# SECTION 28 05 13
# CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY

## PART 1 - GENERAL

### 1.1 DESCRIPTION

A. This section specifies the finishing, installation, connection, testing and certification the conductors and cables required for a fully functional for electronic safety and security (ESS) system.

### 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 28 05 00 – COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY. Requirements for general requirements that are common to more than one section in Division 28.

D. Section 28 05 26 - GROUNDING AND BONDING FOR ELECTRONIC SAFETY AND SECURITY. Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.

E. Section 28 05 28.33 - CONDUITS AND BOXES FOR ELECTRONIC SECURITY AND SAFETY. Requirements for infrastructure.

F. Section 31 20 00 - EARTH MOVING. For excavation and backfill for cables that are installed in conduit.

### 1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. EMI: Electromagnetic interference.

C. IDC: Insulation displacement connector.

D. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).

E. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.

F. Open Cabling: Passing telecommunications cabling through open space (e.g., between the studs of a wall cavity).

G. RCDD: Registered Communications Distribution Designer.

H. Solid-Bottom or Nonventilated Cable Tray: A fabricated structure consisting of integral or separate longitudinal side rails, and a bottom without ventilation openings.

I. Trough or Ventilated Cable Tray: A fabricated structure consisting of integral or separate longitudinal rails and a bottom having openings sufficient for the passage of air and using 75 percent or less of the plan area of the surface to support cables.

J. UTP: Unshielded twisted pair.

**1.4 QUALITY ASSURANCE**

A. See section 28 05 00, Paragraph 1.4.

**1.5 SUBMITTALS**

A. In accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, furnish the following:
   1. Manufacturer's Literature and Data: Showing each cable type and rating.
   2. Certificates: Two weeks prior to final inspection, deliver to the COR four copies of the certification that the material is in accordance with the drawings and specifications and diagrams for cable management system.
   3. Shop Drawings: Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:
      a. Vertical and horizontal offsets and transitions.
      b. Clearances for access above and to side of cable trays.
      c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
      d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.
      e. System labeling schedules, including electronic copy of labeling schedules that are part of the cable and asset identification system of the software specified in Parts 2 and 3.
   4. Wiring Diagrams. Show typical wiring schematics including the following:
      a. Workstation outlets, jacks, and jack assemblies.
      b. Patch cords.
      c. Patch panels.
   5. Cable Administration Drawings: As specified in Part 3 "Identification" Article.
   6. Project planning documents as specified in Part 3.
   7. Maintenance Data: For wire and cable to include in maintenance manuals.

**1.6 APPLICABLE PUBLICATIONS**

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

B. American Society of Testing Material (ASTM):

D2301-04 .....Standard Specification for Vinyl Chloride Plastic Pressure Sensitive Electrical Insulating Tape

C. Federal Specifications (Fed. Spec.):

A-A-59544-08.....Cable and Wire, Electrical (Power, Fixed Installation)

D. National Fire Protection Association (NFPA):

70-11 .....National Electrical Code (NEC)

E. Underwriters Laboratories, Inc. (UL):

| | |
|---|---|
| 44-05 | Thermoset-Insulated Wires and Cables |
| 83-08 | Thermoplastic-Insulated Wires and Cables |
| 467-07 | Electrical Grounding and Bonding Equipment |
| 486A-03 | Wire Connectors and Soldering Lugs for Use with Copper Conductors |
| 486C-04 | Splicing Wire Connectors |
| 486D-05 | Insulated Wire Connector Systems for Underground Use or in Damp or Wet Locations |
| 486E-00 | Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors |
| 493-07 | Thermoplastic-Insulated Underground Feeder and Branch Circuit Cable |
| 514B-04 | Fittings for Cable and Conduit |
| 1479-03 | Fire Tests of Through-Penetration Fire Stops |

**1.7 DELIVERY, STORAGE, AND HANDLING**

A. Test cables upon receipt at Project site.
   1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical loss test set.
   2. Test optical fiber cable on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector; include the loss value of each. Retain test data and include the record in maintenance data.
   3. Test each pair of UTP cable for open and short circuits.

**1.8 PROJECT CONDITIONS**

A. Environmental Limitations: Do not deliver or install UTP, optical fiber, and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

**PART 2 - PRODUCTS**

**2.1 GENERAL**

A. General: All cabling locations shall be in conduit systems as outlined in Division 28 unless a waiver is granted in writing or an exception is noted on the construction drawings.

**2.2 UTP CABLE**

A. Description: 100-ohm, 4-pair UTP, formed into 25-pair binder groups covered with a blue thermoplastic jacket.
   1. Comply with ICEA S-90-661 for mechanical properties.
   2. Comply with TIA/EIA-568-B.1 for performance specifications.

3. Comply with TIA/EIA-568-B.2, Category 6.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
   a. Communications, General Purpose: Type CM or CMG ; or MPP, CMP, MPR, CMR, MP, or MPG.
   b. Communications, Plenum Rated: Type CMP ; or MPP, complying with NFPA 262.
   c. Communications, Limited Purpose: Type CMX; or MPP, CMP, MPR, CMR, MP, MPG, CM, or CMG.
   d. Multipurpose: Type MP or MPG ; or MPP or MPR.
   e. Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.

**2.3 UTP CABLE HARDWARE**

A. UTP Cable Connecting Hardware: IDC type, using modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of the same category or higher.

B. Connecting Blocks: 110-style for Category 6. Provide blocks for the number of cables terminated on the block, plus 25percent spare. Integral with connector bodies, including plugs and jacks where indicated.

**2.4 OPTICAL FIBER CABLE**

A. Description: Multimode, 50/125 -micrometer, 24 -fiber, nonconductive, tight buffer, optical fiber cable.
   1. Comply with ICEA S-83-596 for mechanical properties.
   2. Comply with TIA/EIA-568-B.3 for performance specifications.
   3. Comply with TIA/EIA-492AAAA-Bfor detailed specifications.
   4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
      a. General Purpose, Nonconductive: Type OFN or OFNG , or OFNR, OFNP.
      b. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
   5. Maximum Attenuation: 3.50 dB/km at 850 nm;.
   6. Minimum Modal Bandwidth: 160 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

B. Jacket:
   1. Jacket Color: Aqua for 50/125-micrometer cable.
   2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-B.
   3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches (1000 mm).

**2.5 OPTICAL FIBER CABLE HARDWARE**

A. Cable Connecting Hardware: Meet the Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with TIA/EIA-568-B.3.

1. Quick-connect, simplex and duplex, Type SC connectors. Insertion loss shall be not more than 0.75 dB.
2. Type SFF connectors may be used in termination racks, panels, and equipment packages.

**2.6 LOW-VOLTAGE CONTROL CABLE**

A. Paired Lock Cable: NFPA 70, Type CMG.
   1. 1 pair, twisted, No. 16 AWG, stranded (19x29) tinned copper conductors.
   2. PVC insulation.
   3. Unshielded.
   4. PVC jacket.
   5. Flame Resistance: Comply with UL 1581.

B. Plenum-Rated, Paired Lock Cable: NFPA 70, Type CMP.
   1. 1 pair, twisted, No. 16 AWG, stranded (19x29) tinned copper conductors.
   2. PVC insulation.
   3. Unshielded.
   4. PVC jacket.
   5. Flame Resistance: Comply with NFPA 262.

C. Paired Lock Cable: NFPA 70, Type CMG.
   1. 1 pair, twisted, No. 18 AWG, stranded (19x30) tinned copper conductors.
   2. PVC insulation.
   3. Unshielded.
   4. PVC jacket.
   5. Flame Resistance: Comply with UL 1581.

D. Plenum-Rated, Paired Lock Cable: NFPA 70, Type CMP.
   1. 1 pair, twisted, No. 18 AWG, stranded (19x30) tinned copper conductors.
   2. Fluorinated ethylene propylene insulation.
   3. Unshielded.
   4. Plastic jacket.
   5. Flame Resistance: NFPA 262, Flame Test.

**2.7 CONTROL-CIRCUIT CONDUCTORS**

A. Class 1 Control Circuits: Stranded copper, Type THHN-THWN, in raceway complying with UL 83.

**2.8 IDENTIFICATION PRODUCTS**

A. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

**2.9 SOURCE QUALITY CONTROL**

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test UTP and optical fiber cables on reels according to TIA/EIA-568-B.1.

C. Factory test UTP cables according to TIA/EIA-568-B.2.

D. Factory test multimode optical fiber cables according to TIA/EIA-526-14-A and TIA/EIA-568-B.3.

E. Factory sweep test coaxial cables at frequencies from 5 MHz to 1 GHz. Sweep test shall test the frequency response, or attenuation over frequency, of a cable by generating a voltage whose frequency is varied through the specified frequency range and graphing the results.

F. Cable will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

**2.10 WIRE LUBRICATING COMPOUND**

A. Suitable for the wire insulation and conduit it is used with, and shall not harden or become adhesive.

B. Shall not be used on wire for isolated type electrical power systems.

**2.11 FIREPROOFING TAPE**

A. The tape shall consist of a flexible, conformable fabric of organic composition coated one side with flame-retardant elastomer.

B. The tape shall be self-extinguishing and shall not support combustion. It shall be arc-proof and fireproof.

C. The tape shall not deteriorate when subjected to water, gases, salt water, sewage, or fungus and be resistant to sunlight and ultraviolet light.

D. The finished application shall withstand a 200-ampere arc for not less than 30 seconds.

E. Securing tape: Glass cloth electrical tape not less than 0.18 mm (7 mils) thick, and 19 mm (3/4 inch) wide.

**PART 3 - EXECUTION**

**3.1 INSTALLATION OF CONDUCTORS AND CABLES**

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-B.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. Terminate all conductors; no cable shall contain un-terminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
5. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
6. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.

7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
9. Pulling Cable:
    a. Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
    b. Provide installation equipment that will prevent the cutting or abrasion of insulation during pulling of cables.
    c. Use ropes made of nonmetallic material for pulling feeders.
    d. Attach pulling lines for feeders by means of either woven basket grips or pulling eyes attached directly to the conductors, as approved by the COR.
    e. Pull in multiple cables together in a single conduit.

C. Splice cables and wires where necessary only in outlet boxes, junction boxes, or pull boxes.
1. Splices and terminations shall be mechanically and electrically secure.
2. Where the Government determines that unsatisfactory splices or terminations have been installed, remove the devices and install approved devices at no additional cost to the Government.

D. Seal cable and wire entering a building from underground, between the wire and conduit where the cable exits the conduit, with a non-hardening approved compound.

E. Unless otherwise specified in other sections install wiring and connect to equipment/devices to perform the required functions as shown and specified.

F. Except where otherwise required, install a separate power supply circuit for each system so that malfunctions in any system will not affect other systems.

G. Where separate power supply circuits are not shown, connect the systems to the nearest panel boards of suitable voltages, which are intended to supply such systems and have suitable spare circuit breakers or space for installation.

