable patch panel with EIA/ECA 310 standard spaced vertical mounting holes for digital or high-speed data service CSS, with modular female Category 6A for specialized powered systems with RJ45 jacks designed for size and type of UTP or F/UTP cable installed in rows.
      2) Technical Characteristics:
         a) Number of Horizontal Rows: Minimum 2.
         b) Number of Jacks Per Row: Minimum 24.
         c) Type of Jacks: RJ45.
         d) Terminal Protector: Required for each used or unused jack.
         e) Insulation: Required between each row of jacks.

2.4 EXISTING WIRING

A. Only existing wiring that conforms to specifications and applicable codes can be reused with COR approval; existing wiring that does not meet these requirements cannot be reused and must be removed by contractor.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Install wiring in cable tray or raceway.
2. Seal cable entering a building from underground, between wire and conduit where cable exits conduit, with non-hardening approved compound.
3. Wire Pulling:
   a. Provide installation equipment that prevents cutting or abrasion of insulation during pulling of cables.
   b. Use ropes made of nonmetallic material for pulling feeders.
   c. Attach pulling lines for feeders by means of either woven basket grips or pulling eyes attached to conductors, as accepted by COR.
   d. Pull multiple cables into a single conduit together.

B. Control, Communication and Signal Wiring Installation:

1. Unless otherwise specified in other sections, provide wiring and connect to equipment/devices to perform required functions as indicated.
2. Install separate cables for each system so that malfunctions in any system does not affect other systems, except where otherwise required.
3. Group wires and cables according to service (i.e. AC, grounds, signal, DC, control, etc.); DC, control and signal cables can be included with any group.
4. Form wires and cables to not change position in group throughout the conduit run. Bundle wires and cables in accepted signal duct, conduit, cable ducts, or cable trays neatly formed, tied off in 600 mm to 900 mm (24 inch to 36 inch) lengths to not change position in group throughout run.
5. Concealed splices are not allowed.
6. Separate, organize, bundle, and route wires or cables to restrict EMI, channel crosstalk, or feedback oscillation inside any enclosure.

7. Looking at any enclosure from the rear (wall mounted enclosures, junction, pull or interface boxes from the front), locate AC power, DC and speaker wires or cables on the left; coaxial, control, microphone and line level audio and data wires or cables, on the right.
8. Provide ties and fasteners that do not damage or distort wires or cables. Limit spacing between tied points to maximum 150 mm (6 inches).
9. Install wires or cables outside of buildings in conduit, secured to solid building structures.
10. Wires or cables must be specifically accepted, on a case by case basis, to be installed outside of conduit. Bundled wires or cables must be tied at minimum 460 mm (18 inches) intervals to a solid building structure; bundled wires or cables must have ultra violet protection and be waterproof (including all connections).
11. Laying wires or cables directly on roof tops, ladders, drooping down walls, walkways, floors, etc. is not permitted.
12. Wires or cables installed outside of conduit, cable trays, wireways, cable duct, etc.:
    a. Only when authorized, can wires or cables be identified and approved to be installed outside of conduit.
    b. Provide wire or cable rated plenum and OEM certified for use in air plenums.
    c. Provide wires and cables hidden, protected, fastened and tied at maximum 600 mm (24 inches) intervals, to building structure.
    d. Provide closer wire or cable fastening intervals to prevent sagging, maintain clearance above suspended ceilings.
    e. Remove unsightly wiring and cabling from view, and discourage tampering and vandalism.
    f. Sleeve and seal wire or cable runs, not installed in conduit, that penetrate outside building walls, supporting walls, and two hour fire barriers, with an approved fire retardant sealant.

C. AC Power:

1. Bond to ground contractor-installed equipment and identified Government-furnished equipment, to eliminate shock hazards and to minimize ground loops, common mode returns, noise pickup, crosstalk, etc. for total ground resistance of 0.1 Ohm or less.

2. Use of conduit, signal duct or cable trays as system or electrical ground is not permitted; use these items only for dissipation of internally generated static charges (not to be confused with externally generated lightning) that can be applied or generated outside mechanical and physical confines of system to earth ground. Discovery of improper system grounding is grounds to declare system unacceptable and termination of all system acceptance testing.
3. Equipment: Bond equipment to cabinet bus with copper braid equivalent to at least #12 AWG. Self-grounding equipment enclosures, racks or cabinets, that provide OEM certified functional ground connections through physical contact with installed equipment, are acceptable alternatives.

3.2 EQUIPMENT IDENTIFICATION

A. Control, Communication and Signal System Identification:
   1. Install a permanent wire marker on each wire at each termination.
   2. Identify cables with numbers and letters on the labels corresponding to those on wiring diagrams used for installing systems.
   3. Install labels retaining their markings after cleaning.
   4. In each maintenance hole (manhole) and handhole, install embossed brass tags to identify system served and function.

B. Labeling:
   1. Industry Standard: ANSI/TIA-606-B.
   2. Coordinate labelling information with COR.
   3. Print lettering for voice and data circuits using; handwritten labels are not acceptable.
   4. Cable and Wires (hereinafter referred to as “cable”): Label cables at both ends in accordance with industry standard. Provide permanent labels in contrasting colors. Identify cables matching system Record Wiring Diagrams.
   5. Equipment: Permanently labeled system equipment with contrasting plastic laminate or bakelite material. Label system equipment on face of unit corresponding to its source.
   6. Conduit, Cable Duct, and Cable Tray: Label conduit, duct and tray, including utilized GFE, with permanent marking devices or spray painted stenciling a minimum of 3 meters (10 ft.) identifying system. Label each enclosure according to this standard.

7. Termination Hardware: Label workstation outlets and patch panel connections using color coded labels with identifiers in accordance with industry standard and Record Wiring Diagrams.

3.3 TESTING

A. Minimum test requirements are for impedance compliance, inductance, capacitance, signal level compliance, opens, shorts, cross talk, noise, and distortion, and split pairs on cables in frequency ranges specified.

B. Tests required for data cable must be made to confirm operation of this cable at minimum 10 Mega (M) Hertz (Hz) full bandwidth, fully channel loaded and a Bit Error Rate of a minimum of 10-6 at maximum rate of speed.

C. Provide cable installation and test records at acceptance testing to COR and thereafter maintain in facility's telephone switch room.

D. Record changes (used pair, failed pair, etc.) in these records as change occurs.

E. Test cables after installation and replace any defective cables.

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SECTION 27 15 00
COMMUNICATIONS STRUCTURED CABLING

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies a complete and operating voice and digital structured cabling distribution system and associated equipment and hardware to be installed in VA Medical Center here-in-after referred to as the "facility".

1.2 RELATED WORK

A. Wiring devices: Section 26 27 26, WIRING DEVICES.

B. General electrical requirements that are common to more than one section in Division 27: Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.

C. Conduits for cables and wiring: Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS.

D. Low voltage cabling system infrastructure: Section 27 10 00, CONTROL, COMMUNICATION AND SIGNAL WIRING.

E. Emergency Service Public Address System (PAS) and associated equipment: Section 27 51 16, PUBLIC ADDRESS AND MASS NOTIFICATION SYSTEMS.

1.3 SUBMITTALS

A. Certifications:

1. Submit written certification from OEM indicating that proposed supervisor of installation and proposed provider of contract maintenance are authorized representatives of OEM. Include individual's legal name and address and OEM warranty credentials in the certification.
2. Pre-acceptance Certification: Submit in accordance with test procedures.
3. Test system cables and certify to COR before proof of performance testing can be conducted. Identify each cable as labeled on as-installed drawings.
4. Provide current and qualified test equipment OEM training certificates and product OEM installation certification for contractor installation, maintenance, and supervisory personnel.

B. Closeout Submittal: Provide document from OEM certifying that each item of equipment installed conforms to OEM published specifications.

1.4 WARRANTY

A. Work subject to terms of Article "Warranty of Construction," FAR clause 52.246-21.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA

A. Provide complete system including “punch down” and cross-connector blocks voice and data distribution sub-systems, and associated hardware including telecommunications outlets (TCO); copper distribution cables, connectors, “patch” cables, “break out” devices and equipment cabinets, interface cabinets, and radio relay equipment rack.

B. Industry Standards:

1. Cable distribution systems provided under this section are connected to systems identified as critical care performing life support functions.
2. Conform to National and Local Life Safety Codes (whichever are more stringent), NFPA, NEC, this section, Joint Commission Life Safety Accreditation requirements, and OEM recommendations, instructions, and guidelines.
3. Provide supplies and materials listed by a nationally recognized testing laboratory where such standards are established for supplies, materials or equipment.
4. Refer to industry standards and minimum requirements of Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS and guidelines listed.
5. Active and passive equipment required by system design and approved technical submittal; must conform to each UL standard in effect for equipment, when technical submittal was reviewed and approved by Government or date when COR accepted system equipment to be replaced. Where a UL standard is in existence for equipment to be used in completion of this contract, equipment must bear approved NRTL label.

C. System Performance: Provide complete system to meet or exceed TIA Category 6A for specialized powered systems’ requirements.

D. Provide continuous inter- and/or intra-facility voice, data, and analog service.

1. Provide voice and data cable distribution system based on a physical “Star" topology.

2. Provide separate cable distribution system for emergency, safety and protection systems (i.e. emergency bypass phones; police emergency voice communications from parking lots and stairwells personal protection, duress alarms and annunciation systems; etc.)

E. Specific Subsystem Requirements: Provide products necessary for a complete and functional voice, data, analog and video telecommunications cabling system, including backbone cabling system, and cross-connections, horizontal cabling systems, jacks, faceplates, and patch cords.

F. Coordinate size and type of conduit, pathways and firestopping for maximum 40 percent cable fill with subcontractors.

G. Terminate all interconnecting twisted pair, coaxial cables on patch panels or punch blocks. Terminate unused or spare conductors. Do not leave unused or spare twisted pair wire, coaxial cable unterminated, unconnected, loose or unsecured.

H. Color code distribution wiring to conform to ANSI/TIA 606-B and construction documents, whichever is more stringent. Label all equipment, conduit, enclosures, jacks, and cables on record drawings, to facilitate installation and maintenance.

I. In addition to requirements in Section 27 05 11, REQUIREMENTS FOR COMMUNICATION INSTALLATIONS, provide faceplates to match existing Fargo TCO’s.

2.2 EQUIPMENT AND MATERIALS

A. Cable Systems - Twisted Pair, and Analog:

1. General:

a. Provide cable (i.e. backbone, outside plant, and horizontal cabling) conforming to accepted industry standards with regards to size, color code, and insulation.

b. Some areas can be considered “plenum”. Comply with all codes pertaining to plenum environments. It is contractor’s responsibility to review the VA’s cable requirements with COR and OI&T Service prior to installation to confirm type of environment present at each location.

c. Provide proper test equipment to confirm that cable pairs meet each OEM’s standard transmission requirements, and ensure cable carries data transmissions at required speeds, frequencies, and fully loaded bandwidth.

2. Horizontal Cable: Installed from TCO jack to the TR patch panel.

a. Tested to ANSI/TIA-568-C.2 Category 6A requirements including NEXT, ELFEXT (Pair-to-Pair and Power Sum), Insertion Loss (attenuation), Return Loss, and Delay Skew.
b. Minimum Transmission Parameters: 500 MHz.
c. Provide four pair 0.326 mm2 (22 AWG) cable
d. Terminate all four pairs on same port at patch panel in TR.
e. Terminate all four pairs on same jack, at work area Telecommunication Outlets (TCO):
1) Jacks: Minimum three eight-pin RJ-45 ANSI/TIA-568-C.2 Category 6A Type jacks at TCO.
a) Top Port: RJ-45 jack compatible with RJ-11 plug for voice.
b) Bottom Two Ports: Unkeyed RJ-45 jacks for data.

B. Cross-Connect Systems (CCS):
1. Copper Cables: Provide copper CCS sized to connect cables at TR and allow for a minimum of 50 percent anticipated growth.
2. Maximum DC Resistance per Cable Pair: 28.6 Ohms per 305 m (1,000 feet).

C. Coaxial and Analog Cables: Bond equipment to ground per TIA standards, such that all grounding systems comply with all applicable National, Regional, and Local Building and Electrical codes.
1. Provide a gas surge protector/module and bond to earth ground.

D. Voice (or Telephone) Cable Cross-Connection Subsystem:
1. Provide Insulation Displacement Connection (IDC) hardware.
2. Provide the following for each Category 6A for specialized powered systems, OI&T and FMS Services and COR) Cabling System termination; RJ-45 patch cord connector to RJ-45 patch cord connector.
a. Provide terminations to be accessible without need for disassembly of IDC wafer. Provide IDC wafers removable from their mounts to facilitate testing on either side of connector.
b. Provide removable designation strips or labels to allow for inspection of terminations.
c. Provide cable management system as a part of IDC.
3. Provide IDC connectors capable of re-terminations, without damage, a minimum of 200 IDC insertions or withdrawals on either side of connector panel.
4. Install using only non-impact terminating tool having both a tactile and an audible feedback to indicate proper termination.

5. Provide inputs from PBX, FTS, Local Voice (Telephone) System, or diverse routed voice distribution systems on left side of IDC (110A blocks with RJ45 connections are acceptable alternates to IDC) of MCCS.
6. Provide system outputs from MCCS to voice backbone cable distribution system on the right side of same IDC (or 110A blocks) of MCCS.
7. Do not split pairs within cables between different jacks or connections.
8. Provide UTP cross connect wire to connect each pair of terminals plus an additional 50 percent spare.

E. Copper Outside Plant Cable: Minimum of STP or UTP, 22 AWG solid conductors, solid PVC insulation, and filled core (flex gel - waterproof Rural Electric Association (REA) listed PE 39 code) between outer armor or jacket and inner conductors protective lining.

F. Horizontal Cabling (HC):
1. Horizontal cable length to farthest system outlet to be maximum of 90 m (295 ft).
2. Splitting of pairs within a cable between different jacks is not permitted.

2.3 DISTRIBUTION EQUIPMENT AND SYSTEMS

A. Telecommunication Outlet:
1. TCO consists of minimum one Ivory colored voice (telephone) RJ45 jack and three orange colored data RJ45 jacks mounted in a separate steel outlet box 100 mm (4 inches) x 100 mm (4 inches) x 63 mm (2-1/2 inches) minimum with a labeled faceplate to match existing Fargo TCO’s. Where shown on drawings, provide a second steel outlet box minimum 100 mm (4 inches) x 100 mm (4 inches) x 63 mm (2-1/2 inches), with a labeled faceplate, adjacent to first box to ensure system connections and expandability requirements are met.
2. Provide RJ-45/11 compatible female type voice (telephone) multi-pin connections. Provide RJ-45 female type data multi-pin connections.
3. Provide wall outlet with an Ivory colored nylon face plate and sufficient ports to fit voice (telephone) multi-pin jack, data multi- pin jacks and plastic covers for labels when mounted on outlet box provided (minimum 100mm (4 inches) x 100mm (4 inches) for single and 100mm (4 inches) x 200mm (8 inches) for dual outlet box applications.

4. Data Multi-Conductor:
   a. Unshielded F/UTP cable with solid conductors.
   b. Able to handle the power and voltage used over the distance required.
   c. Meets TIA transmission performance requirements of Category 6A.
   d. Technical Characteristics:
      1) 0.205 mm2 (24 AWG) - 0.326 mm2 (22 AWG) cable
      2) Bend Radius: 10 times cable outside diameter.
      3) Impedance: 100 Ohms + 15%, BAL.
      4) Bandwidth: 500 MHz.
      5) DC Resistance: Maximum 9.38 Ohms/100m (328 ft.) at 20 degrees C.
      6) Maximum Mutual Capacitance: 5.6 nF per 100 m (328 ft.).
      7) Shield Coverage:
         a) Overall Outside (if OEM specified): 100 percent.
         b) Individual Pairs (if OEM specified): 100 percent.
      8) Maximum attenuation for 100m (328 ft.) at 20° C:

Frequency (MHz)	Category 6A (dB)
1	2.1
4	3.8
8	5.3
10	5.9
16	7.5
20	8.4
25	9.4
31.25	10.5
62.5	15.0
100	19.1
200	27.6
250	31.1
300	34.3

Frequency (MHz)	Category 6A (dB)
400	40.1
500	45.3

B. Outlet Connection Cables:

1. Voice (Telephone):

a. Provide a connection cable for each TCO voice (telephone) jack in system with 10 percent spares able to connect voice (telephone) connection cable from voice (telephone) instrument to TCO voice (telephone) jack. Do not provide voice (telephone) instruments or equipment.

b. Technical Characteristics:

1) Length: Minimum 1.8 m (6 feet).

2) Cable: Voice Grade.

3) Connector: RJ-11/45 compatible male on each end.

4) Size: Minimum 24 AWG.

5) Color Coding: Required, telephone industry standard.

2. Data:

a. Provide a connection cable for each TCO data jack in system with 10 percent spares to connect a data instrument to TCO data jack. Do not provide data terminals/equipment.

b. Technical Characteristics:

1) Length: Minimum 1.8 m (6 feet).

2) Cable: Data grade Category 6A.

3) Connector: RJ-45 male on each end.

4) Color Coding: Required, data industry standard.

5) Size: Minimum 24 AWG.

C. System Connectors:

1. Modular (RJ-45/11 and RJ-45): Provide voice and high speed data transmission applications type modular plugs compatible with voice (telephone) instruments, computer terminals, and other type devices requiring linking through modular telecommunications outlet to the system compatible with UTP cables.

a. Technical Characteristics:

1) Number of Pins:

a) RJ-45: Eight.

b) RJ-11/45: Compatible with RJ-45.

2) Dielectric: Surge.

3) Voltage: Minimum 1,000V RMS, 60 Hz at one minute.

4) Current: 2.2A RMS at 30 minutes or 7.0A RMS at 5.0 seconds.

5) Leakage: Maximum 100 µA.

6) Connections:

a) Initial contact resistance: Maximum 20 milli-Ohms.

b) Insulation displacement: Maximum 10 milli-Ohms.

c) Interface: Must interface with modular jacks from a variety of OEMs. RJ-11/45 plugs provide connection when used in RJ-45 jacks.

d) Durability: Minimum 200 insertions/withdrawals.

D. Conduit and Signal Ducts:

1. Conduit:

a. Provide conduit or sleeves for cables penetrating walls, ceilings, floors, interstitial space, fire barriers, etc.

b. Minimum Conduit Size: 19 mm (3/4 inch).

c. Provide separate conduit and signal ducts for each cable type installation. Colored conduit shall be provide per system.

d. For metal (plastic covered, flexible cable protective armor, etc.) systems,, follow installation guidelines and standard specified in Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS and NEC.

e. Maximum 40 percent conduit fill for cable installation.

2. Signal Duct, Cable Duct, or Cable Tray: Use existing signal duct, cable duct, and cable tray, when identified and accepted by COR.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install for ease of operation, maintenance, and testing.

B. Install system to comply with NFPA 70 National Electrical Code, NFPA 99 Health Care Facilities, NFPA 101 Life Safety Code, Joint Commission Manual for Health Care Facilities, and original equipment manufacturers' (OEM) installation instructions.

C. Cable Systems Installation:

1. Install system cables in cable duct, cable tray, cable runway, conduit or when specifically approved, flexible NEC Article 800 communications raceway. Confirm drawings show sufficient quantity

and size of cable pathways. If flexible communications raceway is used, install in same manner as conduit.

2. Bond to ground metallic cable sheaths, etc. (i.e. risers, underground, horizontal, etc.).
3. Install temporary cable to not present a pedestrian safety hazard and be responsible for all work associated with removal. Temporary cable installations are not required to meet Industry Standards; but, must be reviewed and accepted by COR, IT Service, FMS.

D. Labeling:

1. Industry Standard: Provide labeling in accordance with ANSI/TIA-606-B.
2. Print lettering of labels; handwritten labels are not acceptable.
3. Label both ends of all cables in accordance with industry standard. Provide permanent Labels in contrasting colors and identify according to system “Record Wiring Diagrams”.
4. Termination Hardware: Label workstation outlets and patch panel connections using color coded labels with identifiers in accordance with industry standard and record on “Record Wiring Diagrams”.

3.2 FIELD QUALITY CONTROL

A. Interim Inspection:

1. Verify that equipment provided adheres to installation requirements of this section. Interim inspection must be conducted by a factory-certified representative and witnessed by COR.
2. Check each item of installed equipment to ensure appropriate NRTL label.
3. Verify cabling terminations in telecommunications rooms and at workstations adhere to color code for T568A pin assignments and cabling connections comply with TIA standards.
4. Visually confirm marking of cables, faceplates, patch panel connectors and patch cords.
5. Notify COR of the estimated date the contractor expects to be ready for interim inspection, at least 20 working days before requested inspection date, so interim inspection does not affect systems’ completion date.
6. Provide results of interim inspection to COR. If major or multiple deficiencies are discovered, COR can require a second interim inspection before permitting contractor to continue with system installation. The costs of a second inspection shall be the

responsibility of the contractor and shall be at no additional cost to the government.

7. Do not proceed with installation until COR determines if an additional inspection is required. In either case, re-inspection of deficiencies noted during interim inspections must be part of the proof of performance test.

B. Pretesting:

1. Pretest entire system upon completion of system installation.
2. Verify during system pretest, utilizing the accepted equipment, that system is fully operational and meets system performance requirements of this section.
3. Provide COR four copies of recorded system pretest measurements and the written certification that system is ready for formal acceptance test.

C. Microduct Tests:

1. Furnish COR, obstruction and pressure test data for each microduct installed. Complete pressure and obstruction tests per manufacturer’s recommended procedures prior to installing fiber, and ensure 100 percent of all microducts are compliant with manufacturer.
2. Complete microduct pressure testing before proceeding with end-to-end microduct obstruction testing.
3. Notify COR at least three weeks in advance of test date so that Government and design professional may be present to witness testing.
4. Maintain close contact with chosen and technically-approved OEM throughout installation, testing and certification process.

D. Acceptance Test:

1. After system has been pretested and the contractor has submitted pretest results and certification to COR, then schedule an acceptance test date and give COR 30 days' written notice prior to date acceptance test is expected to begin.
2. Test only in presence of a COR.
3. Test utilizing approved test equipment to certify proof of performance.
4. Verify that total system meets the requirements of this section.
5. Include expected duration of test time, with notification of the acceptance test.

E. Verification Tests:

1. Test UTP copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors, and between conductors and shield, if cable has an overall shield. Test cables after termination and prior to cross-connection.

F. Performance Testing:

1. Perform Category 6A powered systems accepted by IT and FMS Services and COR tests in accordance with TIA-568-B.1 and TIA-568-B.2. Include the following tests - wire map, length, insertion loss, return loss, NEXT, PSNEXT, ELFEXT, PSELFEXT, propagation delay and delay skew.

G. Total System Acceptance Test: Perform verification tests for UTP and copper cabling systems after complete telecommunication distribution system and workstation outlet are installed.

3.3 MAINTENANCE

A. Accomplish the following minimum requirements during one year warranty period:

1. Respond and correct on-site trouble calls, during standard work week:
   a. A routine trouble call within one working day of its report. A routine trouble is considered a trouble which causes a system outlet, station, or patch cord to be inoperable.
   b. Standard work week is considered 8:00 A.M. to 5:00 P.M., Monday through Friday exclusive of Federal holidays.
2. Respond to an emergency trouble call within six hours of its report. An emergency trouble is considered a trouble which causes a subsystem or distribution point to be inoperable at any time.
3. Respond on-site to a catastrophic trouble call within four hours of its report. A catastrophic trouble call is considered total system failure.
   a. If a system failure cannot be corrected within four hours (exclusive of standard work time limits), provide alternate equipment, or cables within four hours after four hour trouble shooting time.
   b. Routine or emergency trouble calls in critical emergency health care facilities (i.e., cardiac arrest, intensive care units, etc.) are also be deemed as a catastrophic trouble.

4. Provide COR written report itemizing each deficiency found and the corrective action performed during each official reported trouble call. Provide COR with sample copies of reports for review and approval at beginning of total system acceptance test.

- - - 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 document includes design, engineering, labor, material and products, equipment warranty and system warranty, 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 Public Address System (PAS) and associated equipment (here-in-after referred to as the System) in approved locations indicated on the contract drawings. These items shall be tested and certified capable of receiving, distributing, interconnecting and supporting PAS communications signals generated local and remotely as detailed herein.

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 VA Central Office (VACO), Telecommunications Voice Engineering (TVE 005OP3B) 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.

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

E. Specification Order of Precedence: In the event of a conflict between the text of this document and the Project's Contract Drawings outlined and/or cited herein; THE TEXT OF THIS DOCUMENT TAKES PRECEDENCE. *HOWEVER, NOTHING IN THIS DOCUMENT 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 PM, COR. *The VA PM is the only approving authority* for other amendments to this document that may be granted, on a case by case basis, in writing with technical concurrencies by VA's COR, and identified Facility Project Personnel.

F. 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.

1.2 RELATED SECTIONS

A. 01 33 23 – Shop Drawings, Product Data and Samples.

B. 07 84 00 – Firestopping.

C. 26 05 21 – Low – Voltage Electrical Power Conductors and Cables (600 Volts and Below).

D. 27 05 11 – Requirements for Communications Installations.

E. 27 05 33 – Raceways and Boxes for Communications Systems.

F. 27 10 00 – Control, Communication and Signal Wiring.

G. 27 15 00 – Horizontal and Vertical Communications Cabling Equipment and Systems.

1.3 DEFINITIONS

A. Provide: Design, engineer, furnish, install, connect complete, test, certify and warranty.

B. Work: Materials furnished and completely installed.

C. Review of contract drawings: A service by the engineer to reduce the possibility of materials being ordered which do not comply with contract documents. The engineer's review shall not relieve the Contractor of responsibility for dimensions or compliance with the contract documents. The reviewer's failure to detect an error does not constitute permission for the Contractor to proceed in error.

D. Engineer: The project’s engineer for the VA is FourFront Design Inc.

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.

d) Form 854 – Antenna Structure Registration.

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 c's, for complete list, contact (http://www.osha.gov/dts/otpca/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) 1333 - Vertical (Riser) Fire Rating.
n) 1449 - Standard for Transient Voltage Surge Suppressors.
o) 1479-03 - Standard for Fire Tests of Through-Penetration Fire Stops.
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. 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) 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 160-51 – Sound systems.

7) RS 270 – Tools, Crimping, Solderless Wiring Devices, Recommended Procedures for User Certification.

8) SE 101-A49 – Amplifier for Sound Equipment

9) SE 103-49 – Speakers for Sound Equipment

c. American Society of Mechanical Engineers (ASME):

1) Standard 17.4 – Guide for Emergency Personnel.

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.
   6) 1600 - Disaster Management, Chapter 5.9 - Communications and Warning

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 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 COR 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.

1.7 SCHEDULING

A. After the award of contract, the Contractor shall prepare a detailed schedule (aka milestone chart) using "Microsoft Project" software or equivalent. The Contractor Project Schedule (CPS) shall indicate detailed activities for the projected life of the project. The CPS shall consist of detailed activities and their restraining

relationships. It will also detail manpower usage throughout the project.

B. 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.

1.8 REVIEW OF CONTRACT DRAWINGS AND EQUIPMENT DATA SUBMITTALS

(Note: The Contractor is encouraged, but not required, to submit separate technical submittal(s) outlining alternate technical approach(s) to the system requirements stated here-in as long as each alternate technical document(s) is complete, separate, and submitted in precisely the same manner as outlined herein. VA will review and rate each received alternate submittal, which follows this requirement, in exactly the same procedure as outlined herein. Partial, add-on, or addenda type alternates will not be accepted or reviewed.)

A. Submit at one time within 10 days of contract awarding, drawings and product data on all proposed equipment and system. Check for compliance with contract documents and certify compliance with Contractor's "APPROVED" stamp and signature.

B. Support all submittals with descriptive materials, i.e., catalog sheets, product data sheets, diagrams, and charts published by the manufacturer. These materials shall show conformance to specification and drawing requirements.

C. Where multiple products are listed on a single cut-sheet, circle or highlight the one that you propose to use. Provide a complete and through equipment list of equipment expected to be installed in the system, with spares, as a part of the submittal.

D. Provide four (4) copies to the PM for technical review. The PM will provide a copy to the offices identified in Paragraph 1.3.C & D, at a minimum for compliance review as described herein where each responsible individual(s) shall respond to the PM within 10 days of receipt of their acceptance or rejection of the submittal(s).

E. Provide interconnection methods, conduit (where not already installed), junction boxes (J-Boxes), cable, interface fixtures and equipment lists for the: ENR(s) (aka DMARC), TER, TCR, MCR, MCOR, PCR, ECR, Stacked Telecommunications Rooms (STR), Nurses Stations (NS), Head End Room (HER), Head End Cabinet (HEC), Head End Interface Cabinet (HEIC) and

approved TCO locations Telecommunications Infrastructure Plant (TIP) interface distribution layout drawing, as they are to be installed and interconnected to teach other (REFER TO APPENDIX B - SUGGESTED TELECOMMUNICAITONS ONE LINE TOPOLOGY pull-out drawing).

F. Headend and each interface distribution cabinet layout drawing, as they are expected to be installed.

G. Equipment OEM technical literature detailing the electrical and technical characteristics of each item of equipment to be furnished.

H. Engineering drawings of the System, showing calculated of expected signal levels at the headend input and output, each input and output distribution point, and signal level at each telecommunications outlet.

I. Surveys Required as a Part of The Technical Submittal:

1. The Contractor shall provide the following System survey(s) that depict various system features and capacities required *in addition to* the on-site survey requirements described herein. Each survey shall be in writing and contain the following information (the formats are suggestions and may be used for the initial Technical Submittal Survey requirements), as a minimum:

a. PA Cable System Design Plan:

1) An OEM and contractor designed functioning PA System cable plan to populate the entire TIP empty conduit/pathway distribution systems provided as a part of Specification 27 11 00 shall be provided as a part of the technical proposal. A specific functioning PA: cable, interfaces, J-boxes and back boxes shall coincide with the total growth items as described herein. It is the Contractor's responsibility to provide the Systems' entire PA cable and accessory requirements and engineer a functioning PA distribution system and equipment requirement plan of the following paragraph(s), at a minimum:

2) The required PA Equipment Locations:

EQUIPPED ITEM	**CAPACITY**	**GROWTH**
Master Control Stations	Existing ELEC 2C-25	
Zone Amplifiers	New ELECT 1D-195	
Speakers		
Overhead		

EQUIPPED ITEM	CAPACITY	GROWTH
Locations	(as shown on drawings)	
Maintenance/Programming Console		
Location(s)	New ELECT 1D-195	

3) The required PA Cable Connections:

The Contractor shall clearly and fully indicate this category for each item identified herein as a part of the technical submittal. For this purpose, the following definitions and sample connections are provided to detail the system's capability:

EQUIPPED ITEM	CAPACITY	GROWTH
Central Control Cabinet/Equipment		
Location	Existing ELEC 2C-25	
Speaker Locations	(as shown on drawings)	
Maintenance/Program Console		
Location(s)	New ELECT 1D-195	

1.9 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. All new device locations with UL labels affixed.
2. Conduit locations.
3. Existing PA equipment location for connection (ELEC 2C-25).
4. Telecommunication Outlet (s -TCO) equipment and specific location
5. TIP Wiring diagram(s).
6. Warranty certificate.
7. System test results.
8. System Completion Document(s) or MOU.

1.10 WARRANTIES

A. The Contractor shall warrant the installation 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 system according to the guidelines outlined in Article 4 herein.

1.11 USE OF THE SITE

A. Use of the site shall be at the GC's direction.

B. Coordinate with the GC for lay-down areas for product storage and administration areas.

C. Coordinate work with the GC and their sub-contractors.

D. Access to buildings wherein the work is performed shall be directed by the GC.

1.12 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.

1.13 PROJECT CLOSE-OUT

A. Prior to final inspection and acceptance of the work, remove all debris, rubbish, waste material, tools, construction equipment, machinery and surplus materials from the project site and thoroughly clean your work area.

B. Before the project closeout date, the Contractor shall submit:

1. Warranty certificate.
2. Evidence of compliance with requirements of governing authorities such as the Low Voltage Certificate of Inspection.
3. Project record documents.
4. Instruction manuals and software that is a part of the system.

C. Contractor shall submit written notice that:

1. Contract Documents have been reviewed.
2. Project has been inspected for compliance with contract.
3. Work has been completed in accordance with the contract.

PART 2 – PRODUCTS / FUNCTIONAL REQUIREMENTS

2.0 GENERAL REQUIREMENTS FOR EQUIPMENT AND MATERIALS

B. The existing location for each PA: Central Control Cabinet is Existing ELEC 2C-25, Two (2) Remote Annunciation Consoles is Existing ELEC 2C-25, and Main Equipment Cabinet is Existing ELEC 2C-25. New locations for each PA: Speaker is as shown on the contract drawings, Power Supply is New ELECT 1D-195, Electrical Supervisor Panel is New ELECT 1D-195, Zone(s) are as existing at Fargo VA, and TCOs are as shown on the contract drawings.

C. Coordinate features and select interface components to form an integrated PA system. Match components and interconnections between the systems for optimum performance of specified functions.

D. Expansion Capability: The PA equipment interfaces and cables shall be able to increase number of speakers 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.

F. 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 within and outside the building structure.

G. Weather/Water Proof Equipment: Listed and labeled by an OSHA certified National Recognized Testing Laboratory (NRTL – i.e. UL) for duty outdoors or in damp locations.

H. Deliver a fully functioning and operable PA in the specific locations shown on the drawings.

2.1 SYSTEM DESCRIPTION

A. Furnish and install a complete and fully functional and operable extension to the existing HF Radio System.

B. The Contractor is responsible for verifying the interface with the telephone and 2-way radio systems with the System. If new interfaces will be required to repair this connection the interface unit(s) shall be provided by the Contractor.

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 total PA system shall be configured and installed so that the combination of equipment actually employed does not produce any undesirable visual or aural effects such as signal distortions, noise pulses, glitches, hum, transients, images, etc. The existing interface points must adhere to all standards described herein for the full separation of Critical Care and Life Safety systems.

D. It is not acceptable to utilize the telephone cable system for the control of radio signals and equipment. The System Contractor is not allowed to make any connections to the Telephone System without the approval of the COR.

E. System hardware shall consist of a PA communications network comprised of new amplifiers, mixers, speakers, volume controls, test sets, equipment cabinets/racks, wiring; and existing telephone private branch exchange (PBX) interface equipment, computer interfaces, and printer interfaces. All necessary equipment required to meet the intent of these specifications, whether or not enumerated within these specifications, shall be supplied and installed.

F. The existing PA Head End Equipment shall be located in Existing ELEC 2C-25.

G. The new system equipment 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 24 hours.

H. Provide a backup battery or a UPS for the System (including each distribution cabinet/point, CRT, LCD and Monitor) 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 two (2) Hours.

I. The new system components shall be provided with continuous electrical supervision of the added wires, contact switch connections, wall stations, circuit boards, 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 existing main supervisory panel, and new remote amplifier locations.

I. All passive distribution equipment shall meet or exceed -80 dB radiation shielding (aka RFI) shielding specifications and be provided with screw type audio connectors.

J. All equipment face plates utilized in the system shall be stainless steel, anodized aluminum or UL approved cycolac plastic for the areas where provided.

K. All trunk, branch, and interconnecting cables and unused equipment ports or taps shall be terminated with proper terminating resistors designed for RF, audio and digital cable systems without adapters.

L. 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.

M. Plug-in connectors shall be provided to connect all equipment, except coaxial cables and RF transmission line interface points. Coaxial cable distribution points and RF transmission lines 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.

N. 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. 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.

T. Contractor is responsible for pricing 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.

2.2 SYSTEM PRFORMANCE:

A. At a minimum, each new distribution, 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 existing public address system.
2. New speakers to be a product of approved AVI Bismark Vendor and be compatible with current system.
3. Audio Output: The audio signal level at each speaker shall be a MINIMUM of +0.5 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
5. Coordinate set up and facility requirements with VA COR and Fargo VA Biomed department.

B. Audio Level Processing: New 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.

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.
3. Cabling to be Plenum rates CAT 6A STP.

2.3 MANUFACTURERS

A. The products specified shall be new, FCC and UL Listed, labeled and produced by approved AVI Bismark Vendor to extend the existing system.

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. Equipment Standards and Testing:

1. The System has been defined herein as connected to systems identified as an Emergency performing Public Safety Support Functions. Therefore, at a minimum, the system shall conform to all aforementioned National and/or Local Public and 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 nationally recognized testing laboratory (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 COR 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. Contractor is responsible for pricing all accessories and miscellaneous equipment required to form a complete and operating system. The equipment quantities provided herein shall be as indicated on the drawings with the exception of the indicated spare equipment.
2. Each cabinet shall be provided with internal and external items to maintain a neat and orderly system of equipment, wire, cable and conduit connections and routing.
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 with the OEM's concurrence applied to the list(s), in writing.
   b. The following equipment items are the minimum requirements to provide an acceptable system described herein:

Item		Quantity	Unit
1.	As required	Distribution System(s)	
1.a	As required	Equipment Back Box(s)	
1.a.1.	As required	Speakers	
1.a.1.a	As required	Overhead	
2.	2 (MIN)	Remote Station(s)	
2.a.	As required	Spare Items	

B. Distribution Equipment:

Refer to CFM Physical Security Manual (04-2021) for VA Facilities, Chapters 9.3 & 1) and PG 18-10, EDM, Chapters 7- Table 7-1, 8 & Appendix B, Telecommunications One Line Topology for specific Room and TIP Connection Requirements.

1. Equipment:
   a. New ELECT 1D-195:
      1) Amplifiers:
         a) Paging Amplifier Equipment:
         b) Provide one (1) spare amplifier in addition to the spare Head End Amplifier.
      2) Distributed Amplifier:
         a) Provide the type and number of the amplifier(S) required to meet the system design. Provide this unit as complete and separate technical submittal during the IFB review portion of the project.
         b) Provide one spare amplifier for each 20% (or portion thereof) of amplifiers used in the system.
      3) Provide the equipment in New ELECT 1D-195.
      4) Provide minimum of 30 minute battery (UPS) back-up to system components.

C. TIP DISTRIBUTION SYSTEM:
   1. System Speakers:
      a. Ceiling Cone-Type:
         1) Minimum Axial Sensitivity: 91 dB at one meter, with 1/2-W input.
         2) Frequency Response: Within plus or minus 3 dB from 70 to 15,000 Hz.
         3) Minimum Dispersion Angle: 100 degrees.
         4) Line Transformer: Maximum insertion loss of 0.5 dB, power rating equal to speaker's, and at least four level taps.
         5) 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.
         6) Baffle: For flush speakers, minimum thickness of 0.032-inch aluminum with textured white finish. Completely fill the baffle with fiberglass.
         7) Vandal-Proof, High-Strength Baffle: For flush-mounted speakers, self-aging cast aluminum with tensile strength of 44,000 psi, 0.025-inch minimum thickness; countersunk heat-

treated alloy mounting screws; and textured white epoxy finish.

8) Size: 8 inches with 1-inch voice coil and minimum 5-oz. ceramic magnet.

9) Have a minimum of two (2) safety wires installed to a solid surface or use a flexible conduit from ceiling / wall back box to the speaker back box.

10) The speakers and mounting shall be self contained and wall mounted with flush back box at a minimum of 10 meter intervals and shall match (or contrast with, at the direction of the COR) the color of the adjacent surfaces.

11) Provide one spare speaker, mount, and back box for each 50 speakers or portion thereof.

b. 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:

a) Line level audio cable for inside racks and conduit.

b) Shielded, twisted pair Minimum 18 American Wire Gauge (AWG), stranded conductors and 18 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 riser rated.

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 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.

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 will not be allowed for this project.
3) Conduit Sleeves:
a) Contractor to provide and install fire rated penetrations in accordance with specifications 07 84 00 - Firestopping and 27 05 33 - Raceways and Boxes for communications systems.

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.

4. Telecommunication Outlets (TCO): Populate each TCO that is required to perform system operations in the locations that were provided and cabled as a part of Specifications Sections 27 11 00 and 27 15 00. Provide additional TCO equipment, interfaces and connections as required by System design. Provide secured pathway(s) and TCOs as required.

5. UPS:
a. Provide a backup battery or a UPS for the System 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 1/2 hours.

b. The Contractor shall not make any attachments or connection to the telephone system until specifically directed to do so, in writing, by the COR.

c. Provide UPS for all active system components including but not limited to:

1) System Amplifiers.

D. 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 COR 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.

6) Conduits.

7) Duct.

8) Cable Trays.

3. Coaxial Cable: The coaxial cable kit shall include all coaxial connectors, cable tying straps, heat shrink tabbing, 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. Conduit, Cable Duct, and Cable Tray: The kit shall include all conduit, duct, trays, junction boxes, back boxes, cover plates, feed through nipples, hangers, clamps, other hardware required to accomplish a neat and secure conduit, cable duct, and/or cable tray installation in accordance with the NEC and this document.
6. 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.
7. 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.

3.2 COORDINATION WITH OTHER TRADES

A. Before beginning work, verify the location, quantity, size and access for the following:

1. Isolated ground AC power circuits provided for systems.
2. Junction boxes, wall boxes, wire troughs, conduit stubs and other related infrastructure for the systems.
3. System components installed by others.
4. Overhead supports and rigging hardware installed by others.

B. Immediately notify the Owner, GC and Consultant(s) in writing of any discrepancies

3.3 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. Locate overhead ceiling-mounted loudspeakers as shown on drawings, with minor changes not to exceed 12" in any direction.
   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.
6. Finishes for any exposed work such as plates, racks, panels, speakers, etc. shall be approved by the Architect, and Owner.
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 grommeted holes in size and quantity required.

Do not allow cable to leave or enter boxes without cover plates installed.

8. 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.
9. Color code all distribution wiring to conform to the PA Industry Standard, EIA/TIA, and this document, whichever is the more stringent. At a minimum, all equipment, cable duct and/or conduit (orange in color to match existing 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.
10. Connect the System's primary input AC power to the Facility' Critical Branch of the Emergency AC power distribution system as shown on the plans.
11. 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.
    b. Storage and Handling: Store and protect equipment in a manner, which will preclude damage as directed by the COR.
12. Where TCOs are installed adjacent to each other, install one outlet for each instrument.