H. Install a red warning indicator on the handle of the branch circuit breaker for the power supply circuit for each system to prevent accidental de-energizing of the systems.

I. System voltages shall be 120 volts or lower where shown on the drawings or as required by the NEC.

J. UTP Cable Installation:
1. Comply with TIA/EIA-568-B.2.
2. Do not untwist UTP cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.

K. Optical Fiber Cable Installation:
1. Comply with TIA/EIA-568-B.3.

2. Cable shall be terminated on connecting hardware that is rack or cabinet mounted.

L. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (600 mm).
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).
4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (75 mm).
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).
5. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
6. Separation between Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

**3.2 CONTROL CIRCUIT CONDUCTORS**

A. Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits, No. 14 AWG.
2. Class 2 low-energy, remote-control and signal circuits, No. 16 AWG.
3. Class 3 low-energy, remote-control, alarm and signal circuits, No. 12 AWG.

**3.3 CONNECTIONS**

A. Comply with requirements in Division 28 Section, PHYSICAL ACCESS CONTROL for connecting, terminating, and identifying wires and cables.

B. Comply with requirements in Division 28 Section "VIDEO SURVEILLANCE" for connecting, terminating, and identifying wires and cables.

**3.4 FIRESTOPPING**

A. Comply with requirements in Division 07 Section "PENETRATION FIRESTOPPING."

B. Comply with TIA/EIA-569-A, "Firestopping" Annex A.

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

**3.5 GROUNDING**

A. For communications wiring, comply with ANSI-J-STD-607-A and with BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. For low-voltage wiring and cabling, comply with requirements in Division 28 Section "GROUNDING AND BONDING FOR ELECTRONIC SAFETY AND SECURITY."

**3.6 IDENTIFICATION**

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A.

B. Install a permanent wire marker on each wire at each termination.

C. Identifying numbers and letters on the wire markers shall correspond to those on the wiring diagrams used for installing the systems.

D. Wire markers shall retain their markings after cleaning.

E. In each handhole, install embossed brass tags to identify the system served and function.

**3.7 FIELD QUALITY CONTROL**

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Visually inspect UTP and optical fiber cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA/EIA-568-B.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test UTP cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross connection.
    a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
4. Optical Fiber Cable Tests:
    a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
    b. Link End-to-End Attenuation Tests:
        1) Multimode Link Measurements: Test at 850 or 1300 nm in 1 direction according to TIA/EIA-526-14-A, Method B, One Reference Jumper.

2) Attenuation test results for links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-B.1.

D. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

**3.8 EXISITNG WIRING**

A. Unless specifically indicated on the plans, existing wiring shall not be reused for the new installation. Only wiring that conforms to the specifications and applicable codes may be reused. If existing wiring does not meet these requirements, existing wiring may not be reused and new wires shall be installed.

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**SECTION 28 05 26**
**GROUNDING AND BONDING FOR ELECTRONIC SAFETY AND SECURITY**

## PART 1 - GENERAL

### 1.1 DESCRIPTION

A. This section specifies the finishing, installation, connection, testing and certification of the grounding and bonding required for a fully functional extension of the existing Electronic Safety and Security (ESS) system.

B. “Grounding electrode system” refers to all electrodes required by NEC, as well as including made, supplementary, grounding electrodes.

C. The terms “connect” and “bond” are used interchangeably in this specification and have the same meaning

### 1.2 RELATED WORK

A. Section 01 00 00 - GENERAL REQUIREMENTS. For General Requirements.

B. Section 26 41 00 - FACILITY LIGHTNING PROTECTION. Requirements for a lightning protection system.

C. Section 28 05 00 - REQUIREMENTS FOR ELECTRONIC SAFETY AND SECURITY INSTALLATIONS. For general electrical requirements, quality assurance, coordination, and project conditions that are common to more than one section in Division 28.

D. Section 28 05 13 - CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY. Requirements for low voltage power and lighting wiring.

### 1.3 SUBMITTALS

A. Submit in accordance with Section 28 05 00, COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY.

B. Shop Drawings:

1. Clearly present enough information to determine compliance with drawings and specifications.
2. Include the location of system grounding electrode connections and the routing of aboveground and underground grounding electrode conductors.

C. Test Reports: Provide certified test reports of ground resistance.

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

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

**1.4 APPLICABLE PUBLICATIONS**

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

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

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

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

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

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

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

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

D. National Fire Protection Association (NFPA):

70-11 ..... National Electrical Code (NEC)

99-2005 ..... Health Care Facilities

E. Underwriters Laboratories, Inc. (UL):

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

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

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

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

**PART 2 - PRODUCTS**

**2.1 GROUNDING AND BONDING CONDUCTORS**

A. Equipment grounding conductors shall be UL 83 insulated stranded copper, except that sizes 6 mm² (10 AWG) and smaller shall be solid copper. Insulation color shall be continuous green for all equipment grounding conductors, except that wire sizes 25 mm² (4 AWG) and larger shall be permitted to be identified per NEC.

B. Bonding conductors shall be ASTM B8 bare stranded copper, except that sizes 6 mm² (10 AWG) and smaller shall be ASTM B1 solid bare copper wire.

**2.2 SPLICES AND TERMINATION COMPONENTS**

A. Components shall meet or exceed UL 467 and be clearly marked with the manufacturer, catalog number, and permitted conductor size(s).2.4 ground connections

B. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

C. Below Grade: Exothermic-welded type connectors.

D. Above Grade:

1. Bonding Jumpers: Compression-type connectors, using zinc-plated fasteners and external tooth lockwashers.
2. Ground Busbars: Two-hole compression type lugs, using tin-plated copper or copper alloy bolts and nuts.
3. Rack and Cabinet Ground Bars: One-hole compression-type lugs, using zinc-plated or copper alloy fasteners.
4. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.
   a) Pipe Connectors: Clamp type, sized for pipe.
5. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

**2.3 GROUND TERMINAL BLOCKS**

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

**2.4 SPLICE CASE GROUND ACCESSORIES**

A. Splice case grounding and bonding accessories shall be supplied by the splice case manufacturer when available. Otherwise, use 16 mm² (6 AWG) insulated ground wire with shield bonding connectors.

**PART 3 - EXECUTION**

**3.1 GENERAL**

A. Ground in accordance with the NEC, as shown on drawings, and as specified herein.
B. Equipment Grounding: Metallic structures, including ductwork and building steel, enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits, shall be bonded and grounded.

**3.2 INACCESSIBLE GROUNDING CONNECTIONS**

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

**3.3 CORROSION INHIBITORS**

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

**3.4 CONDUCTIVE PIPING**

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

**3.5 WIREWAY GROUNDING**

A. Ground and Bond Metallic Wireway Systems as follows:

1. Bond the metallic structures of wireway to provide 100 percent electrical continuity throughout the wireway system by connecting a 16 mm² (6 AWG) bonding jumper at all intermediate metallic enclosures and across all section junctions.
2. Install insulated 16 mm² (6 AWG) bonding jumpers between the wireway system bonded as required in paragraph 1 above, and the closest building ground at each end and approximately every 16 meters (50 feet).
3. Use insulated 16 mm² (6 AWG) bonding jumpers to ground or bond metallic wireway at each end at all intermediate metallic enclosures and cross all section junctions.
4. Use insulated 16 mm² (6 AWG) bonding jumpers to ground cable tray to column-mounted building ground plates (pads) at each end and approximately every 15 meters.

**3.6 EXTERIOR LIGHT/CAMERA POLES**

A. Provide 20 ft of No. 4 bare copper coiled at bottom of pole base excavation prior to pour, plus additional unspliced length in and above foundation as required to reach pole ground stud.

**3.7 GROUND RESISTANCE**

A. Grounding system resistance to ground shall not exceed 5 ohms. Make any modifications or additions to the grounding electrode system necessary for compliance without additional cost to the Government. Final tests shall ensure that this requirement is met.

B. Resistance of the grounding electrode system shall be measured using a four-terminal fall-of-potential method as defined in IEEE 81. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not fewer than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.

C. Services at power company interface points shall comply with the power company ground resistance requirements.

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

**3.8 LABELING**

A. Comply with requirements in Division 26 Section "ELECTRICAL IDENTIFICATION" Article for instruction signs. The label or its text shall be green.

B. Install labels at the telecommunications bonding conductor and grounding equalizer.

1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

**3.9 FIELD QUALITY CONTROL**

A. Perform tests and inspections.

B. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal at individual ground rods. Make tests at ground rods before any conductors are connected.
    a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    b. Perform tests by fall-of-potential method according to IEEE 81.

C. Grounding system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Report measured ground resistances that exceed the following values:
1. Power Distribution Units or Panel boards Serving Electronic Equipment: 3 ohm(s).
2. Manhole Grounds: 10 ohms.

F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

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# SECTION 28 05 28.33
# CONDUITS AND BACKBOXES FOR ELECTRONIC SAFETY AND SECURITY

## PART 1 - GENERAL

### 1.1 DESCRIPTION

A. This section specifies the finishing, installation, connection, testing certification of the conduit, fittings, and boxes to form a complete, coordinated, raceway system(s). Conduits and when approved separate UL Certified and Listed partitioned telecommunications raceways are required for a fully functional Electronic Safety and Security (ESS) system. Raceways are required for all electronic safety and security cabling 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 01 00 00 - GENERAL REQUIREMENTS. For General Requirements.

B. Section 06 10 00 - ROUGH CARPENTRY. Requirements for mounting board for communication closets.

C. Section 07 84 00 - FIRESTOPPING. Requirements for sealing around penetrations to maintain the integrity of fire rated construction.

D. Section 07 60 00 - FLASHING AND SHEET METAL. Requirements for fabrications for the deflection of water away from the building envelope at penetrations.

E. Section 07 92 00 - JOINT SEALANTS. Requirements for sealing around conduit penetrations through the building envelope to prevent moisture migration into the building.

F. Section 09 91 00 - PAINTING. Requirements for identification and painting of conduit and other devices.

G. Section 28 05 00 - COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY. For general electrical requirements, general arrangement of the contract documents, coordination, quality assurance, project conditions, equipment and materials, and items that is common to more than one section of Division 28.

H. Section 28 05 26 - GROUNDING AND BONDING FOR ELECTRONIC SAFETY AND SECURITY. Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.

I. Section 31 20 00 - EARTH MOVING. For bedding of conduits.

### 1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. ENT: Electrical nonmetallic tubing.

C. EPDM: Ethylene-propylene-diene terpolymer rubber.

D. FMC: Flexible metal conduit.

E. IMC: Intermediate metal conduit.

F. LFMC: Liquidtight flexible metal conduit.

G. LFNC: Liquidtight flexible nonmetallic conduit.

H. NBR: Acrylonitrile-butadiene rubber.

I. RNC: Rigid nonmetallic conduit.

**1.4 QUALITY ASSURANCE**

A. Refer to Paragraph 1.4 Quality Assurance, in Section 28 05 00, COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY.

**1.5 SUBMITTALS**

A. Submit in accordance with Section 28 05 00, COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY and Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES. Furnish the following:

B. Shop Drawings:

1. Size and location of main feeders;
2. Size and location of panels and pull boxes
3. Layout of required conduit penetrations through structural elements.
4. The specific item proposed and its area of application shall be identified on the catalog cuts.

C. Certification: Prior to final inspection, deliver to the COR four copies of the certification that the material is in accordance with the drawings and specifications and has been properly installed.

D. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

E. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.

1. Handholes and boxes for underground wiring, including the following:
   a. Duct entry provisions, including locations and duct sizes.
   b. Frame and cover design.
   c. Grounding details.
   d. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
   e. Joint details.

F. Source quality-control test reports.

**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 the basic designation only.

B. National Electrical Manufacturers Association (NEMA):

TC-3-04 .....PVC Fittings for Use with Rigid PVC Conduit and Tubing

FB1-07.....Fittings, Cast Metal Boxes and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable

C. National Fire Protection Association (NFPA):

70-11 .....National Electrical Code (NEC)

D. Underwriters Laboratories, Inc. (UL):

1-05 .....Flexible Metal Conduit

5-04 .....Surface Metal Raceway and Fittings

6-07 .....Rigid Metal Conduit

50-07 .....Enclosures for Electrical Equipment

360-09 .....Liquid-Tight Flexible Steel Conduit

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

514A-04.....Metallic Outlet Boxes

514B-04.....Fittings for Cable and Conduit

514C-02 .....Nonmetallic Outlet Boxes, Flush-Device Boxes and Covers

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

651A-07.....Type EB and A Rigid PVC Conduit and HDPE Conduit

797-07 .....Electrical Metallic Tubing

1242-06 .....Intermediate Metal Conduit

## PART 2 - PRODUCTS

### 2.1 GENERAL

A. Conduit Size: In accordance with the NEC, but not less than 20 mm (3/4 inch) unless otherwise shown.

### 2.2 CONDUIT

A. Rigid galvanized steel: Shall Conform to UL 6, ANSI C80.1.

B. Rigid intermediate steel conduit (IMC): Shall Conform to UL 1242, ANSI C80.6.

C. Electrical metallic tubing (EMT): Shall Conform to UL 797, ANSI C80.3. Maximum size not to exceed 105 mm (4 inches) and shall be permitted only with cable rated 600 volts or less.

D. Flexible galvanized steel conduit: Shall Conform to UL 1.

E. Liquid-tight flexible metal conduit: Shall Conform to UL 360.

F. Direct burial plastic conduit: Shall conform to UL 651 and UL 651A, heavy wall PVC or high density polyethylene (PE).

### 2.3 WIREWAYS AND RACEWAYS

A. Surface metal raceway: Shall Conform to UL 5.

### 2.4 CONDUIT FITTINGS

A. Rigid steel and IMC conduit fittings:

1. Fittings shall meet the requirements of UL 514B and ANSI/ NEMA FB1.
2. Standard threaded couplings, locknuts, bushings, and elbows: Only steel or malleable iron materials are acceptable. Integral retractable type IMC couplings are also acceptable.
3. Locknuts: Bonding type with sharp edges for digging into the metal wall of an enclosure.

4. 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.
5. Erickson (union-type) and set screw type couplings: Approved for use in concrete are permitted for use to complete a conduit run where conduit is installed in concrete. Use set screws of case hardened steel with hex head and cup point to firmly seat in conduit wall for positive ground. Tightening of set screws with pliers is prohibited.
6. 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.

B. Electrical metallic tubing fittings:
1. Fittings shall meet the requirements of UL 514B and ANSI/ NEMA FB1.
2. Only steel or malleable iron materials are acceptable.
3. Couplings and connectors: Concrete tight and rain tight, with connectors having insulated throats. Use gland and ring compression type couplings and connectors for conduit sizes 50 mm (2 inches) and smaller. Use set screw type couplings with four set screws each for conduit sizes over 50 mm (2 inches). Use set screws of case-hardened steel with hex head and cup point to firmly seat in wall of conduit for positive grounding.
4. Indent type connectors or couplings are prohibited.
5. Die-cast or pressure-cast zinc-alloy fittings or fittings made of "pot metal" are prohibited.

C. Flexible steel conduit fittings:
1. Conform to UL 514B. Only steel or malleable iron materials are acceptable.
2. Clamp type, with insulated throat.

D. Liquid-tight flexible metal conduit fittings:
1. Fittings shall meet the requirements of UL 514B and ANSI/ NEMA FB1.
2. Only steel or malleable iron materials are acceptable.
3. Fittings must incorporate a threaded grounding cone, a steel or plastic compression ring, and a gland for tightening. Connectors shall have insulated throats.

E. Direct burial plastic conduit fittings:
1. Fittings shall meet the requirements of UL 514C and NEMA TC3.
2. As recommended by the conduit manufacturer.

F. Surface metal raceway fittings: As recommended by the raceway manufacturer.

G. Expansion and deflection couplings:
1. Conform to UL 467 and UL 514B.
2. Accommodate, 19 mm (0.75 inch) deflection, expansion, or contraction in any direction, and allow 30 degree angular deflections.

3. Include internal flexible metal braid sized to guarantee conduit ground continuity and fault currents in accordance with UL 467, and the NEC code tables for ground conductors.
4. Jacket: Flexible, corrosion-resistant, watertight, moisture and heat resistant molded rubber material with stainless steel jacket clamps.

**2.5 CONDUIT SUPPORTS**

A. Parts and hardware: Zinc-coat or provide equivalent corrosion protection.
B. Individual Conduit Hangers: Designed for the purpose, having a pre-assembled closure bolt and nut, and provisions for receiving a hanger rod.
C. Multiple conduit (trapeze) hangers: Not less than 38 mm by 38 mm (1-1/2 by 1-1/2 inch), 12 gage steel, cold formed, lipped channels; with not less than 9 mm (3/8 inch) diameter steel hanger rods.
D. Solid Masonry and Concrete Anchors: Self-drilling expansion shields, or machine bolt expansion.

**2.6 OUTLET, JUNCTION, AND PULL BOXES**

A. UL-50 and UL-514A.
B. Cast metal where required by the NEC or shown, and equipped with rustproof boxes.
C. Nonmetallic Outlet and Device Boxes: NEMA OS 2.
D. Sheet metal boxes: Galvanized steel, except where otherwise shown.
E. Flush mounted wall or ceiling boxes shall be installed with raised covers so that 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.

**2.7 CABINETS**

A. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
B. Hinged door in front cover with flush latch and concealed hinge.
C. Key latch to match panelboards.
D. Metal barriers to separate wiring of different systems and voltage.
E. Accessory feet where required for freestanding equipment.

**2.8 WIREWAYS**

A. Equip with hinged covers, except where removable covers are shown.

**2.9 WARNING TAPE**

A. Standard, 4-Mil polyethylene 76 mm (3 inches) wide tape non-detectable type, red with black letters, and imprinted with “CAUTION BURIED ELECTRONIC SAFETY AND SECURITY CABLE BELOW”.

**2.10 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING**

A. Description: Comply with SCTE 77.
   1. Color of Frame and Cover: Gray.

2. Configuration: Units shall be designed for flush burial and have closed bottom, unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, as indicated for each service.
6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
7. Handholes 300 mm wide by 600 mm long (12 inches wide by 24 inches long) and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or a combination of the two.

**2.11 SLEEVES FOR RACEWAYS**

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch (1.3- or 3.5-mm) thickness as indicated and of length to suit application.

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 84 00 "FIRESTOPPING."

**2.12 SLEEVE SEALS**

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.
1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
2. Pressure Plates: Carbon steel. Include two for each sealing element.
3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

**2.13 GROUT**

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time. WIRELINE DATA TRANSMISSION MEDIA FOR SECURITY SYSTEMS

## PART 3 - EXECUTION

### 3.1 PENETRATIONS

A. Cutting or Holes:
   1. Locate holes in advance where they are proposed in the structural sections such as ribs or beams. Obtain the approval of the COR prior to drilling through structural sections.
   2. Cut 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 allowed, except where permitted by the COR as required by limited working space.

B. Fire Stop: Where conduits, wireways, and other electronic safety and security raceways pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke and gases as specified in Section 07 84 00, FIRESTOPPING, with rock wool fiber or silicone foam sealant only. Completely fill and seal clearances between raceways and openings with the fire stop material.

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

### 3.2 INSTALLATION, GENERAL

A. Install conduit as follows:
   1. In complete runs before pulling in cables or wires.
   2. Flattened, dented, or deformed conduit is not permitted. Remove and replace the damaged conduits with new undamaged material.
   3. Assure conduit installation does not encroach into the ceiling height head room, walkways, or doorways.
   4. Cut square with a hacksaw, ream, remove burrs, and draw up tight.
   5. Mechanically continuous.
   6. Independently support conduit at 2.4 m (8 foot) on center. Do not use other supports i.e., (suspended ceilings, suspended ceiling supporting members, lighting fixtures, conduits, mechanical piping, or mechanical ducts).
   7. Support within 300 mm (12 inches) of changes of direction, and within 300 mm (12 inches) of each enclosure to which connected.
   8. Close ends of empty conduit with plugs or caps at the rough-in stage to prevent entry of debris, until wires are pulled in.
   9. Conduit installations under fume and vent hoods are prohibited.
   10. Secure conduits to cabinets, junction boxes, pull boxes and outlet boxes with bonding type locknuts. For rigid and IMC conduit installations, provide a locknut on the inside of the enclosure, made up wrench tight. Do not make conduit connections to junction box covers.
   11. Flashing of penetrations of the roof membrane is specified in Section 07 60 00, “FLASHING AND SHEET METAL”.

12. Do not use aluminum conduits in wet locations.
13. Unless otherwise indicated on the drawings or specified herein, all conduits shall be installed concealed within finished walls, floors and ceilings.

B. 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.

C. Layout and Homeruns:
1. Install conduit with wiring, including homeruns, as shown.
2. Deviations: Make only where necessary to avoid interferences and only after drawings showing the proposed deviations have been submitted 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. Install conduit through concrete beams only when the following occurs:
a. Where shown on the structural drawings.
b. As approved by the COR prior to construction, and after submittal of drawing showing location, size, and position of each penetration.
4. Installation of conduit in concrete that is less than 75 mm (3 inch) thick is prohibited.
a. Conduit outside diameter larger than 1/3 of the slab thickness is prohibited.
b. Space between conduits in slabs: Approximately six conduit diameters apart, except 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 (3/4 inch) of concrete around the conduits.
5. Make couplings and connections watertight. Use thread compounds that are UL approved conductive type to insure low resistance ground continuity through the conduits. Tightening set screws with pliers is prohibited.

B. Furred or Suspended Ceilings and in Walls:
1. Conduit for conductors above 600 volts:
a. Rigid steel or rigid aluminum.
b. Aluminum conduit mixed indiscriminately with other types in the same system is prohibited.
2. Conduit for conductors 600 volts and below:
a. Rigid steel, IMC, rigid aluminum, or EMT. Different type conduits mixed indiscriminately in the same system is prohibited.