B. Equipment Racks:

1. Fill unused equipment mounting spaces with blank panels or vent panels. Match color to equipment racks.
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 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. Wiring Practice - in addition to the MANDATORY infrastructure requirements outlined in VA Construction Specifications 27 10 00 - TIP Structured Communications Cabling 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 ample service loops at harness break-outs and at plates, panels and equipment. Loops should be sufficient to allow plates, panels and equipment to be removed for service and inspection.
    b. 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.
    d. Employ permanent strain relief for any cable with an outside diameter of 1" or greater.
13. Use only balanced audio circuits unless noted otherwise
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. 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 shall not be installed outside of conduit:

c. Wire or cable runs in conduit, that penetrate walls or floors shall be sleeved and sealed with an approved fire retardant sealant in accordance with specification section 07 84 00 - Firestopping.

d. Completely test all of the cables after installation and replace any defective cables.

D. Labeling: Provide labeling in accordance with ANSI/EIA/TIA-606-A. All lettering for PA circuits shall be stenciled using laser printers or thermal ink transfer process.

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. SYSTEM 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.

F. 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 orange colored conduit (to match existing), junction boxes, connectors, sleeves, weather heads, pitch pockets, 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. 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.

2. Signal Duct or Cable Duct:

a. The Contractor shall use GFE signal duct and/or cable duct.

b. Approved signal and/or cable duct shall be a minimum size of 100 mm x 100 mm (4 in. X 4 in.) inside diameter with removable tops or sides, as appropriate. Protective sleeves, guides or barriers are required 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

3.4 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.

3.5 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.

3.6 FIREPROOFING

A. Where PA wires, cables and conduit penetrate walls floors and ceilings, fireproof the opening.

B. Provide conduit sleeves for cables that penetrate walls 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 penetrations.

C. Use only materials and methods that preserve the integrity of the fire stopping system and its rating.

D. 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.

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

PART 4 – TESTING / WARRANTY / TRAINING

4.0 SYSTEM LISTING

The PA System is NFPA listed as an "Emergency / Public Safety" Communications system. Therefore, the following testing and guaranty provisions are the minimum to be performed and provided by the contractor and OEM.

4.1 PROOF OF PERFORMANCE TESTING

A. Intermediate Testing:

1. After completion of 25 – 30% the installation of equipment, local and remote enunciation stations, and speakers. Prior to any further

work, this portion of the system must be pretested, inspected, and certified. 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) 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 VA approved Credentials to inspect and certify the system. The results of the inspection will be officially recorded by the OEM-certified contractor representative, 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 COR.

B. Pretesting:

1. Upon completing installation of the PA 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 PA 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) Local Control Stations.
      3) Zone Equipment/Systems.
      4) Sub-Zone Equipment/Systems.
      5) Remote Control Panels.
         a.)TCR.
         b.)PCR/SCC.
      6) All Networked locations.
      7) System interface locations (i.e. TELCO, two way radio, etc.).

8) System trouble reporting.
9) System Electrical Supervision.
10) UPS operation.
11) STRs.
12) NSs
13) TCOs.

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 COR.

C. Acceptance Test:

1. After the PA System has been pretested and the Contractor has submitted the pretest results and certification to the COR, then the Contractor shall schedule an acceptance test date and submit to the COR 30 day's written notice prior to the date the acceptance test is expected to begin. COR to then approve or propose an alternate date. The System shall be tested in the presence of an OEM certified representatives. The System shall be tested utilizing the approved test equipment to certify proof of performance and Emergency / Public Safety 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. Retesting of the entire System shall be rescheduled at the convenience of the Government.
3. Retesting of the entire System shall be rescheduled at the convenience of the Government and costs borne by the Contractor.

D. Acceptance Test Procedure:

1. Physical and Mechanical Inspection:

a. The COR will tour all areas where the PA 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 new system 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 equipment test, each speaker (or on board speaker) shall be inspected 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 speaker in each leg to verify the PA distribution system meets all system performance standards.

d. If the RED system is a part of the system, each volume stepper switches shall be checked to insure proper operation of the pillow speaker, the volume stepper and the RED system (if installed).

e. Additionally, each installed amplifier, mixer, distributed speaker/amplifier, power supply and remote amplifiers shall be checked insuring they meet the requirements of this specification.

f. 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: “all call,” three

sub-zoned, minimum of 15 minutes of UPS operation, electrical supervision, trouble panel, corridor speakers and audio paging.

h. Individual Item Test: The COR 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 COR. 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 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. Random Noise Generator.
7. Audio Amplifier with External Speaker.

4.2 WARRANTY

A. Comply with FAR 52.246-21, except that warranty shall be as follows.

B. Contractor’s Responsibility:

1. The Contractor shall warranty 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 COR 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, 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 two year warranty period:
   a. Response Time During the ***Two Year*** warranty Period:
      1) The COR is the Contractor’s ONLY OFFICIAL reporting and contact official for trouble calls, during the warranty period.
      2) A standard work week is considered 8:00 A.M. to 5:00 P.M. or as designated by the COR, 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 power supply; one (1) master System control station, or amplifier 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 COR shall notify the Contractor of this type of trouble call.
         c) An emergency trouble call within four (4) hours of its report. An emergency trouble is considered a trouble which causes a sub-zone, zone, distribution point, terminal cabinet, or all call system to be inoperable at anytime.
      4) If a PA System component failure cannot be corrected within four (4) hours (exclusive of the standard work time limits), the Contractor shall be responsible for providing alternate System equipment. The alternate equipment/system shall be operational within a maximum of 12 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*** warranty Period

1) The Contractor shall visit, on-site, for a minimum of eight (8) hours, once every 12 weeks, during the warranty 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 COR prior to performing the required maintenance visits.
3) Preventive maintenance procedure(s)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 COR and Contractor.
4) The preventive maintenance schedule, functions and reports shall be provided to and approved by the COR.
5) The Contractor shall provide the COR 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 COR 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 warranty period to COR by the fifth (5^{th}) 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.

4.3 TRAINING

B. Provide the following minimum training times and durations:

1. Coordinate with COR for multiple trainings at COR determined days and lengths for a total of 24 hours for supervisors and system administrators.

- - - E N D - - -

SECTION 28 13 00
PHYSICAL 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 operating Physical Access Control System, hereinafter referred to as the PACS.

B. This Section includes a Physical Access Control System consisting of integration to an existing system server, and a field-installed Controller connected by a high-speed electronic data transmission network. The PACS shall have the following:

1. Physical Access Control:

a. Regulating access through doors and gates

e. Credential cards and readers

f. Push-button switches

g. RS-232 ASCII interface

C. System Architecture:

1. Criticality, operational requirements, and/or limiting points of failure may dictate the development of an enterprise and regional server architecture as opposed to system capacity. Provide server and workstation configurations with all necessary connectors, interfaces and accessories as shown.

D. PACS shall provide secure and reliable identification of Federal employees and contractors by utilizing credential authentication per FIPS-201.

E. Physical Access Control System (PACS) shall consist of:

1. Existing Head-End equipment server,
2. One or more existing networked PC-based workstations,
3. Existing Physical Access Control System and Database Management Software,
4. Existing Credential validation software/hardware,
5. Existing Field installed controllers,
6. New Card readers,
7. PIV cards,
8. Door locks and sensors,
9. Interfaces with:

a. New Automatic gate operator,

F. All security relevant decisions shall be made on "secure side of the door". Secure side processing shall include;
   1. Challenge/response management,
   2. PKI path discovery and validation,
   3. Credential identifier processing,
   4. Authorization decisions.

G. For locations where secure side processing is not applicable the tamper switches and certified cryptographic processing shall be provided per FIPS-140-2.

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.

C. Section 08 71 00 – DOOR HARDWARE. Requirements for door installation.

D. Section 10 14 00 – SIGNAGE. Requirements for labeling and signs.

E. Section 26 05 11 – REQUIREMENTS FOR ELECTRICAL INSTALLATIONS. Requirements for connection of high voltage.

F. Section 26 05 33 – RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS. Requirements for infrastructure.

G. Section 27 05 11 – REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS. For general requirements that are common to more than one section in Division 27 and 28.

H. Section 27 10 00 – CONTROL, COMMUNICATION AND SIGNAL WIRING. Requirements for conductors and cables.

I. Section 27 15 00 – COMMUNICATIONS STRUCTURED CABLING. Requirements for conductors and cables.

J. Section 27 05 26 – GROUNDING AND BONDING FOR COMMUNICATIONS INSTALLATIONS. Requirements for grounding of equipment.

K. Section 27 05 33 – RACEWAY AND BOXES FOR COMMUNICATIONS SYSTEMS. Requirements for infrastructure.

1.3 QUALITY ASSURANCE

A. Refer to 27 05 11 REQUIREMENTS FOR COMMUNICATIONS INSTALLATONS.

1.4 SUBMITTALS

A. Refer to 27 05 11 REQUIREMENTS FOR COMMUNICATIONS INSTALLATONS.

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

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.....ADA Standards for Accessible Design 2010

E. Department of Veterans Affairs (VA):

PACS-R: Physical Access Control System (PACS) Requirements

VA Handbook 0730 Security and Law Enforcement

F. Government Accountability Office (GAO):

GAO-03-8-02 Security Responsibilities for Federally Owned and Leased Facilities

G. National Electrical Manufactures Association (NEMA):

250-08.....Enclosures for Electrical Equipment (1000 Volts Maximum)

H. National Fire Protection Association (NFPA):

70-11..... National Electrical Code

I. Underwriters Laboratories, Inc. (UL):

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

J. Homeland Security Presidential Directive (HSPD):

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

K. Federal Communications Commission (FCC):

(47 CFR 15) Part 15 Limitations on the Use of Wireless Equipment/Systems

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 800-63.....Electronic Authentication Guideline

Special Pub 800-96.....PIV Card Reader Interoperability Guidelines

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

Special Pub 800-96.....PIV Card Reader Interoperability Guidelines

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. Institute of Electrical and Electronics Engineers (IEEE):

C62.41.....IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits

O. 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

P. Uniform Federal Accessibility Standards (UFAS) 1984

Q. ADA Standards for Accessible Design 2010

R. Section 508 of the Rehabilitation Act of 1973

1.6 DEFINITIONS

A. ABA Track: Magnetic stripe that is encoded on track 2, at 75-bpi density in binary-coded decimal format; for example, 5-bit, 16-character set.

B. Access Control List: A list of (identifier, permissions) pairs associated with a resource or an asset. As an expression of security policy, a person may perform an operation on a resource or asset if and only if the person's identifier is present in the access control list (explicitly or implicitly), and the permissions in the (identifier, permissions) pair include the permission to perform the requested operation.

C. Access Control: A function or a system that restricts access to authorized persons only.

D. API Application Programming Interface

E. Assurance Level (or E-Authentication Assurance Level): A measure of trust or confidence in an authentication mechanism defined in OMB Memorandum M-04-04 and NIST Special Publication (SP) 800-63, in terms of four levels: [M-04-04]

1. Level 1: LITTLE OR NO confidence
2. Level 2: SOME confidence
3. Level 3: HIGH confidence
4. Level 4: VERY HIGH confidence

F. Authentication: A process that establishes the origin of information, or determines an entity's identity. In this publication, authentication often means the performance of a PIV authentication mechanism.

G. Authenticator: A memory, possession, or quality of a person that can serve as proof of identity, when presented to a verifier of the appropriate kind. For example, passwords, cryptographic keys, and fingerprints are authenticators.

H. Authorization: A process that associates permission to access a resource or asset with a person and the person's identifier(s).

I. BIO or BIO-A: A FIPS 201 authentication mechanism that is implemented by using a Fingerprint data object sent from the PIV Card to the PACS. Note that the short-hand "BIO (-A)" is used throughout the document to represent both BIO and BIO-A authentication mechanisms.

J. Biometric: An authenticator produced from measurable qualities of a living person.

K. CAC EP - CAC End Point with end point PIV applet

L. CAC NG – CAC Next Generation with transitional PIV applet

M. Card Authentication Key (CAK): A PIV authentication mechanism (or the PIV Card key of the same name) that is implemented by an asymmetric or symmetric key challenge/response protocol. The CAK is an optional mechanism defined in NIST SP 800-73. [SP800-73] NIST strongly recommends that every PIV Card contain an asymmetric CAK and corresponding certificate, and that agencies use the asymmetric CAK protocol, rather than a symmetric CAK protocol, whenever the CAK authentication mechanism is used with PACS.

N. CCTV: Closed-circuit television.

O. Central Station: A PC with software designated as the main controlling PC of the PACS. Where this term is presented with initial capital letters, this definition applies.

P. Controller: An intelligent peripheral control unit that uses a computer for controlling its operation. Where this term is presented with an initial capital letter, this definition applies.

Q. CPU: Central processing unit.

R. Credential: Data assigned to an entity and used to identify that entity.

S. File Server: A PC in a network that stores the programs and data files shared by users.

T. FIPS: Federal Information Processing Standards

U. FRAC – First Responder Authentication Credential

V. HSPD: Homeland Security Presidential Directive

W. I/O: Input/Output.

X. Identifier: A credential card, keypad personal identification number or code, biometric characteristic, or other unique identification entered as data into the entry-control database for the purpose of identifying an individual. Where this term is presented with an initial capital letter, this definition applies.

Y. IEC: International Electrotechnical Commission

Z. ISO: International Organization for Standardization

AA. KB: Kilobyte

BB. kbit/s: Kilobits / second

CC. LAN: Local area network.

DD. LED: Light-emitting diode.

EE. Legacy CAC – Contact only Common Access Card with v1 and v2 applets

FF. Location: A Location on the network having a PC-to-Controller communications link, with additional Controllers at the Location connected to the PC-to-Controller link with RS-485 communications loop. Where this term is presented with an initial capital letter, this definition applies.

GG. NIST: National Institute of Standards and Technology

HH. PACS: Physical Access Control System

II. PC/SC: Personal Computer / Smart Card

JJ. PC: Personal computer. This acronym applies to the Central Station, workstations, and file servers.

KK. PCI Bus: Peripheral component interconnect; a peripheral bus providing a high-speed data path between the CPU and peripheral devices (such as monitor, disk drive, or network).

LL. PDF: (Portable Document Format.) The file format used by the Acrobat document exchange system software from Adobe.

MM. PIV: Personal Identification Verification

NN. PIV-I - PIV Interoperable credential

OO. PPS: Protocol and Parameters Selection

PP. RF: Radio frequency.

QQ. ROM: Read-only memory. ROM data are maintained through losses of power.

RR. RS-232: An TIA/EIA standard for asynchronous serial data communications between terminal devices. This standard defines a 25-pin connector and certain signal characteristics for interfacing computer equipment.

SS. RS-485: An TIA/EIA standard for multipoint communications.

TT. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.

UU. TPDU: Transport Protocol Data Unit

VV. TWIC - Transportation Worker Identification Credential

WW. UPS: Uninterruptible power supply.

XX. Vcc: Voltage at the Common Collector

YY. WAN: Wide area network.

ZZ. WAV: The digital audio format used in Microsoft Windows.

AAA. Wiegand: Patented magnetic principle that uses specially treated wires embedded in the credential card.

BBB. Windows: Operating system by Microsoft Corporation.

CCC. Workstation: A PC with software that is configured for specific limited security system functions.

1.7 COORDINATION

A. Refer to 27 05 11 REQUIREMENTS FOR COMMUNICATIONS INSTALLATONS.

1.8 MAINTENANCE & SERVICE

A. Refer to 27 05 11 REQUIREMENTS FOR COMMUNICATIONS INSTALLATONS.

1.9 PERFORMANCE REQUIREMENTS

A. PACS shall provide support for multiple authentication modes and bidirectional communication with the reader. PACS shall provide implementation capability for enterprise security policy and incident response.

B. All processing of authentication information must occur on the "safe side" of a door

C. Physical Access Control System shall provide access to following Security Areas:

1. Controlled

D. PACS shall provide:

1. One authentication factor for access to Controlled security areas

E. PACS shall provide Credential Validation and Path Validation per NIST 800-116.

F. The PACS System shall have an Enterprise Path Validation Module (PVM) component that processes X.509 certification paths composed of X.509 v3 certificates and X.509 v2 CRLs. The PVM component MUST support the following features:

1. Name chaining;
2. Signature chaining;
3. Certificate validity;
4. Key usage, basic constraints, and certificate policies certificate extensions;
5. Full CRLs; and
6. CRLs segmented on names.

G. Distributed Processing: System shall be a fully distributed processing system so that information, including time, date, valid codes, access levels, and similar data, is downloaded to existing Controllers so that each Controller makes access-control decisions for that Location. Do not use intermediate Controllers for physical access control. If communications to Central Station are lost, all Controllers shall automatically buffer event transactions until communications are

restored, at which time buffered events shall be uploaded to the Central Station.

K. Existing Central Station shall provide operator interface, interaction, display, control, and dynamic and real-time monitoring. Central Station shall control system networks to interconnect all system components, including workstations and field-installed Controllers.

Q. Door Hardware Interface: Coordinate with Division 08 Sections that specify door hardware required to be monitored or controlled by the PACS. The Controllers in this Section shall have electrical characteristics that match the signal and power requirements of door hardware. Integrate door hardware specified in Division 08 Sections to function with the controls and PC-based software and hardware in this Section.

R. References to industry and trade association standards and codes are minimum installation requirement standards.

S. Drawings and other specification sections shall govern in those instances where requirements are greater than those specified in the above standards.

1.10 EQUIPMENT AND MATERIALS

A. Refer to 27 05 11 REQUIREMENTS FOR COMMUNICATIONS INSTALLATONS.

1.11 WARRANTY OF CONSTRUCTION.

A. Warrant PACS 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.

1.12 GENERAL REQUIREMENTS

A. For general requirements that are common to more than one section in Division 28 refer to Section 27 05 11 REQUIREMENTS FOR COMMUNICATIONS INSTALLATONS.

B. General requirements applicable to this section include:

1. General Arrangement Of Contract Documents,
2. Delivery, Handling and Storage,
3. Project Conditions,
4. Electrical Power,
5. Lightning, Power Surge Suppression, and Grounding,
6. Electronic Components,
7. Substitute Materials and Equipment, and
8. Like Items.

PART 2 – PRODUCTS

2.1 GENERAL

A. All equipment and materials for the system will be compatible to ensure correct operation as outlined in FIPS 201, March 2006 and HSPD-12.

B. The security system characteristics listed in this section will serve as a guide in selection of equipment and materials for the PACS. If updated or more suitable versions are available then the Contracting Officer will approve the acceptance of prior to an installation.

C. PACS equipment shall meet or exceed all requirements listed below.

D. A PACS shall be comprised of, but not limited to, the following components:

1. Physical Access Control System
2. Existing Application Software
3. Existing System Database
4. Existing Surge and Tamper Protection
5. Existing Standard Workstation Hardware
6. Existing Communications Workstation
7. Existing Controllers (Data Gathering Panel)
8. New Card Readers
9. New Credential Cards
10. System Sensors and Related Equipment
11. Door and Gate Hardware interface
12. Cables

2.2 CARD READERS

A. Power: Card reader shall be powered from its existing associated Controller, including its standby power source.

B. Response Time: Card reader shall respond to passage requests by generating a signal that is sent to the Controller. Response time shall be 800ms or less, from the time the card reader finishes reading the credential card until a response signal is generated.

C. Enclosure: Suitable for surface, semiflush, or pedestal mounting. Mounting types shall additionally be suitable for installation in the following locations:

1. Indoors, controlled environment.

D. Display: LED or other type of visual indicator display shall provide visual and audible status indications and user prompts. Indicate power

on/off, whether user passage requests have been accepted or rejected, and whether the door is locked or unlocked.

E. Shall be utilized for controlling the locking hardware on a door and allows for reporting back to the main control panel with the time/date the door was accessed, the name of the person accessing the point of entry, and its location.

F. Will be fully programmable and addressable, locally and remotely, and hardwired to the system.

G. Shall be individually home run to the main panel.

H. Shall be installed in a manner that they comply with:
   1. The Uniform Federal Accessibility Standards (UFAS)
   2. The Americans with Disabilities Act (ADA)
   3. The ADA Standards for Accessible Design

I. Shall support a variety of card readers that must encompass a wide functional range. The PACS may combine any of the card readers described below for installations requiring multiple types of card reader capability (i.e., card only, supervised inputs, etc.). These card readers shall be available in the approved technology to meet FIPS 201, and is ISO 14443 A or B, ISO/IEC 7816 compliant. The reader output can be Wiegand, RS-22, 485 or TCP/IP.

J. Shall be housed in an aluminum bezel with a wide lead-in for easy card entry.

K. Shall contain read head electronics, and a sender to encode digital door control signals.

L. LED’s shall be utilized to indicate card reader status and access status.

M. Shall be able to support a user defined downloadable off-line mode of operation (e.g. locked, unlocked), which will go in effect during loss of communication with the main control panel.

N. Shall provide audible feedback to indicate access granted/denied decisions. Upon a card swipe, two audible tones or beeps shall indicate access granted and three tones or beeps shall indicate access denied. All keypad buttons shall provide tactile audible feedback.

O. Shall have a minimum of two programmable inputs and two programmable outputs.

P. Shall include a Light Emitting Diode (LED) or other type of visual indicator display and provide visual or visual and audible status

indications and user prompts. The display shall indicate power on/off, and whether user passage requests have been accepted or rejected.

1. Shall respond to passage requests by generating a signal to the local processor. The response time shall be 800 milliseconds or less from the time the last alphanumeric symbol is entered until a response signal is generated.
2. Shall be powered from the source as designed and shall not dissipate more than 150 Watts.
3. Shall be suitable for surface, semi-flush, pedestal, or weatherproof mounting as required.
4. Shall provide a means for users to indicate a duress situation by entering a special code.

R. PIV Contact Card Reader

1. Application Protocol Data Unit (APDU) Support: At a minimum, the contact interface shall support all card commands for contact based access specified in Section 7, End-point PIV Card Application Card Command Interface of SP 800-73-1, Interfaces for Personal Identity Verification.
2. Buffer Size: The reader must contain a buffer large enough to receive the maximum size frame permitted by International Organization for Standardization International Electrotechnical Commission (ISO/IEC) 7816-3:1997, Section 9.4.
3. Programming Voltage: PIV Readers shall not generate a Programming Voltage.
4. Support for Operating Class: PIV Readers shall support cards with Class A Vccs as defined in ISO/IEC 7816-3:1997 and ISO/IEC 7816-3:1997/Amd 1:2002.
5. Retrieval Time: Retrieval time[1] for 12.5 kilobytes (KB) of data through the contact interface of the reader shall not exceed 2.0 seconds.
6. Transmission Protocol: The PIV Reader shall support both the character-based T=0 protocol and block-based T=1 protocol as defined in ISO/IEC 7816-3:1997.
7. Support for PPS Procedure: The reader shall support Protocol and Parameters Selection (PPS) procedure by having the ability to read

character TA1 of the Answer to Reset (ATR) sent by the card as defined in ISO/IEC 7816-3:1997.

S. Contactless Smart Cards and Readers

1. Smart card readers shall read credential cards whose characteristics of size and technology meet those defined by ISO/IEC 7816, 14443, 15693.
2. The readers shall have "flash" download capability to accommodate card format changes.
3. The card reader shall have the capability of reading the card data and transmitting the data to the main monitoring panel.
4. The card reader shall be contactless and meet or exceed the following technical characteristics:
   a. Data Output Formats: FIPS 201 low outputs the FASC-N in an assortment of Wiegand bit formats from 40 - 200 bits. FIPS 201 medium outputs a combination FASC-N and HMAC in an assortment of Wiegand bit formats from 32 - 232 bits. All Wiegand formats or the upgradeability from Low to Medium Levels can be field configured with the use of a command card.
   b. FIPS 201 readers shall be able to read, but not be limited to, DESfire and iCLASS cards.
   c. Reader range shall comply with ISO standards 7816, 14443, and 15693, and also take into consideration conditions, are at a minimum 1” to 2” (2.5 - 5 cm).
   d. APDU Support: At a minimum, the contactless interface shall support all card commands for contactless based access specified in Section 7, End-point PIV Card Application Card Command Interface of SP 800-73-1, Interfaces for Personal Identity Verification.
   e. Buffer Size: The reader shall contain a buffer large enough to receive the maximum size frame permitted by ISO/IEC 7816-3, Section 9.4.
   f. ISO 14443 Support: The PIV Reader shall support parts (1 through 4) of ISO/IEC 14443 as amended in the References of this publication.
   g. Type A and B Communication Signal Interfaces: The contactless interface of the reader shall support both the Type A and Type B communication signal interfaces as defined in ISO/IEC 14443-2:2001.

h. Type A and B Initialization and Anti-Collision The contactless interface of the reader shall support both Type A and Type B initialization and anti-collision methods as defined in ISO/IEC 14443-3:2001.

i. Type A and B Transmission Protocols: The contactless interface of the reader shall support both Type A and Type B transmission protocols as defined in ISO/IEC 14443-4:2001.

j. Retrieval Time: Retrieval time for 4 KB of data through the contactless interface of the reader shall not exceed 2.0 seconds.

k. Transmission Speeds: The contactless interface of the reader shall support bit rates of fc/128 (~106 kbits/s), fc/64(~212 kbits/s), and configurable to allow activation/deactivation.

l. Readibility Range: The reader shall not be able to read PIV card more than 10cm(4inch) from the reader

2.3 CREDENTIAL CARDS

A. Personal Identity Verification (PIV) credential cards shall comply to Federal Information Processing Standards Publication (FIPS) 201.

B. Visual Card Topography shall be compliant with NIST 800-104.

C. PIV logical credentials shall contain multiple data elements for the purpose of verifying the cardholder's identity at graduated assurance levels. These mandatory data elements shall collectively comprise the data model for PIV logical credentials, and include the following:

1. CHUID
2. PIV authentication data (one asymmetric key pair and corresponding certificate)

D. The credential card (PIV) shall be an ISO 14443 type smart card with contactless interface that operates at 13.56 MHZ.

2.4 SYSTEM SENSORS AND RELATED EQUIPMENT

A. The PACS (Physical Access Control System) and related Equipment provided by the Contractor shall meet or exceed the following performer specifications:

B. Request to Exit Detectors:

1. Passive Infrared Request to Exit Motion Detector (REX PIR) (1) The Contractor shall provide a surface mounted motion detector to signal the physical access control system request to exit input. The motion detector shall be a passive infrared sensor designed for wall or ceiling mounting 2134 to 4572 mm (7 to 15 ft) height. The detector shall provide two (2) form "C" (SPDT) relays rated one (1)

Amp. @ 30 VDC for DC resistive loads. The detectors relays shall be user adjustable with a latch time from 1-60 seconds. The detector shall also include a selectable relay reset mode to follow the timer or absence of motion. The detection pattern shall be adjustable plus or minus fourteen (± 14) degrees. The detector shall operate on 12 VDC with approximately 26 mA continuous current draw. The detector shall have an externally visible activation LED. The motion detector shall measure approximately 38 mm H x 158 mm W x 38 mm D (1.5 x 6.25 x 1.5 in). The detector shall be immune to radio frequency interference. The detector shall not activate or set-up on critical frequencies in the range 26 to 950 Megahertz using a 50 watt transmitter located 30.5 cm (1 ft) from the unit or attached wiring. The detector shall be available on gray or black enclosures. The color of the housing shall be coordinated with the surrounding surface.

C. Delayed Egress (DE)

1. General:

a. The delay egress locking hardware shall provide a method to secure emergency exits and provide an approved delayed emergency exit method. The package shall be Underwriters Laboratories listed as a delay egress-locking device. The delay egress device shall be available to support configurations with both rated and non-rated fire doors. The delay egress device shall comply with Life Safety Codes (NFPA-101, BOCA) as it applies to special locking arrangements for delay egress locks. Unless specifically identified as a non-fire rated opening, all doors shall be equipped with fire rated door hardware. The Contractor shall be responsible for providing all equipment and installation to provide a fully functioning system. Need to amend to use crashbars type mechanical release switches.

2. The delay-locking device shall include all of the following features:

a. Delay Egress Mode

1) The delayed egress device shall be a SDC 101V Series Exit Check with wall mounted control module. Upon activation of an approved panic bar the delay locking device shall begin a delay sequence of 30 seconds; a flush mounted wall LED panel adjacent to the door will indicate initiation of the countdown

time. During the 30 second delay period, a local sounding device shall annunciate a tone activation of the delay cycle and verbal exit instructions. At the end of the delay cycle the locking device shall unlock and allow free egress. The reset of the local sounding device shall be user definable and include options to select either local sound until silenced by reset or local sounder silenced upon opening of the door. Unless otherwise indicated the local delay sounder shall be silenced upon opening of the door. The SDC's device trigger output shall be connected to the SMS DGP alarm panel for pre-activation warning. The contractor shall specify the bond sensor option when ordering the delayed egress hardware; this output shall be wired to the SMS DGP to activate an alarm if the door does not lock. Use of reset panel not top mounted device.

2) Delayed egress doors will have bond sensors.

b. Fire Alarm Mode

1) Upon activation of the facility's fire evacuation and water flow alarm signal the delay locking devices shall immediately unlock and provide free egress. The Contractor shall provide any required fire alarm relays or interface devices.

c. Reset Mode

1) The delay egress device shall be manually reset by the Delayed Egress controller located at the door via key switch.
2) The delay egress device shall automatically reset upon fire alarm system reset.
3) The delayed egress shall be resettable through the SMS.

d. The Contractor shall provide a Master Open Switch for all the facility's delayed egress hardware, with protective cover and permanent labeling in the Unit Control Room. The switch shall be wired into the fire alarm system to activate the evacuation alarms. When the switch is pressed all delayed egress or evacuation doors shall unlock and generate an alarm at the security console monitor showing and recording time and date of when the switch was pressed. The contractor is responsible for coordinating the wiring and connection with the fire alarm contactor. The Master Open Switch shall be linked to the fire alarm panel for the release of doors locks.

e. Each individual delayed egress door shall have the ability to unlock through a manual action on the SMS.

f. Unless otherwise indicated the Contractor shall provide all of the above reset methods for each door. All signs will meet the latest ADA requirements.

g. Signs

1) The delay egress package shall be provided with a warning sign complying with local code requirements. The warning sign shall be attached to the interior side of the controlled door. The sign shall be located on the interior side of the door above and within 304 mm (12 in) of the panic bar. The sign shall read:
EMERGENCY EXIT.
PUSH UNTIL
ALARM SOUNDS
DOOR CAN BE OPENED,
IN 30 SECONDS.

2) Signs shall be coordinated and comply with the building's existing sign specifications. Signs shall include grade 2 Braille.

3) Signs shall meet the current ADA requirements.

4) In instances of code and specification conflicts, the life safety code requirement shall prevail.

5) The Division 10 Contractor shall provide samples for approval with their submittal package.

3. Physical Access Control Interface

a. The delay egress device shall be capable of interface with card access control systems.

b. The system shall include a bypass feature that is activated via a dry contact relay output from the physical access control system. This bypass shall allow authorized personnel to pass through the controlled portal without creating an alarm condition or activating the delay egress cycle. The bypass shall include internal electronic shunts or door switches to prevent activation (re-arming) until the door returns to the closed position. An unused access event shall not cause a false alarm and shall automatically rearm the delay egress lock upon expiration of the programmed shunt time. The delay egress physical access control

interface shall support extended periods of automated and/or manual lock and unlock cycles.

E. Key Bypass:
   1. Shall be utilized for all doors that have a mortise or rim mounted door hardware.
   2. Each door shall be individually keyed with one master key per secured area.
   3. Cylinders shall be six (6)-pin and made of brass or equivalent. Keys for the cylinders shall be constructed of solid material and produced and cut by the same distributor. Keys shall not be purchased, cut, and supplied by multiple dealers.
   4. All keys shall have a serial number cut into the key. No two serial numbers shall be the same.
   5. All keys and cylinders shall be stored in a secure area that is monitored by the Intrusion Detection System.

2.5 WIRES AND CABLES

A. Refer to section 271000 "CONTROL, COMMUNICATION AND SIGNAL WIRING" & section 271500 "COMMUNICATIONS STRUCTURED CABLING".

PART 3 – EXECUTION

3.1 GENERAL

A. The Contractor shall install all system components and appurtenances in accordance with the manufacturers' instructions, ANSI C2, and shall furnish all necessary interconnections, services, and adjustments required for a complete and operable system as specified. Control signals, communications, and data transmission lines grounding shall be installed as necessary to preclude ground loops, noise, and surges from affecting system operation. Equipment, materials, installation, workmanship, inspection, and testing shall be in accordance with manufacturers' recommendations and as modified herein.

B. Consult the manufacturers' installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc., before beginning system installation. Refer to the Riser/Connection diagram for all schematic system installation/termination/wiring data.

C. All equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place (e.g., sensors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.

3.2 CURRENT SITE CONDITIONS

A. The Contractor shall visit the site and verify that site conditions are in agreement with the design package. The Contractor shall report all changes to the site or conditions which will affect performance of the system to the Owner in a report as defined in paragraph Group II Technical Data Package. The Contractor shall not take any corrective action without written permission from the COR.

3.3 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.

B. Examine roughing-in for LAN and control cable conduit systems to PCs, Controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.4 PREPARATION

A. Comply with recommendations in SIA CP-01.

B. Comply with EIA/TIA-606, "Administration Standard for the Telecommunications Infrastructure of Commercial Buildings."

C. Obtain detailed Project planning forms from manufacturer of access-control system; develop custom forms to suit Project. Fill in all data available from Project plans and specifications and publish as Project planning documents for review and approval.

1. Record setup data for control station and workstations.
2. For each Location, record setup of existing Controller features and access requirements.
3. Propose start and stop times for time zones and holidays, and match up access levels for doors.
4. Set up groups, linking, and list inputs and outputs for each Controller.
5. Assign action message names and compose messages.
6. Set up alarms.
7. Prepare and install alarm graphic maps.
8. Develop user-defined fields.
9. Develop screen layout formats.
10. Propose setups for key control.

11. Discuss badge layout options; design badges.
12. Complete system diagnostics and operation verification.
13. Prepare a specific plan for system testing, startup, and demonstration.
14. Develop acceptance test concept and, on approval, develop specifics of the test.
15. Develop cable and asset management system details; input data from construction documents. Include system schematics and Technical Drawings.

D. In meetings with Architect and Owner, present Project planning documents and review, adjust, and prepare final setup documents. Use final documents to set up system software.

3.5 CABLING

A. Comply with NECA 1, "Good Workmanship in Electrical Contracting."

B. Install cables and wiring according to requirements in Division 27.

C. Wiring Method: Install wiring in raceway except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces.

E. Install LAN cables using techniques, practices, and methods that are consistent with Category 6A rating of components and that ensure Category 6A performance of completed and linked signal paths, end to end.

F. Install cables without damaging conductors, shield, or jacket.

G. Boxes and enclosures containing security system components or cabling, and which are easily accessible to employees or to the public, shall be provided with a lock. Boxes above ceiling level in occupied areas of the building shall not be considered to be accessible. Junction boxes and small device enclosures below ceiling level and easily accessible to employees or the public shall be covered with a suitable cover plate and secured with tamperproof screws.

H. Install end-of-line resistors at the field device location and not at the Controller or panel location.

3.6 CABLE APPLICATION

A. Comply with EIA/TIA-569, "Commercial Building Standard for Telecommunications Pathways and Spaces."

B. Cable application requirements are minimum requirements and shall be exceeded if recommended or required by manufacturer of system hardware.

C. RS-232 Cabling: Install at a maximum distance of 50 feet (15 m).

D. RS-485 Cabling: Install at a maximum distance of 4000 feet (1220 m).

E. Card Readers:

1. Install number of conductor pairs recommended by manufacturer for the functions specified.
2. Unless manufacturer recommends larger conductors, install No. 22 AWG wire if maximum distance from Controller to the reader is 250 feet (75 m), and install No. 20 AWG wire if maximum distance is 500 feet (150 m).
3. For greater distances, install "extender" or "repeater" modules recommended by manufacturer of the Controller.
4. Install minimum No. 18 AWG shielded cable to readers and keypads that draw 50 mA or more.

F. Install minimum No. 16 AWG cable from Controller to electrically powered locks. Do not exceed 250 feet (75 m).

G. Install minimum No. 18 AWG ac power wire from transformer to Controller, with a maximum distance of 25 feet (8 m).

3.7 GROUNDING

A. Comply with Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Comply with IEEE 1100, "Power and Grounding Sensitive Electronic Equipment."

C. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

D. Signal Ground:

1. Terminal: Locate in each equipment room and wiring closet; isolate from power system and equipment grounding.
2. Bus: Mount on wall of main equipment room with standoff insulators.
3. Backbone Cable: Extend from signal ground bus to signal ground terminal in each equipment room and wiring closet.

3.8 INSTALLATION

A. System installation shall be in accordance with UL 294, manufacturer and related documents and references, for each type of security subsystem designed, engineered and installed.

B. Components shall be configured with appropriate “service points” to pinpoint system trouble in less than 30 minutes.

C. The Contractor shall install all system components including Government furnished equipment, and appurtenances in accordance with the

manufacturer's instructions, documentation listed in Sections 1.4 and 1.5 of this document, and shall furnish all necessary connectors, terminators, interconnections, services, and adjustments required for a operable system.

D. The PACS will be designed, engineered, installed, and tested to ensure all components are fully compatible as a system and can be integrated with all associated security subsystems, whether the system is a stand alone or a network.

E. For integration purposes, the PACS shall be integrated where appropriate with the following associated security subsystems:

1. EPPS:

a. Be programmed to go into an alarm state when an emergency call box or duress alarm/panic device is activated, and notify the Physical Access Control System and Database Management of an alarm event.

F. Integration with these security subsystems shall be achieved by computer programming or the direct hardwiring of the systems.

G. For programming purposes 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. The Contractor shall visit the site and verify that site conditions are in agreement with the design package. The Contractor shall report all changes to the site or conditions that will affect performance of the system. The Contractor shall not take any corrective action without written permission from the Government.

I. The Contractor shall visit the site and verify that site conditions are in agreement/compliance with the design package. The Contractor shall report all changes to the site or conditions that will affect performance of the system to the Contracting Officer in the form of a report. The Contractor shall not take any corrective action without written permission received from the Contracting Officer.

J. Existing Equipment:

1. The Contractor shall connect to and utilize existing door equipment, control signal transmission lines, and devices as outlined in the design package. Door equipment and signal lines that are usable in their original configuration without modification may be reused with Contracting Officer approval.

2. The Contractor shall perform a field survey, including testing and inspection of all existing door equipment and signal lines intended to be incorporated into the PACS, and furnish a report to the Contracting Officer as part of the site survey report. For those items considered nonfunctioning, provide (with the report) specification sheets, or written functional requirements to support the findings and the estimated cost to correct the deficiency. As part of the report, the Contractor shall include a schedule for connection to all existing equipment.
3. The Contractor shall make written requests and obtain approval prior to disconnecting any signal lines and equipment, and creating equipment downtime. Such work shall proceed only after receiving Contracting Officer approval of these requests. If any device fails after the Contractor has commenced work on that device, signal or control line, the Contractor shall diagnose the failure and perform any necessary corrections to the equipment.
4. The Contractor shall be held responsible for repair costs due to Contractor negligence, abuse, or improper installation of equipment.
5. The Contracting Officer shall be provided a full list of all equipment that is to be removed or replaced by the Contractor, to include description and serial/manufacturer numbers where possible. The Contractor shall dispose of all equipment that has been removed or replaced based upon approval of the Contracting Officer after reviewing the equipment removal list. In all areas where equipment is removed or replaced the Contractor shall repair those areas to match the current existing conditions.

K. Enclosure Penetrations: All enclosure penetrations shall be from the bottom of the enclosure unless the system design requires penetrations from other directions. Penetrations of interior enclosures involving transitions of conduit from interior to exterior, and all penetrations on exterior enclosures shall be sealed with rubber silicone sealant to preclude the entry of water and will comply with VA Master Specification 07 84 00, Firestopping. The conduit riser shall terminate in a hot-dipped galvanized metal cable terminator. The terminator shall be filled with an approved sealant as recommended by the cable manufacturer and in such a manner that the cable is not damaged.

L. Cold Galvanizing: All field welds and brazing on factory galvanized boxes, enclosures, and conduits shall be coated with a cold galvanized paint containing at least 95 percent zinc by weight.

M. Control Panels:

1. Connect power and signal lines to the controller.
2. Program the panel as outlined by the design and per the manufacturer's programming guidelines.

N. SMS:

1. Coordinate with the VA agency's IT personnel to place the computer on the local LAN or Intranet and provide the security system protection levels required to insure only authorized VA personnel have access to the system.
2. Program and set-up the SMS to ensure it is in fully operation.

O. Card Readers:

1. Connect all signal inputs and outputs as shown and specified.
2. Terminate input signals as required.
3. Program and address the reader as per the design package.
4. Readers shall be surface or flushed mounted and all appropriate hardware shall be provided to ensure the unit is installed in an enclosed conduit system.

P. Door Status Indicators:

1. Install all signal input and output cables as well as all power cables.
2. RTE's shall be surface mounted and angled in a manner that they cannot be compromised from the non-secure side of a windowed door, or allow for easy release of the locking device from a distance no greater than 6 feet from the base of the door.
3. Door position sensors shall be surface or flush mounted and wide gap with the ability to operate at a maximum distance of up to 2" (5 cm).

Q. Entry Control Devices:

1. Install all signal input and power cables.
2. Strikes and bolts shall be mounted within the door frame.
3. Mortise locks shall be mounted within the door and an electric transfer hinge shall be utilized to transfer the wire from within the door frame to the mortise lock inside the door.
4. Electromagnetic locks shall be installed with the mag-lock mounted to the door frame and the metal plate mounted to the door.

R. System Start-Up:

1. The Contractor shall not apply power to the PACS until the following items have been completed:
   a. PACS equipment items and have been set up in accordance with manufacturer's instructions.
   b. A visual inspection of the PACS has been conducted to ensure that defective equipment items have not been installed and that there are no loose connections.
   c. System wiring has been tested and verified as correctly connected as indicated.
   d. All system grounding and transient protection systems have been verified as installed and connected as indicated.
   e. Power supplies to be connected to the PACS have been verified as the correct voltage, phasing, and frequency as indicated.
2. 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. 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.

S. Supplemental Contractor Quality Control:

1. The Contractor shall provide the services of technical representatives who are familiar with all components and installation procedures of the installed PACS; and are approved by the Contracting Officer.
2. The Contractor will be present on the job site during the preparatory and initial phases of quality control to provide technical assistance.
3. The Contractor shall also be available on an as needed basis to provide assistance with follow-up phases of quality control.
4. 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.

3.9 SYSTEM SOFTWARE

A. Modify, and test existing software and databases for the complete and proper operation of systems involved.

3.10 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect[, test, and adjust] field-assembled components and equipment installation, including connections[, and to assist in field testing]. Report results in writing.

B. Testing Agency: [Owner will engage] [Engage] a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports:

C. Perform the following field tests and inspections and prepare test reports:

1. LAN Cable Procedures: Inspect for physical damage and test each conductor signal path for continuity and shorts. Use Class 2, bidirectional, Category 5 tester. Test for faulty connectors, splices, and terminations. Test according to TIA/EIA-568-1, "Commercial Building Telecommunications Cabling Standards - Part 1 General Requirements." Link performance for UTP cables must comply with minimum criteria in TIA/EIA-568-B.
2. Test each circuit and component of each system. Tests shall include, but are not limited to, measurements of power supply output under maximum load, signal loop resistance, and leakage to ground where applicable. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of the calculated battery operating time. Provide special equipment and software if testing requires special or dedicated equipment.
3. Operational Test: After installation of cables and connectors, demonstrate product capability and compliance with requirements. Test each signal path for end-to-end performance from each end of all pairs installed. Remove temporary connections when tests have been satisfactorily completed.

3.11 PROTECTION

A. Maintain strict security during the installation of equipment and software. Rooms housing the control station, and workstations that have been powered up shall be locked and secured, with an activated burglar alarm and access-control system reporting to a Central Station complying with UL 1610, "Central-Station Burglar-Alarm Units," during

periods when a qualified operator in the employ of Contractor is not present.

3.12 COMMISSIONING

A. Provide commissioning documentation in accordance with the requirements of Section 28 08 00 – COMMISSIONING OF ELECTRONIC SAFETY AND SECURITY SYSTEMS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.

B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 27 08 00 – COMMISSIONING OF COMMUNICATIONS SYSTEMS and related sections for contractor responsibilities for system commissioning.

3.13 DEMONSTRATION AND TRAINING

A. Provide services of manufacturer’s technical representative for four hours to instruct VA personnel in operation and maintenance of units.

B. Develop separate training modules for the following:

1. Computer system administration personnel to manage and repair the LAN and databases and to update and maintain software.
2. Operators who prepare and input credentials to man the control station and workstations and to enroll personnel.
3. Security personnel.
4. Hardware maintenance personnel.
5. Corporate management.

C. All testing and training shall be compliant with the VA General Requirements, Section 01 00 00, GENERAL REQUIREMENTS.

-----END----

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. The fire alarm installed will be an extension of an existing system. 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. The fire alarm system shall not be combined with other systems such as building automation, energy management, security, etc.

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 COR or his authorized representative. Installers shall have a minimum of 2 years experience installing fire alarm systems.

C. Fire alarm signals:

1. Building 1 addition shall have an automatic digitized voice fire alarm signal with emergency manual voice override to notify occupants to evacuate. The digitized voice message shall identify the area of the building (smoke zone) from which the alarm was initiated.

D. Alarm signals (by device), supervisory signals (by device) and system trouble signals (by device not reporting) shall be distinctly transmitted to the main fire alarm system control unit located in room 1D-01.

E. The main fire alarm control unit shall automatically transmit alarm signals to a listed central station using a digital alarm communicator transmitter in accordance with NFPA 72.

1.2 SCOPE

A. An extension of a fully addressable fire alarm system shall be 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. Existing fire alarm bells, chimes, door holders, 120VAC duct smoke detectors, valve tamper switches and waterflow/pressure switches may be reused only as specifically indicated on the drawings and provided the equipment:

1. Meets this specification section
2. Is UL listed or FM approved
3. Is compatible with new equipment being installed
4. Is verified as operable through contractor testing and inspection
5. Is warranted as new by the contractor.

C. Existing 120 VAC duct smoke detectors, waterflow/pressure switches, and valve tamper switches reused by the Contractor shall be equipped with an addressable interface device compatible with the new equipment being installed.

D. Existing reused equipment shall be covered as new equipment under the Warranty specified herein.

E. Basic Performance:

1. Alarm and trouble signals from each building fire alarm control panel shall be digitally encoded by UL listed electronic devices onto a multiplexed communication system.
2. Response time between alarm initiation (contact closure) and recording at the main fire alarm control unit (appearance on alphanumeric read out) shall not exceed 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.

F. Existing System Contractor:
1. Obtain the services of the existing fire alarm system contactor as part of this project to perform all device terminations and programming changes.

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 2019 compatible with current Fargo VA system and include all contractor’s information. The contractor shall be responsible for verifying all critical dimensions shown on the drawings.
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. Three weeks prior to final inspection, the Contractor shall deliver to the COR 3 sets of as-built drawings and one set of the as-built drawing computer files (using AutoCAD files (dwg) compatible with current Fargo VA). As-built drawings (floor plans) shall show all new and/or existing conduit used for the fire alarm system.
6. The fire alarm system subcontractor shall update the floor plans on the Fargo VA fire alarm system computer with the modifications made by this construction project.

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. Furnish manuals in 3 ring loose-leaf binder or manufacturer's standard binder.
i. A printout for all devices proposed on each signaling line circuit with spare capacity indicated.

2. Three weeks prior to final inspection, deliver 2 copies of the final updated maintenance and operating manual to the COR.
   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

A. 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 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 .....Standard for the Installation of Sprinkler Systems, 2019 edition

NFPA 14 ..... Standard for the Installation of Standpipes and Hose Systems, 2019 edition

NFPA 20 ..... Standard for the Installation of Stationary Pumps for Fire Protection, 2019 edition

NFPA 70.....National Electrical Code (NEC), 2017 edition

NFPA 72.....National Fire Alarm Code, 2019 edition

NFPA 90A.....Standard for the Installation of Air Conditioning and Ventilating Systems, 2018 edition

NFPA 101.....Life Safety Code, 2018 edition

C. Underwriters Laboratories, Inc. (UL): Fire Protection Equipment Directory

D. Factory Mutual Research Corp (FM): Approval Guide, 2007-2011

E. American National Standards Institute (ANSI):

S3.41.....Audible Emergency Evacuation Signal, 1990 edition, reaffirmed 2008

F. International Code Council, International Building Code (IBC), 2009 edition

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 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.
4. All new conduits shall be red.

B. Wire:

1. Wiring shall be in accordance with NEC article 760 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 COR.

2.3 FIRE ALARM CONTROL UNIT

A. General:
   1. Existing fire alarm control unit to remain and shall operate as a supervised zoned fire alarm system.

B. Enclosure:
   1. The existing control unit shall remain in existing enclosure.

C. Operator terminal at main control unit:
   1. Operator terminal shall be the existing terminal but shall be updated to include both existing remodeled areas and new building additions.

D. Power Supply:
   1. The existing control unit shall remain with existing power supply.
   2. The door holder power shall be arranged so that momentary or sustained loss of main operating power shall not cause the release of any door.
   3. Power supply for smoke detectors shall be taken from the fire alarm control unit.

E. Circuit Supervision: Each alarm initiating device circuit, signaling line circuit, and notification appliance circuit, shall be supervised against the occurrence of a break or ground fault condition in the field wiring. These conditions shall cause a trouble signal to sound in the control unit until manually silenced by an off switch.

F. Supervisory Devices: All sprinkler system valves and main gate valves shall be supervised for off-normal position. Closing a valve shall sound a supervisory signal at the control unit until silenced by an off switch. The specific location of all closed valves shall be identified at the control unit. Valve operation shall not cause an alarm signal. Low air pressure switches and duct detectors shall be monitored as supervisory signals.

G. Trouble signals:
   1. Arrange the trouble signals for automatic reset (non-latching).

2. System trouble switch off and on lamps shall be visible through the control unit door.

H. Function Switches: Provide the following switches in addition to any other switches required for the system:

1. Door Holder By-Pass Switch: Shall prevent doors from releasing during fire alarm tests. A system trouble alarm shall be energized when switch is in the abnormal position.

I. Remote Transmissions (tie into existing):

1. Provide capability and equipment for transmission of alarm, supervisory and trouble signals to the main fire alarm control unit.
2. Transmitters shall be compatible with the systems and equipment they are connected to such as timing, operation and other required features.

2.4 STANDBY POWER SUPPLY

A. Uninterrupted Power Supply (UPS):

1. Use the existing UPS system.

B. Batteries:

1. Use the existing batteries. Verify that the existing batteries have sufficient capacity to power the additional devices.

C. Battery Charger:

1. Use the existing battery charger. Verify the charger can recharge within VA limits stated below:
   a. Shall be rated for fully charging a completely discharged battery within 48 hours while simultaneously supplying any loads connected to the battery.

2.5 ANNUNCIATION

A. Annunciator, Alphanumeric Type (System):

1. Use the existing Annunciator.

B. Printer:

1. Use the existing printer.

2.6 VOICE COMMUNICATION SYSTEM (VCS)

A. General:

1. An emergency voice communication system is to be installed throughout Building 1 Expansion.
2. Upon receipt of an alarm signal from the building fire alarm system, the VCS shall automatically transmit a pre-recorded fire alarm message throughout the building.

3. A digitized voice module shall be used to store each prerecorded message. The fire alarm subcontractor is to burn and provide more chips for the new digitized message if they are not available in the current fire alarm system library.
4. The VCS shall be arranged as a dual channel system capable of transmitting 2 different messages simultaneously.
5. The VCS shall supervise all speaker circuits, control equipment, remote audio control equipment, and amplifiers.

B. Speaker Circuit Control Unit:
1. Use existing speaker circuit control unit and add new fire alarm zones as noted on fire alarm drawings.

C. Speaker Circuit Arrangement:
1. Speaker circuits shall be arranged such that there is one speaker circuit per smoke zone.
2. Audio amplifiers and control equipment shall be electrically supervised for normal and abnormal conditions.
3. Speaker circuits shall be either 25 VRMS or 70.7 VRMS with a minimum of 50 percent spare power available.
4. Speaker circuits and control equipment shall be arranged such that loss of any one speaker circuit will not cause the loss of any other speaker circuit in the system.

D. Digitized Voice Module (DVM):
1. Use existing Digitized Voice Module and add new fire alarm zones.

E. Audio Amplifiers:
1. Use existing Audio Amplifiers.

F. Tone Generator(s):
1. Use existing Tone Generator(s).

2.7 ALARM NOTIFICATION APPLIANCES

A. Bells:
1. Shall be electric, single-stroke or vibrating, heavy-duty, under-dome, solenoid type.
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. Speakers:
1. Shall operate on either 25 VRMS or 70.7 VRMS with field selectable output taps from 0.5 to 2.0W and originally installed at the 1/2

watt tap. Speakers shall provide a minimum sound output of 80 dBA at 10 feet (3,000 mm) with the 1/2 watt tap.

2. Frequency response shall be a minimum of 400 HZ to 4,000 HZ.
3. Four inches (100 mm) or 8 inches (200 mm) cone type speakers ceiling mounted with white colored baffles in areas with suspended ceilings and wall mounted in areas without ceilings.

C. 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. 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 Section 21 13 13, WET-PIPE SPRINKLER SYSTEMS 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 System Supervisory Switches:

1. Each sprinkler system water supply control valve, riser valve or zone control valve shall be equipped with a supervisory switch. Test and drain valves shall not be equipped with supervisory switches.
2. Main gate valves 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 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 FIRE AND 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 that matches existing at Fargo VA.

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 COR.

2.13 SPARE AND REPLACEMENT PARTS:

A. 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.

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 COR.

E. Speakers shall be ceiling mounted and fully recessed in areas with suspended ceilings. Speakers shall be wall mounted and recessed in finished areas without suspended ceilings. Speakers may be surface mounted in unfinished areas.

F. 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.

G. 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.

H. 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.

I. 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, or smoke detector shall cause the following operations to occur:
   1. Operate the emergency voice communication system in respective Buildings. For sprinkler protected buildings, flash strobes continuously only in the zone of alarm.
   2. Continuously sound pre-recorded digitized voice message alarm as noted in section 4 of this spec and flash all strobes in the building in alarm until reset at the local fire alarm control unit in respective Buildings.
   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 monitoring site.
   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.

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.

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 COR.

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 COR. 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 COR, 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.

PART 4 – SCHEDULES

4.1 SMOKE ZONE DESCRIPTIONS:

A. Notification zones are identified below:

Building One, Basement Floor, EMS

Building One, First Floor, Whole Health

4.2 DIGITIZED VOICE MESSAGES:

A. Digitized voice messages shall be provided for each smoke zone of Building 1. The messages shall be arranged with a 3 second alert tone, a "Code Red" message and a description of the fire alarm area (building number, floor, level and smoke zone). A sample of such a message is as follows:

Alert Tone

Code Red

Building One, Basement Floor, EMS

Code Red

Building One, Basement Floor, EMS

Code Red

Building One, Basement Floor, EMS

4.3 LOCATION OF VOICE MESSAGES:

A. Upon receipt of an alarm signal from the building fire alarm system, the voice communication system shall automatically transmit a 3 second tone alert and a pre-recorded fire alarm message throughout the building.

– – END – –

SECTION 31 20 00
EARTHWORK

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

A. This section specifies the requirements for furnishing all equipment, materials, labor, tools, and techniques for earthwork including, but not limited to, the following:

1. Site preparation.
2. Excavation.
3. Underpinning.
4. Filling and backfilling.
5. Grading.
6. Soil Disposal.
7. Clean Up.

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 material, including silts, which are unstable; and inorganic materials, including silts, too wet to be stable and any material with a liquid limit and plasticity index exceeding 40 and 15 respectively. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction, as defined by ASTM D698.
2. Existing Subgrade (Except Footing Subgrade): Same materials as 1.2.A.1, that are not capable of direct support of slabs, pavement, and similar items with possible exception of improvement by compaction, proofrolling, or similar methods.
3. Existing Subgrade (Footings Only): Same as paragraph 1, but no fill or backfill. If materials differ from design requirements, excavate to acceptable strata subject to COR's approval.

B. Building Earthwork: Earthwork operations required in area enclosed by a line located 1500 mm (5 feet) outside of principal building perimeter. It also includes earthwork required for auxiliary structures and buildings.

C. Trench Earthwork: Trenchwork required for utility lines.

D. Site Earthwork: Earthwork operations required in area outside of a line located 1500 mm (5 feet) outside of principal building perimeter and within new construction area with exceptions noted above.
E. Degree of compaction: Degree of compaction is expressed as a percentage of maximum density obtained by laboratory test procedure. This percentage of maximum density is obtained through use of data provided from results of field test procedures presented in ASTM D1556, ASTM D2167, and ASTM D6938.
F. Fill: Satisfactory soil materials used to raise existing grades. In the Construction Documents, the term “fill” means fill or backfill as appropriate.
G. Backfill: Soil materials or controlled low strength material used to fill an excavation.
H. Unauthorized excavation: Removal of materials beyond indicated sub-grade elevations or indicated lines and dimensions without written authorization by the COR. No payment will be made for unauthorized excavation or remedial work required to correct unauthorized excavation.
I. Authorized additional excavation: Removal of additional material authorized by the COR based on the determination by the Government’s soils testing agency that unsuitable bearing materials are encountered at required sub-grade elevations. Removal of unsuitable material and its replacement as directed will be paid on basis of Conditions of the Contract relative to changes in work.
J. Subgrade: The undisturbed earth or the compacted soil layer immediately below granular sub-base, drainage fill, or topsoil materials.
K. Structure: Buildings, foundations, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
L. Borrow: Satisfactory soil imported from off-site for use as fill or backfill.
M. Drainage course: Layer supporting slab-on-grade used to minimize capillary flow of pore water.
N. Bedding course: Layer placed over the excavated sub-grade in a trench before laying pipe. Bedding course shall extend up to the springline of the pipe.

O. Sub-base Course: Layer placed between the sub-grade and base course for asphalt paving or layer placed between the sub-grade and a concrete pavement or walk.

P. Utilities include on-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

Q. Debris: Debris includes all materials located within the designated work area not covered in the other definitions and shall include but not be limited to items like vehicles, equipment, appliances, building materials or remains thereof, tires, any solid or liquid chemicals or products stored or found in containers or spilled on the ground.

R. Contaminated soils: Soil that contains contaminates as defined and determined by the COR or the Government's testing agency.

1.3 RELATED WORK:

A. Materials testing and inspection during construction: Section 01 45 29, TESTING LABORATORY SERVICES.

B. Protection of existing utilities, fire protection services, existing equipment, roads, and pavements: Section 01 00 00, GENERAL REQUIREMENTS.

1.4 CLASSIFICATION OF EXCAVATION:

1. Open Excavation: Removal and disposal of solid, homogenous, interlocking crystalline material firmly cemented, laminated, or foliated masses or conglomerate deposits.
2. Removal and disposal of solid, homogenous, interlocking crystalline material firmly cemented, laminated, or foliated masses or conglomerate deposits that cannot be removed with conventional methods may not be performed by blasting.

1.5 MEASUREMENT AND PAYMENT FOR EXCAVATION:

Not Used

1.6 MEASUREMENT AND PAYMENT FOR ROCK EXCAVATION:

Not Used

1.7 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 elevation.

C. Furnish to COR:

1. Contactor shall furnish resumes with all personnel involved in the project including Project Manager, Superintendent, and on-site Engineer. Project Manager and Superintendent should have at least 3 years of experience on projects of similar size.
2. Soil samples.
   a. Classification in accordance with ASTM D2487 for each on-site or borrow soil material proposed for fill, backfill, engineered fill, or structural fill.
   b. Laboratory compaction curve in accordance with ASTM D698 for each on site or borrow soil material proposed for fill, backfill, engineered fill, or structural fill.
   c. Test reports for compliance with ASTM D2940 requirements for subbase material.
   d. Pre-excavation photographs and videotape in the vicinity of the existing structures to document existing site features, including surfaces finishes, cracks, or other structural blemishes that might be misconstrued as damage caused by earthwork operations.
   e. The Contractor shall submit a scale plan daily that defines the location, limits, and depths of the area excavated.
3. Contractor shall submit procedure and location for disposal of unused satisfactory material. Proposed source of borrow material. Notification of encountering rock in the project. Advance notice on the opening of excavation or borrow areas. Advance notice on shoulder construction for rigid pavements.

1.8 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 Association of State Highway and Transportation Officials (AASHTO):

T99-10.....Standard Method of Test for Moisture-Density Relations of Soils Using a 2.5 kg (5.5 lb) Rammer and a 305 mm (12 inch) Drop

T180-10.....Standard Method of Test for Moisture-Density Relations of Soils using a 4.54 kg (10 lb) Rammer and a 457 mm (18 inch) Drop

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

C33-03.....Concrete Aggregate

D448-08.....Standard Classification for Sizes of Aggregate for Road and Bridge Construction

D698-07e1.....Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft. lbf/ft^3 (600 kN m/m^3))

D1140-00.....Amount of Material in Soils Finer than the No. 200 (75-micrometer) Sieve

D1556-07.....Standard Test Method for Density and Unit Weight of Soil in Place by the Sand Cone Method

D1557-09.....Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2700 kN m/m^3))

D2167-08.....Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method

D2487-11.....Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)

D2940-09.....Standard Specifications for Graded Aggregate Material for Bases or Subbases for Highways or Airports

D6938-10.....Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth

D. Society of Automotive Engineers (SAE):

J732-07.....Specification Definitions - Loaders

J1179-08.....Hydraulic Excavator and Backhoe Digging Forces

PART 2 - PRODUCTS

2.1 MATERIALS:

A. General: Provide borrow soil material when sufficient satisfactory soil materials are not available from excavations.

B. Fills: Material in compliance with ASTM D2487 and the recommendations of the Geotechnical Engineer or COR , or any combination of these groups; free of rock or gravel larger than 75 mm (3 inches) in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter. Material approved from on site or off site sources having a minimum dry density of 1760 kg/m3 (110 pcf), a maximum Plasticity Index of 15, and a maximum Liquid Limit of 40.

C. Engineered Fill: Naturally or artificially graded mixture of compliance with ASTM D2487 and the recommendations of the Geotechnical Engineer or COR or as approved by the Engineer or material with at least 90 percent passing a 37.5-mm (1 1/2-inch) sieve and not more than 12 percent passing a 75-µm (No. 200) sieve, per ASTM D2940;.

D. Bedding: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940; except with 100 percent passing a 25 mm (1 inch) sieve and not more than 8 percent passing a 75-µm (No. 200) sieve.

E. Drainage Fill: Washed, narrowly graded mixture of crushed stone, or crushed or uncrushed gravel; ASTM D448; coarse-aggregate grading Size 57; with 100 percent passing a 37.5 mm (1 1/2-inch) sieve and 0 to 5 percent passing a 2.36 mm (No. 8) sieve.

F. Granular Fill:

1. Under concrete slab, - granular fill shall consist of clean, poorly graded crushed rock, crushed gravel, or uncrushed gravel placed beneath a building slab with or without a vapor barrier to cut off the capillary flow of pore water to the area immediately below. Fine aggregate grading shall conform to ASTM C 33 with a maximum of 3 percent by weight passing ASTM D 1140,75 micrometers (No. 200) sieve, or 37.5 mm (1-1/2 inches) and no more than 2 percent by weight passing the 4.75 mm (No. 4) size sieve or coarse aggregate Size 57, 67, or 77.
2. Bedding for sanitary and storm sewer pipe, crushed stone or gravel graded from 13 mm (1/2 inch) to 4.75 mm (No 4), per ASTM D2940.

G. Requirements for Offsite Soils: Offsite soils brought in for use as backfill shall be tested for TPH, BTEX and full TCLP including ignitability, corrosivity and reactivity. Backfill shall contain less than 100 parts per million (ppm) of total hydrocarbons (TPH) and less than 10 ppm of the sum of Benzene, Toleune, Ethyl Benzene, and Xylene (BTEX) and shall not fail the TCLP test. TPH concentrations shall be

determined by using EPA 600/4-79/020 Method 418.1. BTEX concentrations shall be determined by using EPA SW-846.3-3a Method 5030/8020. TCLP shall be performed in accordance with EPA SW-846.3-3a Method 1311. Provide Borrow Site Testing for TPH, BTEX and TCLP from a composite sample of material from the borrow site, with at least one test from each borrow site.

H. Buried Warning and Identification Tape: Polyethylene plastic and metallic core or metallic-faced, acid- and alkali-resistant polyethylene plastic warning tape manufactured specifically for warning and identification of buried utility lines. Provide tape on rolls, 3 inch minimum width, color coded as specific below for the intended utility with warning and identification imprinted in bold black letters continuously over the entire tape length. Warning and identification to read, "CAUTION, BURIED (intended service) LINE BELOW" or similar wording. Color and printing shall be permanent, unaffected by moisture or soil. Warning tape color codes:

Red:	Electric
Yellow:	Gas, Oil, Dangerous Materials
Orange:	Telephone and Other Communications
Blue:	Water Systems
Green:	Sewer Systems
White:	Steam Systems
Gray:	Compressed Air

I. Warning Tape for Metallic Piping: Acid and alkali-resistant polyethylene plastic tape conforming to the width, color, and printing requirements specified above. Minimum thickness of tape shall be 0.076 mm (0.003 inch). Tape shall have a minimum strength of 10.3 MPa (1500 psi) lengthwise, and 8.6 MPa (1250 psi) crosswise, with a maximum 350 percent elongation.

J. Detectable Warning Tape for Non-Metallic Piping: Polyethylene plastic tape conforming to the width, color, and printing requirements specified above. Minimum thickness of the tape shall be 0.102 mm (0.004 inch). Tape shall have a minimum strength of 10.3 MPa (1500 psi) lengthwise and 8.6 MPa (1250 psi) crosswise. Tape shall be manufactured with integral wires, foil backing, or other means of enabling detection by a metal detector when tape is buried up to 0.9 m

(3 feet) deep. Encase metallic element of the tape in a protective jacket or provide with other means of corrosion protection.

K. Detection Wire For Non-Metallic Piping: Detection wire shall be Insulated single strand, solid copper with a minimum of 12 AWG.

PART 3 - EXECUTION

3.1 SITE PREPARATION:

A. Clearing: Clear within limits of earthwork operations as shown. Work includes removal of trees, shrubs, fences, foundations, incidental structures, paving, debris, trash, and other obstructions. Remove materials from Medical Center.

B. Grubbing: Remove stumps and roots 75 mm (3 inch) and larger diameter. Undisturbed sound stumps, roots up to 75 mm (3 inch) diameter, and nonperishable solid objects a minimum of 900 mm (3 feet) below subgrade or finished embankment may be left.

C. Trees and Shrubs: Trees and shrubs, not shown for removal, may be removed from areas within 4500 mm (15 feet) of new construction at no added cost to the government and 2250 mm (7.5 feet) of utility lines when removal is approved in advance by COR, at no additional cost to the government. Remove materials from Medical Center. Immediately repair damage to existing trees and shrubs by trimming, cleaning and painting damaged areas, including roots, in accordance with standard industry horticultural practice for the geographic area and plant species. Do not store building materials closer to trees and shrubs, that are to remain, than farthest extension of their limbs.

D. Stripping Topsoil: Strip topsoil from within limits of earthwork operations as specified. Topsoil shall be a fertile, friable, natural topsoil of loamy character and characteristic of locality. Topsoil shall be capable of growing healthy horticultural crops of grasses. Stockpile topsoil and protect as directed by COR. Eliminate foreign materials, such as weeds, roots, stones, subsoil, frozen clods, and similar foreign materials larger than 0.014 m3 (1/2 cubic foot) in volume, from soil as it is stockpiled. Retain topsoil on station. Remove foreign materials larger than 50 mm (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 soil is wet so that the composition of the soil will be destroyed.

E. Concrete Slabs and Paving: 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 300 mm (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 Medical Center.

F. Lines and Grades: Registered Professional Land Surveyor or Registered Civil Engineer, specified in Section 01 00 00, GENERAL REQUIREMENTS, shall establish lines and grades.

1. Grades shall conform to elevations indicated on plans within the tolerances herein specified. Generally grades shall be established to provide a smooth surface, free from irregular surface changes. Grading shall comply with compaction requirements and grade cross sections, lines, and elevations indicated. Where spot grades are indicated the grade shall be established based on interpolation of the elevations between the spot grades while maintaining appropriate transition at structures and paving and uninterrupted drainage flow into inlets.
2. Locations of existing and proposed elevations indicated on plans, except spot elevations, are approximate. from a site survey that measured spot elevations and subsequently generated existing contours and spot elevations. Proposed spot elevations and contour lines have been developed utilizing the existing conditions survey and developed contour lines and may be approximate. Contractor is responsible to notify COR of any differences between existing elevations shown on plans and those encountered on site by Surveyor/Engineer described above. Notify COR of any differences between existing or constructed grades, as compared to those shown on the plans.
3. Subsequent to establishment of lines and grades, Contractor will be responsible for any additional cut and/or fill required to ensure that site is graded to conform to elevations indicated on plans.

G. 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, Sheeting and Bracing: Shore, brace, or slope, its angle of repose or to an angle considered acceptable by the COR, banks of excavations to protect workmen, banks, adjacent paving, structures, and utilities.

1. Design of the temporary support of excavation system is the responsibility of the Contractor. The Contractor shall submit a Shoring and Sheeting plan for approval 21 days prior to starting work. Submit drawings and calculations, certified by a registered professional engineer, describing the methods for shoring and sheeting of excavations. Shoring, including sheet piling, shall be furnished and installed as necessary to protect workmen, banks, adjacent paving, structures, and utilities. Shoring, bracing, and sheeting shall be removed as excavations are backfilled, in a manner to prevent caving.
2. Construction of the support of excavation system shall not interfere with the permanent structure and may begin only after a review by the COR.
3. Extend shoring and bracing to a minimum of 1500 mm (5 feet) below the bottom of excavation. Shore excavations that are carried below elevations of adjacent existing foundations.
4. If bearing material of any foundation is disturbed by excavating, improper shoring or removal of existing or temporary shoring, placing of backfill, and similar operations, the Contractor shall provide a concrete fill support under disturbed foundations, as directed by COR, at no additional cost to the Government. Do not remove shoring until permanent work in excavation has been inspected and approved by COR.
5. The Contractor is required to hire a Professional Geotechnical Engineer to provide inspection of excavations and soil/groundwater conditions as well as helical pier work throughout construction. The Geotechnical Engineer shall be responsible for performing pre-construction and periodic site visits throughout construction to assess site conditions. The Geotechnical Engineer shall update the excavation, sheeting and dewatering plans as construction progresses to reflect changing conditions and shall submit an updated plan if necessary. A written report shall be submitted, at least monthly, informing the Contractor and COR of the status of the plan and an

accounting of the Contractor's adherence to the plan addressing any present or potential problems. The Geotechnical Engineer shall be available to meet with the COR at any time throughout the contract duration.

B. Excavation Drainage: Operate pumping equipment, and/or provide other materials, means and equipment as required to keep excavation free of water and subgrade dry, firm, and undisturbed until approval of permanent work has been received from COR. Approval by the COR is also required before placement of the permanent work on all subgrades. Groundwater flowing toward or into excavations shall be controlled to prevent sloughing of excavation slopes and walls, boils, uplift and heave in the excavation and to eliminate interference with orderly progress of construction. French drains, sumps, ditches or trenches will not be permitted within 0.9 m (3 feet) of the foundation of any structure, except with specific written approval, and after specific contractual provisions for restoration of the foundation area have been made. Control measures shall be taken by the time the excavation reaches the water level in order to maintain the integrity of the in situ material. While the excavation is open, the water level shall be maintained continuously, at least 3 feet below the working level. Operate dewatering system continuously until construction work below existing water levels is complete. Submit performance records weekly. Relieve hydrostatic head in pervious zones below subgrade elevation in layered soils to prevent uplift.

C. Subgrade Protection: Protect subgrades from softening, undermining, washout, or damage by rain or water accumulation. Reroute surface water runoff from excavated areas and not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches. When subgrade for foundations has been disturbed by water, remove disturbed material to firm undisturbed material after water is brought under control. Replace disturbed subgrade in trenches with concrete or material approved by the COR.

D. Blasting: Blasting will not be permitted.

E. Proofrolling:

1. After rough grade has been established in cut areas and prior to placement of fill in fill areas under building and pavements, proofroll exposed subgrade with a fully loaded dump truck to check for pockets of soft material.

2. Proof rolling shall be done on an exposed subgrade free of surface water (wet conditions resulting from rainfall) which would promote degradation of an otherwise acceptable subgrade. After stripping, proof roll the existing subgrade with six passes of a 13.6 meter tons (15 ton), pneumatic-tired roller. Operate the roller in a systematic manner to ensure the number of passes over all areas, and at speeds between 4 to 5.5 km/hour (2 1/2 to 3 1/2 mph). When proof rolling, one-half of the passes made with the roller shall be in a direction perpendicular to the other passes. Notify the COR a minimum of 7 days prior to proof rolling. Proof rolling shall be performed in the presence of the COR. Rutting or pumping of material shall be undercut as directed by the COR and replaced with fill and backfill material. Maintain subgrade until succeeding operation has been accomplished.

F. Building Earthwork:

1. Excavation shall be accomplished as required by drawings and specifications.
2. Excavate foundation excavations to solid undisturbed subgrade.
3. Remove loose or soft materials to a solid bottom.
4. Fill excess cut under footings or foundations with 25 MPa (3000 psi) concrete poured separately from the footings.
5. Do not tamp earth for backfilling in footing bottoms, except as specified.
6. Slope grades to direct water away from excavations and to prevent ponding.
7. Capillary water barrier (granular fill) under concrete floor and area-way slabs on grade shall be placed directly on the subgrade and shall be compacted with a minimum of two passes of a hand-operated plate-type vibratory compactor.
8. Ensure that footing subgrades have been inspected and approved by the COR prior to concrete placement. Excavate to bottom of pile cap prior to placing or driving piles or helical piers, unless authorized otherwise by the COR. Backfill and compact over excavations and changes in grade due to pile driving operations to 95 percent of ASTM D698 maximum density.

G. Trench Earthwork:

1. Utility trenches (except 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 suitable undisturbed earth unless a mechanical support is shown. Unstable material removed from the bottom of the trench or excavation shall be replaced with select granular material placed in layers not exceeding 150 mm (6 inches) loose thickness.
d. Length of open trench in advance of piping laying shall not be greater than is authorized by COR.
e. Provide buried utility lines with utility identification tape. Bury tape 300 mm (12 inches) below finished grade; under pavements and slabs, bury tape 150 mm (6 inches) below top of subgrade
f. Bury detection wire directly above non-metallic piping at a distance not to exceed 300 mm (12 inches) above the top of pipe. The wire shall extend continuously and unbroken, from manhole to manhole. The ends of the wire shall terminate inside the manholes at each end of the pipe, with a minimum of 0.9 m (3 feet) of wire, coiled, remaining accessible in each manhole. The wire shall remain insulated over its entire length. The wire shall enter manholes between the top of the corbel and the frame, and extend up through the chimney seal between the frame and the chimney seal. For force mains, the wire shall terminate in the valve pit at the pump station end of the pipe.
g. Bedding shall be of the type and thickness shown in plans. Initial backfill material shall be placed and compacted with approved tampers to a height of at least one foot above the utility pipe or conduit. The backfill shall be brought up evenly on both sides of the pipe for the full length of the pipe. Care shall be taken to ensure thorough compaction of the fill under the haunches of the pipe. Except as specified otherwise in the individual piping section, provide bedding for buried piping in accordance with AWWA C600, Type 4, except as specified herein. Backfill to top of pipe shall be compacted to 95 percent of ASTM D 698 maximum density. Plastic piping shall have bedding to spring line of pipe. Provide materials as follows:

1) Class I: Angular, 6 to 40 mm (0.25 to 1.5 inches), graded stone, including a number of fill materials that have regional significance such as coral, slag, cinders, crushed stone, and crushed shells.
2) Class II: Coarse sands and gravels with maximum particle size of 40 mm (1.5 inches), including various graded sands and gravels containing small percentages of fines, generally granular and noncohesive, either wet or dry. Soil Types GW, GP, SW, and SP are included in this class as specified in ASTM D2487.

2. Sanitary and storm sewer trenches:
   a. Trench width below a point 150 mm (6 inches) above top of pipe shall be 600 mm (24 inches) maximum for pipe up to and including 300 mm (12 inches) diameter, and four-thirds diameter of pipe plus 200 mm (8 inches) for pipe larger than 300 mm (12 inches). Width of trench above that level shall be as necessary for sheeting and bracing and proper performance of the work.
      1) Bed bottom quadrant of pipe on suitable undisturbed soil or granular fill. Unstable material removed from the bottom of the trench or excavation shall be replaced with select granular material placed in layers not exceeding 150 mm (6 inches) loose thickness. Bell holes shall be no larger than necessary for jointing. Backfill up to a point 300 mm (12 inches) above top of pipe shall be clean earth placed and tamped by hand.
      2) Granular Fill: Depth of fill shall be a minimum of 75 mm (3 inches) plus one sixth of pipe diameter below pipe to 300 mm (12 inches) above top of pipe. Place and tamp fill material by hand.
   c. Place and compact as specified remainder of backfill using acceptable excavated materials. Do not use unsuitable materials.
   d. Use granular fill for bedding where rock or rocky materials are excavated.
   e. Provide buried utility lines with utility identification tape. Bury tape 300 mm (12 inches) below finished grade; under pavements and slabs, bury tape 150 mm (6 inches) below top of subgrade

f. Bury detection wire directly above non-metallic piping at a distance not to exceed 300 mm (12 inches) above the top of pipe. The wire shall extend continuously and unbroken, from manhole to manhole. The ends of the wire shall terminate inside the manholes at each end of the pipe, with a minimum of 0.9 m (3 feet) of wire, coiled, remaining accessible in each manhole. The wire shall remain insulated over its entire length. The wire shall enter manholes between the top of the corbel and the frame, and extend up through the chimney seal between the frame and the chimney seal. For force mains, the wire shall terminate in the valve pit at the pump station end of the pipe.

g. Bedding shall be of the type and thickness shown. Initial backfill material shall be placed and compacted with approved tampers to a height of at least one foot above the utility pipe or conduit. The backfill shall be brought up evenly on both sides of the pipe for the full length of the pipe. Care shall be taken to ensure thorough compaction of the fill under the haunches of the pipe. Except as specified otherwise in the individual piping section, provide bedding for buried piping in accordance with AWWA C600, Type 4, except as specified herein. Backfill to top of pipe shall be compacted to 95 percent of ASTM D698 maximum density. Plastic piping shall have bedding to spring line of pipe. Provide materials as follows:

1) Class I: Angular, 6 to 40 mm (0.25 to 1.5 inches), graded stone, including a number of fill materials that have regional significance such as coral, slag, cinders, crushed stone, and crushed shells.

2) Class II: Coarse sands and gravels with maximum particle size of 40 mm (1.5 inches), including various graded sands and gravels containing small percentages of fines, generally granular and noncohesive, either wet or dry. Soil Types GW, GP, SW, and SP are included in this class as specified in ASTM D2487.

CORH. Site Earthwork: Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; together with soil, boulders, and other materials not classified as rock or unauthorized excavation. Excavation shall be accomplished as required by drawings and

specifications. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 25 mm (1 inch). Extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, complying with OSHA requirements, and for inspections. Remove subgrade materials that are determined by COR 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 and the materials shall be examined by an independent testing laboratory for soil classification to determine whether it is unsuitable or not, at no additional cost to the government.

1. Site Grading:
   a. Provide a smooth transition between adjacent existing grades and new grades.
   b. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
   c. Slope grades to direct water away from buildings and to prevent ponds from forming where not designed. Finish subgrades to required elevations within the following tolerances:
      1) Lawn or Unpaved Areas: Plus or minus 25 mm (1 inch).
      2) Walks: Plus or minus 25 mm (1 inch).
      3) Pavements: Plus or minus 13 mm (1 inch).
   d. Grading Inside Building Lines: Finish subgrade to a tolerance of 13 mm (1/2 inch) when tested with a 3000 mm (10 foot) straightedge.

I. CONTRACTOR TO OBTAIN DIGGING PERMIT FROM COR PRIOR TO START OF EXCAVATION.

3.3 UNDERPINNING:

A. Design of the underpinning system is the responsibility of the Contractor and should be designed by a registered professional engineer and is subject to review and approval by the COR. Underpinning of existing building foundations, as indicated on structural drawings, or where excavation undermines existing foundations, shall be accomplished in the following manner:

1. Make general excavation for new construction, where new foundations are to be below existing foundations, to elevation of new

foundations (or sized stone subbase), maintaining a 45 degree sloped berm.

2. For underpinning pits, underpin existing wall foundations by excavating 1200 mm (4 feet) wide pits to depth shown on drawings skipping 3 sections at any one time so as to maintain support for wall at all times.
3. Underpin intervening sections one at a time; no adjacent sections shall be underpinned until concrete in adjacent sections shall have reached 20 MPa (2500 psi) strength and have been dry packed with non-shrink grout to obtain positive bearing. Sheet and brace underpinning pits if soil will not stand on a vertical cut during this operation, or as required for safety of workmen. Repack any voids behind sheeting to prevent sloughing which could cause settlement of existing foundations. Contractor performing this portion of work shall have been prequalified by COR as having previously performed successfully this type of work or will demonstrate his capability for successfully performing this work. It shall be sole responsibility of the Contractor to guard against objectionable movement or settlement and to preserve integrity of existing structures.
4. The tip elevation of the underpinning pits shall be a minimum of 900 mm (3 feet) below the adjacent excavation elevation.
5. Subgrades at the tip of the underpinning pit shall be clean, dry, and free of debris and shall be observed by the COR prior to concrete placement.
6. Concrete shall not be free fall greater than 3000 mm (10 feet) into the pit.

3.4 FILLING AND BACKFILLING:

A. General: Do not fill or backfill until all debris, water, unsatisfactory soil materials, obstructions, and deleterious materials have been removed from excavation. For fill and backfill, use excavated materials and borrow meeting the criteria specified herein, as applicable. Borrow will be supplied at no additional cost to the Government. Do not use unsuitable excavated materials. Do not backfill until foundation walls have been completed above grade and adequately braced, waterproofing or dampproofing applied, foundation drainage, and pipes coming in contact with backfill have been installed and work inspected and approved by COR.

B. Placing: Place materials in horizontal layers not exceeding 200 mm (8 inches) in loose depth for material compacted by heavy compaction equipment, and not more than 100 mm (4 inches) in loose depth for material compacted by hand-operated tampers and then compacted. Place backfill and fill materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure. Place no material on surfaces that are muddy, frozen, or contain frost.

C. Compaction: Compact with approved tamping rollers, sheepsfoot rollers, pneumatic tired rollers, steel wheeled rollers, vibrator compactors, or other approved equipment (hand or mechanized) well suited to soil being compacted. Do not operate mechanized vibratory compaction equipment within 3000 mm (10 feet) of new or existing building walls without prior approval of COR. Moisten or aerate material as necessary to provide moisture content that will readily facilitate obtaining specified compaction with equipment used. Backfill adjacent to any and all types of structures shall be placed and compacted to at least 90 percent laboratory maximum density for cohesive materials or 95 percent laboratory maximum density for cohesionless materials to prevent wedging action or eccentric loading upon or against the structure. Compact soil to not less than the following percentages of maximum dry density, according to ASTM D698 or ASTM D1557 as specified below:

   1. Fills, Embankments, and Backfill
      a. Under proposed structures, building slabs, steps, and paved areas, scarify and recompact top 300 mm (12 inches) of existing subgrade and each layer of backfill or fill material in accordance with ASTM D698 95 percent.
      b. Curbs, curbs and gutters, ASTM D698 95 percent.
      c. Under Sidewalks, scarify and recompact top 150 mm (6 inches) below subgrade and compact each layer of backfill or fill material in accordance with ASTM D698 95 percent.
      d. Landscaped areas, top 400 mm (16 inches), ASTM D698 85 percent.
      e. Landscaped areas, below 400 mm (16 inches) of finished grade ASTM D698 90 percent.
   2. Natural Ground (Cut or Existing)
      a. Under building slabs, steps and paved areas, top 150 mm (6 inches), ASTM D698 95 percent.

b. Curbs, curbs and gutters, top 150 mm (6 inches), ASTM D698 95 percent.

c. Under sidewalks, top 150 mm (6 inches), ASTM D698 95 percent.