3. Align and run conduit parallel or perpendicular to the building lines.
4. Connect recessed lighting fixtures to conduit runs with maximum 1800 mm (6 feet) of flexible metal conduit extending from a junction box to the fixture.
5. Tightening set screws with pliers is prohibited.

**3.4 EXPOSED WORK INSTALLATION**

A. Unless otherwise indicated on the drawings, exposed conduit is only permitted in mechanical and electrical rooms.

B. Conduit for Conductors 600 volts and below:
   1. Rigid steel, IMC, rigid aluminum, or EMT. Different type of conduits mixed indiscriminately in the system is prohibited.

C. Align and run conduit parallel or perpendicular to the building lines.

D. Install horizontal runs close to the ceiling or beams and secure with conduit straps.

E. Support horizontal or vertical runs at not over 2400 mm (eight foot) intervals.

F. Surface metal raceways: Use only where shown.

G. Painting:
   1. Paint exposed conduit as specified in Section09 91 00, “PAINTING”.
   2. Paint all conduits containing cables rated over 600 volts safety orange. Refer to Section 09 91 00, “PAINTING” for preparation, paint type, and exact color. In addition, paint legends, using 50 mm (two inch) high black numerals and letters, showing the cable voltage rating. Provide legends where conduits pass through walls and floors and at maximum 6000 mm (20 foot) intervals in between.

**3.5 EXPANSION JOINTS**

A. Conduits 75 mm (3 inches) and larger, that are secured to the building structure on opposite sides of a building expansion joint, require expansion and deflection couplings. Install the couplings in accordance with the manufacturer's recommendations.

B. Provide conduits smaller than 75 mm (3 inches) with junction boxes on both sides of the expansion joint. Connect conduits to junction boxes with sufficient slack of flexible conduit to produce 125 mm (5 inch) vertical drop midway between the ends. Flexible conduit shall have a copper green ground bonding jumper installed. In lieu of this flexible conduit, expansion and deflection couplings as specified above for 375 mm (15 inches) and larger conduits are acceptable.

C. Install expansion and deflection couplings where shown.

**3.6 CONDUIT SUPPORTS, INSTALLATION**

A. Safe working load shall not exceed 1/4 of proof test load of fastening devices.

B. Use pipe straps or individual conduit hangers for supporting individual conduits. Maximum distance between supports is 2.5 m (8 foot) on center.

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 90 kg (200 pounds). 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 (1/4 inch) bolt size and not less than 28 mm (1-1/8 inch) embedment.
   b. Power set fasteners not less than 6 mm (1/4 inch) diameter with depth of penetration not less than 75 mm (3 inches).
   c. Use vibration and shock resistant anchors and fasteners for attaching to concrete ceilings.

F. Hollow Masonry: Toggle bolts are permitted.

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.

**3.7 BOX INSTALLATION**

A. Boxes for Concealed Conduits:

1. Flush mounted.
2. Provide raised covers for boxes to suit the wall or ceiling, construction and finish.

B. In addition to boxes shown, install additional boxes where needed to prevent damage to cables and wires during pulling in operations.

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

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

E. Minimum size of outlet boxes for ground fault interrupter (GFI) receptacles is 100 mm (4 inches) square by 55 mm (2-1/8 inches) deep, with device covers for the wall material and thickness involved.

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

G. On all Branch Circuit junction box covers, identify the circuits with black marker.

**3.8 ELECTRONIC SAFETY AND SECURITY CONDUIT**

A. Install the electronic safety and security raceway system as shown on drawings.

B. Minimum conduit size of 19 mm (3/4 inch), but not less than the size shown on the drawings.

C. All conduit ends shall be equipped with insulated bushings.

D. All 100 mm (four inch) conduits within buildings shall include pull boxes after every two 90 degree bends. Size boxes per the NEC.

E. Vertical conduits/sleeves through closets floors shall terminate not less than 75 mm (3 inches) below the floor and not less than 75 mm (3 inches) below the ceiling of the floor below.

F. Terminate conduit runs to/from a backboard in a closet or interstitial space at the top or bottom of the backboard. Conduits shall enter communication closets next to the wall and be flush with the backboard.

G. Where drilling is necessary for vertical conduits, locate holes so as not to affect structural sections such as ribs or beams.

H. All empty conduits located in communications closets or on backboards shall be sealed with a standard non-hardening duct seal compound to prevent the entrance of moisture and gases and to meet fire resistance requirements.

I. Conduit runs shall contain no more than four quarter turns (90 degree bends) between pull boxes/backboards. Minimum radius of communication conduit bends shall be as follows (special long radius):

| Sizes of Conduit<br>Trade Size | Radius of Conduit Bends<br>mm, Inches |
|---|---|
| ¾ | 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) |

J. Furnish and install 19 mm (3/4 inch) thick fire retardant plywood specified in on the wall of communication closets where shown on drawings. Mount the plywood with the bottom edge 300 mm (one foot) above the finished floor.

K. Furnish and pull wire in all empty conduits. (Sleeves through floor are exceptions).

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# SECTION 28 08 00
# COMMISSIONING OF ELECTRONIC SAFETY AND SECURITY SYSTEMS

## PART 1 - GENERAL

### 1.1 DESCRIPTION

A. The requirements of this Section apply to all sections of Division 28.

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 electronic safety and security 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 28 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 28, is required in cooperation with the VA and the Commissioning Agent.

B. The Facility exterior closure 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 Electronic Safety and Security systems will require inspection of individual elements of the electronic safety and security systems 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 electronic safety and security 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 28 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 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.

**3.5 TRAINING OF VA PERSONNEL**

A. Training of the VA operation and maintenance personnel is required in cooperation with the COR 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 COR after submission and approval of formal training plans. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS and Division 28 Sections for additional Contractor training requirements.

**----- END -----**

# SECTION 28 23 00
# VIDEO SURVEILLANCE

## PART 1 – GENERAL

### 1.1 DESCRIPTION

A. Provide and install a complete extension to the existing Video Surveillance System, which is identified as the Video Assessment and Surveillance System hereinafter referred to as the VASS System as specified in this section. The system will be an extension to an existing system.

B. This Section includes video surveillance system consisting of cameras, data transmission wiring, and a control station with its associated equipment.

### 1.2 RELATED WORK

A. Section 01 00 00 - GENERAL REQUIREMENTS. For General Requirements.

B. Section 10 14 00 - SIGNAGE. Requirements for labeling and signs.

C. Section 26 05 11 - REQUIREMENTS FOR ELECTRICAL INSTALLATIONS. Requirements for connection of high voltage.

D. Section 26 05 19 - LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW). Requirements for power cables.

E. Section 26 05 41 - UNDERGROUND ELECTRICAL CONSTRUCTION. Requirements for underground installation of wiring.

F. Section 26 56 00 - EXTERIOR LIGHTING. Requirements for perimeter lighting.

G. Section 28 05 00 – COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY. Requirements for general requirements that are common to more than one section in Division 28.

H. Section 28 05 13 - CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY. Requirements for conductors and cables.

I. Section 28 05 26 - GROUNDING AND BONDING FOR ELECTRONIC SAFETY AND SECURITY. Requirements for grounding of equipment.

J. Section 28 05 28.33 - CONDUITS AND BACKBOXES FOR ELECTRONIC SAFETY AND SECURITY. Requirements for infrastructure.

K. Section 28 08 00 - COMMISIONING OF ELECTRONIC SAFETY AND SECURITY. Requirements for commissioning, systems readiness checklists, and training.

### 1.3 DEFINITIONS

A. AGC: Automatic gain control.

B. B/W: Black and white.

C. CCD: Charge-coupled device.

D. CIF: Common Intermediate Format CIF images are 352 pixels wide and 88/240 (PAL/NTSC) pixels tall (352 x 288/240).

E. 4CIF: resolution is 704 pixels wide and 576/480 (PAL/NTSC) pixels tall (704 x 576/480).

F. H.264 (also known as MPEG4 Part 10): a encoding format that compresses video much more effectively than older (MPEG4) standards.

G. ips: Images per second.

H. MPEG: Moving picture experts group.

I. MPEG4: a video encoding and compression standard that uses inter-frame encoding to significantly reduce the size of the video stream being transmitted.

J. NTSC: National Television System Committee.

K. UPS: Uninterruptible power supply.

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

**1.4 QUALITY ASSURANCE**

A. The Contractor shall be responsible for providing, installing, and the operation of the extension to the existing VASS System as shown. The Contractor shall also provide certification as required.

B. The security system shall be installed and tested to ensure all components are fully compatible as a system and can be integrated with all associated security subsystems, whether the security system is stand-alone or a part of a complete Information Technology (IT) computer network.

C. The Contractor or security sub-contractor shall be a licensed security Contractor as required within the state or jurisdiction of where the installation work is being conducted.

D. Manufacturers Qualifications: The manufacturer shall regularly and presently produce, as one of the manufacturer's principal products, the equipment and material specified for this project, and shall have manufactured the item for at least three years.

E. Product Qualification:

1. Manufacturer's product shall have been in satisfactory operation, on three installations of similar size and type as this project, for approximately three years.
2. The Government reserves the right to require the Contractor to submit a list of installations where the products have been in operation before approval.

F. Contractor Qualification:

1. The Contractor or security sub-contractor shall be a licensed security Contractor with a minimum of five (5) years experience installing and servicing systems of similar scope and complexity. The Contractor shall be an authorized regional representative of the Video Assessment and Surveillance System's (VASS) manufacturer. The Contractor shall provide four (4) current references from clients with systems of similar scope and complexity which became operational in the past three (3) years. At least three (3) of the references shall be utilizing the same system components, in a similar configuration as the proposed system. The references must include a current point of contact, company or agency name, address, telephone number, complete system description, date of completion, and approximate cost of the project. The owner reserves the option to visit the reference sites, with the site owner's

permission and representative, to verify the quality of installation and the references' level of satisfaction with the system. The Contractor shall provide copies of system manufacturer certification for all technicians. The Contractor shall only utilize factory-trained technicians to install, program, and service the VASS. The Contractor shall only utilize factory-trained technicians to install, terminate and service cameras, control, and recording equipment. The technicians shall have a minimum of five (5) continuous years of technical experience in electronic security systems. The Contractor shall have a local service facility. The facility shall be located within 60 miles of the project site. The local facility shall include sufficient spare parts inventory to support the service requirements associated with this contract. The facility shall also include appropriate diagnostic equipment to perform diagnostic procedures. The COR reserves the option of surveying the company's facility to verify the service inventory and presence of a local service organization.

2. The Contractor shall provide proof project superintendent with BICSI Certified Commercial Installer Level 1, Level 2, or Technician to provide oversight of the project.
3. Cable installer must have on staff a Registered Communication Distribution Designer (RCDD) certified by Building Industry Consulting Service International. The staff member shall provide consistent oversight of the project cabling throughout design, layout, installation, termination and testing.