D. Borrow Material: Borrow material shall be selected to meet the requirements and conditions of the particular fill or embankment for which it is to be used. Borrow material shall be obtained from the borrow areas or from approved private sources.

E. Opening and Drainage of Excavation and Borrow Pits: The Contractor shall notify the COR sufficiently in advance of the opening of any excavation or borrow pit to permit elevations and measurements of the undisturbed ground surface to be taken. Except as otherwise permitted, borrow pits and other excavation areas shall be excavated providing adequate drainage. Overburden and other spoil material shall be transported to designated spoil areas or otherwise disposed of as directed. Borrow pits shall be neatly trimmed and drained after the excavation is completed. The Contractor shall ensure that excavation of any area, operation of borrow pits, or dumping of spoil material results in minimum detrimental effects on natural environmental conditions.

3.5 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 pipe spaces or other unfinished areas, fill low spots and level off with coarse sand or fine gravel.

C. Slope backfill outside building away from building walls for a minimum distance of 1800 mm (6 feet).

D. Finish grade earth floors in pipe basements as shown to a level, uniform slope and leave clean.

E. Finished grade shall be at least 150 mm (6 inches) below bottom line of window or other building wall openings unless greater depth is shown.

F. Place crushed stone or gravel fill under concrete slabs on grade, tamped, and leveled. Thickness of fill shall be 150 mm (6 inches) unless otherwise shown.

G. Finish subgrade in a condition acceptable to COR at least one day in advance of paving operations. Maintain finished subgrade in a smooth and compacted condition until succeeding operation has been accomplished. Scarify, compact, and grade subgrade prior to further construction when approved compacted subgrade is disturbed by Contractor's subsequent operations or adverse weather.

H. Grading for Paved Areas: Provide final grades for both subgrade and base course to +/- 6 mm (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. Remove from site and dispose of any excess excavated materials after all fill and backfill operations have been completed.

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 all debris, rubbish, and excess material from Medical Center Property.

----- E N D -----

SECTION 31 63 21
HELICAL PIERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies excavation and concrete required for construction of helical piers.

1.2 DEFINITION

A. Helical Pier: Consists of a central steel shaft with one or more helix-shaped bearing plates and a load transfer device (bracket) that allows attachment to structures. Helical piers are installed into the ground by application of torque and axial compressive force.

1.3 RELATED WORK

A. Materials testing and inspection during construction: Section 01 45 29, TESTING LABORATORY SERVICES.

B. Subsurface investigation: Section 01 00 00, GENERAL REQUIREMENTS, Article, PHYSICAL DATA.

1.4 CONTRACTOR QUALIFICATIONS

A. Approval by COR is required of service of proposed Contractor and will be based upon submission by Contractor of certification that:

1. Contractor has technical qualifications, experience, trained personnel and facilities to install helical piers as specified. Approval will not be given, however, where an experience record is one of unsatisfactory performance.
2. Contractor has installed helical piers on three installations similar and equivalent to this project for 5 years. Submit list of installations.

1.5 TOLERANCES

A. Locate piers where indicated by the shop drawings. The maximum permissible variation of the center of each pier from the required locations is 50 mm (2 inches) at the ground surface. No pier shall be out of required axial alignment by more than 2 percent. Periodically check the required axial alignment of each pier during the drilling operation and after reaching the required tip elevation.

1.6 DESIGN MODIFICATIONS

A. Where piers are installed exceeding specified tolerances for plumb or location. Costs for analysis, redesign, and remediation shall be responsibility of Contractor.

B. Additional helical piers and pier cap modifications necessitated by redesign shall be furnished and installed, at no additional cost to the Government.

1.7 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Certification to Examination of Site and Records: Before proceeding with the Work, submit copy of certification in acceptable form signed by the Contractor, stating that careful examination has been made of the site, existing structures, and records of utility lines, test boring records, soil samples, Drawings, and Specifications.

C. Shop Drawings and Miscellaneous Submittals:
   1. Description of helical pier installation equipment.
   2. Complete description of method for helical pier installation with a pier layout plan referenced to the structural plans, including a numbering system capable of identifying each individual pier, and pier sizes, including pier length. In addition, furnish a detailed description of construction procedures.
   3. Pier Installation records for all helical piers.

D. Reports:
   1. Installation of each pier
   2. Pier location and plumbness
   3. Load Test

E. Product Data: Submit copies of manufacturers' specifications for the following products, including copies of laboratory test reports and other data as may be required to show compliance with these specifications.
   1. Helical lead section
   2. Helical extension section

F. Certificates: Contractor's qualifications as specified: Experienced specialty subcontractor having a minimum of 5 years successful experience installing Work of same type required for this project, and evidence of satisfactory completion of at least three helical pier installations comparable in scope of the Work and subsurface conditions. Employ only skilled tradesmen who are thoroughly experienced with the materials and equipment to be used in the Work.

G. Helical Pier Load Testing:

1. A schedule and sequencing plan for pier testing and installation: Contractor to submit a schedule and sequencing plan at least three weeks before commencing pier load testing.
2. Pier Load Test Work Plan:
   a. At least three weeks before commencing pier load testing work, the Contractor shall submit a pier load test work plan describing the equipment, apparatus, procedures, and schedule for testing helical piers in accordance with ASTM D1143 and as specified herein, to verify the design pier capacity. The work plan shall also include the proposed instrumentation of the test pier indicating depth, location, and details of the pier.
   b. As part of the Pier Load Test Work Plan, submit shop drawings and other information describing the loading and test monitoring arrangement for pier load tests, including the following:
      1) Structural design of the test load support/reaction frame.
      2) Details of equipment and apparatus to be used for the monitoring load and pier movements.
      3) Data on testing and measuring equipment including required jack, load cell and/or gauge calibrations.
      4) Sample field data recording sheets or examples of automated data acquisition records proposed for recording load test data.

H. Independent Testing and Inspection Agency: The Contractor shall retain an Independent Testing and Inspection Agency (Agency) to document, monitor, and observe load test, test pier, and production pier work. This Agency shall submit field reports and test results required by Section 3.2 for pier load tests and pier installations. They shall submit a pier installation report for each pier no later than three days after the installation is complete.

J. Welding Certificates.

K. Qualification Data: For Installer, Land Surveyor, and Testing and Inspection Agency.

L. Upon completion of helical pier installations, the Contractor shall submit five copies of drawings indicating actual in-place pier locations. The Contractor shall pay for all surveying costs. Drawings must be submitted and approved prior to beginning any pier cap or mat installation. One electronic copy of the drawings shall be submitted in AutoCAD DWG format on CD-ROM.

M. Record drawings at Project closeout according to Division 01 Section "Closeout Procedures."

1.8 QUALITY CONTROL

A. Contractor’s Quality Control Responsibilities: Contractor is solely responsible for quality control of the Work.

B. A Quality Control Program shall be submitted by the Contractor at least three weeks prior to the commencement of work. The implementation of a Contractor Quality Control Program does not relieve the Contractor from the responsibility to provide work in accordance with the Contract Documents, applicable codes, regulations, and Governing Authorities.

C. Contractor's Independent Testing and Inspection Agency (Agency): The Contractor shall retain at his own expense, the services of a qualified Independent Testing and Inspection Agency, licensed in the state of the project, to provide testing and inspection services during the installation of all foundation piling involved in this Work. This firm shall also provide consultation services to the Contractor if problems are encountered during the execution of the Work. The Agency shall be primarily concerned with the testing and construction methods which will result in finished foundation of the required quality and strength. The Agency shall also be concerned with preventing settlement and/or damage to surrounding structures, roads, utilities, embankments, etc., both within the property lines and on adjoining properties during the construction.

D. The Agency shall be experienced in the testing and installation of helical pier foundations. It shall have been involved in at least five different helical pier projects in the last 5 years, and shall have experience in recommending, testing, and specifying helical piers for similar subsurface conditions.

E. Survey Work: The Contractor shall engage a qualified land surveyor or professional engineer to perform surveys, layouts, and measurements for helical piers. The surveyor shall record actual measurements of each helical pier location, bottom and top elevations, deviations from specified tolerances, and other specified data.

F. Welding Standards: Qualify procedures and personnel according to the following:

1. AWS D1.1
2. AWS D1.4

G. Regulatory Requirements: Comply with applicable requirements of the laws, codes, ordinances and regulations of Federal authorities having jurisdiction. Obtain necessary approvals from such authoritie.

1.9 QUALITY ASSURANCE

A. The Contractor shall retain the services of a Geotechnical Consultant (Consultant) to provide general observation of all pier operations and to provide technical advice to the Contractor with regard to pier operations and performance.

B. The Consultant shall have been involved in at least five different helical pier projects in the last 5 years, and shall have experience in recommending, testing, and specifying helical piers for similar subsurface conditions.

1.10 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 Institute of Steel Construction (AISC)
AISC 360: Specification for Structural Steel Buildings

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

A36.....ASTM A36: Carbon Structural Steel

A123.....Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

A153.....Zinc Coating (Hot-Dip) on Iron and Steel Hardware

A307.....Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength

A500.....Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

A513.....Electric-Resistance Welded Carbon and Alloy Steel Mechanical Tubing

A572.....High-Strength Low-Alloy Columbian-Vanadium Structural Steel

B633.....Electrodeposited Coatings of Zinc on Iron and Steel

D1143.....Deep Foundations Under Static Axial Compressive Load

D3689-07.....Standard Test Method for Deep Foundations Under Static Axial Tensile Load

E329-11.....Standard Specification for Agencies Engaged in Construction Inspections, Testing, or Special Inspections

C. International Code Council Evaluation Services (ICC-ES):
AC358.....Acceptance Criteria for Helical Pile Systems and Devices

D. American Welding Society (AWS):
D1.1 (2010).....Structural Welding Code – Steel

PART 2 - PRODUCTS

2.1 MATERIALS

A. Structural steel: ASTM A500, ASTM A572, or as required by manufacturer

B. Bolts: SAE J429 grade 5, ASTM A307, ASTM A325 or as required by manufacturer.

C. Except for pier load test and test pier purposes, no pier materials shall be ordered or delivered to the job site until the required load tests have been made and are acceptable to the COR. Materials ordered or delivered to the project site prior to verification of the assumed pier length, will be at the Contractor's risk.

I. After pier lengths are verified by the pier load test program, deliver materials to the project site in such quantities and at such times to assure the continuity of pier drilling operations to the project schedule.

2.2 EQUIPMENT

A. Equipment:

1. The contractor shall provide equipment as required to install helical piers with a torque capacity at least 15% greater than the minimum final torque of the helical pier to be installed.
2. Equipment shall be capable of applying adequate downward pressure and torque simultaneously for site specific subgrade conditions and load requirements.

PART 3 - EXECUTION

3.1 GENERAL

A. Survey: Registered Professional Land Surveyor or Registered Civil Engineer shall establish lines and levels and stake pier locations.

B. Before installing piers adjacent to any existing utilities, the Contractor shall notify the COR to ensure that protective Work will be

coordinated and performed in accordance with the requirements of the COR. If any existing service lines, utilities and utility structures to remain in service are uncovered or encountered during these operations, protect from damage and provide support if necessary.

C. Should uncharted or incorrectly charted piping or other utilities be encountered during operations, immediately notify the COR. Cooperate with the COR in keeping their respective services, utilities and facilities in operation.

D. After all helical piers are in place, the Surveyor shall make a field survey of completed piers and shall submit a drawing to the COR showing the plumbness of the piers and the actual pier locations with respect to planned pier locations.

E. Pier Record: Submit complete and accurate record of all piers to the COR. Record shall indicate the pier location, diameter, length, and elevation of bottom and top of pier. Any unusual conditions encountered during pier installation shall also be noted.

F. Completion Certificate: The Contractor shall provide a written statement, stamped by a Professional Engineer registered in the State of the Work, verifying that the piers were installed per the Contract Documents, and that any piers not installed per the Contract Documents were installed in such a manner that they will not have a negative impact on the proposed structure.

3.2 ALLOWABLE LOAD ON PIERS

A. Load test piers:

1. Load tests will be performed on a minimum of two piers. The data from the load test will be used to verify pier design load.
2. Contractor shall conduct load tests in accordance with ASTM D1143 standard loading procedure. These tests will be conducted at no additional cost to the Government. No additional piers shall be installed until test reports of test piers are received and approved by COR.
3. Additional load tests or an increase in production pier length may be required if the test pier fails the load test.

3.3 INSTALLATION

A. The length and criteria of production piers will be determined by the Contractor’s retained specialty engineer from the installation of the reaction piers, test piers, and the pier load tests. The installation shall be performed in an orderly sequence.

B. Install helical piers to required length, with the center of helical pier within 50 mm (2 inches) of plan location, top elevation within 25 mm (1 inch) above design vertical elevation, and center of reinforcing steel within 20 mm (0.75 inches) of pier center.

C. Provide OSHA protective caps on all projecting reinforcement.

D. The Contractor shall install additional piers at no additional cost for damaged, misaligned and/or mislocated piers.

3.4 OBSTRUCTIONS:

A. The advancement of the helical piers through naturally occurring materials such as cobbles, boulders and rock ledges, as outlined in the Geotechnical Report, is the responsibility of the Contractor. The Contractor is responsible for providing the necessary means and methods of advancing through this material.

B. In the event that unforeseen non-drillable material is encountered, such as cobbles, boulders, rock ledge, metal timbers or debris which causes the pier to drift from its location, then the pier shall be completed to the depth of the non-drillable material in accordance with these specifications. If required by the COR, additional adjacent piers shall be installed.

3.5 QUALITY CONTROL AND ASSURANCE:

A. The Contractor shall retain the services of a qualified Independent Testing and Inspection Agency (Agency), licensed in the state of the project, to provide Quality Control through testing and inspection services during the installation of all foundation piers involved in this Work.

B. The Contractor shall employ a Geotechnical Consultant (Consultant) to provide Quality Assurance through general observation and consultation of all pier operations.

C. The Contractor and their Agency shall cooperate with the Consultant and the COR in the performance of the Work. The presence of Consultant shall in no way relieve the Contractor of his obligation to perform the pier installation in accordance with the Contract Documents and these Specifications.

D. Pier Acceptance: The Agency shall immediately notify the Consultant and the COR if any pier is not in conformance with these Specifications.

E. Reports: The Agency shall maintain an installation record of each pier. The record shall note the project name and number, name of Contractors, pier location, design pier capacity, pier elevation, pier top

elevation, and any unusual occurrences during the pier installation. The Consultant shall also maintain a daily report, which summarizes all work performed by the Contractor.

3.6 CORRECTIONS OF DEFICIENCIES:

A. The contractor shall notify the COR in writing, of the failure of a pier to meet any requirement of the Section. Such written notification shall include all information required for the evaluation of remedial measures, including all information required for redesign.

B. Based on the survey provided, if a pier fails to comply with the location or tolerance requirements of 1.6, or the design load requirements noted on the Contract Documents, the Contractor's retained specialty engineer will calculate the load capacity requirements of that pier or, if in a pier group, each pier in that pier group, based on the actual locations and inclinations. If the calculation indicates that the loading on that pier or, if in a pier group, on any pier in that pier group, exceeds the design load, then the Contractor shall perform such remedial work as the Contractor's retained specialty engineer, COR, VA CO, and Engineer of Record may require. Such work may include, but is not limited to furnishing and installing additional piers at locations approved by the COR. These corrective measures shall be performed solely at the Contractor's expense.

C. If a pier fails to comply with the requirements of this Section and the COR determines that installation of additional piers is necessary, the Contractor will perform all required reanalysis, redesign and detailing. All reanalysis, redesign and redetailing costs will be the responsibility of the contractor.

D. The Contractor, at his option and at any time that he determines that a pier will not satisfy the requirements of this Section for a reason other than encountering an unforeseen underground obstruction, may, subject to the provisions of this specification, abandon such pier and replace it with a new pier or piers rather than await direction or approval from the COR. However, the Contractor, in exercising this option, assumes the risk that such replacement pier or piers will be acceptable to the COR.

E. Abandoned piers shall be cut off 300 mm (1 foot) below the elevation of the bottom of the pier cap or mat as shown on the Contract Drawings and will not be paid for.

3.7 CLEAN UP:

A. All debris from excavation of objectionable material, removal of obstructions, and any material not to remain as part of the construction are to be removed and disposed of by the subcontractor in a legal manner at no additional cost to the Owner.

B. The site shall be cleaned at frequent intervals and no material shall be stored on the site in a manner, which would obstruct the easy access of equipment and personnel.

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SECTION 32 05 23
CEMENT AND CONCRETE FOR EXTERIOR IMPROVEMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Subbase for concrete pavements.
2. Curbs, gutters, and combination curbs and gutters.
3. Pedestrian Pavement: Walks, grade slabs, wheelchair curb ramps
4. Vehicular Pavement: Service drives.

1.2 RELATED REQUIREMENTS

A. Subgrade Preparation and Subbase Compaction: Section 31 20 00, EARTHWORK.

1.3 APPLICABLE PUBLICATIONS

A. Comply with references to extent specified in this section.

B. American Association of State Highway and Transportation Officials (AASHTO):

1. M147-65-UL-04 - Materials for Aggregate and Soil-Aggregate Subbase, Base and Surface Courses.
2. M233-86 - Boiled Linseed Oil Mixture for Treatment of Portland Cement Concrete.

C. American Concrete Institute (ACI):

1. 305R-10 - Guide to Hot Weather Concreting.
2. 306R-10 - Guide to Cold Weather Concreting.

D. American National Standards Institute (ANSI):

1. B101.3 - Wet DOCF of Common Hard Surface Floor Materials (Including Action and Limit Thresholds for the Suitable Assessment of the Measured Values).

E. ASTM International (ASTM):

1. A615/A615M-16 - Deformed and Plain Carbon Steel Bars for Concrete Reinforcement.
2. A996/A996M-15 - Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement.
3. A1064/A1064M-16 - Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
4. C33/C33M-16 - Concrete Aggregates.
5. C94/C94M-16 - Ready Mixed Concrete.
6. C143/C143M-15a - Slump of Hydraulic Cement Concrete.

7. C150/C150M-16 - Portland Cement.
8. C171-16 - Sheet Materials for Curing Concrete.
9. C260/C260M-10a - Air Entraining Admixtures for Concrete.
10. C309-11 - Liquid Membrane Forming Compounds for Curing Concrete.
11. C494/C494M-15a - Chemical Admixtures for Concrete.
12. C618-15 - Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
13. C979/C979M-16 - Pigments for Integrally Colored Concrete.
14. C989/C989M-14 - Slag Cement for Use in Concrete and Mortars.
15. C1240-15 - Silica Fume Used in Cementitious Mixtures.
16. D1751-04(2013)e1 - Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
17. D5893/D5893M-10 - Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements.
18. D6690-15 - Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.

1.4 SUBMITTALS

A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Submittal Drawings:
   1. Show size, configuration, and fabrication and installation details.
   2. Show reinforcing.
   3. Include jointing plan for concrete pavements, curbs and gutters.

C. Manufacturer's Literature and Data:
   1. Description of each product.
   2. Installation instructions.

D. Samples:
   1. Exposed Aggregate Concrete Panel: 0.4 sq. m by 50 mm (4 sq. ft. by 2 inches) thick, 2 required, each color and finish.
   2. Colored Concrete Panel: As specified in Section 09 06 00, SCHEDULE FOR FINISHES, with mix data.

E. Test reports: Certify products comply with specifications.
   1. Concrete materials.
   2. Select subbase materials.
   3. Field test reports.

F. Certificates: Certify products comply with specifications.
   1. Expansion joint filler.

2. Reinforcement.
3. Curing materials.
4. Concrete protective coating.

G. Qualifications: Substantiate qualifications comply with specifications.
1. Installer with project experience list.
2. Land surveyor.

H. Concrete mix design.

I. Select subbase job-mix design.

J. Proposed hot and cold weather concreting methods.

K. Land surveyor's construction staking notes, before placing concrete.
1. Identify discrepancies between field conditions and Drawings.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:
1. Regularly installs specified products.
2. Installed specified products with satisfactory service on five similar installations.
a. Project Experience List: Provide contact names and addresses for completed projects.

B. Land Surveyor: Professional land surveyor or engineer registered to provide land surveys in jurisdiction where project is located.

C. Preconstruction Testing:
1. Engage independent testing laboratory to perform tests and submit reports.
a. Deliver samples to laboratory in number and quantity required for testing.
2. Concrete mix design.
3. Select subbase job-mix design. Report the following:
a. Material sources.
b. Gradation.
c. Plasticity index.
d. Liquid limit.
e. Laboratory compaction curves indicating maximum density at optimum moisture content.

1.6 DELIVERY

A. Deliver steel reinforcement to prevent damage.

B. Before installation, return or dispose of distorted or damaged steel reinforcement.

C. Bulk Products: Deliver bulk products away from buildings, utilities, pavement, and existing turf and planted areas. Maintain dry bulk product storage away from contaminants.

1.7 STORAGE AND HANDLING

A. Store products indoors in dry, weathertight facility.

B. Protect products from damage during handling and construction operations.

1.8 FIELD CONDITIONS

A. Hot Weather Concreting Procedures: ACI 305R.

B. Cold Weather Concreting Procedures: ACI 306R.

1. Use non-corrosive, non-chloride accelerator admixture.
2. Do not use calcium chloride, thiocyanates or admixtures containing more than 0.05 percent chloride ions.

1.9 WARRANTY

A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."

PART 2 - PRODUCTS

2.1 CONCRETE MATERIALS

A. Portland Cement: ASTM C150/C150M, Type I or II.

B. Pozzolans:

1. Fly Ash: ASTM C618, Class C or F including supplementary optional physical requirements.
2. Slag: ASTM C989/C989M; Grade 80, Grade 100 or Grade 120.
3. Silica Fume: ASTM C1240.

C. Coarse Aggregate: ASTM C33/C33M; sized to suit application.

D. Fine Aggregate: ASTM C33/C33M.

E. Mixing Water: Fresh, clean, and potable.

F. Air-Entraining Admixture: ASTM C260/C260M.

G. Chemical Admixtures: ASTM C494/C494M.

H. Reinforcing Steel: ASTM A615/A615M or ASTM A996/A996M, deformed.

I. Welded Wire Fabric: ASTM A1064/A1064M, plain; Grade 385 (56); sized as indicated.

J. Expansion Joint Filler: ASTM D1751.

K. Sheet Materials for Curing Concrete: ASTM C171.

2.2 SELECT SUBBASE

A. Subbase: AASHTO M147; Grade A

1. Select granular material composed of sand, sand-gravel, crushed stone, crushed or granulated slag, with or without soil binder, or combinations of these materials.

SUBBASE GRADING REQUIREMENTS							
Sieve Size		Percentage Passing by Mass					
		Grades					
(mm)	(in)	A	B	C	D	E	F
50	2	100	100				
25	1		75-95	100	100	100	100
9.5	3/8	30-65	40-75	50-85	60-100		
4.47	No. 4	25-55	30-60	35-65	50-85	55-100	70-100
2.00	No. 10	15-40	20-45	25-50	40-70	40-100	55-100
0.425	No. 40	8-20	15-30	15-30	25-45	20-50	30-70
0.075	No. 200	2-8	5-20	5-15	5-20	6-20	8-25

B. Other Acceptable Gradations: Materials within three to five percent, plus or minus, of specified gradation, or as recommended by the geotechnical engineer and approved by the Contracting Officer's Representative.

2.3 FORMS

A. Forms: Wood, plywood, metal, or other materials, approved by Contracting Officer's Representative, of grade or type suitable to obtain type of finish specified.

1. Plywood: Exterior grade, free of defects and patches on contact surface.
2. Lumber: Sound, grade-marked, S4S stress graded softwood, minimum 50 mm (2 inches) thick, free from warp, twist, loose knots, splits, or other defects.
3. Form Coating: As recommended by Architect/Engineer.

B. Provide forms suitable in cross-section, depth, and strength to resist springing during depositing and consolidating concrete.

1. Do not use forms varying from straight line more than 3 mm in 3000 mm (1/8 inch in 10 feet), horizontally and vertically.

C. Provide flexible or curved forms for forming radii.

2.4 CONCRETE CURING MATERIALS

A. Concrete curing materials, conform to one of the following:

1. Burlap: Minimum 233 g/sq. m (7 ounces/sq. yd.) dry.
2. Sheet Materials for Curing Concrete: ASTM C171.
3. Curing Compound: ASTM C309, Type 1 clear; liquid membrane forming type, without paraffin or petroleum.

2.5 CONCRETE MIXES

A. Design concrete mixes according to ASTM C94/C94M, Option C.

B. Concrete Type: Air-entrained. See Table I.

TABLE I - CONCRETE TYPES

Concrete Type	Minimum 28 Day Compressive Strength f'c MPa (psi)	Non-Air-Entrained		Air-Entrained	
		Min. Cement kg/cu. m (lbs./cu. yd.)	Max. Water Cement Ratio	Min. Cement kg/cu. m (lbs./cu. yd.)	Max. Water Cement Ratio
A	35 (5000)1,3	375 (630)	0.45	385 (650)	0.40
B	30 (4000)1,3	325 (550)	0.55	340 (570)	0.50
C	25 (3000)1,3	280 (470)	0.65	290 (490)	0.55
D	25 (3000)1,2	300 (500)	*	310 (520)	*

Footnotes:

1. If trial mixes are used, achieve compressive strength 8.3 MPa (1,200 psi) in excess of f'c. For concrete strengths greater than 35 MPa (5,000 psi), achieve compressive strength 9.7 MPa (1,400 psi) in excess of f'c.
2. For Concrete Exposed to High Sulfate Content Soils: Maximum water cement ratio is 0.44.
3. Laboratory Determined according to ACI 211.1 for normal weight concrete.

C. Maximum Slump: ASTM C143/C143M. See Table II.

TABLE II - MAXIMUM SLUMP

APPLICATION	MAXIMUM SLUMP
Curb & Gutter	75 mm (3 inches)
Pedestrian Pavement	75 mm (3 inches)
Vehicular Pavement	50 mm (2 inches) Machine Finished 100 mm (4 inches) Hand Finished
Equipment Pad	75 to 100 mm (3 to 4 inches)

2.6 ACCESSORIES

A. Equipment and Tools: Obtain VA approval of equipment and tools needed for handling materials and performing work before work begins.

B. Maintain equipment and tools in satisfactory working condition.

C. Sealants:

1. Concrete Paving Expansion Joints: ASTM D5893/D5893M, Type SL, single component, self-leveling, silicone joint sealant.
2. Concrete Paving Joints: ASTM D6690, Type IV, hot-applied, single component joint sealant.

D. Concrete Protective Coating: AASHTO M233 linseed oil mixture.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine and verify substrate suitability for product installation.

B. Protect existing construction and completed work from damage.

C. Prepare, construct, and finish subgrade. See Section 31 20 00, EARTHWORK.

D. Maintain subgrade in smooth, compacted condition, in conformance with the required section and established grade until the succeeding operation has been accomplished.

3.2 SELECT SUBBASE

A. Placing:

1. Place subbase material on prepared subgrade in uniform layer to required contour and grades, and to maximum 200 mm (8 inches) loose depth.
2. When required compacted thickness exceeds 150 mm (6 inches), place subbase material in equal thickness layers.
3. When subbase elevation is 13 mm (1/2 inch) or more below required grade, excavate subbase minimum 75 mm (3 inches) deep. Place and compact subbase to required grade.

B. Compaction:

1. Perform compaction with approved hand or mechanical equipment well suited to the material being compacted.
2. Maintain subbase at optimum moisture content for compaction.
3. Compact each subbase layer to minimum 95 percent or 100 percent of maximum density as specified in Section 31 20 00, EARTHWORK.

C. Subbase Tolerances:

1. Variation from Indicated Grade: Maximum 9 mm (3/8 inch).

2. Variation from Indicated Thickness: Maximum 13 mm (1/2 inch).

D. Protection:

1. Protect subbase from damage until concrete is placed.
2. Reconstruct damaged subbase before placing concrete.

3.3 SETTING FORMS

A. Form Substrate:

1. Compact form substrate to uniformly support forms along entire length.
2. Correct substrate imperfections and variations by cutting, filling, and compacting.

B. Form Setting:

1. Set forms to indicated line and grade with tight joints. Rigidly brace forms preventing movement.
2. Remove forms when removal will not damage concrete and when required for finishing.
3. Clean and oil forms before each use.
4. Correct forms, when required, immediately before placing concrete.

C. Land Surveyor: Establish control, alignment, and grade for forms and slip forming machine operations.

1. Notify Contracting Officer's Representative immediately when discrepancies exist between field conditions and drawings.
2. Correct discrepancies greater than 25 mm (1 inch) before placing concrete.

D. Form Tolerances:

1. Variation from Indicated Line: Maximum 6 mm (1/4 inch).
2. Variation from Indicated Grade: Maximum 3 mm in 3000 mm (1/8 inch in 10 feet).

3.4 PLACING REINFORCEMENT

A. Keep reinforcement clean from contamination preventing concrete bond.

B. Install reinforcement shown on drawings.

C. Support and securely tie reinforcing steel to prevent displacement during concrete placement.

D. Obtain Contracting Officer's Representative's reinforcement placement approval before placing concrete.

3.5 JOINTS - GENERAL

A. Place joints, where shown on approved submittal Drawings.

1. Conform to details shown.

2. Install joints perpendicular to finished concrete surface.

B. Make joints straight and continuous from edge to edge of pavement.

3.6 CONSTRUCTION JOINTS

A. Locate longitudinal and transverse construction joints between slabs of vehicular pavement as shown on approved submittal Drawings.

B. Place transverse construction joints of type shown, where indicated, and whenever concrete placement is suspended for more than 30 minutes.

C. Provide butt-type joint with dowels in curb and gutter at planned joint locations.

D. Provide keyed joints with tie bars when joint occurs in middle third of planned curb and gutter joint interval.

3.7 CONTRACTION JOINTS

A. Tool or cut joints to width, depth, and radius edge shown on drawings using grooving tool, jointer, or saw.

B. Construct joints in curbs and gutters by inserting 3 mm (1/8 inch) steel plates conforming to curb and gutter cross sections.

1. Keep plates in place until concrete can hold its shape.

C. Finish joint edges with edging tool.

D. Score pedestrian pavement with grooving tool or jointer.

3.8 EXPANSION JOINTS

A. Expansion joint material shall conform to ASTM D-1751 Type 5. It shall be ¾ inch in thickness and shall have a width equal to the full depth of the slab in which it is to be used.

1. Locate joints around perimeter of structures and features abutting site work concrete.

2. Create complete, uniform separation between structure and site work concrete.

B. Extend expansion joint material full depth of concrete with top edge of joint filler below finished concrete surface where sealant is indicated on Drawings.

C. Cut and shape material matching cross section.

D. Anchor with approved devices to prevent displacing during placing and finishing operations.

E. Round joint edges with edging tool.

3.9 PLACING CONCRETE - GENERAL

A. Preparation before Placing Concrete:

1. Obtain Contracting Officer's Representative approval.

2. Remove debris and other foreign material.
3. Uniformly moisten substrate, without standing water.

B. Convey concrete from mixer to final location without segregation or loss of ingredients. Deposit concrete to minimize handling.

C. During placement, consolidate concrete by spading or vibrating to minimize voids, honeycomb, and rock pockets.
1. Vibrate concrete against forms and along joints.
2. Avoid excess vibration and handling causing segregation.

D. Place concrete continuously between joints without bulkheads.

E. Install construction joint in concrete placement suspended for more than 30 minutes.

F. Replace concrete with cracks, chips, bird baths, and other defects to nearest joints, approved by Contracting Officer's Representative.

3.10 PLACING CONCRETE FOR CURB AND GUTTER, PEDESTRIAN PAVEMENT, AND EQUIPMENT PADS

A. Place concrete in one layer conforming to cross section shown on Drawings after consolidating and finishing.

B. Deposit concrete near joints without disturbing joints. Do not place concrete directly onto joint assemblies.

C. Strike concrete surface to proper section ready for consolidation.

D. Consolidate concrete by tamping and spading or with approved mechanical finishing equipment.

E. Finish concrete surface with wood or metal float.

F. Construct concrete pads and pavements with sufficient slope to drain, preventing standing water.

3.11 PLACING CONCRETE FOR VEHICULAR PAVEMENT

A. Deposit concrete as close as possible to its final position.

B. Place concrete continuously between construction joints without cold joints.

C. Strike and consolidate concrete with finishing machine, vibrating screed, or by hand-finishing.

D. Finish concrete surface to elevation and crown shown on drawings.

E. Deposit concrete near joints without disturbing joints. Do not place concrete directly onto joint assemblies.

F. Obtain Contracting Officer's Representative's approval before placing adjacent lanes.

G. Mountable Curb-Forming Machines: Curb-forming machines for constructing curbs and gutter will be approved based on trial use on the project. When equipment produces unsatisfactory results, discontinue use of the equipment at any time during construction and accomplish work by hand method construction. Remove unsatisfactory work and reconstruct full length between regularly scheduled joints. Dispose of removed portions off the project site.

3.12 FORM REMOVAL

A. Keep forms in place minimum 12 hours after concrete placement. Remove forms without damaging concrete.

B. Do not use bars or heavy tools against concrete to remove forms. Repair damage concrete found after form removal.

3.13 CONCRETE FINISHING - GENERAL

A. Follow operation sequence below, unless otherwise indicated on Drawings:

1. Consolidating, floating, striking, troweling, texturing, and joint edging.

B. Use edging tool with 6 mm (1/4 inch) radius, unless otherwise shown on Drawings.

C. Keep finishing equipment and tools clean and suitable for use.

3.14 CONCRETE FINISHING - PEDESTRIAN PAVEMENT

A. Walks, Grade Slabs, Wheelchair Curb Ramps.

1. Finish concrete surfaces with metal float, troweled smooth, and finished with a broom moistened with clear water.
2. Finish slab edges and formed transverse joints with edger.
3. Broom surfaces transverse to traffic direction.
   a. Use brooming to eliminate flat surface produced by edger.
   b. Produce uniform corrugations, maximum 1.5 mm (1/16 inch) deep profile.
4. Provide surface uniform in color and free of surface blemishes, form marks, and tool marks.
5. Paving Tolerances:
   a. Variation from Indicated Plane: Maximum 5 mm in 3000 mm (3/16 inch in 10 feet).
   b. Variation from Indicated Thickness: Maximum 6 mm (1/4 inch).
6. Replace paving within joint boundary when paving exceeds specified tolerances.

B. Step Treads, Risers and Sidewalls: Finish as specified for pedestrian pavement, except as follows:
   1. Remove riser forms sequentially, starting with top riser.
   2. Rub riser face with wood or concrete rubbing block and water. Remove blemishes, form marks, and tool marks. Use outside edger to round nosing; use inside edger to finish bottom of riser.
   3. Apply uniform brush finish to treads, risers, and sidewall.
      a. Apply stiff brush finish to treads to provide slip resistant surface complying with ANSI B101.3.
   4. Step Tolerance:
      a. Variation from Indicated Plane: Maximum 5 mm in 3000 mm (3/16 inch in 10 feet).

3.15 CONCRETE FINISHING - VEHICULAR PAVEMENT

A. Align finish surfaces where new and existing pavements abut.
B. Longitudinally float pavement surface to profile and grade indicated on drawings.
C. Straighten surface removing irregularities and maintaining specified tolerances while concrete is plastic.
D. Finish pavement edges and joints with edging tool.
E. Broom finish concrete surface after bleed water dissipates and before concrete hardens.
   1. Broom surface transverse to traffic direction.
      a. Use brooming to eliminate flat surface produced by edger.
      b. Produce uniform corrugations, maximum 3 mm (1/8 inch) deep profile.
F. Pavement Tolerances:
   1. Variation from Indicated Plane: Maximum 6 mm in 3000 mm (1/4 inch in 10 feet) tested parallel and perpendicular to traffic direction at maximum 1500 mm (5 feet) intervals.
   2. Variation from Indicated Thickness: Maximum 6 mm (1/4 inch).
G. Replace paving within joint boundary when paving exceeds specified tolerances.

3.16 CONCRETE FINISHING - CURBS AND GUTTERS

A. Round edges of gutter and top of curb with edging tool.
B. Gutter and Curb Top:
   1. Float surfaces and finish with smooth wood or metal float until true to grade and section and uniform color.

2. Finish surfaces, while still plastic, longitudinally with bristle brush.

C. Curb Face:

1. Remove curb form and immediately rub curb face with wood or concrete rubbing block removing blemishes, form marks, and tool marks and providing uniform color.
2. Brush curb face, while still plastic, matching gutter and curb top.

D. Curb and Gutter Tolerances: Except at grade changes or curves.

1. Variation from Indicated Plane and Grade:
   a. Gutter: Maximum 3 mm in 3000 mm (1/8 inch in 10 feet).
   b. Curb Top and Face: Maximum 6 mm in 3000 mm (1/4 inch in 10 feet).

E. Replace curbs and gutters within joint boundary when curbs and gutters exceed specified tolerances.

F. Correct depressions causing standing water.

3.17 CONCRETE FINISHING - EQUIPMENT PADS

A. Strike pad surface to elevation shown on Drawings.

B. Provide smooth, dense float finish, free from depressions or irregularities.

C. Finish pad edges with edger.

D. After removing forms, rub pad edge faces with wood or concrete rubbing block, removing blemishes, form marks, and tool marks and providing uniform color.

E. Pad Tolerances:

1. Variation from Indicated Plane: Maximum 3 mm in 3000 mm (1/8 inch in 10 feet).
2. Variation from Indicated Elevation: Maximum 6 mm (1/4 inch).
3. Variation from Indicated Thickness: Maximum 6 mm (1/4 inch).

F. Replace pads when pads exceed specified tolerances.

3.18 SPECIAL FINISHES

A. Exposed Aggregate Finish:

1. Prepare concrete base 10 to 13 mm (3/8 to 1/2 inch) lower than the finish grade.
2. Scatter aggregate over concrete base surface and embed by use of hand float, straight edge, or darby.
3. Apply concrete mix and mark off surface as shown. with surface joints at least 10 mm (3/8 inch) deep. Level off finish to a true

surface and compact with wood float, working as little as possible so that coarse material will remain at the top. Before finish has set, treat top surface with cement retarding material. When body of concrete finish has set, remove retarded surface film by wire brushes and fine water spray to remove mortar from top of colored aggregate. Continue washing and brushing until flush water runs clear and no noticeable cement film left on the aggregate.

3.19 CONCRETE CURING

A. Concrete Protection:
   1. Protect unhardened concrete from rain and flowing water.
   2. Provide sufficient curing and protection materials available and ready for use before concrete placement begins.
   3. Protect concrete to prevent pavement cracking from ambient temperature changes during curing period.
      a. Replace pavement damaged by curing method allowing concrete cracking.
      b. Employ another curing method as directed by Contracting Officer's Representative.

B. Cure concrete for minimum 7 days by one of the following methods appropriate to weather conditions preventing moisture loss and rapid temperature change:
   1. Burlap Mat: Provide minimum two layers kept saturated with water during curing period. Overlap Mats at least 150 mm (6 inches).
   2. Sheet Materials:
      a. Wet exposed concrete surface with fine water spray and cover with sheet materials.
      b. Overlap sheets minimum 300 mm (12 inches).
      c. Securely anchor sheet materials preventing displacement.
   3. Curing Compound:
      a. Protect joints indicated to receive sealants preventing contamination from curing compound.
      b. Insert moistened paper or fiber rope into joint or cover joint with waterproof paper.
      c. Apply curing compound before concrete dries.
      d. Apply curing compound in two coats at right angles to each other.
      e. Application Rate: Maximum 5 sq. m/L (200 sq. ft./gallon), both coats.

f. Immediately reapply curing compound to surfaces damaged during curing period.

3.20 CONCRETE PROTECTIVE COATING

A. Apply protective coating of linseed oil mixture to exposed-to-view concrete surfaces, drainage structures, and features that project through, into, or against concrete exterior improvements to protect the concrete against deicing materials.

B. Complete backfilling and curing operation before applying protective coating.

C. Dry and thoroughly clean concrete before each application.

D. Apply two coats, with maximum coverage of 11 sq. m/L (50 sq. yds./gal.); first coat, and maximum 16 sq. m/L (70 sq. yds./gal.); second coat, except apply commercially prepared mixture according to manufacturer's instructions.

E. Protect coated surfaces from vehicular and pedestrian traffic until dry.

F. Do not heat protective coating, and do not expose protective coating to open flame, sparks, or fire adjacent to open containers or applicators. Do not apply material at temperatures lower than 10 degrees C (50 degrees F).

3.21 FIELD QUALITY CONTROL

A. Field Tests: Performed by testing laboratory specified in Section 01 45 29, TESTING LABORATORY SERVICES.

1. Compaction.
   a. Pavement subgrade.
   b. Curb, gutter, and sidewalk.
2. Concrete:
   a. Delivery samples.
   b. Field samples.
3. Slip Resistance: Steps and pedestrian paving.

3.22 CLEANING

A. After completing curing:

1. Remove burlap and sheet curing materials.
2. Sweep concrete clean, removing foreign matter from the joints.
3. Seal joints as specified.

3.23 PROTECTION

A. Protect exterior improvements from traffic and construction operations.

1. Prohibit traffic on paving for minimum seven days after placement, or longer as directed by Contracting Officer's Representative.

B. Remove protective materials immediately before acceptance.

C. Repair damage.

1. Replace concrete containing excessive cracking, fractures, spalling, and other defects within joint boundary, when directed by Contracting Officer's Representative, and at no additional cost to the Government.

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SECTION 32 12 16
ASPHALT PAVING

PART 1 - GENERAL

1.1 DESCRIPTION

A. 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. Subgrade Preparation: Paragraph 3.3 and Section 31 20 00, EARTHWORK.

1.3 INSPECTION OF PLANT AND EQUIPMENT

A. The COR 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, and other tests required by State Highway Department.
2. Asphalt Base/Surface Course: Aggregate source, gradation, soundness loss, percentage of wear, and other tests required by State Highway Department.
3. Job-mix formula.

C. Certifications:

1. Asphalt prime and tack coat material certificate of conformance to State Highway Department requirements.

2. Asphalt cement certificate of conformance to State Highway Department requirements.
3. Job-mix certification - Submit plant mix certification that mix equals or exceeds the State Highway Specification.

D. Provide MSDS (Material Safety Data Sheets) for all chemicals used on ground.

PART 2 - PRODUCTS

2.1 GENERAL

A. Aggregate base and asphalt concrete materials shall conform to the requirements of the following and other appropriate sections of the latest version of the State Highway Material Specifications, including amendments, addenda and errata. Where the term "Engineer" or "Commission" is referenced in the State Highway Specifications, it shall mean the VA COR or VA Contracting Officer.

2.2 AGGREGATES

A. Provide aggregates consisting of crushed stone, gravel, sand, or other sound, durable mineral materials processed and blended, and naturally combined.

B. Subbase aggregate (where required) maximum size: 38mm(1-1/2").

C. Base aggregate maximum size:
1. Base course over 152mm(6") thick: 38mm(1-1/2");
2. Other base courses: 19mm(3/4").

D. Asphaltic base course:
1. Maximum particle size not to exceed 25.4mm(1”).
2. Where conflicts arise between this specification and the requirements in the latest version of the State Highway Specifications, the State Specifications shall control.

E. Aggregates for asphaltic concrete paving: Provide a mixture of sand, mineral aggregate, and liquid asphalt mixed in such proportions that the percentage by weight will be within:

Sieve Sizes	Percentage Passing
19mm(3/4")	100
9.5mm(3/8")	67 to 85
6.4mm(1/4")	50 to 65
2.4mm(No. 8 mesh)	37 to 50
600µm(No. 30 mesh)	15 to 25

75µm(No. 200 mesh) 3 to 8

plus 50/60 penetration liquid asphalt at 5 percent to 6-1/2 percent of the combined dry aggregates.

2.3 ASPHALTS

A. Comply with provisions of Asphalt Institute Specification SS2:

1. Asphalt cement: Penetration grade 50/60
2. Prime coat: Cut-back type, grade MC-250
3. Tack coat: Uniformly emulsified, grade SS-1H

2.4 SEALER

A. Provide a sealer consisting of suitable fibrated chemical type asphalt base binders and fillers having a container consistency suitable for troweling after thorough stirring, and containing no clay or other deleterious substance.

B. Where conflicts arise between this specification and the requirements in the latest version of the State Highway Specifications, the State Specifications shall control.

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: 143 degrees C(290 degrees F) minimum, 160 degrees C(320 degrees F) maximum.
2. Temperature at time of placing: 138 degrees C(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 45 tonne (50 ton) gross weight dump truck as directed by VA COR 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. Subbase 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 subbase rolling there shall be no hauling over the subbase other than the delivery of material for the top course.

B. Base
   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.

C. Thickness tolerance: Provide the compacted thicknesses shown on the Drawings within a tolerance of minus 0.0mm (0.0") to plus 12.7mm (0.5").

D. Smoothness tolerance: Provide the lines and grades shown on the Drawings within a tolerance of 5mm in 3m (3/16 inch in ten feet).

E. Moisture content: Use only the amount of moisture needed to achieve the specified compaction.

3.5 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 130 degrees C(280 degrees F).
   2. Do not commence placement of asphaltic concrete materials when the atmospheric temperature is below 10 degrees C (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 76mm (3") 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 own 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 1.8m (1/8" 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 17 23
PAVEMENT MARKINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Paint and reflective glass beads on pavement surfaces, in form of traffic lanes, parking bays, areas restricted to handicapped persons, crosswalks, and other detail pavement markings.

1.2 RELATED REQUIREMENTS

A.

B. Paint Color: Section 09 06 00, SCHEDULE FOR FINISHES.

1.3 APPLICABLE PUBLICATIONS

A. Comply with references to extent specified in this section.

B. Federal Specifications (Fed. Spec.):

1. TT-B-1325D - Beads (Glass Spheres) Retro-Reflective.
2. TT-P-1952F - Paint, Traffic and Airfield Marking, Waterborne.

C. Master Painters Institute (MPI):

1. No. 97 - Traffic Marking Paint, Latex.

1.4 SUBMITTALS

A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Submittal Drawings:

1. Show pavement marking configuration and dimensions.
2. Show international symbol of accessibility at designated parking spaces.

C. Manufacturer's Literature and Data:

1. Description of each product.
2. Application instructions.

D. Samples:

1. Paint: 200 mm (8 inches) square, each type and color.

E. Certificates: Certify products comply with specifications.

F. Qualifications: Substantiate qualifications comply with specifications.

1. Installer with project experience list.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:

1. Regularly installs specified products.
2. Installed specified products with satisfactory service on five similar installations for minimum five years.
   a. Project Experience List: Provide contact names and addresses for completed projects.

1.6 DELIVERY

A. Deliver products in manufacturer's original sealed packaging.

B. Mark packaging, legibly. Indicate manufacturer's name or brand, type, color, production run number, and manufacture date.

C. Before installation, return or dispose of products within distorted, damaged, or opened packaging.

1.7 STORAGE AND HANDLING

A. Store products indoors in dry, weathertight conditioned facility.

B. Protect products from damage during handling and construction operations.

1.8 FIELD CONDITIONS

A. Environment:
   1. Product Temperature: Minimum 13 degrees C (55 degrees F) for minimum 48 hours before installation.
      a. Surface to be painted and ambient temperature: Minimum 10 degrees C (50 degrees F) and maximum 35 degrees C (95 degrees F).

B. Field Measurements: Verify field conditions affecting traffic marking installation. Show field measurements on Submittal Drawings.

1.9 WARRANTY

A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Design paint complying with specified performance:
   1. Application: Fed. Spec. TT-P-1952.

2.2 PRODUCTS - GENERAL

A. Basis of Design: Section 09 06 00, SCHEDULE FOR FINISHES.

B. Provide each product from one manufacturer and from one production run.

1. Low Pollutant-Emitting Materials: Comply with VOC limits specified in Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS for the following products:
   a. Paints and coatings.

2.3 SANDBLASTING EQUIPMENT

A. Air compressor, hoses, and nozzles of proper size and capacity as required for cleaning painted surfaces. Compressor to provide minimum 0.08 cu. m/s (150 cfm) of air at pressure of minimum 625 kPa (90 psi) at each nozzle used.

2.4 PAINT APPLICATOR

A. Apply marking paint with approved mechanical equipment. Provide equipment with constant agitation of paint and travel at controlled speeds. Synchronize one or more paint "guns" to automatically begin and cut off paint flow in case of skip lines. Equipment to have manual control to apply continuous lines of varying length and marking widths as indicated on Drawings. Provide pneumatic spray guns for hand application of paint in areas where mobile paint applicator cannot be used. Use separate piece of equipment when equipment does not have glass bead dispenser. Adjust and synchronize equipment with paint applicator to distribute reflective beads on paint lines uniformly within ten seconds without any waste.

2.5 PAINT

A. Paint: MPI No. 97. For obliterating existing markings comply with Fed. Spec. TT-P-1952. Provide minimum 18 L (5 gallons) containers.

2.6 REFLECTIVE GLASS BEADS

A. Beads: Comply with Fed. Spec. TT-B-1325, Type I, Gradation A. In regions of high humidity, coat beads with silicone or other suitable waterproofing material to ensure free flow. Provide glass beads in containers suitable for handling and strong enough to prevent loss during shipment.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine and verify substrate suitability for product installation.
   1. Allow new pavement surfaces to cure for period of minimum 14 days before application of marking materials.

B. Protect existing construction and completed work from damage.

C. Clean substrates. Remove contaminants capable of affecting subsequently installed product's performance.

1. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water, or combination of these methods.
2. Completely remove rubber deposits, existing paint markings, and other coatings adhering to pavement with scrapers, wire brushings, sandblasting, mechanical abrasion, or approved chemicals as directed by Contracting Officer's Representative.
3. As an option, comply with Fed. Spec. TT-P-1952 for removal of existing paint markings on asphalt pavement. Apply black paint in as many coats as necessary to completely obliterate existing markings.
4. Scrub affected areas with several applications of trisodium phosphate solution or other approved detergent or degreaser, and rinse thoroughly after each application, Where oil or grease are present on old pavements to be marked, .
   a. After cleaning, seal oil-soaked areas with cut shellac to prevent bleeding through new paint.
5. Clean and dry surface before pavement marking.Do not begin any marking until Contracting Officer's Representative inspected surface and gives permission to proceed.

3.2 TEMPORARY PAVEMENT MARKING

A. Apply Temporary Pavement Markings of colors, widths and lengths shown on drawings or directed by Contracting Officer's Representative. After temporary marking has served its purpose and when so ordered by Contracting Officer's Representative, remove temporary marking by carefully controlled sandblasting, approved grinding equipment, or other approved method to prevent damage on applied surface.

B. As an option, provide approved preformed pressure sensitive, reflective, adhesive tape type of temporary pavement marking of required colors, widths and lengths in lieu of temporary paintedand reflective marking. Continuous durability and effectiveness of such marking is required during period for which its use is required. Remove any unsatisfactory tape type marking and replace with painted and reflective markings.

3.3 INSTALLATION - GENERAL

A. Install products according to manufacturer's instructions and approved submittal drawings.
   1. When manufacturer's instructions deviate from specifications, submit proposed resolution for Contracting Officer's Representative consideration.

3.4 PAINT APPLICATION

A. Apply uniformly painted and reflective pavement marking of required colors, length, and width with true, sharp edges and ends on properly cured, prepared, and dried surfaces.

B. Comply with details as indicated on drawings and established control points.

C. Apply paint at wet film thickness of 0.4 mm (0.015 inch). Disperse reflective glass beads evenly on wet paint at rate of 720 g/L (6 pounds per gal.) of paint. Apply paint in one coat. When directed by Contracting Officer's Representative, apply additional coats at markings showing light spots. Comply with paint manufacturer's maximum drying time requirements to prevent undue softening of asphalt, and pick-up, displacement, or discoloration by tires of traffic.

D. When deficiency in marking drying occurs, discontinue paint operations until cause of slow drying is determined and corrected.

E. Remove and replace marking applied less than minimum material rates, deviates from true alignment, exceeds stipulated length and width tolerances, or shows light spots, faulty distribution of beads, smears, or other deficiencies or irregularities.

F. Remove marking by carefully controlled sandblasting, approved grinding equipment, or other approve method to prevent damage on applied surface.

3.5 DETAIL PAVEMENT MARKING APPLICATION

A. Apply Detail Pavement Markings, exclusive of actual traffic lane marking as follows:
   1. At exit and entrance islands and turnouts.
   2. On curbs.
   3. At crosswalks.
   4. At parking bays.
   5. Other locations as indicated on drawings.

B. Apply International Handicapped Symbol at indicated parking spaces. Color as shown on drawings. Apply paint for symbol using suitable template that will provide pavement marking with true, sharp edges and ends.

C. Install detail pavement markings of colors, widths and lengths, and design pattern at locations indicated on drawings.

3.6 TOLERANCES

A. Length and Width of Lines: Plus or minus 75 mm (3 inches) and plus or minus 3 mm (1/8 inch), respectively, in case of skip markings.

B. Length of intervals exceeding line length tolerance are not acceptable.

3.7 CLEANING

A. Remove excess paint before paint sets.

3.8 PROTECTION

A. Protect pavement markings from traffic and construction operations.

1. Protect newly painted markings from vehicular traffic until paint is dry and track free.
2. Place warning signs at beginning of wet line, and at points well in advance of marking equipment for alerting approaching traffic from both directions.
3. Place small flags or other similarly effective small objects near freshly applied markings at frequent intervals to reduce crossing by traffic.

B. Repair damage.

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SECTION 32 31 40
HIGH SECURITY FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. High security fences, gates and accessories.

1.2 RELATED REQUIREMENTS

A. Temporary Construction Fence: Section 01 00 00, GENERAL REQUIREMENTS.

B. Concrete Footings: Section 03 30 00, CAST-IN-PLACE CONCRETE.

C. Physical Access Control System: Section 28 13 00 – PHYSICAL ACCESS CONTROL SYSTEM.

1.3 APPLICABLE PUBLICATIONS

A. Comply with references to extent specified in this section.

B. ASTM International (ASTM):

1. A653/A653M-15e1 - Steel Sheet, Zinc-Coated (Galvanized) or Zinc Alloy-Coated (Galvannealed) by Hot-Dip Process.
2. A924/A924M-14e1 - General Requirements for Steel Sheet, Metallic Coated by the Hot-dip Process.
3. D2794-93(2010) - Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
4. F2408-16 - Ornamental Fences Employing Galvanized Steel Tubular Pickets.

C. Master Painters Institute (MPI):

1. No. 18 - Primer, Zinc Rich, Organic.

1.4 SUBMITTALS

A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Submittal Drawings:

1. Show size, configuration, and fabrication and installation details.

C. Manufacturer's Literature and Data:

1. Description of each product.

D. Certificates: Certify each product complies with specifications.

1. Fence alignment.
2. Zinc-coating complies with specifications.
3. Structural characteristics comply with indicated and criteria on Drawings.
4. Connections comply with requirements indicated on Drawings.

E. Qualifications: Substantiate qualifications comply with specifications.
   1. Manufacturer with project experience list.
   2. Installer with project experience list.
   3. Welders and welding procedures.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications:
   1. Regularly manufactures specified products.
   2. Manufactured specified products with satisfactory service on five similar installations for minimum five years.
      a. Project Experience List: Provide contact names and addresses for completed projects.

B. Installer Qualifications: Manufacturer authorized installer.
   1. Regularly installs specified products.
   2. Installed specified products with satisfactory service on five similar installations for minimum five years.
      a. Project Experience List: Provide contact names and addresses for completed projects.

C. Welders and Welding Procedures Qualifications: AWS D1.1/D1.1M.

1.6 DELIVERY

A. Deliver products in manufacturer's original sealed packaging.

B. Mark packaging, legibly. Indicate manufacturer's name or brand, type, color, production run number, and manufacture date.

C. Before installation, return or dispose of products within distorted, damaged, or opened packaging.

1.7 STORAGE AND HANDLING

A. Store products indoor in dry, weathertight facility.

B. Protect products from damage during handling and construction operations.

1.8 FIELD CONDITIONS

A. Field Measurements: Verify field conditions affecting high security fence fabrication and installation. Show field measurements on Submittal Drawings.
   1. Coordinate field measurement and fabrication schedule to avoid delay.

1.9 WARRANTY

A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. System components includes pickets, pales, mesh, fabric, rails, posts, gates and hardware required with following performance requirements:
   1. Steel Yield Strength: ASTM A924, minimum 344 MPa (50,000 psi).
   2. Impact Resistance: ASTM D2794, over 6.8 Nm (60 in-lb.) when using 0.625 ball forward impact.

B. Gates: Design to meet same forced entry and anti-climb characteristics as other portions of fence.

2.2 MATERIALS

A. Zinc-Coated Steel: ASTM A653, G90 coating designation ASTM A924.

B. Tubular Steel: ASTM F2408.

C. Concrete: As specified in Section 03 30 00, Cast-in-Place Concrete.

2.3 PRODUCTS - GENERAL

A. Provide fence components from one manufacturer.

Steel Recycled Content: 30 percent total recycled content, minimum.

2.4 HIGH SECURITY FENCE

A. Pickets: Hot-dip galvanized steel, nominal 68.75 mm (2 3/4 inches) by 18.75 mm (3/4 inch) by 1.98 mm (0.078 inch) thick.

B. Rails: Hot-dip galvanized steel, nominal 50 mm (2 inch) square.

C. Gate Posts: Tubular steel, nominal 100 mm 4 inch) square.
   1. Provide motorized sliding gates for vehicle access.

2.5 FABRICATION

A. Fabricate fence and gate to profile and dimensions indicated on Drawings.

B. Fabricate components with joints tightly fitted and secured.

2.6 FINISHES

A. Steel Paint Finish:
   1. Powder-Coat Finish: Manufacturer's standard two-coat finish system as follows:
      a. One coat primer.
      b. One coat thermosetting topcoat.

c. Dry-film Thickness: 0.05 mm (2 mils) minimum.

d. Color: As selected by Architect.

B. Finish exposed surfaces after fabrication.

2.7 ACCESSORIES

A. Accessories: Manufacturer's required accessories for complete installation.

B. Barrier Coating: ASTM D1187/D1187M.

C. Welding Materials: AWS D1.1/D1.1M, type to suit application.

D. Fasteners: Fasteners as recommended by manufacturer.

E. Gate Hardware: Fence manufacturers standard hardware for motorized sliding gates.

F. Galvanizing Repair Paint: MPI No. 18.

G. Touch-Up Paint: Match shop finish.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine and verify substrate suitability for product installation.

B. Protect existing construction and completed work from damage.

C. Remove existing gates to permit new installation.

1. Dispose of removed materials.

3.2 INSTALLATION - GENERAL

A. Install products according to manufacturer's instructions and approved submittal drawings.

1. When manufacturer's instructions deviate from specifications, submit proposed resolution for Contracting Officer's Representative consideration.

B. Excavate for concrete-embedded items.

C. Set posts in concrete foundation with a minimum depth of 914 mm (36 inches).

D. Attached fence panel to the line and end posts with manufacturer's standard fasteners.

E. Install gate to gate posts spaced as indicated on Drawings. Install required hardware and adjust for smooth operation.

F. Touch up damaged factory finishes.

1. Repair galvanized surfaces with galvanized repair paint.

2. Repair painted surfaces with touch up primer.

3.3 CLEANING

A. Clean exposed high security fence and gate surfaces. Remove contaminants and stains.

3.4 PROTECTION

A. Protect high security fences and gates from traffic and construction operations.

B. Remove protective materials immediately before acceptance.

C. Repair damage.

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SECTION 33 08 00

COMMISSIONING OF SITE UTILITY SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. The requirements of this Section apply to all sections of Division 31.

B. This project will have selected building systems commissioned. The complete list of equipment and systems to be commissioned is specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. The commissioning process, which the Contractor is responsible to execute, is defined in Section 01 91 00 GENERAL COMMISSIONING REQUIRMENTS. A Commissioning Agent (CxA) will manage the commissioning process.

1.2 RELATED WORK

A. Section 01 00 00 GENERAL REQUIREMENTS.

B. Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

C. Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

1.3 SUMMARY

A. This Section includes requirements for commissioning the Facility site utilities systems, related subsystems and related equipment. This Section supplements the general requirements specified in Section 01 91 00 General Commissioning Requirements.

B. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for more details regarding processes and procedures as well as roles and responsibilities for all Commissioning Team members.

1.4 DEFINITIONS

A. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for definitions.

1.5 COMMISSIONED SYSTEMS

A. Commissioning of a system or systems specified in Division 31 is part of the construction process. Documentation and testing of these systems, as well as training of the VA’s Operation and Maintenance personnel in accordance with the requirements of Section 01 91 00 and of Division 31, is required in cooperation with the VA and the Commissioning Agent.

B. The Facility site utilities systems commissioning will include the systems listed in Section 01 91 00 General Commissioning Requirements.

1.6 SUBMITTALS

A. The commissioning process requires review of selected Submittals that pertain to the systems to be commissioned. The Commissioning Agent will provide a list of submittals that will be reviewed by the Commissioning Agent. This list will be reviewed and approved by the VA prior to forwarding to the Contractor. Refer to Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, and SAMPLES for further details.

B. The commissioning process requires Submittal review simultaneously with engineering review. Specific submittal requirements related to the commissioning process are specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 CONSTRUCTION INSPECTIONS

A. Commissioning of Site Utility systems will require inspection of individual elements of the site utility systems construction throughout the construction period. The Contractor shall coordinate with the Commissioning Agent in accordance with Section 01 91 00 and the Commissioning plan to schedule site utility systems inspections as required to support the Commissioning Process.

3.2 PRE-FUNCTIONAL CHECKLISTS

A. The Contractor shall complete Pre-Functional Checklists to verify systems, subsystems, and equipment installation is complete and systems are ready for Systems Functional Performance Testing. The Commissioning Agent will prepare Pre-Functional Checklists to be used to document equipment installation. The Contractor shall complete the checklists. Completed checklists shall be submitted to the VA and to the Commissioning Agent for review. The Commissioning Agent may spot check a sample of completed checklists. If the Commissioning Agent determines that the information provided on the checklist is not accurate, the Commissioning Agent will return the marked-up checklist to the Contractor for correction and resubmission. If the Commissioning Agent determines that a significant number of completed checklists for similar equipment are not accurate, the Commissioning Agent will select a broader sample of checklists for review. If the Commissioning Agent determines that a significant number of the broader sample of checklists is also inaccurate, all the checklists for the type of equipment will be returned to the Contractor for correction and

resubmission. Refer to SECTION 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for submittal requirements for Pre-Functional Checklists, Equipment Startup Reports, and other commissioning documents.

3.3 CONTRACTORS TESTS

A. Contractor tests as required by other sections of Division 31 shall be scheduled and documented in accordance with Section 01 00 00 GENERAL REQUIREMENTS. All testing shall be incorporated into the project schedule. Contractor shall provide no less than 21 calendar days' notice of testing. The Commissioning Agent will witness selected Contractor tests at the sole discretion of the Commissioning Agent. Contractor tests shall be completed prior to scheduling Systems Functional Performance Testing.

3.4 SYSTEMS FUNCTIONAL PERFORMANCE TESTING

A. The Commissioning Process includes Systems Functional Performance Testing that is intended to test systems functional performance under steady state conditions, to test system reaction to changes in operating conditions, and system performance under emergency conditions. The Commissioning Agent will prepare detailed Systems Functional Performance Test procedures for review and approval by the COR. The Contractor shall review and comment on the tests prior to approval. The Contractor shall provide the required labor, materials, and test equipment identified in the test procedure to perform the tests. The Commissioning Agent will witness and document the testing. The Contractor shall sign the test reports to verify tests were performed. See Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS, for additional details.

----- END -----

SECTION 33 10 00

WATER UTILITIES

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies materials and procedures for construction of underground water distribution for domestic and/or fire supply systems outside the building that are complete and ready for operation. This includes piping, structures, appurtenances and all other incidentals.

1.2 RELATED WORK

A. Excavation, Trench Widths, Pipe Bedding, Backfill, Shoring, Sheeting, Bracing: Section 31 20 00, EARTHWORK.

B. Concrete: Section 03 30 00, CAST IN-PLACE CONCRETE.

C. General plumbing: Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

D. 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 DEFINITIONS

A. Water distribution system: Pipelines and appurtenances which are part of the distribution system outside the building for potable water and fire supply.

B. Water service line: Pipeline from main line to 5 feet outside of building.

1.4 ABBREVIATIONS

A. PVC: Polyvinyl chloride plastic.

B. DI: Ductile iron pipe.

C. WOG: Water, Oil and Gas.

1.5 DELIVERY, STORAGE AND HANDLING

A. Ensure that valves are dry and internally protected against rust and corrosion. Protect valves against damage to threaded ends and flange faces.

B. Use a sling to handle valves and fire hydrants if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

C. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

D. Protect stored piping from moisture and dirt by elevating above grade. Protect flanges, fittings, and specialties from moisture and dirt.

E. Store plastic piping protected from direct sunlight and support to prevent sagging and bending.

F. Cleanliness of Piping and Equipment Systems:

1. Care shall be exercised in the storage and handling of equipment and piping material to be incorporated in the work. Debris arising from cutting, threading and welding of piping shall be removed.
2. Piping systems shall be flushed, blown or pigged as necessary to deliver clean systems.

1.6 COORDINATION

A. Coordinate connection to water main with Public Utility company.

B. Coordinate water service lines with building contractor.

1.7 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. Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least three years. Digital electronic devices, software and systems such as controls, instruments or computer work stations shall be the current generation of technology and basic design that has a proven satisfactory service record of at least three years.

C. Regulatory requirements:

1. Comply with the rules and regulations of the public utility company having jurisdiction over the connection to public water lines and the extension and/or modifications to public utility systems.

2. Comply with the rules and regulations of the Federal State and/or Local Health Department Department of Environmental Quality having jurisdiction for potable water-service.
3. Comply with rules and regulations of Federal Stat and/or Local authorities having jurisdiction for fire-suppression water-service piping including materials, hose threads, installation and testing.

D. Provide certification of factory hydrostatic testing of not less than 500 psi (3.5 MPa) in accordance with AWWA C151. Piping materials shall bear the label, stamp or other markings of the specified testing agency.

E. Before any welding is performed, contractor shall submit a certificate certifying that welders comply with the following requirements:

1. Qualify welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualifications".
2. Comply with provisions of ASME B31 series "Code for Pressure Piping".
3. Certify that each welder has passed American Welding Society (AWS) qualification tests for the welding processes involved, and that certification is current.
4. All welds shall be stamped according to the provisions of the American Welding Society.

F. Where installation procedures or any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be furnished to the Resident Engineer prior to installation.

G. Applicable codes:

1. Plumbing Systems: IPC, International Plumbing Code.
2. Electrical components, devices and accessories shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for intended use.
3. Fire-service main products shall be listed in the FM Global “Approval Guide” or Underwriters Laboratories (UL) “Fire Protection Equipment Directory”.

1.8 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 National Standards Institute (ANSI):

MSS SP-60-2004 .....Connecting Flange Joint Between Tapping Sleeves and Tapping Valves

MSS SP-108-2002.....Resilient-Seated Cast Iron, Eccentric Plug Valves

MSS SP-123-1998(R2006)..Non-Ferrous Threaded and Solder-Joint Unions for Use With Copper Water Tube

C. American Society of Mechanical Engineers (ASME):

A112.1.2-2004.....Air Gaps in Plumbing Systems (for Plumbing Fixtures and Water-Connected Receptors))

A112.6.3-2001.....Floor Drains

B16.1-2010.....Gray Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250

B16.18-2001.....Cast Copper Alloy Solder Joint Pressure Fittings

B16.22-2001.....Wrought Copper and Copper Alloy Solder Joint Pressure Fittings

B16.24-2006.....Cast Copper Alloy Pipe Flanges and Flanged Fittings; Classes 150, 300, 600, 900, 1500 and 2500

B31.....Code for Pressure Piping Standards

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

A36/A36M-08.....Carbon Structural Steel

A48/A48M-08(2008).....Gray Iron Castings

A536-84(2009).....Ductile Iron Castings

A674-10.....Polyethylene Encasement for Ductile Iron Pipe for Water or Other Liquids

B61-08.....Steam or Valve Bronze Castings

B62-09.....Composition Bronze or Ounce Metal Castings

B88/B88M-09.....Seamless Copper Water Tube

C651-05.....Disinfecting Water Mains

C858-10e1.....Underground Precast Utility Structures

D1785-06.....Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120

D2239-03.....Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter

D2464-06.....Threaded Poly (Vinyl Chloride) PVC Pipe Fittings, Schedule 80

D2466-06.....Poly (Vinyl Chloride) (PVC) Pipe Fittings, Schedule 40

D2467-06.....Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80

D2609-02(2008).....Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe

D3350-10a.....Polyethylene Plastics Pipe and Fittings Materials

F714-10.....Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter

F1267-07.....Metal, Expanded, Steel

E. American Water Works Association (AWWA):

B300-10.....Hypochlorites

B301-10.....Liquid Chlorine

C104-08.....Cement-Mortar Lining for Ductile Iron Pipe and Fittings

C105/A21.5-10.....Polyethylene Encasement for Ductile Iron Pipe Systems

C110-08.....Ductile Iron and Gray-Iron Fittings

C111/A21.11-07.....Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings

C115/A21.11-11.....Flanged Ductile Iron Pipe with Ductile Iron or Gray-Iron Threaded Flanges

C151/A21.51-09.....Ductile Iron Pipe, Centrifugally Cast

C153/A21.53-11.....Ductile Iron Compact Fittings for Water Service

C502-05.....Dry-Barrel Fire Hydrants

C503-05.....Wet-Barrel Fire Hydrants

C504-10.....Rubber-Seated Butterfly Valves

C508-09.....Swing-Check Valves for Waterworks Service, 2-In. Through 24-In. (50-mm Through 600-mm) NPS

C509-09.....Resilient-Seated Gate Valves for Water Supply Service

C510-07.....Double Check Valve Backflow Prevention Assembly

C511-07.....Reduced-Pressure Principle Backflow Prevention Assembly

C512-07.....Air Release, Air/Vacuum and Combination Air Valves

C550-05.....Protective Interior Coatings for Valves and Hydrants

C600-10.....Installation of Ductile Iron Mains and Their Appurtenances

C605-11.....Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water

C606-11.....Grooved and Shouldered Joints

C651-05.....Disinfecting Water Mains

C700-09.....Cold-Water Meters, “Displacement Type,” Bronze Main Case

C800-05.....Underground Service Line Valves and Fittings

C900-09.....Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Transmission and Distribution

C906-07.....Polyethylene (PE) Pressure Pipe and Fittings, 4 In. (100 mm) Through 64 In. (1,600 mm), for Water Distribution and Transmission

C907-04.....Injection-Molded PVC Pressure Fittings, 4 Inch through 12 Inch (100 mm through 300 mm), for Water Distribution

M23-2nd Ed.....PVC Pipe, Design and Installation

M44-2nd Ed.....Distribution Valves: Selection, Installation, Field Testing and Maintenance

F. National Fire Protection Association (NFPA):

NFPA 24-2010 Ed.....Installation of Private Fire Service Mains and Their Appurtenances

NFPA 1963-2009 Ed.....Fire Hose Connections

G. NSF International (NSF):

NSF/ANSI 14 (2013).....Plastics Piping System Components and Related Materials

NSF/ANSI 61-2012.....Drinking Water System Components - Health Effects

NSF/ANSI 372-2011.....Drinking Water System Components – Lead Content

H. American Welding Society (AWS):

A5.8/A5.8M-2004 .....Filler Metals for Brazing and Braze Welding

I. American Society of Safety Engineers (ASSE):

1003-2009 .....Water Pressure Reducing Valves

1015-2009.....Double Check Backflow Prevention Assemblies and Double Check Fire Protection Backflow Prevention Assemblies

1020-2004.....Pressure Vacuum Breaker Assembly

1047-2009.....Performance Requirements for Reduced Pressure Detector Fire Protection Backflow Prevention Assemblies

1048-2009.....Performance Requirements for Double Check Detector Fire Protection Backflow Prevention Assemblies

1060-2006.....Performance Requirements for Outdoor Enclosures for Fluid Conveying Components

J. Underwriters' Laboratories (UL):

246.....Hydrants for Fire-Protection Service

262.....Gate Valves for Fire-Protection Service

312.....Check Valves for Fire-Protection Service

405.....Fire Department Connection Devices

753.....Alarm Accessories for Automatic Water-Supply Control Valves for Fire Protection Service

789.....Indicator Posts for Fire-Protection Service

1091.....Butterfly Valves for Fire-Protection Service

1285.....Pipe and Couplings, Polyvinyl Chloride (PVC), and Oriented Polyvinyl Chloride (PVCO) for Underground Fire Service

1.9 WARRANTY

A. 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 two years from final acceptance. Further, the Contractor will furnish all manufacturers' and supplier's written guarantees and warranties covering materials and equipment furnished under this Contract.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Material or equipment containing lead shall not be, and shall be certified in accordance with NSF/ANSI 61 or NSF 372.

B. Plastic pipe, fittings, and solvent cement shall meet NSF/ANSI 14 and shall be NSF listed for the service intended.

2.2 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.

2.3 SAFETY GUARDS

A. All equipment shall have moving parts protected to prevent personal injury. Pump shafts and couplings shall be fully guarded by a sheet

steel guard, covering coupling and shaft but not bearings. Material shall be minimum 16-gauge sheet steel; ends shall be braked and drilled and attached to pump base with minimum of four 1/4 inch (6 mm) bolts. Reinforce guard as necessary to prevent side play forcing guard onto couplings.

2.1 LIFTING ATTACHMENTS

A. Equipment shall be provided with suitable lifting attachments to enable equipment to be lifted in its normal position. Lifting attachments shall withstand any handling conditions that might be encountered, without bending or distortion of shape, such as rapid lowering and braking of load.

2.2 PE PIPE AND FITTINGS

A. PE, ASTM Pipe: ASTM D2239, SIDR No. 5.3, 7, or 9; with PE compound number required to give pressure rating not less than 200 psi (1380 kPa).

1. Insert Fittings for PE Pipe: ASTM D2609, made of PA, PP, or PVC with serrated male insert ends matching inside of pipe. Include bands or crimp rings.
2. Molded PE Fittings: ASTM D3350, PE resin, socket- or butt-fusion type, made to match PE pipe dimensions and class.

B. PE, AWWA Pipe: AWWA C906, DR No. 7.3, 9, or 9.3; with PE compound number required to give pressure rating not less than 200 psi (1380 kPa).

1. PE, AWWA Fittings: AWWA C906, socket- or butt-fusion type, with DR number matching pipe and PE compound number required to give pressure rating not less than 200 psi (1380 kPa).

C. PE, Fire-Service Pipe: ASTM F714, AWWA C906, or equivalent for PE water pipe; FMG approved, with minimum thickness equivalent to FMG Class 150

1. Molded PE Fittings: ASTM D3350, PE resin, socket-or butt-fusion type, made to match PE pipe dimensions and class.

2.3 COPPER TUBE AND FITTINGS

A. Soft Copper Tubing: ASTM B88, Type K water tube, annealed temper.

B. Hard Copper Tubing: ASTM B88, Type K water tube, drawn temper.

C. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper alloy, solder joint pressure fittings.

D. Brazing Alloy: AWS A5.8/A5.8M, Classification BCuP.

E. Bronze Flanges: ASME B16.24, Class 150, with solder joint ends.

F. Copper Unions: ANSI MSS SP-123, cast copper alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.

2.4 VALVES

A. Gate Valves: AWWA C509, Non-rising Stem, Resilient Seat, 200 psi (1380 kPa).

1. Valves 3 inches (75 mm) and larger: Resilient seat valve with gray- or ductile iron body and bonnet; cast iron or bronze double-disc gate; bronze gate rings; non-rising bronze stem and stem nut.
2. Interior and exterior coating: AWWA C550, thermo-setting or fusion epoxy.
3. Underground valve nut: Furnish valves with 2 inch (50 mm) nut for socket wrench operation.
4. Aboveground and pit operation: Furnish valves with hand wheels.
5. End connections shall match main line pip.

B. Gate Valve Accessories and Specialties

1. Tapping-Sleeve Assembly: ANSI MSS SP-60; sleeve and valve to be compatible with the drilling matching.
   a. Tapping Sleeve: Stainless-Steel, two-piece bolted sleeve. Sleeve to match the size and type of pipe material being tapped.
   b. Valve shall include one raised face flange mating tapping-sleeve flange.
2. Valve Boxes: AWWA M44 with top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel.

C. Corporation Valves and Curb Valves

1. Service-Saddle Assemblies: AWWA C800.
   a. Service Saddle: Copper alloy with seal and threaded outlet for corporation valve.
   b. Corporation Valve: Bronze body and ground-key plug, with threaded inlet and outlet matching service piping material.
   c. Manifold: Copper fitting with two to four inlets as required, with ends matching corporation valves and outlet matching service piping material.
2. Curb Valves: AWWA C800, bronze body, ground-key plug or ball, wide tee head, with inlet and outlet matching service piping material, minimum pressure of 200 psi (1375 kPa).

3. Service Boxes for Curb Valves: AWWA M44, cast iron telescoping top section; plug shall include lettering "WATER"; bottom section with base that fits over curb valve.
4. Shutoff Rods: Steel, tee-handle with one pointed end. Stem length shall extend 2 feet (600 mm) above top of valve box for operation of deepest buried valve, with slotted end matching curb valve.

2.5 FIRE HYDRANTS

A. All hydrants shall have removable interiors capable of replacement without digging up the hydrant and be packable under pressure. Threaded joints or spindles shall be bronze and upper and lower barrels shall be of equal diameter. Upper barrel shall be of sufficient length to permit setting hydrant with barrel flange not more than 4 inches (100 mm) above finished grade. Pressure Rating: 250 psi (1725 kPa). Hydrant valve shall open by turning operating nut to left or counterclockwise. Exterior finish shall be red alkyd-gloss enamel paint, unless otherwise indicated. Outlet threads shall meet NFPA 1963, with external hose thread used by local fire department. Include cast iron caps with steel chains and Pentagon, 1-1/2 inch (38 mm) point to flat operating and cap nuts.

1. Dry-Barrel Fire Hydrants: AWWA C502, freestanding, one NPS 4-1/2 (DN 115) and two NPS 2-1/2 (DN 65) outlets, 5-1/4 inch (133 mm) main valve, drain valve, and NPS 6 (DN 150) mechanical-joint inlet; interior coating according to AWWA C550; cast iron body, compression-type valve opening against pressure and closing.

Alarm Devices

B. Alarm Devices-General: UL 753 and FMG approved, of types and sizes to mate and match piping and equipment.

C. Water-Flow Indicators: Vane-type water-flow detector, rated for 250-psi (1725-kPa) working pressure; designed for horizontal or vertical installation; 2 single-pole, double-throw circuit switches to provide isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal when cover is removed.

D. Supervisory Switches: Single pole, double throw; designed to signal valve in other than fully open position.

E. Pressure Switches: Single pole, double throw; designed to signal increase in pressure.

2.6 DISINFECTION CHLORINE

A. Liquid chlorine: AWWA B301.

B. Sodium Hypochlorite: AWWA B300 with 5 percent to 15 percent available chlorine.

C. Calcium hypochlorite: AWWA B300 supplied in granular form of 5 g. tablets, and shall contain 65 percent chlorine by weight.

D. Do not open to domestic water supply until COR receives passing test reports provided by contractors for piping system contaminants.

2.7 WARNING TAPE

A. Warning tape shall be standard, 4 mil. Polyethylene, 3 inch (76 mm) wide tape, detectable type, blue with black letters and imprinted with "CAUTION BURIED WATER LINE BELOW".

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Use pipe, fittings, and joining methods for piping systems according to the following applications.

1. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.
2. Do not use flanges or unions for underground piping.
3. Flanges, unions, grooved-end-pipe couplings, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.

B. Underground water-service piping NPS 3/4 to NPS 3 (DN 20 to DN 80) shall be any of the following:

1. Soft copper tube with copper, pressure-seal fittings; and pressure-sealed joints.
2. PE, ASTM pipe; fittings for PE pipe; and clamped joints.
3. PVC, Schedule 40 pipe, socket fittings; and solvent-cemented joints.

C. Underground water-service piping NPS 4 to NPS 8 (DN 100 to DN 200) shall be any of the following:

1. Soft copper tube with wrought-copper, solder-joint fittings; and brazed joints.
2. Ductile iron, mechanical-joint pipe; ductile iron, mechanical-joint fittings; and mechanical joints.
3. PE, AWWA pipe; PE, AWWA fittings; and heat-fusion joints.
4. PVC, Schedule 40 pipe; socket fittings; and solvent-cemented joints.

5. PVC, AWWA Class 150 pipe for NPS 4 and NPS 6 (DN 100 and DN 150): NPS 6 (DN 150) PVC, AWWA Class 150 pipe; PVC, AWWA Class 150 fabricated fittings; and gasketed joints.
6. PVC, AWWA Class 200 pipe for NPS 8 (DN 200): PVC, AWWA Class 200 fabricated mechanical-joint, ductile iron fittings; and gasketed joints.

D. Underground Fire-Service-Main Piping NPS 4 to NPS 12 (DN 100 to DN 300) shall be any of the following:

1. Ductile iron, push-on-joint pipe; ductile iron, push-on-joint fittings; and gasketed mechanical-joint pipe; ductile iron, mechanical-joint fittings; and mechanical grooved-end pipe; ductile iron-pipe appurtenances; and grooved joints.
2. PE, Class 150 fire-service pipe; molded PE fittings; and heat-fusion joints.
3. PVC, AWWA Class 150 pipe listed for fire-protection service; PVC Class 150 fabricated or molded fittings; and gasketed joints.
4. Ductile iron, push-on-joint pipe; Ductile Iron, push-on-joint fittings; and gasketed mechanical-joint pipe; Ductile Iron, mechanical-joint fittings; and mechanical grooved-end pipe; Ductile Iron-pipe appurtenances; and grooved joints.
5. PVC, AWWA Class 150 pipe listed for fire-protection service; PVC fabricated or molded fittings of same Class as pipe; and gasketed joints.

3.2 VALVE APPLICATIONS

A. Use mechanical-joint-end valves for NPS 3 (DN 80) and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use corporation valves and curb valves with ends compatible with piping, for NPS 2 (DN 50) and smaller installation.

B. Where specific valve types are not indicated, the following requirements apply:

1. Underground Valves, NPS 3 (DN 80) and Larger: AWWA, cast iron, non-rising-stem, metal -seated gate valves with valve box.
2. Use the following for valves in vaults and aboveground:
   a. Gate Valves, NPS 2 (DN 50) and Smaller: Bronze, rising stem.
   b. Gate Valves, NPS 3 (DN 80) and Larger: cast iron, OS&Y rising stem, resilient seated UL/FMG, cast iron, OS&Y rising stem .
   c. Check Valves: AWWA C508 swing type.

3.3 DUCTILE IRON PIPE

A. Not used.

3.4 PVC PIPE

A. PVC piping shall be installed in strict accordance with the manufacturer's instructions and AWWA C605. Place selected material and thoroughly compacted to one foot above the top of the pipe.

B. Install Copper Tracer Wire, No. 14 AWG solid, single conductor, insulated. Install in the trench with piping to allow 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 per ASTM 828. Solder joints shall be wrapped with rubber tape and electrical tape. At least every 1000 feet (300 m) provide a 5 pound (2.3 kg) 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 also 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 location. Generally, install markers on 20 foot (6 m) centers. If pipe is in a congested piping area, install on 10 foot (3 m) centers. Prepare as-built drawing indicating exact location of magnetic markers.