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

**1.5 SUBMITTALS**

A. Submit below items in conjunction with Master Specification Sections 01 33 23, Shop Drawings, Product Data, and Samples, and Section 02 41 00, Demolition Drawings.
B. Provide certificates of compliance with Section 1.4, Quality Assurance.
C. Provide a pre-installation and as-built design package in both electronic format and on paper, minimum size 1220 x 1220 millimeters (48 x 48 inches); drawing submittals shall be per the established project schedule.
D. Pre-installation design and as-built packages shall include, but not be limited to:
   1. Index Sheet that shall:
      a. Define each page of the design package to include facility name, building name, floor, and sheet number.
      b. Provide a list of all security abbreviations and symbols.
      c. Reference all general notes that are utilized within the design package.
      d. Specification and scope of work pages for all security systems that are applicable to the design package that will:
         1) Outline all general and job specific work required within the design package.

2) Provide a device identification table outlining device Identification (ID) and use for all security systems equipment utilized in the design package.

2. Floor plans, site plans, and enlarged plans shall:
   a. Include a title block as defined above.
   b. Define the drawings scale in both standard and metric measurements.
   c. Provide device identification and location.
   d. Address all signal and power conduit runs and sizes that are associated with the design of the electronic security system and other security elements (e.g., barriers, etc.).
   e. Identify all pull box and conduit locations, sizes, and fill capacities.
   f. Address all general and drawing specific notes for a particular drawing sheet.
3. A riser drawing for each applicable security subsystem shall:
   a. Indicate the sequence of operation.
   b. Relationship of integrated components on one diagram.
   c. Include the number, size, identification, and maximum lengths of interconnecting wires.
   d. Wire/cable types shall be defined by a wire and cable schedule. The schedule shall utilize a lettering system that will correspond to the wire/cable it represents (example: A = 18 AWG/1 Pair Twisted, Unshielded). This schedule shall also provide the manufacturer's name and part number for the wire/cable being installed.
4. A system drawing for each applicable security system shall:
   a. Identify how all equipment within the system, from main panel to device, shall be laid out and connected.
   b. Provide full detail of all system components wiring from point-to-point.
   c. Identify wire types utilized for connection, interconnection with associate security subsystems.
   d. Show device locations that correspond to the floor plans.
   e. All general and drawing specific notes shall be included with the system drawings.
5. A schedule for all of the applicable security subsystems shall be included. All schedules shall provide the following information:
   a. Device ID.
   b. Device Location (e.g. site, building, floor, room number, location, and description).
   c. Mounting type (e.g. flush, wall, surface, etc.).
   d. Power supply or circuit breaker and power panel number.
   e. In addition, for the VASS Systems, provide the camera ID, camera type (e.g. fixed or pan/tilt/zoom (P/T/Z), lens type (e.g. for fixed cameras only) and housing model number.
6. Detail and elevation drawings for all devices that define how they were installed and mounted.

E. Pre-installation design packages shall be reviewed by the Contractor along with a VA representative to ensure all work has been clearly defined and completed. All reviews shall be conducted in accordance with the project schedule. There shall be four (4) stages to the review process:
   1. 35 percent
   2. 65 percent
   3. 90 percent
   4. 100 percent

F. Provide manufacturer security system product cut-sheets. Submit for approval at least 30 days prior to commencement of formal testing, a Security System Operational Test Plan. Include procedures for operational testing of each component and security subsystem, to include performance of an integrated system test.

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

H. Submit completed System Readiness Checklists provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 28 08 00 COMMISSIONING OF ELECTRONIC SAFETY AND SECURITY SYSTEMS.

**1.6 APPLICABLE PUBLICATIONS**

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

B. American National Standards Institute (ANSI)/Electronic Industries Alliance (EIA):
   330-09 ..... Electrical Performance Standards for CCTV Cameras
   375A-76 ..... Electrical Performance Standards for CCTV Monitors

C. Institute of Electrical and Electronics Engineers (IEEE):
   C62.41-02 ..... IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits
   802.3af-08 ..... Power over Ethernet Standard

D. Federal Communications Commision (FCC):
   (47 CFR 15) Part 15 Limitations on the Use of Wireless Equipment/Systems

E. National Electrical Contractors Association (NECA):
   303-2005 ..... Installing Closed Circuit Television (CCTV) Systems

F. National Fire Protection Association (NFPA):
   70-08 ..... Article 780-National Electrical Code

G. Federal Information Processing Standard (FIPS):

140-2-02 ..... Security Requirements for Cryptographic Modules

H. Underwriters Laboratories, Inc. (UL):

983-06 ..... Standard for Surveillance Camera Units

3044-01 ..... Standard for Surveillance Closed Circuit Television Equipment

**1.7 COORDINATION**

A. Coordinate arrangement, mounting, and support of video surveillance equipment:
   1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
   2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
   3. To allow right of way for piping and conduit installed at required slope.
   4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for video surveillance items that are behind finished surfaces or otherwise concealed.

**1.8 WARRANTY OF CONSTRUCTION**

A. Warrant VASS System work subject to the Article “Warranty of Construction” of FAR clause 52.246-21.

B. Demonstration and training shall be performed prior to system acceptance.

**PART 2 – PRODUCTS**

**2.1 GENERAL**

A. Video signal format shall comply with the NTSC standard composite video, interlaced. Composite video signal termination shall be 75 ohms.

B. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor entry connection to components.

C. Power Connections: Comply with requirements in Section 28 05 00 COMMON WORK REQUIREMENTS FOR ELECTRONIC SAFETY AND SECURITY, Part 2, as recommended by manufacturer for type of line being protected.

D. Tamper Protection: Tamper switches on enclosures, control units, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled. Control-station, control-unit alarm display shall identify tamper alarms and indicate locations.

**2.2 CAMERAS**

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

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

1. Will be charge coupled device (CCD cameras and shall conform to National Television System Committee (NTSC) formatting.
2. Fixed cameras shall be color and the primary choice for monitoring following the activities described below.
3. Shall be powered over Ethernet. Network switches supporting PoE cameras shall have a back-up power source to ensure cameras are still operational in the event of loss of primary power to the VASS System. Provide power supplies and/or power injectors where needed.
4. Shall be rated for continuous operation under the environmental conditions listed in Part 1, Project Conditions.
5. Each function and activity shall be addressed within the system by a unique user defined name, with minimum of twenty (20) characters. The use of codes or mnemonics identifying the VASS action shall not be accepted.
6. Shall come with built-in video motion detection that shall automatically monitor and process information from each camera. The camera motion detection shall detect motion within the camera's field of view and provide automatic visual, remote alarms as a result of detected motion.
7. Shall be programmed to digitally flip from color to black and white at dusk and vice versa at low light conditions.
8. Will be fitted with AI/DC lenses to ensure the image quality under different light conditions.

**2.3 VIDEO CAMERAS**

A. The cameras shall be high-resolution color video cameras with wide dynamic range capturing capability.

B. The camera shall meet or exceed the following specifications:

1. The image capturing device shall be designed for capturing wide dynamic images.
   a. The image capturing device shall have a separate analog-to-digital converter for every pixel.
   b. The image capturing device shall sample each pixel multiple times per second.
   c. The dynamic range shall be 95 dB typical and 120 dB maximum.
2. The camera shall optimize each pixel independently.
3. The camera shall have onscreen display menus for programming of the camera’s settings.
4. The signal system shall be NTSC.

C. The camera shall have composite video output.

D. The camera shall come with a manual varifocal lens.

E. The video output shall be composite: 1.0 volts peak-to-peak at 75-ohm load.

F. Fixed Color Camera

1. The camera shall be a high-resolution color video camera with wide dynamic range capturing capability.
2. Comply with UL 639.
3. Pickup Device: 1/3 / 1/4 CCD interline transfer.
4. Signal-to-Noise Ratio: Not less than 50 dB, with the camera AGC off.
5. With AGC, manually selectable on or off.
6. Manually selectable modes for backlight compensation or normal lighting.
7. Scanning Synchronization: Determined by external synch over the coaxial cable. Camera shall revert to internally generated synchronization on loss of external synch signal.
8. White Balance: Auto-tracing white balance, with manually selectable fixed balance option.
9. Fixed Color Cameras Technical Characteristics:

| | |
|---|---|
| Pickup device | 1/3" interline transfer CCD |
| Total pixels | NTSC: 811(H) x 508(V) |
| Effective pixels | NTSC: 768(H) x 494(V) |
| Resolution | 500 TV lines |
| Sync. System | Internal Sync |
| Scanning system | NTSC: 525 Lines/60 Fields |
| S/N ratio | More than 48 dB |
| Electronic shutter | Auto 1/60 (1/50) ~1/100,000 sec. |
| Min. illumination | 0.2 lux F2.0 |
| Video output | Composite 1.0 Vp-p/75 ohm |
| White balance | Auto |
| Automatic gain control | ON |
| Frequency horizontal | NTSC: 15.734 KHz |
| Frequency vertical | NTSC: 59.94Hz |
| Lens type | Board lens / DC/ AI varifocal lens |
| Focal length | 3-60mm |
| Power source | DC12V/500mA or AC24/500mA |
| Power consumption | < 3W (Max) |

10. Fixed color camera shall be enclosed in dome and have board mounted varifocal lens.
11. Camera accessories shall include:
    a. Surface mount adapter

b. Wall mount adapter

c. Flush mount adapter

G. Megapixel High Definition Integrated Digital Network Camera

1. The network camera shall offer dual video streams with up to 3.1 megapixel resolution (2048 x 1536) in progressive scan format.
2. An alarm input and relay output shall be built in for integration with hard wired external sensors.
3. The network camera shall be capable of firmware upgrades through a network using a software-based device utility.
4. The network camera shall offer auto back focus (ABF) functionality through a push button on the camera. ABF parameters shall also be configurable through a standard Web browser interface.
5. The network camera shall offer a video output port providing an NTSC/PAL analog video output signal for adjusting field of view and focus at the camera.
6. The network camera shall provide advanced low-light capabilities for color and day/night models with sensitivity down to 0.12 lux in color and 0.03 lux in black-white (B-W).
7. The network camera shall have removable IR cut filter mechanism for increased sensitivity in low-light installations. The sensitivity of IR cut filter removal shall be configurable through a Web browser.
8. The network camera shall support two simultaneous, configurable video streams. H.264 and MJPEG compression formats shall be available for primary and secondary streams with selectable unicast and multicast protocols. The streams shall be configurable in a variety of frame rates and bit rates.
9. The network camera shall support industry standard Power over Ethernet (PoE)
10. IEEE 802.3af to supply power to the camera over the network. The network camera shall also offer a 24 VAC power input for optional use.
11. The network camera shall use a standard Web browser interface for remote administration and configuration of camera parameters.
12. The network camera shall have a window blanking feature to conceal user-defined privacy areas that cannot be viewed by an operator. The network camera shall support up to four blanked windows. A blanked area shall appear on the screen as a solid gray window.
13. The network camera shall support standard IT protocols.
14. The network camera shall support open architecture best practices with a published API available to third-party network video recording and management systems.
15. Megapixel High Definition Integrated Digital Network Camera Technical Specifications:

| | |
|---|---|
| Imaging Device | 1/3-inch, effective |

| | |
|---|---|
| Imager Type | CMOS, Progressive scan |
| Maximum Resolution | 2048 x 1536 |
| Signal-to-Noise Ratio | 50 dB |
| Auto Iris Lens Type | DC drive |
| Electronic Shutter Range | 1~1/100,000 sec |
| Wide Dynamic Range | 60 dB |
| White Balance Range | 2,000° to 10,000°K |
| Sensitivity | f/1.2; 2,850K; SNR >24dB Color (1x/33ms) 0.50 lux Color SENS (15x/500 ms) 0.12 lux<br>Mono SENS (15x/500 ms) Mono (1x/33ms)0.25 lux 0.03 lux |
| Dome Attenuation | Clear Zero light loss<br>Smoke f/1.0 light loss |
| Compression | H.264 in base profile and MJPEG |
| Video Streams | Up to 2 simultaneous streams, the second Stream variable based on the setup of the primary stream |
| Frame Rate | Up to 30, 25, 24, 15, 12.5, 12, 10, 8, 7.5, 6.5, 4, 3, 2, and 1 (depending upon coding, resolution, and stream configuration |
| Available Resolutions | 3.1 MPx2048 x 1536; 4:3 aspect ratio; 2.0 ips max., 10.0 Mbps bit rate for MJPEG; 3.0 ips max., 2.6 Mbps bit rate H.264<br>2.1 MPx1920 x 1080; 16:9 aspect ratio: 15.0 ips max.,10.0 Mbps bit rate for MJPEG; 5.0 ips max., 2.7 Mbps bit rate H.264 3.1.9 MPx1600 x 1200; 4:3 aspect ratio; 15.0 ips max.,10.0 Mbps bit rate for MJPEG; 6.0 ips max., 2.6 Mbps bit rate H.264<br>1.3 MPx1280 x 1024; 5:4 aspect ratio; 15.0 ips max.,10.0 Mbps bit rate for MJPEG; 8.0 ips max., 2.5 Mbps bit rate H.264<br>1.2 MPx1280 x 960; 4:3 aspect ratio; 15.0 ips max., 9.8 Mbps bit rate for MJPEG; 9.8 ips max., 8.5 Mbps bit rate H.264 6.0.9 MPx1280 x 720; 16:9 aspect ratio; 30.0 ips max.,10.0 Mbps bit rate for MJPEG; 12.5 ips max., 2.5 Mbps bit rate H.264<br>0.5 MPx800 x 600; 4:3 aspect ratio; 30.0 ips max., 5.8 Mbps bit rate for MJPEG; 25.0 ips max., 2.0 Mbps bit rate H.264 8.0.3 MPx640 x 480; 4:3 aspect ratio; 30.0 ips max., 3.7 Mbps bit rate for MJPEG; 30.0 ips max.,1.6 Mbps bit rate H.264<br>0.1 MPx320 x 240; 4:3 aspect ratio; 30.0 ips max., 0.9 Mbps bit rate for MJPEG; 30.0 ips max., 0.4 Mbps bit rate H.264 |

| | |
|---|---|
| | Additional640 x 512, 640 x 352, 480 x 368, 480 x 272, 320 x 256, 320 x 176 |
| Supported Protocols | TCP/IP, UDP/IP (Unicast, Multicast IGMP), UPnP, DNS, DHCP, RTP, RTSP, NTP,IPv4, SNMP, QoS, HTTP, HTTPS, LDAP(client), SSH, SSL, STMP, FTP, MDNS(Bonjour), and 802.1x (EAP) |
| Security Access | Password protected |
| Software Interface | Web browser view and setup, up to 16 cameras |
| Connectors | RJ-45 for 100Base-TX, Auto MDI/MDI-X |
| Cable | Cat6E |
| Input Voltage | 24 VAC or PoE (IEEE802.3af class 3) |
| Power Consumption | 6 W |
| Current Consumption | PoE <200 mA maximum<br>24 VAC <295 mA nominal; <390 mA maximum |
| Alarm Input | 10 VDC maximum, 5 mA maximum |
| Alarm Output | 0 to 15 VDC maximum, 75 mA maximum |
| Lens Mount | CS mount, adjustable |
| Pan/Tilt Adjustment | Pan 368°<br>Tilt 160° (10° to 170°)<br>Rotate 355° |

16. Accessories
    a. Pendant mount
    b. Wall mount for pendant
    c. Corner adapter for wall mount
    d. Pole adapter for wall mount
    e. Pole mount
17. Recommended Lenses
    a. Megapixel lens, varifocal, 2.2~6.0 mm, f/1.3~2.0
    b. Megapixel lens, varifocal, 2.8~8.0 mm,f/1.1~1.9
    c. Megapixel lens, varifocal, 2.8~12.0 mm, f/1.4~2.7

H. LENSES
1. Camera Field of View shall be set by the Contractor to produce full view of door or window opening and anyone entering or leaving through it. Follow the project construction drawings for design intent.
2. Camera Lenses shall be of the type supplied with the camera from the manufacture. All cameras which are not supplied with lenses from the factory are specified in this specification. The lens shall be equipped with an auto-iris mechanism unless otherwise

specified. Lenses having auto-iris, DC iris, or motor zoom functions shall be supplied with connectors, wiring, receiver/drivers, and controls as needed to operate the lens functions. Lenses shall have sufficient circle of illumination to cover the image sensor evenly. Lenses shall not be used on a camera with an image format larger than the lens is designed to cover. Lenses shall be provided with pre-set capability.

3. Lenses shall have optical-quality coated optics, designed specifically for video surveillance applications, and matched to specified camera. Provide color-corrected lenses with color cameras, megapixel lenses for megapixel cameras, and lenses with day/night for color/b&w cameras.
4. Auto-Iris Lens: Electrically controlled iris with circuit set to maintain a constant video level in varying lighting conditions.
5. Zoom Lenses: Motorized, remote-controlled units, rated as "quiet operating." Features include the following:
   a. Electrical Leads: Filtered to minimize video signal interference.
   b. Motor Speed: Variable.
   c. Lens shall be available with preset positioning capability to recall the position of specific scenes.
6. Lenses: Shall be utilized in a manner that provides maximum coverage of the area being monitored by the camera. The lenses shall:
   a. Be 1/3” to fit CCD fixed camera.
   b. Be all glass with coated optics.
   c. Have mounts that are compatible with the camera selected.
   d. Be packaged and supplied with the camera.
   e. Have a maximum f-stop of f/1.3 for fixed lenses, and a maximum f-stop of f/1.6 for variable focus lenses.
   f. Be equipped with an auto-iris mechanism.
   g. Have sufficient circle of illumination to cover the image sensor evenly.
   h. Not be used on a camera with an image format larger than the lens is designed to cover.
   i. Be provided with pre-set capability.
7. Two types of lenses shall be utilized for both interior and exterior fixed cameras:
   a. Manual Variable Focus
   b. Auto Iris Fixed
8. Manual Variable Focus:
   a. Shall be utilized in large areas that are being monitored by the camera. Examples of this are perimeter fence lines, vehicle entry points, parking areas, etc.
   b. Shall allow for setting virtually any angle of field, which maximizes surveillance effects.
   c. Technical Characteristics:

| | |
|---|---|
| Image format | 1/3 inch |
| Focal length | 3-8mm |
| Iris range | F1.4 to close |
| Focus range | 1m (3.3 ft) |
| Back focus distance | 10.05 mm (0.4 in) |
| Angle view Wide (1/3 in) | 53.4 x 40.1 |
| Angle view Tele (1/3 in) | 5.3 x 4.1 |
| Iris control | manual |
| Focus ctrl | manual |
| Zoom ctrl | manual |

I. CAMERA HOUSINGS AND MOUNTS

1. This section pertains to all interior and exterior housings, domes, and applicable wall, ceiling, corner, pole, and rooftop mounts associated with the housing. Housings and mounts shall be specified in accordance to the type of cameras used.
2. All cameras and lenses shall be enclosed in a tamper resistant housing. Any additional mounting hardware required to install the camera housing at its specified location shall be provided along with the housing.
3. The camera and lens contained inside the housing shall be installed on a camera mount. All additional mounting hardware required to install the camera housing at its specified location shall be provided along with the housing.
4. Shall be manufactured in a manner that are capable of supporting a maximum of three (3) cameras with housings, and meet environmental requirements for the geographical area the camera support equipment is being installed on or within.
5. Environmentally Sealed
   a. Shall be designed in manner that it provides a condensation free environment for correct camera operation.
   b. Shall be operated in a 100 percent condensing humidity atmosphere.
   c. Shall be constructed in a manner that:
      1) Has a fill valve to allow for the introduction of nitrogen into the housing to eliminate existing atmospheric air and pressurize the housing to create moisture free conditions.
      2) Has an overpressure valve to prevent damage to the housing in the event of over pressurization.
      3) Is equipped with a humidity indicator that is visible to the eye to ensure correct atmospheric conditions at all times.

4) The leak rate of the housing is not to be greater than 13.8kPa or 2 pounds per square inch at sea level within a 90 day period.
5) It shall contain camera mounts or supports as needed to allow for correct positioning of the camera and lens.
6) The housing and sunshield are to be white in color.

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

**2.4 POWER SUPPLIES**

A. Power supplies shall be a low-voltage power supplies matched for voltage and current requirements of cameras and accessories, type as recommended by cameraand lens manufacturer.
B. Technical specifications:
1. Input: 277VAC, 60Hz
2. Outputs:
a. Number of outputs, 2 minimum
b. Fuse/PTC protected, power limited
c. Output voltage & power:
1) 24VAC @ 12.5 amps (300VA) or 28VAC @ 10 amp (280VA) supply current
3. Illuminated power disconnect circuit breaker with manual reset
4. Surge suppression
5. Camera synchronization
6. Enclosure: NEMA 250, Type 4X for exterior applications.

**2.5 WIRES AND CABLES**

A. Shall meet or exceed the manufactures recommendation for power and signal.
B. Will be carried in an enclosed conduit system, utilizing electromagnetic tubing (EMT) to include the equivalent in flexible metal, rigid galvanized steel (RGS) to include the equivalent of liquid tight, polyvinylchloride (PVC) schedule 40 or 80.
C. All conduits will be sized and installed per the NEC. All security system signal and power cables that traverse or originate in a high security office space will contained in either EMT or RGS conduit.
D. All conduit, pull boxes, and junction boxes shall be clearly marked with colored permanent tape or paint that will allow it to be distinguished from all other conduit and infrastructure.
E. Conduit fills shall not exceed 50 percent unless otherwise documented.