3.5 ANCHORAGE INSTALLATION

A. Install water-distribution piping with restrained joints. .

B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:

1. Gasketed-Joint, Ductile Iron, Water-Service Piping: According to AWWA C600.
2. Gasketed-Joint, PVC Water-Service Piping: According to AWWA M23.
3. Fire-Service-Main Piping: According to NFPA 24.

C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.6 VALVE INSTALLATION

A. AWWA Valves: Install each underground valve with stem pointing up and with valve box.

B. UL/FMG, Valves: Install each underground valve and valves in vaults with stem pointing up.

C. MSS Valves: Install as component of connected piping system.

D. Corporation Valves and Curb Valves: Install each underground curb valve with head pointed up and with service box.

E. Raise or lower existing valve and curb stop boxes and fire hydrants to finish grade in areas being graded.

3.7 FLUSHING HYDRANT INSTALLATION

A. Install post-type flushing hydrants with valve below frost line and provide for drainage. Support in upright position. Include separate gate valve or curb valve and restrained joints in supply piping.

B. Install ground-type flushing hydrants with valve below frost line and provide for drainage. Install hydrant box flush with grade. Include separate gate valve or curb valve and restrained joints in supply piping.

C. Install sampling stations with valve below frost line and provide for drainage. Attach weather-resistant housing and support in upright position. Include separate curb valve in supply piping.

3.8 FIRE HYDRANT INSTALLATION

A. Install each fire hydrant with separate gate valve in supply pipe, anchor with restrained joints or thrust blocks, and support in upright position.

B. Install Wet-Barrel Fire Hydrants with valve below frost line. Provide for drainage.

3.9 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties. Install water service lines to a point of connection within approximately 5 feet (1500 mm) outside of building(s) to which service is to be connected and make connections thereto. If building services have not been installed provide temporary caps and mark for future connection.

B. COR shall witness all testing.

3.10 FIELD QUALITY CONTROL

A. Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.

B. 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.

C. Perform hydrostatic tests at not less than one-and-one-half times working pressure for two hours.

1. Increase pressure in 50-psi (350-kPa) increments and inspect each joint between increments. Hold at test pressure for 1 hour; decrease to 0 psi (0 kPa). Slowly increase again to test pressure and hold for 1 more hour. Maximum allowable leakage is 2 quarts (1.89 L) per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.

D. Prepare reports of testing activities.

E. Turn over all testing reports to the COR.

3.11 IDENTIFICATION

A. Install continuous underground warning tape 12 inches (300 mm) directly over piping.

3.12 CLEANING

A. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.

B. Use purging and disinfecting procedure prescribed by local utility provider or other authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:

1. Fill the water system with a water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours.
2. Drain the system of the previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow system to stand for 3 hours.
3. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
4. Submit water samples in sterile bottles to testing agent. Repeat procedure if biological examination shows evidence of contamination. Provide test results to COR.

C. Prepare reports of purging and disinfecting activities to COR.

D. Do not open up piping to mains until COR has test reports including pipe/water passed tests.

--- E N D ---

SECTION 33 30 00

SANITARY SEWER UTILITIES

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies materials and procedures for construction of outside, underground sanitary sewer 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, EARTHWORK.

B. General plumbing, protection of Materials and Equipment, and quality assurance: Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

C. Fabrication of Steel Ladders: Section 05 50 00, METAL FABRICATION.

D. 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 ABBREVIATIONS

A. PVC: Polyvinyl chloride plastic

B. DI: Ductile iron pipe

1.4 DELIVERY, STORAGE AND HANDLING

A. Store plastic piping protected from direct sunlight and support to prevent sagging and bending. Protect stored piping from moisture and dirt by elevating above grade. Protect flanges, fittings, and specialties from moisture and dirt.

B. Handle manholes according to manufacturer's written rigging instructions.

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.

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.

1.6 SUBMITTALS:

A. Manufacturers' Literature and Data shall be submitted for the following as one package:

1. Pipe, Fittings, and, Appurtenances.
2. Jointing Material.
3. Manhole and Structure Material.
4. Frames and Covers.
5. Steps and Ladders.

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):

A74-09.....Cast Iron Soil Pipe and Fittings

A185/A185M-07.....Steel Welded Wire Reinforcement, Plain, for Concrete

A615/A615M-09b.....Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

A746-99.....Ductile-Iron Gravity Sewer Pipe

C478-09.....Precast Reinforced Concrete Manhole Sections

C857-11.....Minimum Structural Design Loading for Underground Precast Concrete Utility Structures

C890-11.....Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater 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

C1173-10.....Flexible Transition Couplings for Underground Piping Systems

C1440-08.....Thermoplastic Elastomeric (TPE) Gasket Materials for Drain, Waste and Vent (DWV), Sewer, Sanitary and Storm Plumbing Systems

C1460-08.....Shielded Transition Couplings for Use With Dissimilar DWV Pipe and Fittings Above Ground

C1461-08.....Mechanical Couplings Using Thermoplastic Elastomeric (TPE) Gaskets for Joining Drain, Waste and Vent (DWV), Sewer, Sanitary and Storm Plumbing systems for Above and below Ground Use

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

F477-10.....Elastomeric Seals (Gaskets) for Joining Plastic Pipe

F679-08.....Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings

F891-10.....Coextruded Poly(vinyl Chloride) (PVC) Plastic Pipe With a Cellular Core

F949-10.....Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe With a Smooth Interior and Fittings

F1417-11.....Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air

F1668-08.....Construction Procedures for Buried Plastic Pipe

C. American Water Works Association (AWWA):

C105/A21.5-10.....Polyethylene Encasement for Ductile-Iron Pipe Systems

C110-08.....Ductile-Iron and Gray-Iron Fittings

C111/A21.11-06.....Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings

C151/A21.51-09.....Ductile Iron Pipe, Centrifugally Cast

C153/A21.53-06.....Ductile Iron Compact Fittings for Water Service

C219-11.....Bolted, Sleeve-Type Couplings for Plain-End Pipe

C512-07.....Air Release, Air/Vacuum and Combination Air Valves for Water Works Service

C600-10.....Installation of Ductile-Iron Mains and Their Appurtenances

C900-07.....Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Transmission and Distribution

D. American Society of Mechanical Engineers:

A112.14.1–2003.....Backwater Valves

A112.36.2M-1991.....Cleanouts

1.8 WARRANTY

A. 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 provide all manufacturers’ 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. 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, GRAVITY SEWER PIPE AND FITTINGS

A. PVC Gravity Sewer Piping:

1. Pipe and Fittings shall conform to ASTM D3034..
2. Gaskets: ASTM F477.

B. PVC Type PSM Sewer Piping:

1. Pipe shall conform to ASTM D3034 or ASTM F679 SDR 35.
2. Fittings: ASTM D3034.
3. Gaskets: ASTM F477.

2.3 PVC, PRESSURE PIPE AND FITTINGS

A. PVC:

1. Pipe: AWWA C900, Class 150 and Class 20 PVC pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: AWWA C900, Class 150 and Class 200.
3. Gaskets: ASTM F477.

2.4 NONPRESSURE-TYPE TRANSITION COUPLINGS

A. Comply with ASTM C1173, elastomeric, sleeve type, reducing or transition coupling, for joining underground nonpressure piping. Include ends to match same sizes of main line piping and install corrosion-resistant metal tension bands and tightening mechanism on each end.

B. Sleeve Materials:

1. For Plastic Pipes: ASTM F477, elastomeric seal.
2. For Dissimilar Pipes: PVC or other material compatible with pipe materials being joined.

2.5 CLEANOUTS

A. Cast-Iron Cleanouts:

1. Cleanouts shall be as per ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
2. Top-Loading Classification(s): Valve loadings shall be designed for Heavy Duty

B. PVC Cleanouts:

1. PVC body with PVC threaded plug: Cleanout shall be as per ASTM D3034. PVC sewer pipe fitting and riser to cleanout.
2. Cleanout Riser: Sewer pipe fitting on main line sewer and riser shall match main line piping.

2.6 MANHOLES

A. Standard precast concrete manholes and vaults shall be constructed of precast concrete segmental blocks, precast reinforced concrete rings, precast reinforced sections or cast-in-place concrete.
   1. Precast Concrete Manholes: Material shall be as per ASTM C478, precast, reinforced concrete, of depth indicated, with sealed joints.
   2. Concrete Base: Concrete for base of manhole shall have a minimum compressive strength of 5000 psi (35 MPa) at 28 days. Thickness to be 8 inches (200 mm), minimum.
   3. Riser Section: 4 inch (100 mm) minimum thickness, of lengths to provide the total depth of manhole.
   4. Top Section: Eccentric-cone type unless otherwise indicated. Top section to match adjustment ring configurations.
   5. Joint Sealant: ASTM C990.
   6. Resilient Pipe Connectors: ASTM C923.
   7. Steps: If over 60 inches (1500 mm) in depth, individual FRP steps or ladder ASTM A615 deformed, 1/2 inch (13 mm) steel reinforcing rods encased in precast concrete with 16 inch (400 mm) minimum width, 12 inches (300 to 400 mm) center-to-center from top to bottom.
   8. Adjusting Rings: Reinforced-concrete rings; 6 to 9 inch (150 to 225 mm) total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.

B. Designed Concrete Manholes:
   1. Description: ASTM C913; designed according to ASTM C890 for 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, bitumen or butyl rubber.
   4. Resilient Pipe Connectors: ASTM C923, cast or fitted into manhole walls, for each pipe connection.
   5. Steps: If over 60 inches (1500 mm) in depth, individual FRP steps or FRP ladder width 16 inches (400 mm) minimum, 12 to 16 inches (300 to 400 mm) center-to-center from top to bottom.
   6. Adjusting Rings: Reinforced-concrete rings; 6 to 9 inch (150 to 225 mm) total thickness, with diameter matching manhole frame and cover,

and with height as required to adjust manhole frame and cover to indicated elevation and slope.

7. Manhole covers should be ¼" to ½" below new asphalt or concrete so plows don't hit them in the winter.

C. Manhole Base Channels: Manhole channels shall be main line pipe material. Lay main pipe through manhole and cut top of pipe out to be three-fourths of pipe diameter. Slope through manhole to match run slopes of the main pipe.

2.7 CONCRETE

A. Cast-in-place concrete shall be 4000 psi (27.6 MPa) minimum, with 0.45 maximum water/cementitious materials ratio.

B. Reinforcement

1. Reinforcing fabric shall be ASTM A185, steel, welded wire fabric, plain.
2. Reinforcing bars shall be ASTM A615, Grade 60 (420 MPa) deformed steel.

C. Benches shall be concrete, sloped to drain into the channel. Provide 6 inches (150 mm) from the cut section of top of pipe to edge of manhole.

D. Ballast and Pipe Supports shall be Portland cement design mix, 3000 psi (20.7 MPa) minimum, with 0.58 maximum water/cementitious materials ratio.

2.8 WARNING TAPE

A. Warning tape shall be standard, 4 mil (0.1 mm) polyethylene 3 inch (76 mm) wide tape detectable type, green with black letters and imprinted with "CAUTION BURIED SEWER LINE BELOW".

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Drawing plans and details indicate the general location and arrangement of underground sanitary sewer piping. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at the low point, true to grades and alignment indicated on the drawings, 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 using lubricants, cements, and other installation requirements.

C. Do not lay pipe on unstable material, in wet trench or when trench and weather conditions are unsuitable for the work.

D. Support pipe on compacted bedding material. Excavate bell holes only large enough to properly make the joint.
E. 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.
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 walk on pipe in trenches until covered by layers of bedding or backfill material to a depth of 12 inches (300 mm) over the crown of the pipe.
H. Warning tape shall be continuously placed 12 inches (300 mm) above sewer pipe
I. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
J. 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.
K. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process or microtunneling.
L. Install gravity-flow, non-pressure, drainage piping according to the following:
    1. Install piping pitched down in direction of flow, at minimum slope of 1 percent unless otherwise indicated.
    2. Install piping with 36 inch (915 mm) minimum cover as shown on Drawings.
    3. Install ductile iron, gravity sewer piping according to AWWA C600.
    4. Install PVC corrugated sewer, PSM sewer and PVC gravity sewer according to ASTM D2321 and ASTM F1668.
M. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.2 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, non-pressure, drainage piping according to the following:

1. Join ductile iron, gravity sewer piping according to AWWA C600 for push-on joints.
2. Join PVC piping according to ASTM D2321.
3. Join dissimilar pipe materials with nonpressure-type, flexible or rigid couplings.

B. 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 non-pressure flexible couplings where required to join gravity-flow, non-pressure sewer piping unless otherwise indicated.
a. Flexible or Rigid couplings for pipes of same or slightly different OD.
b. Unshielded, increaser/reducer-pattern, flexible or rigid 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.

3.3 SEWER AND MANHOLE SUPPORTS, CONCRETE CRADLES WITHIN VAULTS

A. Install reinforced concrete as detailed on the drawings. The concrete shall not restrict access for future maintenance of the joints within the piping system.

3.4 BUILDING SERVICE LINES

A. Install sanitary sewer service lines to point of connection within approximately 5 feet (1500 mm) outside of building(s) where service is required and make connections. Coordinate the invert and location of the service line with the Contractor installing the building lines.

3.5 MANHOLE INSTALLATION

A. Install manholes complete with appurtenances and accessories indicated.
1. Precast concrete segmental blocks shall lay true and plumb. All horizontal and vertical joints shall be completely filled with mortar. Parge interior and exterior of structure with 1/2 inch (15 mm) or cement mortar applied with a trowel and finished to an even glazed surface.
2. 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 as per manufacturer’s recommendations. Adjust the length of the rings so that the top section will be at the required elevation. Cutting the top section is not acceptable.

3. Concrete manhole risers and tops: Install as specified.

B. Designed Concrete Structures:

1. Concrete structures shall be installed in accordance with Section 03 30 00, CAST-IN-PLACE CONCRETE.

C. Do not build structures when air temperature is 32 deg F (0 deg C), or below.

D. The wall that supports access rungs or ladder shall be 90 deg vertical from the floor of structure to manhole cover.

E. 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.

F. Set tops of frames and covers ¼" to ½" below finished surface of pavements. In unpaved areas, the rim elevation shall be 2 inches (50 mm) above the adjacent finish grade.

G. Install manhole frames and covers on a mortar bed, such that 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. Install an 8 inches (200 mm) thick, by 12 inches (300 mm) wide concrete collar around the perimeter of the frame. Slope the top of the collar away from the frame.

3.6 CONNECTIONS

A. Make connections to existing piping and underground manholes by coring and installing the pipe at the design invert. Install an elastomeric gasket around the pipe, and grout the interstitial space between the pipe and the core.

B. Connection to an existing manhole: The bench of the manhole shall be cleaned and reshaped to provide a smooth flowline for all new pipes connected to the manhole.

C. Use commercially manufactured wye fittings for piping branch connections. Encase entire wye 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).

1. Make branch connections from the side into existing piping, NPS 4 to NPS 20 (DN 100 to DN 500), by removing a section of the existing pipe.

2. Make branch connections from the side into existing piping, NPS 21 (DN 525) or larger, or to underground manholes by cutting an opening into existing unit 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 or manhole wall, encase entering connection in concrete to provide additional support of collar from connection to undisturbed ground.

3. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

3.7 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.

3.8 PIPE SEPARATION

A. Horizontal Separation - Water Mains and Sewers:

1. Existing and proposed water mains shall be at least 10 feet (3 m) 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 10 feet (3 m) but not closer than 6 feet (1.8 m) to a water main when:

   a. Local conditions prevent a lateral separation of 10 feet (3 m); and

   b. The water main invert is at least 18 inches (450 mm) above the crown of the gravity sewer or 24 inches (600 mm) above the crown of the pressure (force) main; and 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.

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 24 inches (600 mm) above the crown of gravity flow sewer or 48 inches (1200 mm) above the crown of pressure (force) mains. The vertical separation shall be maintained within 10 feet (3 m) horizontally of the sewer and water crossing. When these vertical separations are met, no additional protection is required.
2. In no case shall pressure (force) sanitary main cross above, or within 24 inches (600 mm) of water lines.
3. When it is impossible to meet (1) above, the gravity flow sewer may be installed 18 inches (450 mm) above or 12 inches (300 mm) below the water main, provided that both the water main and sewer shall be constructed of push-on or mechanical ductile pipe. Pressure (Force) sewers may be installed 24 inches (600 mm) below the water line provided both the water line and sewer line are constructed of ductile iron pipe.
4. 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 10 feet (3 m).

3.9 IDENTIFICATION

A. Install green warning tape directly over piping and at outside edges of underground manholes.

3.10 FIELD QUALITY CONTROL

A. All systems shall be inspected and obtain the COR’s approval. 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.

B. To inspect, thoroughly flush out the lines and manholes before inspection. Lamp test between structures and show full bore indicating sewer is true to line and grade. Lips at joints on the inside of gravity sewer lines are not acceptable.

1. Submit separate report for each system inspection.
2. Defects requiring correction include the following:

a. Alignment: Less than full diameter of inside of pipe is visible between structures.
b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
d. Infiltration: Water leakage into piping.
e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Re-inspect and repeat procedure until results are satisfactory.

C. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:

1. Test plastic gravity sewer piping according to ASTM F1417.
2. 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 4 psi (28 kPa) and allowed to stabilize. After pressure stabilization, the pressure shall be dropped to 3.5 psi (24 kPa) greater than the average back-pressure of any groundwater above the sewer.

3.11 CLEANING

A. Clean dirt and superfluous material from interior of piping.

--- E N D ---

SECTION 33 40 00

STORM SEWER UTILITIES

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies materials and procedures for construction of outside, underground storm sewer 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, EARTHWORK.

B. Concrete Work, Reinforcing, Placement and Finishing: Section 03 30 00, CAST-IN-PLACE CONCRETE.

C. General plumbing, protection of Materials and Equipment, and quality assurance: Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

D. Fabrication of Steel Ladders: Section 05 50 00, METAL FABRICATIONS.

E. Materials and Testing Report Submittals: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.

F. Erosion and Sediment Control: Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS.

1.3 ABBREVIATIONS

A. HDPE: High-density polyethylene

B. PE: Polyethylene

1.4 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic manholes, pipe, and fittings in direct sunlight.

B. Handle manholes stormwater inlet/ according to manufacturer's written rigging instructions.

1.5 COORDINATION

A. Coordinate exterior utility lines and connections to building services up to the actual extent of building wall.

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.

1.7 SUBMITTALS

A. Manufacturers' Literature and Data shall be submitted, as one package, for pipes, fittings and appurtenances, including jointing materials, hydrants, valves and other miscellaneous items.

1.8 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

A242/A242M-04(2009).....High-Strength Low-Alloy Structural Steel

A536-84(2009).....Ductile Iron Castings

A615/A615M-09b.....Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

A760/A760M-10.....Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains

A798/A798M-07.....Installing Factory-Made Corrugated Steel Pipe for Sewers and Other Applications

A849-10.....Post-Applied Coatings, Paving, and Linings for Corrugated Steel Sewer and Drainage Pipe

A929/A929M-01(2007).....Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe

B745/B745M-97(2005).....Corrugated Aluminum Pipe for Sewers and Drains

B788/B788M-09.....Installing Factory-Made Corrugated Aluminum Culverts and Storm Sewer Pipe

C14-07.....Non-reinforced Concrete Sewer, Storm Drain, and Culvert Pipe

C33/C33M-08.....Concrete Aggregates

C76-11.....Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe

C139-10.....Concrete Masonry Units for Construction of Catch Basins and Manholes

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/ft3 (600 kN-m/m3))

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

D3753-05e1.....Glass-Fiber-Reinforced Polyester Manholes and Wetwells

D4101-11.....Polypropylene Injection and Extrusion 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

F714-10.....Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter

F794-03(2009).....Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter

F891-10.....Coextruded Poly(Vinyl Chloride) (PVC) Plastic Pipe With a Cellular Core

F894-07.....Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe

F949-10.....Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe With a Smooth Interior and Fittings

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

M252-09.....Corrugated Polyethylene Drainage Pipe

M294-10.....Corrugated Polyethylene Pipe, 12 to 60 In. (300 to 1500 mm) Diameter

D. American Water Works Association(AWWA):

C105/A21.5-10.....Polyethylene Encasement for Ductile iron Pipe Systems

C110-08.....Ductile-Iron and Gray-Iron Fittings

C219-11.....Bolted, Sleeve-Type Couplings for Plain-End Pipe

C600-10.....Installation of Ductile iron Mains and Their Appurtenances

C900-07.....Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Transmission and Distribution

M23-2nd ed.....PVC Pipe ”Design And Installation”

E. American Society of Mechanical Engineers (ASME):

A112.6.3-2001.....Floor and Trench Drains

A112.14.1-2003.....Backwater Valves

A112.36.2M-1991.....Cleanouts

F. American Concrete Institute (ACI):

318-05.....Structural Commentary and Commentary

350/350M-06.....Environmental Engineering Concrete Structures and Commentary

G. National Stone, Sand and Gravel Association (NSSGA): Quarried Stone for Erosion and Sediment Control

1.9 WARRANTY

A. 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 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.

B. 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, PVC socket-type fittings.

C. PVC Corrugated Sewer Piping
1. Pipe: ASTM F949, PVC, corrugated pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: ASTM F949, PVC molded or fabricated, socket type.
3. Gaskets: ASTM F477, elastomeric seals.

D. PVC Profile Sewer Piping
1. Pipe: ASTM F794, PVC profile, gravity sewer pipe with bell-and-spigot ends.
2. Fittings: ASTM D3034, PVC with bell ends.
3. Gaskets: ASTM F477, elastomeric seals.

E. PVC Type PSM Sewer Piping
1. Pipe: ASTM D3034, SDR 35 PVC Type PSM sewer pipe with bell-and-spigot ends.
2. Fittings: ASTM D3034, PVC with bell ends.
3. Gaskets: ASTM F477, elastomeric seals.

F. PVC Gravity Sewer Piping
1. Pipe and fittings shall be ASTM F679, T-1 wall thickness, PVC gravity sewer pipe with bell-and-spigot ends.
2. Gaskets: ASTM F477, elastomeric seals for gasketed joints.

G. PVC Pressure Piping
1. Pipe: AWWA C900, Class 100, Class 150, and Class 200 PVC pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: AWWA C900, Class 100, Class 150, and Class 200 PVC pipe with bell ends
3. Gaskets: ASTM F477, elastomeric seals.

2.2 CONCRETE PIPE AND FITTINGS

A. Non-Reinforced-Concrete sewer pipe and fittings shall be ASTM C14, Class 1 with bell-and-spigot or tongue-and-groove ends and gasketed joints with ASTM C443, rubber gaskets sealant joints with ASTM C990, bitumen or butyl-rubber sealant.

B. Reinforced-Concrete sewer pipe and fittings shall be ASTM C76 or ASTM C655.
1. Bell-and-spigot or tongue-and-groove ends and gasketed joints with ASTM C443, rubber gaskets.

2. Class I: Wall A
3. Class II, Wall B
4. Class III: Wall A
5. Class IV: Wall A
6. Class V: Wall C

C. Reinforced arch culvert and storm drainpipe and fittings shall be ASTM C506, Class A-III and gasketed joints with ASTM C443, rubber gaskets.

D. Reinforced-Concrete elliptical culvert and storm drainpipe and fittings shall be ASTM C507, Class HE III and gasketed joints with ASTM C443, rubber gaskets.

2.3 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: Coupling shall be an elastomeric sleeve with stainless-steel shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

D. Shielded, flexible couplings shall be elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

E. Ring-Type, flexible couplings shall be elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

2.4 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.
5. Riser Sections: 4 inch (102 mm) minimum thickness, and lengths to provide depth indicated.
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). Individual FRP steps or FRP ladder, 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 , 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 A536, Grade 60-40-18 ductile iron unless otherwise indicated.

2.5 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.

C. Manhole Channels and Benches: Channels shall be the main line pipe material. Include benches in all manholes and catch basins.
   1. Channels: Main line pipe material or concrete invert. Height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope. Invert Slope: Same slope as the main line pipe. Bench to be concrete, sloped to drain into channel. Minimum of 6 inch slope from main line pipe to wall sides.

2.6 WARNING TAPE

A. Standard, 4-Mil polyethylene 3 inch (76 mm) wide tape detectable type, green with black letters, and imprinted with “CAUTION BURIED STORM DRAIN LINE 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. Plastic pipe bedding requirements shall meet the requirements of ASTM D2321. Bedding, haunching and initial backfill shall be either Class IB or Class II material. Corrugated metal pipe bedding requirements shall conform to ASTM A798.

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 36 inch (915 mm) 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 gravity-flow, nonpressure drainage piping according to the following:
   1. Install piping pitched down in direction of flow.
   2. 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 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 ½" below finished surface of adjacent finish grade (asphalt, concrete, grass). Set tops flush tofinished surface elsewhere unless otherwise indicated.
C. Circular Structures:
   1. Precast concrete segmental blocks shall lay true and plumb. All horizontal and vertical joints shall be completely filled with mortar. Parge interior and exterior of structure with 1/2 inch (15 mm) or cement mortar applied with a trowel and finished to an even glazed surface.
   2. 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.

3. Precast reinforced concrete manhole risers and tops. Install as specified for precast reinforced concrete rings.

D. Rectangular Structures:

1. Precast concrete structures shall be placed on a 8 inch (200 mm) reinforced concrete pad, or be provided with a precast concrete base section. Structures provided with a base section shall be set on an 8 inch (200 mm) thick aggregate base course compacted to a minimum of 95 percent of the maximum density as determined by ASTM D698. Set precast section true and plumb. Seal all joints with preform flexible gasket material.
2. Do not build structures when air temperature is 32 deg F (0 deg C), 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 to 12 or more than 1 to 6. Bottom slab and benches shall be concrete.
5. The wall that supports access rungs or ladder shall be 90 deg vertical from the floor of structure to manhole cover.
6. 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.
7. Install manhole frames and covers on a mortar bed, and ½" below 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 flush with (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.

3.6 CATCH BASIN INSTALLATION

A. Construct catch basins to sizes and shapes indicated.

B. Set frames and grates to elevations indicated.

3.7 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 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 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.

3.8 IDENTIFICATION

A. Install green warning tape directly over piping and at outside edge of underground structures.

3.9 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 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. Alignment: Less than full diameter of inside of pipe is visible between structures.
      b. Damage: Crushed, broken, cracked, or otherwise damaged piping.
      c. Infiltration: Water leakage into piping.
      d. 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.

3.10 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 COR having jurisdiction with at least 2 weeks 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. Testing of individual joints shall conform to ASTM C1103.
   6. Test force-main storm drainage piping. Perform hydrostatic test after thrust blocks, supports, and anchors have hardened. Test at pressure

not less than 1-1/2 times the maximum system operating pressure, but not less than 150 psi (1035 kPa)

a. Ductile iron Piping: Test according to AWWA C600, "Hydraulic Testing" Section.

b. PVC Piping: Test according to AWWA M23, "Testing and Maintenance" Chapter.

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.

3.11 CLEANING

A. Clean interior of piping of dirt and superfluous materials. Flush with potable water.

--- E N D ---

GEOTECHNICAL EXPLORATION and ENGINEERING REVIEW

VA Building 1 Expansion

Fargo, North Dakota

NTI Project 20.FGO 10880

Prepared For:

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December 3, 2020

FOURFRONT Design, Inc.
517 7th Street
Rapid City, SD 57701

Attn: Mr. Karl Parson, Project Manager

Subject: Geotechnical Exploration and Engineering Review
VA Building 1 Expansion
Fargo, North Dakota
NTI Project 20.FGO 10880

In accordance with your request and subsequent October 6, 2020 authorization, Northern Technologies, LLC (NTI) conducted a Geotechnical Exploration for the above referenced project. Our services included advancement of exploration borings, laboratory testing, and preparation of an engineering report with recommendations developed from our geotechnical services. We performed our work in general accordance with our proposal of July 31, 2020.

We will retain soil samples for 60 days after which we will discard the samples. Please advise us in writing if you wish to have us retain them for a longer period. You will be assessed an additional fee if soil samples are retained beyond 60 days.

We appreciate the opportunity to have been of service on this project. Please contact us at your convenience if there are any questions regarding the soils explored, or our review and recommendations.

Northern Technologies, LLC

Daniel Gibson

Dan Gibson, P.E.
Senior Engineer

Josh Holmes, P.E.
Engineer

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GEOTECHNICAL EXPLORATION AND ENGINEERING REVIEW

VA Building 1 Expansion

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1.0 EXECUTIVE SUMMARY

We briefly summarize below our geotechnical recommendations for the proposed project. You must read this summary in complete context with our report.

We conclude you may support the proposed VA Building 1 Expansion [Addition] using a deep foundation system bearing within the hard glacial till soils occurring at depth below project site. Major items of issue for your project include the following:

- Our original "scope of services" for project excluded assessment of stability for embankments / excavations. We direct you to other report discussion concerning independent assessment of stability under Contractor's "means and methods".

  The deeper excavations anticipated for project necessitate either widened excavations east and south of the Addition, the installation of earth retention system, or composite system employing both excavation and earth retention of site clays. We present discussion concerning such excavations and the alternative use of earth retention within other sections of this report.

- Our exploration indicates topsoil and fill (clay / sand) extend from approximately 6.2 to 15 feet below present ground surface. Concrete sidewalks are present on the eastern side of the addition. Included within this area is a number of existing and abandoned utilities. The fill represents prior backfill material for these utilities and the former chiller units.

- We did not encounter measurable groundwater during or after completion of drilling operations. However, we anticipate some groundwater seepage into excavations required for construction of basement level.

  The moisture content of lens soils and the host clays can vary annually and per recent precipitation. Such soils and other regional dependent conditions may produce groundwater entry of project excavations. We direct your attention to other report sections and appendices attachments concerning groundwater issues and subsurface drainage recommendations.

- The higher structural loads and integration of the Addition with existing structure necessitate use of deep foundations in support of construction. Deep foundations may include caisson drilled shaft, driven piles, auger cast piles, or helical piles. The first three items of this listing, while applicable for use, have detrimental or economic implications which, in our opinion, preclude their use for

support of the Addition. Please contact us if you would like further discussion on the excluded deep foundation systems.

We therefore recommend use of rotary advanced helical piles for support of the Addition. We provide within other report section discussion on their use and likely capacity. It is generally accepted that such foundation elements are independently designed by professional engineer retained by the Contractor or their sub-contractor, with such design then verified by project Structural Engineer of Record. We herein presume such independent design / build of deep foundations will be provided in support of Addition.

- Through material composition, clay soils have a tendency to swell with absorption of moisture. This is especially true for fat clays (CH) or silty fat clays (CH-MH) due to increased montmorillonite mineral content. The attachment presented within the appendices provides a brief description of the swell process of clay, and provides limited recommendation(s) for reducing this risk on your project. Note a major attribute contributing to swell of clays is absorption of moisture under reduced confinement. Continuous drainage of site excavations is necessary to reduce swelling impacts to your project.

2.0 INTRODUCTION

2.1 Site / Project Description

We understand the Addition will be constructed on the south side of the existing VA building 1 located at 2101 Elm Street North in Fargo, North Dakota. Table 1 lists proposed construction for the Addition.

Table 1: Project & Site Description

Item	Description
Building Type:	A multi level, heavy concrete and structural steel with deep basement addition to existing building. Plans are for basement (near existing grade) and one levels above with future construction of 4 additional floors.
Floor Elevations:	200.0 feet [NTI assigned elevation to receiving dock floor, Temporary Benchmark, referece boring diagram]. Estimated elevation of 893 per site topo plan provided. Estimated basement level to be 893 or near our TBM of 200 ft.
Maximum Change in Site Elevation:	2.7 feet of change in site grade occurs from north to south between soil borings.
Depth of Excavation at Site:	Estimated to be nominal 13 to 16 feet from present grade for construction of basement.
Below Grade Foundation Walls	Basement Level Construction.
Existing Land Use	Present facility includes heavy, multi level health care facility of heavy construction and surrounding parking and driveways.

Note: After completion of the soil borings it was decided to move the addition to the south side of Building 1. Additional borings may be warranted. We have included a site plan and soil borings from a previous expansion in this area for reference.

2.2 Scope of Services

The purpose of this report is to present a summary of our geotechnical exploration and provide generalized opinions and recommendations regarding the soil conditions and design parameters for founding of the project. Our "scope of services" was limited to the following:

1. Explore the project subsurface by means of four standard penetration borings extending from 26 to maximum depth of 111 feet, and conduct laboratory tests on representative samples to characterize the engineering and index properties of the soils.
2. Prepare a report presenting our findings from our field exploration, laboratory testing, and engineering recommendations for foundation depths, allowable bearing capacity, estimated settlements, floor slab support, excavation, engineered fill, backfill, compaction and potential construction difficulties related to excavation, backfilling and drainage.

Our current authorized "scope of services" did not include assessment of environmental issues, or analysis and discussion of stability for project.

3.0 EXPLORATION PROGRAM RESULTS

3.1 Exploration Scope

Site geotechnical drilling occurred on October 7, 8, & 9, 2020 with individual borings advanced at approximate locations as presented on the diagram within the appendices. NTI located the borings relative to existing site features, and determined the approximate elevation of the borings relative to the temporary benchmark (TBM); the the concrete floor at the receiving dock north of the proposed Addition (reference boring diagram). We assigned an elevation of 200 feet to the TBM.

3.2 Surface Conditions

The Addition property surface is currently green space and concrete sidewalk. The area south of Building 1 consists of parking lot and a small retaining wall. We understand prior development of the property where the borings were conducted consisted of chiller pads and existing or abandoned utilities. Surface drainage appears to flow towards the existing storm water system.

3.3 Subsurface Conditions

Please refer to the boring logs within the appendices for a detailed description and depths of stratum at each boring. The boreholes were backfilled with auger cuttings, or were abandoned using high solids bentonite or neat cement grout as per appropriate local and state statutes. Minor settlement of the boreholes will occur. Owner is responsible for final closure of the boreholes.

Based on results of the current geotechnical exploration, Table 2 provides a general depiction of subsurface conditions at the project site. We present additional comment on the evaluation of recovered soil samples within the report appendices.

Table 2: Typical Subsurface Stratigraphy at Project Site [Note 1]

Stratum	Elevation / Depth to Base of Stratum (ft)	Material Description	Relative Density / Consistency
Surface	193.2 to 195.9		
No. 1	189.4 to 178.2 / 6.2 to 15	Topsoil, Concrete, Fill, Existing Utilities	NA
No. 2	102 / 91.5 to 93	Fat Clay - Glacial Lake Agassiz	Rather Stiff to Soft
No. 3	Below 102 / -	Lean Clay, Silty Glaciated Sand - Glacial Till	Very Stiff and Very Dense

Note 1 Table summary is a generalization of subsurface conditions and may not reflect variation in subsurface strata occurring on site. The upper portion of each boring is approximate as such was sampled using flight auger.

3.4 Groundwater Conditions

The drill crew observed the borings for groundwater and noted cave-in depth of the borings, if any, during and at the completion of drilling activities. We did not encounter measurable groundwater during or after completion of drilling operations. However, we anticipate some groundwater seepage into excavations required for construction of basement level.

The moisture content of lens soils and the host clays can vary annually and per recent precipitation. Such soils and other regional dependent conditions may produce groundwater entry of project excavations. We direct your attention to other report sections and appendices attachments concerning groundwater issues and subsurface drainage recommendations.

3.5 Laboratory Test Program

We base our analysis and report recommendations upon our interpretation of the standard penetration resistance determined while sampling soils, hand penetrometer test results obtained during classification of retained soils, and experience with similar soils from other sites near the project. We summarize such results on appended boring logs or attached forms.

4.0 ENGINEERING REVIEW AND RECOMMENDATIONS

We base our report recommendation on our present knowledge of the project. We ask that you or your design team notify us immediately if you implement any significant changes to project size, location or design, as this notification would allow our review of current recommendations, and provide means for our issue of modified or different recommendations with respect to such change(s).

4.1 Project Scope

We understand the Addition will include concrete foundation walls and deep foundations for support of above grade construction. Table 3 presents our premise of foundations and basement level loads as loading and finished floor information has not been provided at the time of report issue.

Table 3: Presumed Foundation Loads / Change in Grade / Bearing Elevation

Building Element	***Load / Condition***
Basement Perimeter Strip Footings	10 kips / lf
Perimeter Column Footings (integral to basement strip footings)	500 kips
Basement Interior Column Footings	1000 to 1200 kips
Change in Overall Site Grade (from original ground)	On the order of 3 feet.
Basement Excavation	Estimated excavation of 0 to 6 feet for basement level.

4.2 Site Preparation

Project construction, as proposed, will involve stripping of the site and implementation of corrective grading. We recommend removal of all topsoil, concrete, fill, debris (from old utilities), and/or any unsuitable material(s) encountered during advancement of project excavations. Our field exploration indicates removal of topsoil, concrete, and fill should result in excavations extending from approximately 6.2 to 15 feet below existing grade. ***These depths likely no longer apply but you should be prepared to remove a significant amount of fill on the south side of Building 1. Additional borings may be warranted to determine fill depths.***

You must oversize all earthwork improvements and excavations that include placement of engineered fill below foundations. The minimum excavation oversize should extend per the requirements outlined on appended *Figure 1: Excavation Oversize*. Table 4 presents summary of excavation necessary for the removal of unsuitable materials [at respective borings]. Additional excavation will be necessary to achieve basement elevation in select areas.

Table 4: Summary of Project Excavation [Note 1]

Boring Number	***Existing Ground Elev.*** (NTI Datum feet)	***Depth*** (feet)	***Unsuitable Soil / Material***	***Est. Excavation Elevation*** (feet)
SB-1	193.2	15	4.5” Concrete over Fill	178.2
SB-2	194.7	6.5	Topsoil and Clay Fill	188.2
SB-3	194.7	6.2	Topsoil and Clay Fill	188.5
SB-4	195.9	6.5	Topsoil and Clay Fill	189.4

Note 1: Refer to report for excavation at, and within, the vicinity of the soil borings.

You must pump seepage from excavations continuously until the Geotechnical Engineer of Record or their designated representative determines such seepage no longer influences bearing soils, engineered fill system, backfill system or soils and concrete placement.

The Geotechnical Engineer of Record or their designated representative must review project excavations to verify removal of unsuitable material(s), and determine exposed soils provide adequate bearing support of proposed construction. All such observations must occur prior to the placement of engineered fill, or construction of footings and floor slabs.

Native soils and any fill placed for support of footings (if required) can weaken by construction operations. You should consider and, where necessary, place a lean concrete "mud slab" below footing and floor slab construction if site conditions become disturbed or supporting soils are excessively wet and/or compromised by site activities. This placement will reduce loss of foundation support and minimize future soil removal due to continued disturbance. We direct you to appendices attachment on discussion relative to "mud slab" construction.

While not mandatory, you should place geotextile separation fabric as part of corrective earthwork below footing and floor slab construction [especially at locations lacking the above lean concrete "mud slab"]. The Geotechnical Engineer of Record or their designated representative should determine need for geotextile placement after observation of completed excavations. We present within appendices attachment comment and recommendations for materials type and placement of geotextile.

Engineered fill for overall corrective earthwork and for support of project perimeter foundations should consist of native, non-organic clay. Engineered fill placed interior to and above the base of perimeter frost footings should consist of granular soils that comply with the material properties listed for granular fill placement below floor slab construction.

Unless otherwise directed specifically within this report, you should temper engineered fill for correct moisture content and then place and compact individual lifts of engineered fill to criteria as presented within the appendix.

4.3 Global Stability of Excavation / Earth Retention

NOTE OUR WORK RELATIVE TO THIS SECTION OF REPORT IS CONCEPTUAL ONLY AND INTENDED AS GUIDE TO YOUR / CONTRACTOR INDEPENDENT ASSESSMENT OF GLOBAL STABILITY / DESIGN OF EARTH RETENTION FOR PROJECT. ALL SUCH DISCUSSION DOES NOT CONSTITUTE OPINION AS TO SAFE STABILITY OF SYSTEM OR DESIGN OF EARTH RETENTION FOR PROJECT.

The deep basement of Addition will necessitate that you "lay back" the excavation face at a two horizontal to one vertical or flatter (2H: 1V or flatter) profile should you construct project without earth retention. This preliminary finding is based on premise silt / granular soils are not present within the exposed embankment nor is there seepage occurring from exposed embankment. Such finding is void if any of above limitation exist at location or if soil mass / construction materials / staging of equipment occurs within 30 feet of excavation crest.

Advancement of excavation to such lateral extent beyond exterior of periphery wall may be restricted by site limitations / property boundary. As such we recommend you consider use of a hybrid system of partial depth excavation and installation of sheet piling (with or without whale / strut) as means of retaining the excavation as needed. *All such analysis and design of earth retention system must be based on means and methods of Contractor, who is responsible for design of system via professional engineer retained under their sole directive.*

4.4 Lateral Earth Pressure

Foundation walls for basement area or other areas of unbalanced earthen fill will experience lateral loading from retained soils. You may model this lateral loading as an equivalent earth pressure applied to the foundation wall providing site geometric and related conditions complies with the parameters supporting such modeling. We recommend use of the Table 5 at-rest "equivalent fluid earth pressures" for establishing lateral loading of basement foundations walls with unbalanced earthen fill.

Table 5: Retained Soil - Equivalent Fluid Weight / Coefficient of Friction

		Equivalent Fluid Unit Weight of Retained Soil [1]		
Soil Type	***Friction Factor for Sliding Resistance*** [2]	***"At Rest" Condition*** (pcf)	***"Active" Condition*** (pcf)	***"Passive Condition*** (pcf)
Engineered Fat Clay Fill	0.30	95	75	145
Engineered Sand Fill	0.50	65	45	250
Native Fat Clay	0.25	100	90	130

1 The "equivalent fluid weight" recommendation based solely on premise of sloping ground and/or surcharge loads. We caution design professional that actual loads imparted to the structure will be dependent on soil conditions, site geometric considerations, and surcharge loads imparted to the structure.