F. A pull string shall be pulled along and provided with signal and power cables to assist in future installations.

G. At all locations where there is a wall penetration or core drilling is conducted to allow for conduit to be installed, fire stopping materials shall be applied to that area

H. High voltage and signal cables shall not share the same conduit and shall be kept separate up to the point of connection. High voltage for the security system shall be defined as any cable or sets of cables carrying 30 VDC/VAC or higher.

I. For all equipment that is carrying digital data between the Physical Access Control System and Database Management or at a remote monitoring station, shall not be less that 20 AWG and stranded copper wire for each conductor. The cable or each individual conductor within the cable shall have a shield that provides 100% coverage. Cables with a single overall shield shall have a tinned copper shield drain wire.

J. All cables and conductors, except fiber optic cables, that act as a control, communication, or signal lines shall include surge protection. Surge protection shall be furnished at the equipment end and additional triple electrode gas surge protectors rated for the application on each wire line circuit shall be installed within 1 m. (3 ft.) of the building cable entrance. The inputs and outputs shall be tested in both normal and common mode using the following wave forms:

1. A 10 microsecond rise time by 1000 microsecond pulse width waveform with a peak voltage of 1500 watts and peak current of 60 amperes.
2. An 8 microsecond rise time by 20 microsecond pulse width wave form with a peak voltage of 1000 volts and peak current of 500 amperes.

K. The surge suppression device shall not attenuate or reduce the video or sync signal under normal conditions. Fuses and relays shall not be used as a means of surge protection.

L. Signal Cables

1. Signal Cables:
   a. Signal wiring for PoE cameras depends on the distance the camera is being installed from either a hub or the server.
   b. If the camera is up to 300 ft from a hub or the server, then use a shielded UTP category 6E cable a with standard RJ-45 connector at each end. The cable with comply with the Power over Ethernet, IEEE802.3af, Standard.
   c. If the camera is over 300 ft from a hub or server then utilize a multimode fiber optic cable with a minimum size of 62 microns.
   d. Provide a separate cable for power.
   e. CAT-6E Technical Characteristics:

| | |
|---|---|
| Number of Pairs | 4 |
| Total Number of Conductors | 8 |
| AWG | 24 |

| | |
|---|---|
| Stranding | Solid |
| Conductor Material | BC - Bare Copper |
| Insulation Material | PO – Polyolefin |
| Overall Nominal Diameter | .230 in. |
| IEC Specification | 11801 Category 6E |
| TIA/EIA Specification | 568-B.2 Category 6E |
| Max. Capacitance Unbalance | (pF/100 m) 150 pF/100 m |
| Nom. Velocity of Propagation | 70 % |
| Max. Delay | (ns/100 m) 538 @ 100MHz |
| Max. Delay Skew | (ns/100m) 45 ns/100 m |
| Max. Conductor DC Resistance | 9.38 Ohms/100 |
| Max. DCR Unbalance@ 20°C | 3 % |
| Max. Operating Voltage | UL 300 V RMS |

2. Fiber Optic Cables Technical Characteristics:

| | |
|---|---|
| Fiber Type | 62.5 Micron |
| Number of Fibers | 4 |
| Core Diameter 6 | 2.5 +/- 2.5 microns |
| Core Non-Circularity | 5% Maximum |
| Clad Diameter | 125 +/- 2 microns |
| Clad Non-Circularity | 1% Maximum |
| Core-clad Offset | 1.5 Microns Maximum |
| Primary Coating Material | Acrylate |
| Primary Coating Diameter | 245 +/- 10 microns |
| Secondary Coating Material | Engineering Thermoplastic |
| Secondary Coating Diameter | 900 +/- 50 microns |
| Strength Member Material | Aramid Yarn |
| Outer Jacket Material | PVC |
| Outer Jacket Color | Orange |
| Overall Diameter | .200 in. |
| Numerical Aperture | .275 |
| Maximum Gigabit Ethernet | 300 meters |
| Maximum Gigabit Ethernet | 550 meters |

3. Power Cables
   a. Will be sized accordingly and shall comply with the NEC. High voltage power cables will be a minimum of three conductors, 14 AWG, stranded, and coated with a non-conductive

polyvinylchloride (PVC) jacket. Low voltage cables will be a minimum of 18 AWG, stranded and non-conductive polyvinylchloride (PVC) jacket.

b. Will be utilized for all components of the VASS System that require either a 110 VAC 60 Hz or 220 VAC 50 Hz input. Each feed will be connected to a dedicated circuit breaker at a power panel that is primarily for the security system.

c. All equipment connected to AC power shall be protected from surges. Equipment protection shall withstand surge test waveforms described in IEEE C62.41. Fuses shall not be used as a means of surge protection.

d. Shall be rated for either 110 or 220 VAC, 50 or 60 Hz, and shall comply with VA Master Spec 26 05 21 Low Voltage Electrical Power Conductors and Cables (600 Volts and Below).

e. Low Voltage Power Cables

1) Shall be a minimum of 18 AWG, Stranded and have a polyvinylchloride outer jacket.

2) Cable size shall be determined using a basic voltage over distance calculation and shall comply with the NEC's requirements for low voltage cables.

**PART 3 - EXECUTION**

**3.1. GENERAL**

A. Installation: The Contractor shall install all system components including Owner furnished equipment, and appurtenances in accordance with the manufacturer's instructions, ANSI C2 and as shown, and shall furnish all necessary connectors, terminators, interconnections, services, and adjustments required for a complete and operable data transmission system.

B. Identification and Labeling: The Contractor shall supply permanent identification labels for each cable at each end that will appear on the as-built drawings. The labeling format shall be identified and a complete record shall be provided to the Owner with the final documentation. Each cable shall be identified by type or signal being carried and termination points. The labels shall be printed on letter size label sheets that are self laminated vinyl that can be printed from a computer data base or spread sheet. The labels shall be E-Z code WES12112 or equivalent.

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

C. Transient Voltage Surge Suppressors (TVSS): The Contractor shall mount TVSS within 3 m (118 in) of equipment to be protected inside terminal cabinets or suitable NEMA 1 enclosures. Terminate off-premise conductors on input side of device. Connect the output side of the device to the equipment to be protected. Connect ground lug to a low impedance earth ground (less than 10 ohms) via Number 12 AWG insulated, stranded copper conductor.

D. Contractor's Field Test: The Contractor shall verify the complete operation of the data transmission system during the Contractor's Field Testing. Field test shall include a bit error rate test. The Contractor shall perform the test by sending a minimum of 1,000,000 bits of data on

each DTM circuit and measuring the bit error rate. The bit error rate shall not be greater than one (1) bit out of each 100,000 bits sent for each dial-up DTM circuit, and one (1) bit out of 1,000,000 bits sent for each leased or private DTM circuit. The Contractor shall submit a report containing results of the field test.

E. Acceptance Test and Endurance Test: The wire line data transmission system shall be tested as a part of the completed IDS and EECS during the Acceptance test and Endurance Test as specified.

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

**3.2 INSTALLATION**

A. System installation shall be in accordance with NECA 303, manufacturer and related documents and references, for each type of security subsystem 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 1.5 of this document, and shall furnish all necessary connectors, terminators, interconnections, services, and adjustments required for a complete and operable system.

D. The VASS System 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 complete network.

E. 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.

F. A complete VASS System shall be comprised of, but not limited to, the following components:
   1. Cameras
   2. Lenses
   3. Camera Housings and Mounts
   4. Wiring and Cables

G. 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.

H. Existing Equipment

1. The Contractor shall connect to and utilize existing video equipment, video and control signal transmission lines, and devices as outlined in the design package. Video 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 video equipment and signal lines intended to be incorporated into the VASS System, 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 incorrect 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.

I. 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.

J. 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.

K. Interconnection of Console Video Equipment: The Contractor shall connect signal paths between video equipment as specified by the OEM. Cables shall be as short as practicable for each signal

path without causing strain at the connectors. Rack mounted equipment on slide mounts shall have cables of sufficient length to allow full extension of the slide rails from the rack.

L. Cameras:
1. Install the cameras with the focal length lens as indicated for each zone.
2. Connect power and signal lines to the camera.
3. Aim camera to give field of view as needed to cover the alarm zone.
4. Aim fixed mounted cameras installed outdoors facing the rising or setting sun sufficiently below the horizon to preclude the camera looking directly at the sun.
5. Focus the lens to give a sharp picture (to include checking for day and night focus and image quality) over the entire field of view
6. Synchronize all cameras so the picture does not roll on the monitor when cameras are selected.
7. PTZ cameras shall have all preset positions and privacy areas defined and programmed.

M. Camera Housings, Mounts, and Poles:
1. Install the camera housings and mounts as specified by the manufacturer and as shown, provide mounting hardware sized appropriately to secure each camera, housing and mount with maximum wind and ice loading encountered at the site.
2. Provide a foundation for each camera pole as specified and shown.
3. Provide a ground rod for each camera pole and connect the camera pole to the ground rod as specified in Division 26 of the VA Master Specification and the VA Electrical Manual 730.
4. Provide electrical and signal transmission cabling to the mount location via a hardened carrier system from the Physical Access Control System and Database Management to the device.
5. Connect signal lines and AC power to the housing interfaces.
6. Connect pole wiring harness to camera.

**3.3 SYSTEM START-UP**

A. The Contractor shall not apply power to the VASS System until the following items have been completed:
1. VASS System equipment items and have been set up in accordance with manufacturer's instructions.
2. A visual inspection of the VASS System has been conducted to ensure that defective equipment items have not been installed and that there are no loose connections.
3. System wiring has been tested and verified as correctly connected as indicated.
4. All system grounding and transient protection systems have been verified as installed and connected as indicated.
5. Power supplies to be connected to the VASS System have been verified as the correct voltage, phasing, and frequency as indicated.

B. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the COR and Commissioning Agent. Provide a minimum of 7 days prior notice.

C. Satisfaction of the above requirements shall not relieve the Contractor of responsibility for incorrect installation, defective equipment items, or collateral damage as a result of Contractor work efforts.

**3.4 SUPLEMENTAL CONTRACTOR QUIALITY CONTROL**

A. The Contractor shall provide the services of technical representatives who are familiar with all components and installation procedures of the installed VASS System; and are approved by the Contracting Officer.

B. The Contractor will be present on the job site during the preparatory and initial phases of quality control to provide technical assistance.

C. The Contractor shall also be available on an as needed basis to provide assistance with follow-up phases of quality control.

D. The Contractor shall participate in the testing and validation of the system and shall provide certification that the system installed is fully operational as all construction document requirements have been fulfilled.

**3.5 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 28 08 00 – “COMMISSIONING OF ELECTRONIC SAFETY AND SECURITY SYSTEMS” and related sections for contractor responsibilities for system commissioning.

**3.6 DEMONSTRATION AND TRAINING**

A. All testing and training shall be compliant with the VA General Requirements, Section 01 00 00, “GENERAL REQUIREMENTS”.

B. Provide services of manufacturer’s technical representative for eight hours to instruct VA personnel in operation and maintenance of units.