2 The determination of resistance to sliding determined based on multiplication of the respective coefficient of friction by the effective vertical stress occurring at the elevation of interest.

4.5 Deep Foundations

Site conditions and heavy loads from project necessitate support of project using a deep foundation system. We base our report bearing recommendations for the design of deep foundations that will bear within competent glacial till per report discussion. You must notify us of any changes made to the project size, location, design, or site grades so we can assess how such changes influences our recommendations. It is our premise foundation elements will impose maximum vertical loads as listed within Table 3.

We previously noted multiple options available for foundation support of Addition. The relatively small footprint of the Addition and cost of mobilization of type specific equipment for the installation of drilled caissons, driven piles, and auger cast piles would, in our opinion result in unfavorable pricing. Other adverse issues associated with these deep foundations include:

- Caisson construction would require extensive soil removal and mobilization of specialty drilling equipment not as readily available. We have also noticed these foundations are not as economical as other deep foundation options.

- Driven piles will produce significant noise during installation while also producing ground movement (seismic wave) within site soils. Such impacts would be a nuisance to VA patients and personnel, as well as possible damage to the existing building.
- The installation of auger cast foundations at location necessitate retention of contractor from significant distance from project. We believe the mobilization cost alone limits use of this system. Additionally, small, non-cased auger cast foundation have a high risk of "necking" of the GLA soils / collapse of bore opening during drilling operations, or during placement of cementitious grout.

The above discussion presents our reasoning for limiting foundation support to rotary advanced helical piles in support of the Addition. Benefits from this installation include, minimal adverse installation noise and no ground vibration, and local available contractors with extensive experience in installation of foundation type. The following subsection provides additional discussion and general estimate of foundation type.

4.5.1 Helical Pile Foundations

Rotary advanced helical piles, like driven piles, provide foundation support via deeply installed members. However, helical piles derive their bearing support via end bearing of the helix flights within competent soils while driven piles relying primarily on adhesive skin resistance to derive capacity. It is for this reason we do not assign significant reduction in ultimate bearing capacity of helical piles [helix flights to bear within glacial till, no bearing resistance of GLA clays included in assessing adhesive skin resistance of helical pile shaft].

The design of helical piles for this project must include allowance for presence of cobbles / boulders present within the glaciated alluvium stratum at depth. We recommend that helical piles increase the pitch ratio of helix flights and provide further spacing of helix flights, and increase the section of helix flights to address presence of cobbles / boulders.

Design of conventional helical piles is governed by AC 358 - "Acceptance Criteria for Helical Pile Systems and Devices". Note such document covers helical methods of analysis and acceptance criteria for helical pile shafts of up to 4 1/2 inch outside diameter (OD) [nominal 16-inch OD maximum helix flight]. Over the last 10 plus years, the helical pile industry has expanded the capacity of helical piles with shaft size and helix flight increasing to nominal 13 3/4 inch OD shaft with helix flights of up to 48-inch OD. The theoretical capacity of these heavy systems approach or exceed 350 kips design capacity.

While not specific to large helical pile systems, we recommend design of helical pile support for the Addition be based on similar analysis as defined per AC 358, as herein amended to address use of helical piles in excess of 4 1/2" OD. Sizing of helix flights of heavy helical pile may be based on the ultimate soil shear strengths listed within Table 6.

Conceptually, large helical piles installed with bearing within the pre-till or glacial till soils are capable of 150 to 350 kips design capacity per member. Helix plates along shaft of lead section should be spaced at a minimum of three and one half to four times the diameter of smaller plate member. Normal practice is to provide a spacing factor equal to or greater than three times the diameter of the largest helix bearing plate as lateral separation of helical piles [for bearing support].

However, the extreme strength of the glacial till soils at this location would, in our opinion, allow this lateral spacing factor to be reduced to no less than 2 1/2 times the OD of largest helix flight. We recommend assessment of helical pile lateral capacity occur as recommended for driven piles. The ultimate bearing capacity of helical piles must be no less than twice the design capacity of member. Static load testing of helical pile should be performed to optimize / verify capacity of installed member(s).

Soils displaced by helical pile foundations, while less than driven piling, will cause a slight upward heave of the excavation base due to the nominal one to one volumetric relationship of the GLA clays. We recommend you include additional 3-inch allowance and hold down of granular fill placed as drainage / working platform of deeper construction at site as preparation to installation of deep foundations.

We expect installed helical piles will likely attain bearing support within the glacial till soils occurring approximately 100 feet below present ground surface. The high stiffness of the glacial till soils at this location present challenge with respect to seating of helix flights within the bearing material. It is likely helical piles for this project may be designed with two helix flights of differing diameter. However, all such design must take into account that the entire load of helical pile is supported by a single helix flight. We recommend that all helical pile design for this project include structural assessment of helix and of pipe shaft to confirm stress of member does not exceed allowable design limits.

Table 6: Recommended Soil Design Criteria for Deep Foundations [Notes 1, 2, 3]

Stratum	***Nominal Datum Elevation / Depth from Ground Surface***	***Estimated Modulus E***	***Net Allowable End Bearing Capacity*** [2]	***Skin Adhesion*** (Comp.) [3]	***Skin Adhesion*** (Tension) [3]
Glacial Lake Agassiz Clay	102 / 93 feet	NA	NA	None	None
Weathered Glacial Till/Glaciated Sand	92/103 feet	0.8	6 ksf	0.3 ksf	0.2 ksf
Glacial Till	82 /111 feet	11 ksi	25 ksf	1.8 ksf	1.3 ksf

1. We do not recommend assigning any skin friction to the GLA soils as these soils can easily lose cohesive capacity when clay minerals shift relative to adjacent mineral particles (slickenside effect).
2. Net Allowable End Bearing based on surface area of element at bearing elevations *with two or higher safety factor* applied from ultimate soil capacity.
3. Adhesion capacity (compressive or tension) based on applying allowable design values (*with applied two safety factor*) to cylindrical surface area of shaft occurring within indicated stratum to till soils only.

We recommend that you infill rotary advanced helical piles and push piers with 6,000 psi minimum compressive strength cementitious grout. This infill will assist in stabilizing of respective shaft section against excessive bending stress as well as assist in conveyance of applied compressive loads to supporting glacial till.

We understand the depth of construction will provide adequate cover against adverse frost action to basement foundation walls. We recommend that the bottom of basement foundation walls and pile caps extend no less than 2 feet below bottom of basement floor. This recommendation is provided with understanding such placement will provide initial lateral restraint of soils and lessen seepage to interior of basement.

We previously noted clay soils swell with absorption of moisture. This is especially true when clay soils absorb excess runoff, pooled within excavations. Partially constructed foundations, foundations of reduced confining load, and more importantly, lightly loaded on-grade floor construction may heave due to clay soil swell. You must maintain constant automated subsurface drainage of the construction site to reduce this risk of heaved foundations.

4.6 Load Test of Deep Foundations

The deep foundation support of project warrants static load testing of helical piles. Static load testing should be completed via general conformance to the "Quick Load Test" of ASTM D1143 "Method of Testing Individual Piles Under Static Axial Compressive Load". We recommend at a minimum one (1) load test per helical pier size and an overall minimum of two (2) load tests if they are all sized for the same capacity.

4.7 Estimate of Settlement

In our opinion, the overall lack of any additional soil placement at site for the Addition should minimize future consolidation of the underlying GLA clays. It is likely that engineered clay and engineered granular fill placed as backfill of basement foundation walls may settle from 1 to 2 inches. Final grading of site must account for this internal settlement of placed soils.

We anticipate settlement of the basement level at-grade floor should be less than ½ inch as referenced to movement of the structure [i.e. does not address or include mass movement of site due to soil placement]. Furthermore, total and differential movement of footings and floor slabs could be significantly greater than the above estimates if you support construction on frozen soils, the moisture content of the bearing soils significantly changes from insitu conditions, and/or you incorporate snow or ice lenses into site earthwork.

We present within Table 7 our estimate of settlement for Deep Foundation support of project.

Table 7: Estimated Settlement of Deep Foundations [Notes 1]

	Rotary Advanced Helical Piles	
Location	Est. Total Settlement	Est. Differential Settlement
Existing Basement Foundation	NA	NA
New Basement Foundation Wall (as grade beam)	1/2 to 1 inch	1/4 to 1/2 inch
Integral Colum with Basement Foundation Wall	1/2 to 1 inch	1/4 to 1/2 inch
Basement Isolated Column	1/2 to 1 inch	1/4 to 1/2 inch

4.8 Subsurface Drainage

We recommend you install subsurface drainage at the exterior and interior base of basement foundation walls. As a general guideline, subsurface drainage consists of a geotextile and coarse drainage encased slotted or perforated pipe extending to sump basin(s). The project Architect and/or Structural Engineer of Record should determine the need / type of subsurface drainage.

4.9 Utilities

Placement of underground utilities typically includes granular bedding for support of piped systems. Placement of granular soils within underground utility construction promotes migration of subsurface moisture towards and below the bearing stratum of footing construction. This, in turn, can lead to moisture uptake by native clays producing heave of construction, loss of shear strength and/or differential settlement of footing and floors.

Therefore, we recommend that you eliminate placement of all granular bedding soils within 10 feet of project excavations creating a zone where cohesive soils or lean concrete (i.e. controlled density fill) is used for all soil replacement within utility trenches. This “zone of control” should significantly reduce moisture migration below the project foundations. You should place and compact all clay-bedding fill to same criteria recommended for utility trench backfill.

In lieu of placing clay soils within the above referenced “zone of control”, you may provide alternate means of interception and blockage of drainage along site utilities pending review and approval by Geotechnical Engineer of Record.

You should place wetter soils in the lower portion of utility trench construction, and dryer soils in the upper most portion of trench fill. You should temper the utility trench fill for correct moisture content and then place and compact individual lifts of trench fill to criteria established within the report appendices.

There is a high probability that fine and coarse alluvium laminations occur within site soils and may be present along utility trench excavations. Such formations and other regional dependent soil conditions may be water bearing. While it is our opinion small pumps should handle typical seepage from site clays, we caution that exposure of a major “water bearing” strata could produce significant seepage of utility construction. Therefore, we recommend that you include provisions within construction document for pumping of seepage from utility excavations.

4.10 Basement Slab-on-Grade Floor

Our borings indicate support of basement floor and underlying engineered aggregate section will be provided by native fat clays. We understand finished floor will be set at a common elevation with the existing basement/lower level floor of the existing building.

Construction of project foundations will likely include movement of equipment across the floor of the Addition basement. This movement may include heavy equipment necessary for the installation of deep foundations. Subgrade preparation will need to establish a stable base for construction of project. The

native soils at the base of basement excavation can easily loose structural capacity with uptake of moisture, are easily disturbed, and may rut with excessive movement of construction equipment across bare ground. We thus recommend that you install geotextile separation fabric between the exposed cohesive soils and overlying aggregate section to limit this displacement / distress. It is our opinion this geotextile should consist of a "polypropylene yarn based" fabric with the Table 8 properties:

Table 8: Geotextile Separation Fabric Properties

Parameter	***Requirement*** [Note 1]
Base Yarn	Non-Woven, Fused Polypropylene
Apparent Opening Size [AOS, US Sieve]	40 - 70
Permitivity [gal/min/sq. ft CH, ASTM D 4491]	Nominal, 110 gpm/sq. ft.
Grab Tensile Strength [lbs, %, ASTM D 4632]	160 x 160 @ 50%
Installation (Panels)	Minimum 2 feet overlap of side seams and 3 feet overlap of butt seams (nominal 12 ft panel width)

1. All physical strength properties are minimum average roll values [MARV], unless noted otherwise.

Engineered fill placement above the subgrade separation fabric [i.e. from native soils to within 6 inches of the bottom of floor slab / nominal 24 inches of *Bearing Aggregate*] should consist of natural stone / sand mixture or crushed concrete material conforming to the Table 9 mechanical analysis. You must temper the granular material for correct moisture, place 8-inch maximum depth loose lifts, and compact the Bearing Aggregate to no less than 95% of Standard Proctor maximum dry density.

Fill placement within 6 inches of the bottom of basement floor [i.e. *Drainage Aggregate*] should occur after completion of regraded and compacted the underlying granular material. This Drainage Aggregate should consist of a material conforming to the Table 9 mechanical analysis requirement. You should temper the Drainage Aggregate from plus or minus 3% of optimum moisture content and then compact individual lifts of material to no less than 95% of Standard Proctor maximum dry density.

Table 9: Mechanical Analysis of Granular Fill for Floor Slab Construction

U.S. Sieve Designation	***Bearing Aggregate*** ***Percent Passing*** (by dry weight of material)	***Drainage Aggregate*** ***Percent Passing*** (by dry weight of material)
1 inch	100%	
1/2	70 - 85	100%
No. 4	50 – 65	50 - 75
10	40 – 50	40 - 60
40	20 – 40	20 - 40
200	2 – 10	0 - 5

You may design of the floor slab based on an estimated subgrade reaction modulus (k) of 150 lbs/ in^3 providing a minimum of 36 inches of granular fill supports floor construction. Otherwise, we recommend you use a subgrade reaction modulus of 50 lbs/ in^3 for design of at grade or basement floor slab. While it is

our opinion that you reinforce floor slab construction, the Structural Engineer should determine need for inclusion of reinforcement within at-grade floor construction.

All areas of basement floor with impervious or near impervious surfacing such as, but not limited to, paint, hardening agent, vinyl tile, ceramic tile, or wood flooring, will require your installation of a commercial grade vapor barrier system. Historically, vapor barrier systems can consist of many different types of synthetic membrane with placement either below sand cushion materials or at the underside of the concrete floor. All such issues are contentious and have positive and negative aspects associated with long-term performance of floor. Overall, we recommend you install some form of vapor barrier below the project basement floor.

You should isolate the basement floor from other building components. It is our opinion such isolation should include installation of a ½ inch thick expansion joint between the floor and walls, and/or columns to minimize binding between construction materials. This construction should also include application of a compatible sealant after curing of the floor slab to reduce moisture penetration though the expansion joint. As a minimum, you must install bond breaker to isolate and reduce binding between building components.

We previously noted risk of heave of on-grade floor slab construction if exposed clay soils absorb moisture. We direct your attention to the attachment "Swell of Clay Soils" provided within the report appendices.

4.11 Exterior Backfill

Exterior fill placement around the foundation and associated final grading adjacent to the building can significantly influence the performance of a structure. We recommend you install subsurface drainage of the basement foundation system as previously noted per this report.

Exterior backfill for basement foundation should consist of a native, coarse alluvium or "pit run" granular soil with a fine content equal to or less than 40 percent passing the No. 40 US Sieve opening and 12 percent passing the No. 200 US Sieve opening (i.e. fill extending to within 2 feet of final grade). The final two to three feet of exterior backfill within lawn areas should consist of clay and topsoil while exterior backfill below sidewalks and pavements should consist of a free draining aggregate base. You should temper all backfill for correct moisture content and then place and compact individual lifts of exterior backfill per criteria presented within the appendix attachment. *You must limit placement of exterior backfill until lateral restraint of foundation walls complies with minimum criteria of Structural Engineer of Record.*

4.12 Surface Drainage

You should maintain positive drainage during and after construction of project and eliminate ponding of water on site soils. We recommend you include provisions within construction documents for positive drainage of site. You should install sumps at critical areas around project to assist in removal of seepage and runoff from site. We present within appendices attachment recommendations for sump construction.

You should maintain the moisture content of site clays as close to existing as possible as excessive changes can cause shrinkage or expansion of the soil, and lead to distress of construction.

We understand sidewalks, curbing, pavements, and lawn will direct drainage from structure. You should grade exterior to slope from building(s). We recommend that you provide a five percent gradient within 10 feet of building for drainage from lawn, and two percent minimum gradient from building for drainage of sidewalks / pavements. All pavements should drain to on-site storm collection, municipal collection system, or roadside ditching.

You should direct roof runoff from building by a system of interior roof and scupper drains, or rain gutters, down spouts and splash pads. It is our opinion interior roof drains plumbed directly to the storm water piping system provide the most favorable method of conveying drainage from the roof as interior drains do not freeze or discharge runoff onto exterior sidewalks and pavements.

4.13 Vegetation

Vegetation planting near structures can change the soil moisture content via uptake by or excessive watering of plantings. The resulting change in soil moisture contributes to lateral earth pressure development and frost related heave of local soils. You should eliminate planting of trees or shrubs within 10 feet of the structures as a cautionary measure to reduce the seasonal fluctuation of soil moisture.

5.0 CONSTRUCTION CONSIDERATIONS

5.1 Excavation Stability / Person in Charge

Excavation depth and sidewall inclination should not exceed those specified in local, state, or federal regulations. You may need to widen and slope, or temporarily brace excavations to maintain or develop a safe work environment. A licensed Professional Engineer retained by Contractor must design temporary shoring in accordance with applicable regulatory requirements.

We base all report stability findings on premise with respect to loading, site conditions, groundwater issues, and likely extent of work / surcharge conditions as listed. Such findings do not imply or intend actual excavations advanced at project, or findings relative to 29 CFR 1926.6 as referenced above. *Contractor is solely responsible per "means and methods" for ascertaining stability of embankments / excavations, or any other work occurring on site.*

5.2 Engineered Fill & Winter Construction

The Geotechnical Engineer of Record or their designated representative must observe and evaluate excavations to verify removal of uncontrolled fills, topsoil, and/or unsuitable material(s), and adequacy of bearing support of exposed soils. Such observation should occur prior to construction of foundations or placement of engineered fill supporting excavations. Lacking observation(s), you cannot hold NTI, its officers and professional engineers responsible for issues resulting from undocumented site conditions.

We must evaluate engineered fill for moisture content, mechanical analysis and/or Atterberg limits prior to placement. You must also temper engineered fill for correct moisture content and then place and compact individual lifts of engineered fill to criteria established within this report.

You must never use frozen soil as engineered fill or backfill nor should you support foundations on frozen soils. Moisture freezing within the soil matrix of fine grained and/or cohesive soils produces ice lenses. Such soils gain moisture from capillary action and, with continued growth, heave with formation of ice lenses within the soil matrix. Foundations constructed on frozen soils settle after thaw resulting in distress or failure of construction.

You must protect excavations and foundations from freezing conditions or accumulation of snow, and remove frozen soils, snow, and ice from within excavations, fill section or from below proposed foundations. Replacement soil should consist of similar material as removed from excavation with moisture content, placement, and compaction conforming to report criteria.

5.3 Operation of Project Sumps

We previously noted the importance of removal of seepage and runoff from project excavations. You must maintain temporary drainage of project excavations until such time that the Geotechnical Engineer of Record determines excess groundwater pore pressure, seepage, and/or runoff no longer influences the strength or support of construction.

We presented within appendices attachment typical recommendations for temporary project sumps. Such provides general guideline of the minimum temporary drainage of project. It is our premise the Contractor is solely responsible for establishing the magnitude, type, and operation of subsurface drainage for project.

6.0 CLOSURE

Our conclusions and recommendations, as represented within this report, imply NTI's future observation and testing of earthwork under the direction of the Geotechnical Engineer of Record. We arrived at our opinions based on presumptive data collected from the site. Note that the collection of such data results from limited sampling of site conditions typical of geotechnical explorations performed for projects of similar scope. For this and other reasons, we do not warrant conditions between or below the depth of our borings, or that the strata logged from our borings are necessarily typical of the site. Thus, you agree herein to relieve, hold harmless, and indemnify NTI, its officers and engineering staff of responsibility pending any deviation(s) from our recommendations by plans, written specifications, or field applications, unless you establish and receive from NTI prior issued written concurrence with such deviations.

We have prepared this report for FOURFRONT Design, Inc. in specific application to proposed "VA Building 1 Expansion" project in Fargo, North Dakota. Northern Technologies, LLC has endeavored to comply with generally accepted geotechnical engineering practice common to the local area. Northern Technologies, LLC makes no other warranty, expressed or implied.

Northern Technologies, LLC

Daniel Gibson

Dan Gibson, P.E.
Senior Engineer

Josh Holmes, P.E.
Engineer

DG:jh

Attachments

Daniel Gibson

Daniel Gibson, P.E.

Date: 12/3/2020

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APPENDIX A

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GEOTECHNICAL EVALUATION OF RECOVERED SOIL SAMPLES

We visually examined recovered soil samples to estimate color, distribution of grain sizes, plasticity, consistency, moisture condition, and presence of lenses and seams. We then classified the soils according to the Unified Soil Classification System (ASTM D2488). We provide a chart describing this classification system and general notes explaining sampling procedures.

We estimated the stratification lines between soil types based on the available data from our borings only. Insitu, the transition between type(s) may be distinct or gradual in the horizontal or vertical directions. Variations in the soil stratigraphy may occur between and around the borings, with the nature and extent of such change not readily evident until exposed by excavation. You must properly assess these variations when utilizing information presented on the boring logs.

FIELD EXPLORATION PROCEDURES

Soil Sampling – Standard Penetration Boring:

We performed soil sampling according to the procedures described by ASTM D-1586. Using this procedure, we drive a 2-inch outside diameter "split barrel sampler" into the soil by a 140-pound weight falling 30 inches. After an initial set of six inches, the number of blows required to drive the sampler an additional 12 inches is recorded (known as the penetration resistance (i.e. "N-value") of the soil at the point of sampling. This N-value, as corrected for efficiency of equipment operation is an index of the relative density of cohesionless soils and an approximation of the consistency of cohesive soils [i.e. N_{60}].

Soil Sampling – Power Auger Boring:

The boring(s) was/were advanced with a 6-inch nominal diameter continuous flight auger. As a result, samples recovered from the boring are disturbed, and our determination of the depth, extend of various stratum and layers, and relative density or consistency of the soils is approximate.

Soil Classification:

Soil samples were visually and manually classified in general conformance with ASTM D-2488 at removal from the sampler(s). We then sealed within containers and returned representative fractions of soil samples to the laboratory for further examination and verification of the field classification. We also submitted representative soil samples for laboratory tests. We document on the boring logs and individual test reports sample information, identification of sampling methods, method of advancement of samples, and other pertinent information concerning the soil samples.

General Notes

DRILLING & SAMPLING SYMBOLS		LABORATORY TEST SYMBOLS	
SYMBOL	DEFINITION	SYMBOL	DEFINITION
C.S.	Continuous Sampling	W	Moisture content-percent of dry weight
P.D.	2-3/8" Pipe Drill	D	Dry Density-pounds per cubic foot
C.O.	Cleanout Tube	LL, PL	Liquid and plastic limits determined in accordance with ASTM D 423, ASTM D 424
3 HSA	3 ¼" I.D. Hollow Stem Auger	Qu	Unconfined compressive strength-pounds per square foot in accordance with ASTM D 2166-66
4 FA	4" Diameter Flight Auger		
6 FA	6" Diameter Flight Auger		
2 ½ C	2 ½" Casing		
4 C	4" Casing	Additional insertions in Qu Column	
D.M.	Drilling Mud	Pq	Penetrometer reading-tons/square foot
J.W.	Jet Water	S	Torvane reading-tons/square foot
H.A.	Hand Auger	G	Specific Gravity – ASTM D 854-58
NXC	Size NX Casing	SL	Shrinkage limit – ASTM 427-61
BXC	Size BX Casing	pH	Hydrogen ion content-meter method
AXC	Size AX casing	O	Organic content-combustion method
SS	2" O.D. Split Spoon Sample	M.A.*	Grain size analysis
2T	2" Thin Wall Tube Sample	C*	One dimensional consolidation
3T	3" Thin Wall Tube Sample	Qc*	Triaxial Compression
		* See attached data Sheet and/or graph	

Water Level Symbol

Water levels shown on the boring logs were determined at the time and under the conditions indicated. In sand, you may consider the indicated levels reliable for most site conditions. In clay soils, it is not possible to determine the groundwater level within the normal scope of a geotechnical investigation, except where lenses or layers of more pervious water bearing soil are present; and then a long period may be necessary to reach equilibrium. Therefore, the position of the water level symbol for cohesive or mixed soils may not indicate the true level of the groundwater table. We present, if any, available water level information on the boring logs.

Descriptive Terminology

DENSITY		***CONSISTENCY***	
TERM	"N_{60}" VALUE	TERM	"N_{60}" VALUE
Very Loose	0-4	Soft	0-4
Loose	5-8	Medium	5-8
Medium Dense	9 – 15	Rather Stiff	9 – 15
Dense	16 – 30	Stiff	16 – 30
Very Dense	Over 30	Very Stiff	Over 30

Standard "N_{60}" Penetration: Blows per foot of a mechanical hammer using nominal 2-inch OD split spoon as corrected to reflect similar sampling using a Standard Safety Hammer.

Relative Proportions

TERMS	RANGE
Trace	0-5%
A little	5-15%
Some	15-30%
With	30-50%

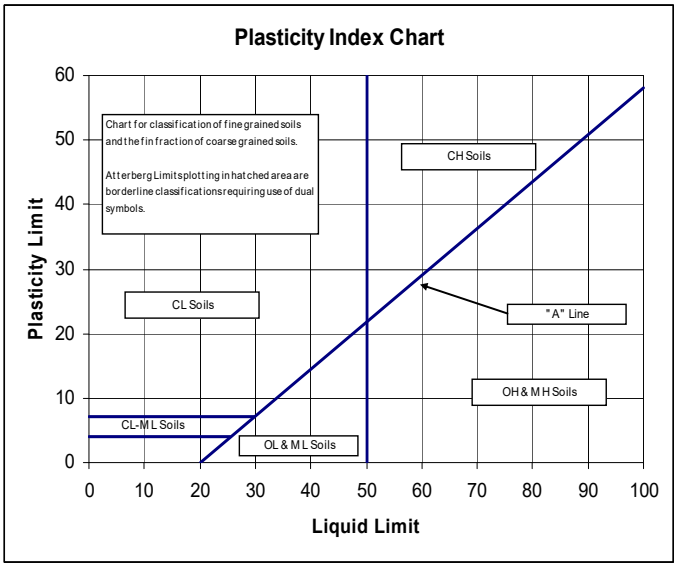
Particle Sizes

MATERIAL	DESTRIPTION	US SIEVE SIZE
Boulders		Over 3"
Gravel -	Coarse	¾" – 3"
	Medium	#4 – ¾"
Sand -	Coarse	#4 - #10
	Medium	#10 - #40
	Fine	#40 - #200
Silt and Clay	Determined by plasticity characteristics.	

Classification of Soils for Engineering Purposes

ASTM Designation D-2487 and D 2488 (Unified Soil Classification System)

Major Divisions			Group Symbol	Typical Name	Classification Criteria		
Course Grained Soils More than 50% retained on No. 200 sieve *	Gravels 50% or more of coarse fraction retained on No. 4 sieve.	Clean Gravels	**GW**	Well –graded gravels and gravel-sand mixtures, little or no fines.	**Classification on basis of percentage of fines.** Less than 5% passing No. 200 Sieve: GW, GP, SW, SP More than 12% passing No. 200 Sieve: GM, GC, SM, SC From 5% to 12% passing No. 200 Sieve: Borderline Classification requiring use of duel symbols.	Cu = D60 / D10 greater than 4. Cz = (D30)2 / (D10 x D60) between 1 & 3.	
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines.		Not meeting both criteria for GW materials.	
		Gravels with Fines	**GM**	Silty gravels, gravel-sand-silt mixtures.		Atterberg limits below "A line", or P.I. less than 4.	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols.
			GC	Clayey gravels, gravel-sand-clay mixtures.		Atterberg limits above "A line" with P.I. greater than 7.	
	Sands More than 50% of coarse fraction passes No 4 sieve.	Clean Sands	**SW**	Well-graded sands and gravelly sands, little or no fines.		Cu = D60 / D10 greater than 6. Cz = (D30)2 / (D10 x D60) between 1 & 3.	
			SP	Poorly-graded sands and gravelly sands, little or no fines.		Not meeting both criteria for SW materials.	
		Sands with Fines	**SM**	Silty sands, sand-silt mixtures.		Atterberg limits below "A line", or P.I. less than 4.	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols.
			SC	Clayey sands, sand-clay mixtures.		Atterberg limits above "A line" with P.I. greater than 7.	
Fine Grained Soils More than 50% passes No. 200 sieve *	Silts and Clays Liquid Limit of 50% or less		**ML**	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands.			
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.			
			OL	Organic silts and organic silty clays of low plasticity.			
	Silts and Clays Liquid Limit greater than 50%.		**MH**	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts.			
			CH	Inorganic clays of high plasticity, fat clays.			
			OH	Organic clays of medium to high plasticity.			
	Highly Organic Soils		**Pt**	Peat, muck and other highly organic soils.			



Excavation Oversize

Excavation oversize facilitates distribution of "load derived" stress to supporting soils. Unless otherwise superseded by report specific requirements, all construction should conform to the minimum oversize and horizontal offset requirements as presented within the diagram and associated chart.

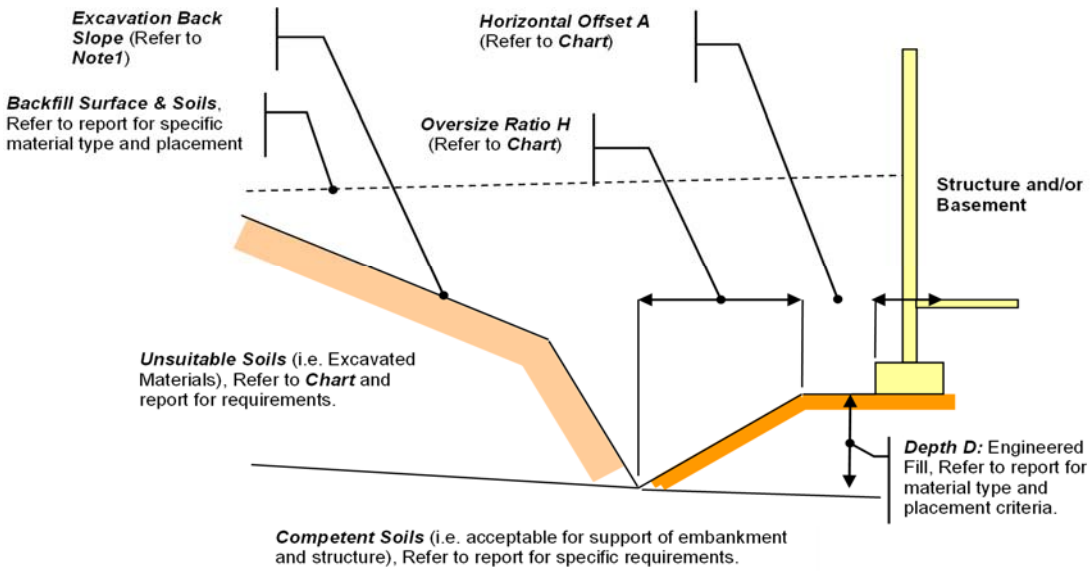


Figure 1: Excavation Oversize

Definitions

Oversize Ratio H: The ratio of the horizontal distance divided by the engineered fill depth (i.e. # Horizontal / Depth D). Refer to Chart for specific requirements.

Horizontal Offset A: The horizontal distance between the outside edge of footing or critical position, and the crest of the engineered fill section. Refer to Chart for specific requirements.

Note 1: Excavation depth and sidewall inclination should not exceed those specified in local, state or federal regulations including those defined by Subpart P of Chapter 27, 29 CFR Part 1926 (of Federal Register). You may need to widen and slope, or temporarily brace excavations to maintain or develop a safe work environment. Contractor is solely responsible for assessing stability under "means and methods".

Condition	***Unsuitable Soil Type***	***Horizontal Offset A***	***Oversize Ratio H***
Foundation Unit Load equal to or less than 3,000 psf.	SP, SM soils, CL & CH soils with cohesion greater than 1,000 psf	2 feet or width of footing, whichever is greater	Equal to or greater than one (1) x Depth D
Foundation Unit Load greater than 3,000 psf	SP, SM soils, CL & CH soils with cohesion less than 1,000 psf	5 feet or width of footing, whichever is greater	Equal to or greater than one (1) x Depth D
Foundation Unit Load equal to or less than 3,000 psf.	Topsoil or Peat	2 feet or width of footing, whichever is greater	Equal to or greater than two (2) x Depth D
Foundation Unit Load greater than 3,000 psf	Topsoil or Peat	5 feet or width of footing, whichever is greater	Equal to or greater than two (3) x Depth D

APPENDIX B

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GROUNDWATER ISSUES

The following presents additional comment and soil specific issues related to measurement of groundwater conditions at your project site.

Note that our groundwater measurements, or lack thereof, will vary depending on the time allowed for equilibrium to occur in the borings. Extended observation time was not available during the scope of the field exploration program and, therefore, groundwater measurements as noted on the boring logs may or may not accurately reflect actual conditions at your site.

Seasonal and yearly fluctuations of the groundwater level, if any, occur. Perched groundwater may be present within sand and silt lenses bedded within cohesive soil formations. Groundwater typically exists at depth within cohesive and cohesionless soils.

Documentation of the local groundwater surface and any perched groundwater conditions at the project site would require installation of temporary piezometers and extended monitoring due to the relatively low permeability exhibited by the site soils. We have not performed such groundwater evaluation due to the scope of services authorized for this project.

We anticipate pumps installed within temporary sumps should control subsurface seepage from perched conditions. However, we caution such seepage from such formations and any water entry from excavations below the groundwater table may be heavy and will vary based on seasonal and annual precipitation, and ground related impacts in vicinity of project.

GEOTEXTILE FABRIC and GEOGRID REINFORCEMENT

Unless otherwise amended by report, we recommend installation of a geotextile separation fabric between the native soils and the engineered fill section below project foundations, floors and/or between a clay subgrade and aggregate base of pavement construction. It is our opinion this geotextile should consist of a non-woven, needle punched or woven, fabric conforming to the following tabulated parameters.

Geotextile Separation Fabric Properties [1]

Parameter	*Requirement*
Base Yarn	Polypropylene
Apparent Opening Size [AOS, US. Sieve]	40 – 70
Permitivity [gal/min/sq. ft CH, ASTM D 4491]	110
Grab Tensile Strength [lbs, %, ASTM D 4632]	160 lbs by 160 lbs at 50% by 50% strain

1. All physical strength properties are minimum average roll values [MARV], unless noted otherwise.

We recommend that the geotextile panels be oriented parallel with proposed aggregate placement activities, and occur in such a manner that the overall number of individual panels are kept to a minimum. As placed, individual panels of geotextile should have a width equal to or greater than 12 feet. We recommend that the Contractor overlap longitudinal and butt seam of adjacent panels a minimum of 18 inches with such joints oriented to follow initial construction traffic (shingles profile with traffic).

Geogrid Reinforcement provided for support of permanent structural loads requires separate evaluation based on project specific conditions and applied loading. Such work is beyond the scope of findings as presented by this report.

Unless otherwise amended by report, Geogrid Reinforcement for placement below pavements should consist of material and provide properties as outlined within the following tabulation.

Geogrid Reinforcement of Aggregate Base Section [1]

Parameter	*Requirement*
Base Yarn	Polypropylene
Aperture Size [inch by inch]	Minimum 1.5 by 1.5, Maximum 1.75 by 1.75
Wide Width Tensile Strength [lbs/ft, ASTM D 6637]	Minimum 800 MD by 800 CD at 2% strain
	Minimum 1600 MD by 1,600 CD at 5% strain
	Minimum 2,000 MD by 2,000 CD at ultimate strain
Tensile Modulus [lb/ft, ASTM D 6637	Minimum 41,000 MD by 41,000 CD at 2% strain
	Minimum 32,000 MD by 32,000 CD at 5% strain

2. All physical strength properties are minimum average roll values [MARV], unless noted otherwise.

The Table B geogrid should be placed above the above recommended geotextile separation fabric with individual 12-foot minimum width individual panels of geogrid reinforcement oriented parallel to major traffic movement. Side seams of geogrid reinforcement must be overlapped no less than 12 inches while butt seams of geogrid should be overlapped no less than 24 inches.

PLACEMENT and COMPACTION OF ENGINEERED FILL

Unless otherwise superseded within the body of the Geotechnical Exploration Report, we recommend you following the following criteria for placement of engineered fill on project. This includes, but is not limited to earthen fill placement to improve site grades, fill placed below structural footings, fill placed interior of structure, and fill placed as backfill of foundations.

Engineered fill placed for construction, if necessary, should consist of natural, non-organic, competent soils native to the project area. Such soils may include, but are not limited to gravel, sand, or clays with Unified Soil Classification System (ASTM D2488) classifications of GW, SP, SM, CL or CH. Use of silt or clayey silt as project fill will require additional review and approval of project Geotechnical Engineer of Record. Such soils have USCS classifications of ML, MH, ML-CL, and MH-CH. *You must never use topsoil, marl, peat, other organic soils construction debris, and/or other unsuitable materials as engineered fill. Such soils have USCS classifications of OL, OH, Pt.*

You should temper engineered fill, classified as clay for moisture content at the time of placement equal to and no more than four percent above the optimum content for as defined by the appropriate proctor test. Likewise, you should temper engineered granular fill [gravel or sand] such that moisture content at the time of placement enables compaction to appropriate criteria.

You should place all engineered fill in individual 8- inch maximum depth lifts. Each lift of fill should be compacted by large vibratory equipment until the in-place soil density is equal to or greater than the criteria established within the following tabulation.

Type of Construction	***Compaction Criteria (% respective Proctor)*** [1]	
	Clay	Sand or Gravel
General Embankment Fill	95 to 100	Min. 95
Engineered Fill below Foundations	Min. 95	Min. 95
Engineered Fill below Floor Slabs	95 to 98	Min. 95
Engineered Fill placed against Foundation Walls	95 to 98	95 to 100
Engineered Fill placed as Pavement Subgrade	Min. 95	Min. 95
Engineered Fill placed as Pavement Aggregate Base	NA	Min. 98
Engineered Fill placed within Utility Trench (to within 3 feet of pavement aggregate base or final grade	Min. 95	Min. 95
Engineered Fill placed as Utility Trench Fill (within 3 feet of pavement aggregate base or final grade	Min. 98	Min. 98

1 Unless otherwise required, compaction criteria per Standard Proctor Test (ASTM D698).

Density tests should be taken during engineered fill placement to document earthwork has achieved necessary compaction of the material(s). Recommendations for interior fill placement and backfill of foundation walls presented within other sections of this report.

SWELLING of CLAY SOILS

Swell of clay soil occurs when moderate to highly desiccated, "over consolidated", moderate to highly plastic clay absorbs moisture concurrent within removal of overburden pressure. The fat clay soils comprising the Glacial Lake Agassiz formation have "moderate" to "high risk" of swelling when conditions favorable for heave occur.

Clay minerals are generally elongated bipolar charged particles aligned in plate like structures. Absorption of water by the clay minerals is cause, in part, by the electrical attraction between the bipolar mineral and the electrical charged water molecule. The electrical attraction at the molecular level is a strong bond that forces separation of the clay particle into a stratified system of bonded clay and water. The resulting composite system has greatly increased volume as compared to the original clay minerals.

Major clay minerals include Kaolinite, Holloysite, Illite, Calcium Montmorillonite, Sodium Montmorillonite, and Sodium Hectorite. Mielenz and King (1955) have noted that absorption of water by clays leads to expansion or swelling with magnitude of swelling varied widely depending upon the type and quantity of clay mineral present, their exchangeable ions, electrolyte content of the aqueous phase, particle-size distribution, void size and distribution, the internal structure, water content, superimposed load, and possibly other factors. Research geology professor Mr. Ralph Grim [University of Illinois] collaborates free swelling of clay minerals varied widely [see below referenced table].

Free Swelling Data for Clay Minerals (%) [After Mielenz and King, 1955]

Clay Mineral Type	***Sample Source***	***Percent Swell***
Calcium Montmorillonite:	Forest, Mississippi	145
	Wilson Creek Dam, Colorado	95
	Davis Dam, Arizona	45 - 85
	Osage, Wyoming (prepared from Na-Mont.)	125
Sodium Montmorillonite:	Osage, Wyoming	1,400 - 1,600
Sodium Hectorite:	Hector, California	1,600 - 2,000
Illite:	Fithian, Illinois	115 - 120
	Morris, Illinois	60
	Tazewell, Virginia	15
Kaolinite:	Mesa Alta, New Mexico	5
	Macon, Georgia	60
	Langley, North Carolina	20
Halloysite:	Santa Rita, New Mexico	70

As shown above, the effective range of swell in percent varies widely from as little as 5% with Kaolinite to 2,000% with Sodium Hectorite. Of major concern, regional clay soils typically include varying concentration of montmorillonite mineral [commonly defined as smectite]. Note that defining the percent content and mineral type of clay soils calls for very costly and time intensive laboratory analysis. We cannot make such determination through visual classification or simple laboratory testing of soil samples.

You may achieve reduction of free swell through reduction or chemical modification of high swell mineral, elimination of water absorption, and/or replacement by soils having no risk of swell. Each of these issues requires further review and/or modification to recommendations of this report. Such may include but are not limited to the isolation of lightly loaded floor slabs from more heavily loaded foundation element, allowing unhindered movement between walls / floor and any piped penetrations and, most importantly, providing continuous automated drainage of site during construction and permanent subsurface drainage of foundations and at-grade floors long term. Lacking access to moisture, heave prone clay soils typically experience minimal volume change.

MUD SLAB CONSTRUCTION

Historically, construction typically installed a thin concrete “mud slab” at the base of project excavations to minimize further disturbance to supporting soils with construction of project. This placement also provides confirmed separation between foundation and earth thereby allowing lesser depth of concrete cover of footing reinforcement. Recent use of “mud slab” placement on other project has proved beneficial in maintaining schedule of construction in addition to above described benefits.

Forgoing any specific recommendation of report, we recommend you place a nominal 3-inch thick concrete “mud slab” across exposed clay soils within excavations advanced for project. The lean concrete for the “mud slab” should consist of a cementitious sand slurry mixture designed to provide a 28-day compressive strength on the order or slightly in excess of 300 pounds per square inch (psi). Compressive strengths below this threshold can result in premature failure of the protective system, while compressive strengths in excess of this threshold make installation of staking or construction of plumbing / electrical systems difficult. Slump of the lean concrete mixture should range between five and seven inches.

PROJECT SUMPS

The collection, control and removal of seepage and runoff from within project excavations is critical in maintaining the bearing capacity of native soils, in-place density of engineered fill and stability of embankments at project excavations.

As constructed, it is our opinion all sumps should consist of a 2 foot by 2 foot or larger plan dimension excavation(s) located adjacent to and directly exterior to the excavation oversize limit for structural engineered fill [see appended Figure 1]. Sump excavations should extend a minimum of 2 feet below the base of the excavation for collection of seepage and runoff.

You should line all sumps with a non-woven, needle-punched, geotextile having a grab tensile strength equal to or greater than 70 pounds per square inch (psi). A standpipe of 12 inches in diameter or larger should be centered within the sump excavation. This pipe should include sufficient openings for entry of seepage. We recommend that the standpipe extend to the ground surface to facilitate pumping during project construction. Infill within the sump area should consist of a 1½ to ¾ inch clear rock placed between the standpipe and walls of the sump excavation.

Pump sump(s) until completion of the construction or until the Geotechnical Engineer of Record indicates such pumping is no longer necessary for stability of the project footings and related construction. Properly abandon or remove sumps per the more stringent of methods required by the Geotechnical Engineer of Record, or per Federal, State and local governmental statutes.

Discharge from sumps should be directed away from site and be disposed within storm water systems or other systems which comply with Federal, State and local governmental statute. As constructed and operated, the General Contractor should be responsible for all permits, operation and abandonment of sumps or other temporary dewatering systems.

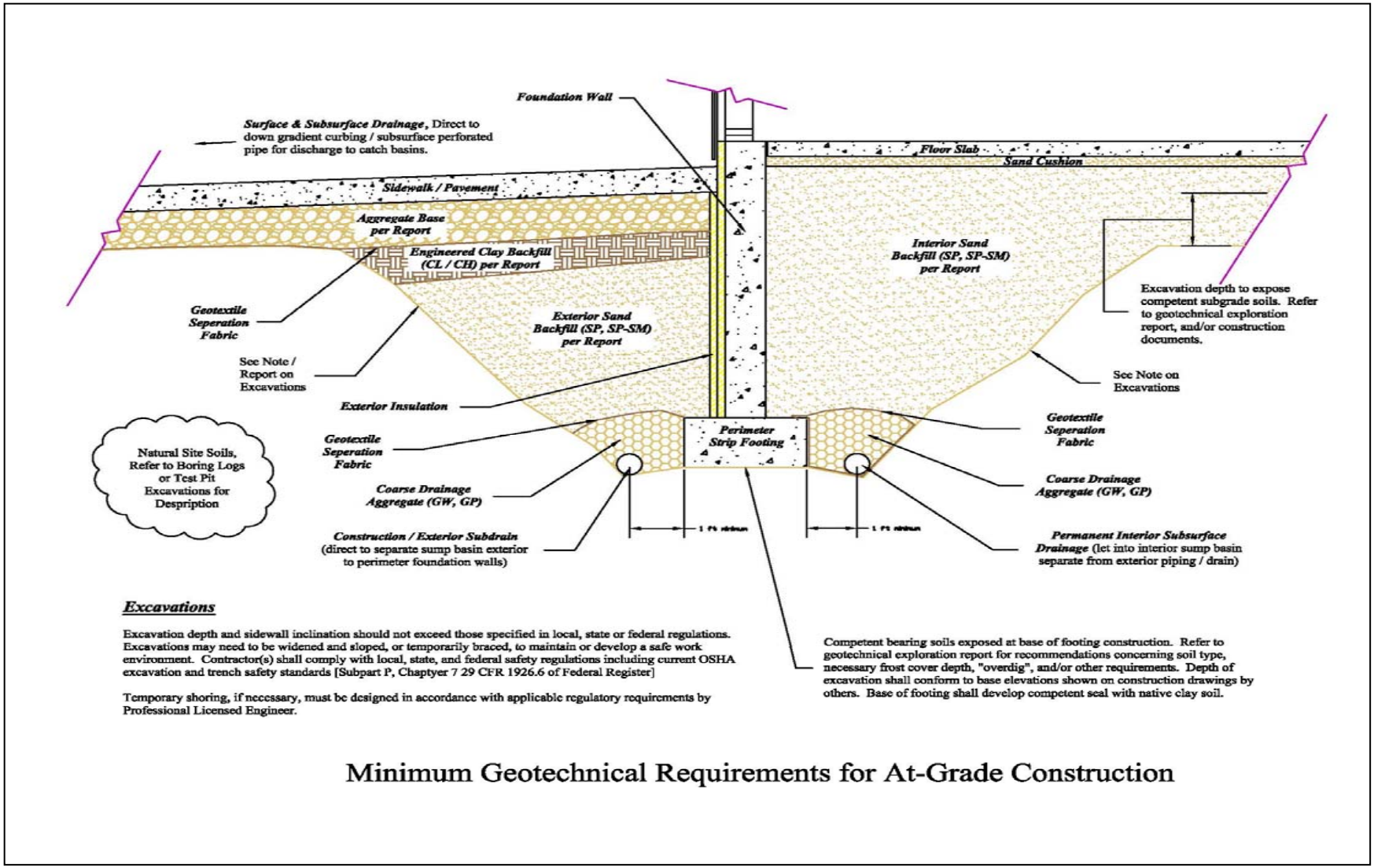

Figure 2: Minimum Geotechnical Requirements for At-Grade Construction

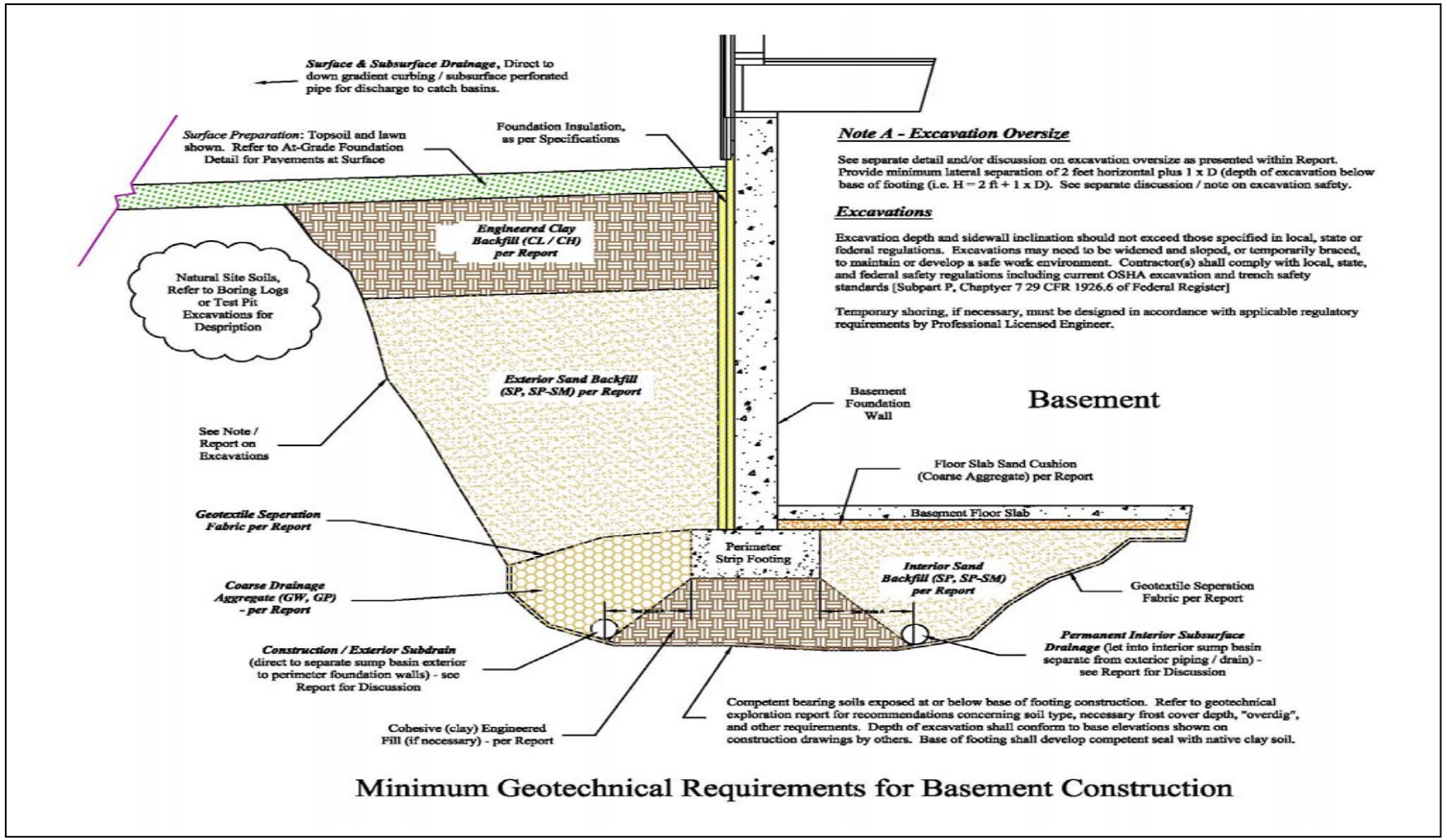

Figure 3: Minimum Geotechnical Requirements for Basement Construction

APPENDIX C

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Fargo VA - Building 1 Expansion
Project #20.FGO10880.000
Fargo, North Dakota
Legend
Soil Boring
Temporary Benchmark
TBM
SB-04
SB-03
SB-02
SB-01
N
100 ft
Google Earth
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3522 4th Ave S
Fargo, ND 58103
P: 701.232.1822 F: 701.232.1864
www.NTIGEO.com

BORING NUMBER SB-01

Long: -96.774007
Lat: 46.905391

CLIENT FOURFRONT Design, Inc.
PROJECT NAME Fargo VA - Building 1 Expansion
PROJECT NUMBER 20.FGO10880.000
PROJECT LOCATION Fargo, North Dakota
DATE STARTED 10/8/20 **COMPLETED** 10/8/20
GROUND ELEVATION 193.2 feet **HOLE SIZE** 6 1/2 in.
DRILLING CONTRACTOR NTI
GROUND WATER LEVELS:
DRILLING METHOD 3 1/4 in. H.S.A. then Rotary Drilling with Mud
AT TIME OF DRILLING --- --
LOGGED BY Chris Nelson **CHECKED BY** Dan Gibson
AT END OF DRILLING ---
CAVE IN (ft) NR **FROST DEPTH (ft)** NA
AFTER DRILLING ---
NOTES

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES
0		0.4 4.5" of CONCRETE 192.8	AU 1									
		0.6 FILL, SILTY SAND, brown, fine to coarse grained, trace gravel 192.6	SS 2	78	5-6-9 (15)		90	31				
		FILL, FAT CLAY, black to dark brown										
		4.0 189.2	SS 3	78	3-3-6 (9)	3.0	89	32				
5		FILL, FAT CLAY, dark brown										
		6.5 186.7	SS 4	67	2-2-3 (5)	1.0	82	42				
		FILL, FAT CLAY, bluish gray to black, organic odor										
		9.0 184.2	SS 5	78	2-2-3 (5)	0.6	72	45				
10		FILL, FAT CLAY, black to gray										
			SS 6	33	2-1-2 (3)	0.8		39				
15		15.0 178.2	SS 7	78	2-2-2 (4)	1.8	94	30				
		FAT CLAY, (CH) bluish gray, soft										
		17.0 176.2	SS 8	94	2-4-5 (9)	2.1	98	27				
		FAT CLAY, (CH) brown, rather stiff to medium										
20			SS 9	94	3-4-5 (9)	2.7	94	30				
25			SS 10	111	2-3-4 (7)	2.5	96	30				
		27.0 166.2										
		FAT CLAY, (CH) dark gray, soft										
30			SS 11	133	1-2-2 (4)	1.3	65	60				
35			SS 12	133	1-1-2 (3)	0.8	64	62				

(Continued Next Page)

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BORING NUMBER SB-01

Long: -96.774007
Lat: 46.905391

CLIENT FOURFRONT Design, Inc.
PROJECT NAME Fargo VA - Building 1 Expansion
PROJECT NUMBER 20.FGO10880.000
PROJECT LOCATION Fargo, North Dakota

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES
40		FAT CLAY, (CH) dark gray, soft *(continued)*										
45			SS 13	133	1-1-2 (3)	0.7	58	76				
50												
55			SS 14	133	1-1-1 (2)	0.6	64	64				
60												
65			SS 15	133	1-1-2 (3)	0.8	76	48				
70												
75			SS 16	133	1-1-1 (2)	0.7	75	49				
80												

(Continued Next Page)

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Lat: 46.905391

CLIENT FOURFRONT Design, Inc.
PROJECT NAME Fargo VA - Building 1 Expansion
PROJECT NUMBER 20.FGO10880.000
PROJECT LOCATION Fargo, North Dakota

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES
85		FAT CLAY, (CH) dark gray, soft *(continued)*	SS 17	133	1-2-2 (4)	0.7	73	50				
90		91.5										
		POORLY GRADED GRAVEL, (GP) gray, wet, very dense										
		93.0										
		SANDY LEAN CLAY, (CL) dark gray, very stiff, trace gravel										
95			SS 18	44	4-25-46 (71)	6.0	106	12				
		97.0										
		LEAN CLAY, (CL) dark gray, very stiff, trace sand, trace gravel										
100			SS 19	56	13-20-14 (34)	2.3	105	22				
105			SS 20		21-79/5"							
110			SS 21	94	16-54-37 (91)	6.0	109	18				
		111.0										

101.7
100.2
96.2
82.2

Bottom of borehole at 111.0 feet.
Borehole grouted.

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BORING NUMBER SB-02

Long: -96.77389
Lat: 46.90554

CLIENT FOURFRONT Design, Inc.
PROJECT NAME Fargo VA - Building 1 Expansion
PROJECT NUMBER 20.FGO10880.000
PROJECT LOCATION Fargo, North Dakota
DATE STARTED 10/7/20 **COMPLETED** 10/7/20
GROUND ELEVATION 194.7 feet **HOLE SIZE** 6 1/2 in.
DRILLING CONTRACTOR NTI
GROUND WATER LEVELS:
DRILLING METHOD 3 1/4 in H.S.A
AT TIME OF DRILLING --- No Groundwater Encountered
LOGGED BY Chris Nelson **CHECKED BY** Dan Gibson
AT END OF DRILLING ---
CAVE IN (ft) NR **FROST DEPTH (ft)** NA
AFTER DRILLING ---
NOTES

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES
0		0.3 TOPSOIL, ORGANIC CLAY, (OH) black 194.5	AU 1									
		FILL, FAT CLAY, brown to black, trace lenses of sand	SS 2	44	3-3-5 (8)	2.1	88	29				
5			SS 3	56	2-2-4 (6)	2.2	80	34				
		6.5 188.2										
		FAT CLAY, (CH) brown, medium	SS 4	78	2-2-3 (5)	1.2	88	34				
		9.0 185.7										
10		FAT CLAY, (CH) dark gray, medium	SS 5	83	2-2-3 (5)	1.4	91	32				
		11.5 183.2										
		FAT CLAY, (CH) brown, medium	SS 6	94	2-2-4 (6)	1.2	91	33				
15			SS 7	111	2-3-5 (8)	1.7	91	32				
			SS 8	100	2-4-4 (8)	1.5	96	30				
		19.0 175.7										
20		FAT CLAY, (CH) brown to gray, rather stiff, trace laminations of silt	SS 9	111	4-4-8 (12)	2.8	94	29				
		23.0 171.7										
		FAT CLAY, (CH) brown, rather stiff										
25			SS 10	111	3-5-6 (11)	2.8	95	29				
		26.0 168.7										

Bottom of borehole at 26.0 feet.
Borehole backfilled with auger cuttings.

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BORING NUMBER SB-03

Long: -96° 46' 25.5288"
Lat: 46° 54' 20.3652"

CLIENT FOURFRONT Design, Inc.
PROJECT NAME Fargo VA - Building 1 Expansion
PROJECT NUMBER 20.FGO10880.000
PROJECT LOCATION Fargo, North Dakota
DATE STARTED 10/9/20 **COMPLETED** 10/9/20
GROUND ELEVATION 194.7 feet **HOLE SIZE** 6 1/2 in.
DRILLING CONTRACTOR NTI
GROUND WATER LEVELS:
DRILLING METHOD 3 1/4 in. H.S.A. then Rotary Drilling with Mud
AT TIME OF DRILLING --- --
LOGGED BY Chris Nelson **CHECKED BY** Dan Gibson
AT END OF DRILLING ---
CAVE IN (ft) NR **FROST DEPTH (ft)** NA
AFTER DRILLING ---
NOTES

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES
0		0.3 TOPSOIL, ORGANIC CLAY, (OH) black 194.5	AU 1									
		FILL, FAT CLAY, dark brown to black, trace sand	SS 2	56	4-4-5 (9)		90	28				
5			SS 3	56	4-4-5 (9)	3.0	91	28				
		6.2 188.5 FAT CLAY, (CH) brown, medium	SS 4	67	3-3-4 (7)	2.8	92	31				
		9.0 185.7 FAT CLAY, (CH) gray, medium	SS 5	83	3-3-4 (7)	1.1	88	35				
10		11.5 183.2 FAT CLAY, (CH) dark gray, medium	SS 6	89	2-3-4 (7)	1.3	88	33				
			SS 7	111	2-2-3 (5)	1.3	78	42				
15			SS 8	117	2-2-3 (5)	2.0	90	31				
		18.0 176.7 FAT CLAY, (CH) gray, medium										
		19.0 175.7 FAT CLAY, (CH) brown to gray, medium	SS 9	100	2-3-4 (7)	2.4	91	32				
20		23.0 171.7 FAT CLAY, (CH) light brown to light gray, medium										
			SS 10	94	2-3-3 (6)	1.5	95	30				
25												
			SS 11	100	2-3-5 (8)	1.8	92	30				
30												
		35.0 159.7 FAT CLAY, (CH) dark gray, soft	SS 12	133	0-1-2 (3)	0.8	60	66				
35												

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BORING NUMBER SB-03

Long: -96° 46' 25.5288"
Lat: 46° 54' 20.3652"

CLIENT FOURFRONT Design, Inc.
PROJECT NAME Fargo VA - Building 1 Expansion
PROJECT NUMBER 20.FGO10880.000
PROJECT LOCATION Fargo, North Dakota

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES
40		FAT CLAY, (CH) dark gray, soft *(continued)*										
45			SS 13	133	1-1-2 (3)	0.6	60	67				
50												
55			SS 14	133	1-1-1 (2)	0.6	63	63				
60												
65			SS 15	133	1-1-2 (3)	0.6	69	55				
70												
75			SS 16	133	1-2-2 (4)	0.8	75	48				
80												

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Long: -96° 46' 25.5288"
Lat: 46° 54' 20.3652"

CLIENT FOURFRONT Design, Inc.
PROJECT NAME Fargo VA - Building 1 Expansion
PROJECT NUMBER 20.FGO10880.000
PROJECT LOCATION Fargo, North Dakota

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES
		FAT CLAY, (CH) dark gray, soft *(continued)*										
85			SS 17	133	2-2-2 (4)	0.7	80	42				
90												
		93.0 / 101.7										
		94.0 / 100.7 POORLY GRADED GRAVEL, (GP) gray										
95		95.0 / 99.7 LEAN CLAY, (CL) dark gray, very stiff, trace sand, trace gravel	SS 18	100	21-30-63 (93)	6.0	107	16				
		SILTY SAND, (SM) dark red, very dense										
100			SS 19	85	39-61/6"							
		103.0 / 91.7										
		SANDY LEAN CLAY, (CL) dark gray, very stiff, trace gravel										
105		106.0 / 88.7	SS 20			4.9	109	15				

Bottom of borehole at 106.0 feet.
Borehole grouted.

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Fargo, ND 58103
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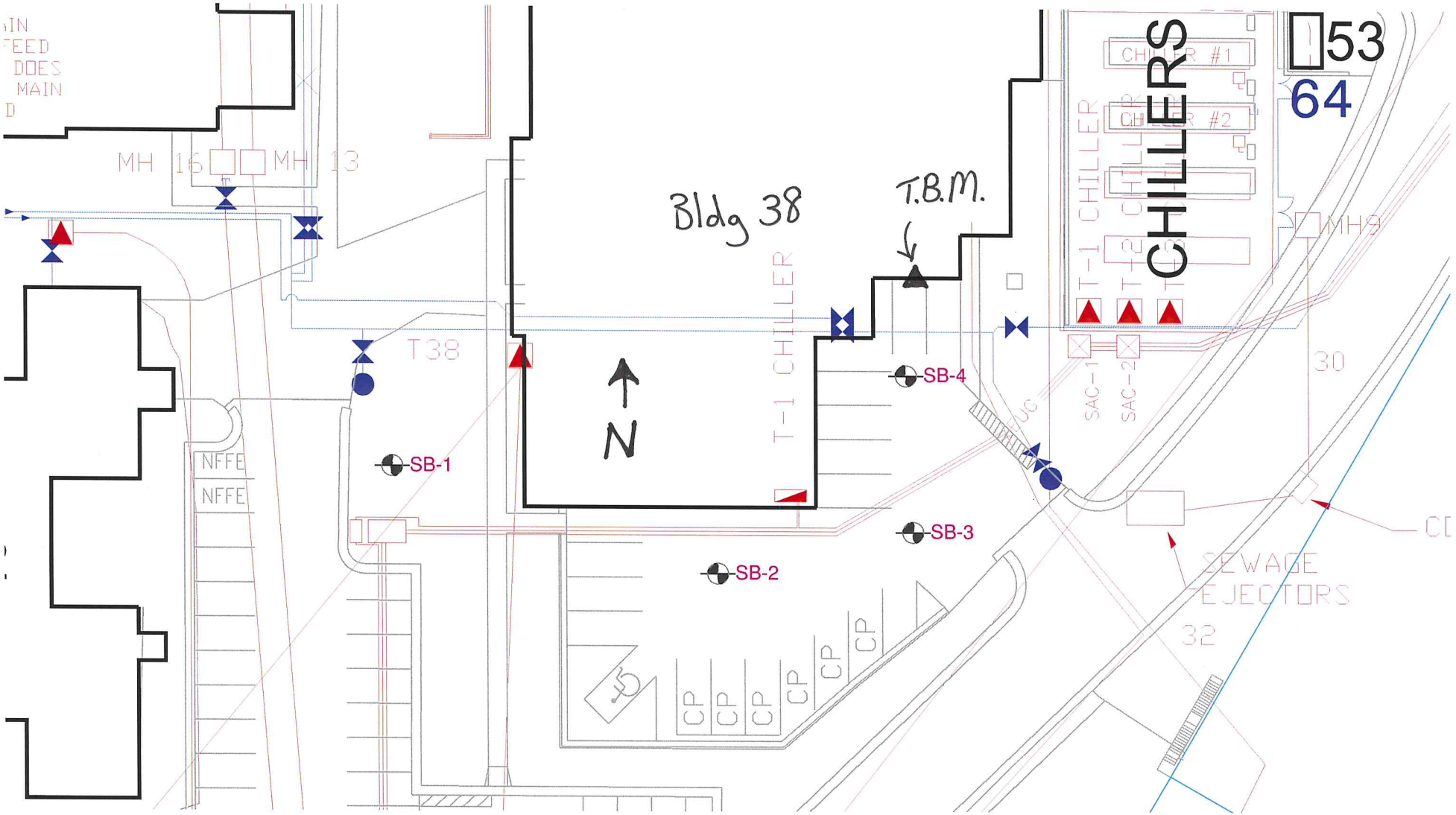
BORING NUMBER SB-04

Long: -96.773966
Lat: 46.905681

CLIENT FOURFRONT Design, Inc.
PROJECT NAME Fargo VA - Building 1 Expansion
PROJECT NUMBER 20.FGO10880.000
PROJECT LOCATION Fargo, North Dakota
DATE STARTED 10/7/20 **COMPLETED** 10/7/20
GROUND ELEVATION 195.9 feet **HOLE SIZE** 6 1/2 in.
DRILLING CONTRACTOR NTI
GROUND WATER LEVELS:
DRILLING METHOD 3 1/4 in H.S.A
▽ **AT TIME OF DRILLING** 9.00 ft / Elev 186.90 ft
LOGGED BY Chris Nelson **CHECKED BY** Dan Gibson
AT END OF DRILLING ---
CAVE IN (ft) NR **FROST DEPTH (ft)** NA
AFTER DRILLING ---
NOTES

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES
0		0.5 TOPSOIL, ORGANIC CLAY, (OH) black 195.4	AU 1									
		FILL, FAT CLAY, brown to black	SS 2	44	3-2-3 (5)	1.7	88	34				
5			SS 3	56	2-2-4 (6)	1.8						
		6.5 189.4 FAT CLAY, (CH) dark brown, moist, medium to soft										
		▽	SS 4	94	2-2-3 (5)	1.6	91	34				
10			SS 5	106	2-2-2 (4)	1.0	80	45				
		11.5 184.4 FAT CLAY, (CH) brown, moist, medium to rather stiff	SS 6	111	2-2-4 (6)	1.8	94	32				
15			SS 7	111	2-4-5 (9)	3.5	96	29				
			SS 8	117	2-4-4 (8)	2.7	98	28				
20			SS 9	117	3-6-7 (13)	4.7	100	27				
		23.0 172.9 FAT CLAY, (CH) dark gray, medium										
25			SS 10	133	2-3-3 (6)	0.9	63	62				
		26.0 169.9										

Bottom of borehole at 26.0 feet.
Borehole backfilled with auger cuttings.


MH 16
MH 13
Bldg 38
T.B.M.
T-1 CHILLER
CHILLERS
T-1 CHILLER
T-2 CHILLER
CHILLER #1
CHILLER #2
53
64
MH9
30
T38
N
SB-1
SB-2
SB-3
SB-4
NFFE
NFFE
SAC-1
SAC-2
SEWAGE EJECTORS
32
CP
CP
CP
CP
CP
CP

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Fargo, North Dakota 58103
Telephone: 701-232-1822
Fax: 701-232-1864

BORING NUMBER SB-1

CLIENT Image Group Architecture and Interiors
PROJECT NAME VA Medical Center - Outpatient Treatment Space
PROJECT NUMBER 11-11161.100
PROJECT LOCATION Fargo, North Dakota
DATE STARTED 7/17/11 **COMPLETED** 7/17/11
GROUND ELEVATION 87.4 ft **HOLE SIZE** 6 1/2"
DRILLING CONTRACTOR NTI
GROUND WATER LEVELS:
DRILLING METHOD 3 1/4" H.S.A.
AT TIME OF DRILLING ---
LOGGED BY TS **CHECKED BY** DG
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0							
	AU 1						**Topsoil / Fill,** Organic fat clay, black (OH)
	SS 2		4-4-6 (10)				
5							
	SS 3		5-6-8 (14)				
							7.0 80.4
	SS 4		2-4-5 (9)	PP = 3.4 tsf MC = 30% DD = 92 pcf			Fat Clay, brown and gray, lenses of light gray silt, rather stiff to medium (CH)
10							
	SS 5		2-3-6 (9)	PP = 2.9 tsf MC = 32% DD = 90 pcf			
	SS 6		2-3-4 (7)	PP = 1.7 tsf MC = 29% DD = 94 pcf			
15							
	SS 7		1-3-5 (8)	PP = 2.3 tsf MC = 31% DD = 90 pcf	CH		
20							
	SS 8		1-4-5 (9)	PP = 2.7 tsf MC = 28% DD = 96 pcf Qu = 450 psf			
25							
	SS 9		2-3-5 (8)	PP = 1.8 tsf MC = 31% DD = 91 pcf Qu = 875 psf			
							27.5 59.9
30							Fat Clay, dark gray, soft (CH)
	SS 10	89	2-3-5 (8)	PP = 3.0 tsf MC = 36% DD = 86 pcf Qu = 500 psf			
35					CH		
40							

(Continued Next Page)

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Telephone: 701-232-1822
Fax: 701-232-1864

BORING NUMBER SB-1

CLIENT Image Group Architecture and Interiors **PROJECT NAME** VA Medical Center - Outpatient Treatment Space

PROJECT NUMBER 11-11161.100 **PROJECT LOCATION** Fargo, North Dakota

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
40							
	SS 11	111	1-1-1 (2)	PP = 0.5 tsf MC = 73% DD = 59 pcf			Fat Clay, dark gray, soft (CH) *(continued)*
45							
50	SS 12	111	0-1-1 (2)	PP = 0.5 tsf MC = 70% DD = 59 pcf			
55							
60	SS 13	111	0-0-1 (1)	PP = 0.5 tsf MC = 56% DD = 68 pcf			
65					CH		
70	SS 14	111	0-1-2 (3)	PP = 0.5 tsf MC = 60% DD = 65 pcf			
75							
80	SS 15	111	1-2-2 (4)	PP = 0.1 tsf MC = 71%			
85							

(Continued Next Page)

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Fax: 701-232-1864

BORING NUMBER SB-1

CLIENT Image Group Architecture and Interiors **PROJECT NAME** VA Medical Center - Outpatient Treatment Space

PROJECT NUMBER 11-11161.100 **PROJECT LOCATION** Fargo, North Dakota

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
90	SS 16	28	2-2-2 (4)	PP = 0.1 tsf MC = 42% DD = 82 pcf	CH		Fat Clay, dark gray, soft (CH) *(continued)*
93.5							-6.1
95					CL		Sandy Lean Clay, dark gray, very stiff (CL)
100	SS 17	78	8-12-25 (37)	PP = 1.8 tsf MC = 20%			
105.0							-17.6
105	SS 18	78	24-35-50 (85)	PP = 6.0 tsf MC = 17% DD = 112 pcf			Lean Clay, trace of gravel, dark gray, very stiff (CL)
110	SS 19	89	28-94-39 (133)	PP = 6.0 tsf MC = 18% DD = 111 pcf	CL		
115	SS 20	100	32-85-91 (176)	PP = 6.0 tsf MC = 14% DD = 120 pcf			
116.0							-28.6
							Bottom of hole at 116.0 feet.

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Fargo, North Dakota 58103
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BORING NUMBER SB-2

CLIENT Image Group Architecture and Interiors
PROJECT NAME VA Medical Center - Outpatient Treatment Space
PROJECT NUMBER 11-11161.100
PROJECT LOCATION Fargo, North Dakota
DATE STARTED 7/17/11 **COMPLETED** 7/17/11
GROUND ELEVATION 87.6 ft **HOLE SIZE** 6 1/2"
DRILLING CONTRACTOR NTI
GROUND WATER LEVELS:
DRILLING METHOD 3 1/4" H.S.A.
AT TIME OF DRILLING ---
LOGGED BY TS **CHECKED BY** DG
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION
0						**Pavement,** 5 inches of Asphalt over 7 inches of gravel. 1.0 / 86.6
	AU 1					**Topsoil / Fill,** Organic fat clay, black
	SS 2	67	2-3-5 (8)			
5						
	SS 3	67	3-4-6 (10)			
	SS 4	67	2-3-6 (9)	PP = 2.2 tsf		9.0 / 78.6
10						Fat Clay, Grayish brown, lenses of light gray silt, medium to rather stiff (CH)
	SS 5	78	1-3-3 (6)	PP = 2.5 tsf		
	SS 6	89	2-2-4 (6)	PP = 1.6 tsf		
15						
	SS 7	100	2-3-4 (7)	PP = 3.1 tsf		
20						
	SS 8	100	1-4-5 (9)	PP = 23.2 tsf		22.0 / 65.6
						Fat Clay, Dark gray, rather stiff (CH)
25						
	SS 9	100	2-4-5 (9)	PP = 2.6 tsf		26.0 / 61.6
						Bottom of hole at 26.0 feet.

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BORING NUMBER SB-3

CLIENT Image Group Architecture and Interiors
PROJECT NAME VA Medical Center - Outpatient Treatment Space
PROJECT NUMBER 11-11161.100
PROJECT LOCATION Fargo, North Dakota
DATE STARTED 7/17/11 **COMPLETED** 7/17/11
GROUND ELEVATION 85.4 ft **HOLE SIZE** 6 1/2"
DRILLING CONTRACTOR NTI
GROUND WATER LEVELS:
DRILLING METHOD 3 1/4" H.S.A.
AT TIME OF DRILLING ---
LOGGED BY TS **CHECKED BY** DG
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION
0						
						Pavement, 5 inches of Asphalt over 7 inches of gravel. 1.0 / 84.4
	AU 1					**Topsoil / Fill,** Organic fat clay, black
	SS 2	33	3-5-6 (11)			
5						
	SS 3	56	3-4-6 (10)			7.0 / 78.4
						Fill, Fat clay, dark gray, medium (CH)
	SS 4	56	2-3-4 (7)			
10						10.0 / 75.4
	SS 5	78	2-2-3 (5)	PP = 1.4 tsf		Fat Clay, Brown and gray, medium (CH)
	SS 6	89	1-2-3 (5)	PP = 1.3 tsf		
15						
	SS 7	89	1-2-3 (5)	PP = 1.5 tsf		17.0 / 68.4
						Fat Clay, Grayish brown, medium to rather stiff (CH)
20						
	SS 8	78	1-3-4 (7)	PP = 2.0 tsf		
25						
	SS 9	67	1-4-5 (9)	PP = 2.2 tsf		26.0 / 59.4
						Bottom of hole at 26.0 feet.

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BORING NUMBER SB-4

CLIENT Image Group Architecture and Interiors
PROJECT NAME VA Medical Center - Outpatient Treatment Space
PROJECT NUMBER 11-11161.100
PROJECT LOCATION Fargo, North Dakota
DATE STARTED 7/17/11 **COMPLETED** 7/17/11
GROUND ELEVATION 85.8 ft **HOLE SIZE** 6 1/2"
DRILLING CONTRACTOR NTI
GROUND WATER LEVELS:
DRILLING METHOD 3 1/4" H.S.A.
AT TIME OF DRILLING ---
LOGGED BY TS **CHECKED BY** DG
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
0								
							1.0 **Pavement,** 5 inches of Asphalt over 7 inches of gravel.	84.8
	AU 1						**Topsoil / Fill,** Organic fat clay, black and dark gray	
	SS 2	33	2-4-6 (10)					
5								
	SS 3	56	3-3-6 (9)				7.5	78.3
	SS 4	78	2-4-6 (10)	PP = 3.5 tsf MC = 28% DD = 95 pcf			**Fill,** Fat Clay, Brown and gray, rather stiff to soft (CH)	
10								
	SS 5	89	2-2-3 (5)	PP = 1.3 tsf MC = 35% DD = 85 pcf	CH			
	SS 6	78	1-2-3 (5)	PP = 1.2 tsf MC = 38% DD = 82 pcf			13.0	72.8
15							Fat Clay, Brown and dark gray, rather stiff to soft (CH)	
	SS 7	100	1-1-3 (4)	PP = 1.3 tsf MC = 40% DD = 81 pcf	CH			
							17.0	68.8
20							Fat Clay, Grayish brown, medium to rather stiff (CH)	
	SS 8	100	1-3-4 (7)	PP = 1.5 tsf MC = 36% DD = 86 pcf	CH			
25							25.0	60.8
	SS 9	89	1-4-5 (9)	PP = 2.2 tsf MC = 27% DD = 98 pcf			Fat Clay, Dark gray with brown mottling, medium (CH)	
30					CH			
	SS 10	100	2-3-5 (8)	PP = 1.7 tsf MC = 30% DD = 93 pcf Qu = 475 psf			33.0	52.8
35							Fat Clay, Dark gray, soft to medium (CH)	
	SS 11	100	1-1-1 (2)	PP = 0.5 tsf MC = 71% DD = 58 pcf Qu = 300 psf	CH			
40								

GENERAL BH / TP / WELL VA LOGS.GPJ GINT US.GDT 8/23/11

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BORING NUMBER SB-4

CLIENT Image Group Architecture and Interiors **PROJECT NAME** VA Medical Center - Outpatient Treatment Space

PROJECT NUMBER 11-11161.100 **PROJECT LOCATION** Fargo, North Dakota

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
40							
	SS 12	100	0-1-1 (2)	PP = 0.4 tsf MC = 69% DD = 59 pcf Qu = 550 psf			Fat Clay, Dark gray, soft to medium (CH) *(continued)*
45							
	SS 13	100	0-0-1 (1)	PP = 0.5 tsf MC = 59% DD = 65 pcf			
50							
	SS 14	100	0-0-1 (1)	PP = 0.4 tsf MC = 66%			
55							
	SS 15	67	2-2-2 (4)	PP = 0.6 tsf MC = 66% DD = 62 pcf			
60							
	SS 16	111	0-1-1 (2)	PP = 0.5 tsf MC = 55% DD = 66 pcf	CH		
65							
	SS 17	111	0-1-1 (2)	PP = 0.5 tsf MC = 82% DD = 61 pcf			
70							
	SS 18	111	0-1-1 (2)	PP = 0.5 tsf MC = 49% DD = 73 pcf			
75							
	SS 19	111	0-1-1 (2)	PP = 0.5 tsf MC = 50% DD = 71 pcf			
80							
	SS 20	111	1-1-2 (3)	PP = 0.3 tsf MC = 60% DD = 65 pcf			
85							
	SS		1-1-1	PP = 0.2 tsf			

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BORING NUMBER SB-4

CLIENT Image Group Architecture and Interiors **PROJECT NAME** VA Medical Center - Outpatient Treatment Space

PROJECT NUMBER 11-11161.100 **PROJECT LOCATION** Fargo, North Dakota

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
	21	111	(2)	MC = 57% DD = 68 pcf	CH		Fat Clay, Dark gray, soft to medium (CH) *(continued)*
90	SS 22	111	1-2-3 (5)	PP = 0.1 tsf MC = 52% DD = 70 pcf			92.0 -6.2
95	SS 23	67	18-20-23 (43)	PP = 1.5 tsf MC = 18% DD = 114 pcf	CL		Lean Clay, trace of gravel, dark gray, very stiff (CL)
100	SS 24	78	21-27-34 (61)	PP = 2.9 tsf MC = 21%			102.5 -16.7
105	SS 25	100	35-66-128 (194)	PP = 4.7 tsf MC = 21% DD = 101 pcf	CL		Sandy Lean Clay, dark gray, very stiff (CL)
110	SS 26	100	42-78-135 (213)	PP = 4.4 tsf MC = 19% DD = 103 pcf			111.0 -25.2 Bottom of hole at 111.0 feet.

Job Summary

Job Date : 10/6/2020

Customer	Northern Technologies Inc.	**Phone Number**	701.232.1822

Billing Address	City	State	Zip
3522 4th Ave S	Fargo	ND	58103

Job Details

Jobsite Location	2101 N. ELM ST
City	FARGO
State	ND

WA Number	222567
Job Num	
PO Num	

Lead Technician	BARTLETT, TROY	**Phone**	320-247-0451	**Email**	troy.bartlett@gprsinc.com

Thank you for using GPRS on your project. We appreciate the opportunity to work with you. If you have questions regarding the results of this scanning, please contact the lead GPRS technician on this project.

EQUIPMENT USED

The following equipment was used on this project:

- Underground Scanning GPR antenna. Typically capable of detecting objects up to 8' deep or more in ideal conditions but maximum effective depth can vary widely and depends on site and soil conditions. Depth penetration is most commonly limited by moisture and clay/conductive soils. Depths provided should always be treated as estimates as their accuracy can be affected by multiple factors.
- Electromagnetic Pipe and Cable Locator. Detects electromagnetic fields. Used to actively trace conductive pipes and tracer wires, or passively detect power and radio signals traveling along conductive pipes and utilities. Depths provided should always be treated as estimates as their accuracy can be affected by multiple factors.
- Scanning to mark private utilities within 10' radius of four soil boring locations located in area SE of VA hospitals old chiller plant.

Work Performed

Ground Penetrating Radar Systems performed the following work on this project:

Underground Utility

The scope of work included scanning the specified area to locate underground utilities. A tracer signal was sent along any accessible metallic utility or tracer wire, and the area was scanned with GPR to locate any additional targets. The locations of any detected utilities and anomalies were marked directly at the site with paint, flags, stakes, or other appropriate means, and results were reviewed with onsite personnel unless otherwise noted.

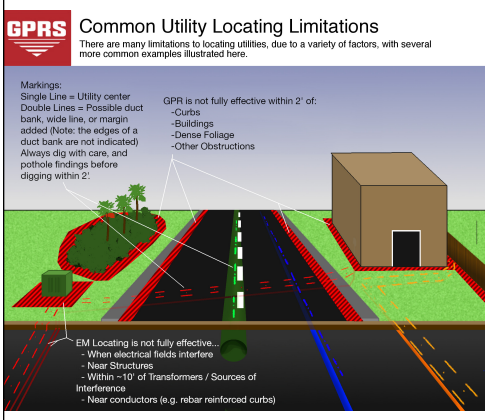
- The total area scanned was approximately 7500 square feet.
- The scope of work included scanning the areas around proposed soil borings. A radius of approximately 10' around each proposed soil boring was scanned unless otherwise noted. A total of four boring locations were scanned.
- Using Rd 8100/400 MHz GPR to scan to mark private utilities/live power/unknown anomalies within 10' radius of up to four soil boring locations on SE side of VA hospital near old chiller plant.

Job Summary

Job Date : 10/6/2020

- The effective depth of GPR will vary throughout a site depending on surface and soil conditions. In this area, the maximum effective GPR depth was approximately 3 feet.
- Used Rd 8100/400 MHz GPR to scan to attempt to mark private utilities in 10' radius of four soil boring locations. Marked lines verified and unknowns with paint/flags. Hand dig within 2' of markings. Used Rd in passive mode to sweep for live power and unknowns in areas staked for future soil bores. Effective depth of GPR less than 2 feet. Could not verify any utilities with 400 MHz GPR due to site/soil conditions. Verified site lighting and some but not all sanitary lines. Reviewed findings on site wiyh Dan Gibson.

Pictures



Utility Limitations

Job Summary

Job Date : 10/6/2020

TERMS & CONDITIONS

http://www.gprsinc.com/termsandconditions.html

Job Summary

Job Date : 10/6/2020

SIGNATURE

X

Contact Name

Dan Gibson 701.232.1822 dang@ntigeo.com