C. Submit training plans and instructor qualifications in accordance with the requirements of Section 28 08 00 – “COMMISSIONING OF ELECTRONIC SAFETY AND SECURITY SYSTEMS”.

-----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 D1557
   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 reference borings and design requirements, excavate to acceptable strata subject to COR's approval.

B. Trench Earthwork: Trenchwork required for utility lines.

C. 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.

D. 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.

E. Fill: Satisfactory soil materials used to raise existing grades. In the Construction Documents, the term “fill” means fill or backfill as appropriate.
F. Backfill: Soil materials or controlled low strength material used to fill an excavation.
G. 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.
H. 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.
I. Subgrade: The undisturbed earth or the compacted soil layer immediately below granular sub-base, drainage fill, or topsoil materials.
J. Structure: Buildings, foundations, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
K. Borrow: Satisfactory soil imported from off-site for use as fill or backfill.
L. Drainage course: Layer supporting slab-on-grade used to minimize capillary flow of pore water.
M. 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.
N. 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.
O. Utilities include on-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.
P. 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.
Q. 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. Safety requirements and blasting operations: Section 00 72 00, GENERAL CONDITIONS, Article, ACCIDENT PREVENTION.
C. Protection of existing utilities, fire protection services, existing equipment, roads, and pavements: Section 01 00 00, GENERAL REQUIREMENTS.

D. Subsurface Investigation: Section 01 00 00, GENERAL REQUIREMENTS, Article, PHYSICAL DATA.

E. Erosion Control: Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS, and Section 32 90 00, PLANTING.

F. Site preparation: Section 31 23 19, DEWATERING, and Section 02 41 00, DEMOLITION.

H. Paving sub-grade requirements: Section 32 12 16, ASPHALT PAVING.

**1.4 CLASSIFICATION OF EXCAVATION:**

A. Unclassified Excavation: Removal and disposal of pavements and other man-made obstructions visible on surface; utilities, and other items including underground structures indicated to be demolished and removed; together with any type of materials regardless of character of material and obstructions encountered.

B. Rock Excavation:

1. Trenches and Pits: Removal and disposal of solid, homogenous, interlocking crystalline material with firmly cemented, laminated, or foliated masses or conglomerate deposits that cannot be excavated with a late-model, track-mounted hydraulic excavator; equipped with a 1050 mm (42 inch) wide, short-tip-radius rock bucket; rated at not less than 103 kW (138 hp) flywheel power with bucket-curling force of not less than 125 kN (28,090 lbf) and stick-crowd force of not less than 84.5 kN (19,000 lbf); measured according to SAE J-1179. Trenches in excess of 3000 mm (10 feet) wide and pits in excess of 9000 mm (30 feet) in either length or width are classified as open excavation.
2. Open Excavation: Removal and disposal of solid, homogenous, interlocking crystalline material firmly cemented, laminated, or foliated masses or conglomerate deposits that cannot be dislodged and excavated with a late-model, track-mounted loader; rated at not less than 157 kW (210 hp) flywheel power and developing a minimum of 216 kN (48,510 lbf) breakout force; measured according to SAE J-732.
3. Other types of materials classified as rock are unstratified masses, conglomerated deposits and boulders of rock material exceeding 0.76 m3 (1 cubic yard) for open excavation, or 0.57 m3 (3/4 cubic yard) for footing and trench excavation that cannot be removed by rock excavating equipment equivalent to the above in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted.
4. Blasting: 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.
5. Definitions of rock and guidelines for equipment are presented for general information purposes only. The Contractor is expected to use the information presented in the

Geotechnical Engineering Report to evaluate the extent and competency of the rock and to determine both quantity estimations and removal equipment and efforts.

**1.5 MEASUREMENT AND PAYMENT FOR EXCAVATION:**

A. Measurement: The unit of measurement for excavation and borrow will be the cubic yard, computed by the average end area method from cross sections taken before and after the excavation and borrow operations, including the excavation for ditches, gutters, and channel changes, when the material is acceptably utilized or disposed of as herein specified. Quantities should be computed by a Registered Professional Land Surveyor or Registered Civil Engineer, specified in Section 01 00 00, GENERAL REQUIREMENTS. The measurement will include authorized excavation for rock, authorized excavation of satisfactory subgrade soil, and the volume of loose, scattered rocks and boulders collected within the limits of the work; allowance will be made on the same basis for selected backfill ordered as replacement. The measurement will not include the volume of subgrade material or other material used for purposes other than directed. The volume of overburden stripped from borrow pits and the volume of excavation for ditches to drain borrow its, unless used as borrow material, will not be measured for payment. The measurement will not include the volume of any excavation performed prior to taking of elevations and measurements of the undisturbed grade.

**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 D1557 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. Granular Borrow: Fill to raise site grades to subgrade and backfill of utility pipe trenches should be sand or silty sand meeting the following gradation:

| Granular Borrow | |
|---|---|
| Sieve Size | Percent Finer By Weight |
| 6 inch | 100 |
| Portion Passing 3 inch Sieve | |
| No. 40 | 0 to 70 |
| No. 200 | 0 to 20 |

B. Structural Fill (NHDOT 209.2.1.2): Backfill within 3 feet of the below grade foundations and manholes should be clean, non-frost susceptible sand and gravel meeting the gradation requirements for Structural Fill as given below

| Structural Fill | |
|---|---|
| Sieve Size | Percent Finer By Weight |
| 4 inch | 100 |
| 4 inch | 90 to 100 |
| ¼ inch | 25 to 90 |
| No. 40 | 0 to 30 |
| No. 200 | 0 to 6 |

C. Crushed Stone: Crushed stone used beneath retaining wall blocks, retaining wall drainage column, and for working mat above over-blast bedrock should be washed, hard, durable rock

meeting the requirements of 2016 NHDOT Standard Specification 703-1 Standard Stone Size #57.

D. 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.
   1. 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.

E. 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.

F. 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 |

G. 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.

H. 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.

I. 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. mm (8 feet) below finished grade.

C. Trees and Shrubs: Trees and shrubs, not shown for removal, may be removed from areas within 4500 mm (15 feet) of new construction and 2250 mm (7.5 feet) of utility lines when removal is approved in advance by COR. Remove materials from Medical Center. Trees and shrubs, shown to be transplanted, shall be dug with a ball of earth and burlapped in accordance with latest issue of, "American Standard for Nursery Stock" of the American Association of Nurserymen, Inc. Transplant trees and shrubs to a permanent or temporary position within two hours after digging. Maintain trees and shrubs held in temporary locations by watering as necessary and feeding semiannually with liquid fertilizer with a minimum analysis of 5 percent nitrogen, 10 percent phosphorus, and 5 percent potash. Maintain plants moved to permanent positions as specified for plants in temporary locations until conclusion of contract. Box, and otherwise protect from damage, existing trees and shrubs which are not shown to be removed in construction area. 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 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.
4. Finish grading is specified in Section 32 90 00, PLANTING.

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 15 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 in compliance with specifications Section 31 23 23.33, FLOWABLE FILL, 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 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 1 m below the working level. Operate dewatering system continuously until construction work below existing water levels is complete. Submit performance records weekly. Measure and record performance of dewatering system at same time each day by use of observation wells or piezometers installed in conjunction with the dewatering system. 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 of the pavement and below blocks and reinforced zone for retaining walls by statically rolling with a 10 ton vibratory drum roller. In areas of granular fill it may be necessary to proof-compact using the vibration feature. 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 3 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 structural fill material. Maintain subgrade until succeeding operation has been accomplished

F. 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 it's 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 D 698 maximum density. Plastic piping shall have bedding to spring line of pipe. Provide materials in accordance with compatible piping materials as directed by the pipe manufacturer. If bedding is to consist of sand, in areas of bedrock removal, a layer of Mirafi 180N (or equivalent) should be used below the sand overlying the crushed stone working mat over the bedrock surface.

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.1)Undisturbed: 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.

b. Place and compact as specified remainder of backfill using acceptable excavated materials. Do not use unsuitable materials.
c. Use granular fill for bedding where rock or rocky materials are excavated.
d. 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
e. 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 it's 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.
f. 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 in accordance with compatible piping materials as directed by the pipe manufacturer. If bedding is to consist of sand, in areas of bedrock removal, a layer of Mirafi 180N (or equivalent) should be used below the sand overlying the crushed stone working mat over the bedrock surface.

G. 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, under the direction of the COR, and the materials shall be examined by an independent testing laboratory for soil classification to determine whether it is unsuitable or not. When unsuitable material is encountered and removed, contract price and time will be adjusted in accordance with Articles, DIFFERING SITE CONDITIONS, CHANGES and CHANGES-SUPPLEMENT of the GENERAL CONDITIONS as applicable. Adjustments to be based on volume in cut section only.

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.

**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 D1557 95 percent.
      b. Curbs, curbs and gutters, ASTM D1557 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 D1557 95 percent.
      d. Landscaped areas, top 400 mm (16 inches), ASTM D1557 85 percent.
      e. Landscaped areas, below 400 mm (16 inches) of finished grade, ASTM D1557 90 percent.
   2. Natural Ground (Cut or Existing)
      a. Under building slabs, steps and paved areas, top 150 mm (6 inches), ASTM D1557 95 percent.
      b. Curbs, curbs and gutters, top 150 mm (6 inches), ASTM D1557 95 percent.
      c. Under sidewalks, top 150 mm (6 inches), ASTM D1557 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 within the limits of the project site, selected by the Contractor or from approved private sources. Unless otherwise provided in the contract, the Contractor shall obtain from the

owners the right to procure material, pay royalties and other charges involved, and bear the expense of developing the sources, including rights-of-way for hauling. Borrow material from approved sources on Government-controlled land may be obtained without payment of royalties. Unless specifically provided, no borrow shall be obtained within the limits of the project site without prior written approval. Necessary clearing, grubbing, and satisfactory drainage of borrow pits and the disposal of debris thereon shall be considered related operations to the borrow excavation.

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.

C. Place excess excavated materials suitable for fill and/or backfill on site where directed.

D. Remove from site and dispose of any excess excavated materials after all fill and backfill operations have been completed.

E. Segregate all excavated contaminated soil designated by the COR from all other excavated soils, and stockpile on site on two 0.15 mm (6 mil) polyethylene sheets with a polyethylene cover. A designated area shall be selected for this purpose. Dispose of excavated contaminated material in accordance with State and Local requirements.

**3.7 CLEAN UP:**

A. Upon completion of earthwork operations, clean areas within contract limits, remove tools, and equipment. Provide site clear, clean, free of debris, and suitable for subsequent construction operations. Remove all debris, rubbish, and excess material from Medical Center Property.

----- E N D -----

# SECTION 31 23 19
# DEWATERING

## PART 1 - GENERAL

### 1.1 DESCRIPTION:

A. This section specifies performance of dewatering required to lower and control ground water table levels and hydrostatic pressures to permit excavation, backfill, and construction to be performed in the dry. Control of surface water shall be considered as part of the work under this specification.

### 1.2 SUMMARY:

A. The work to be completed by the Contractor includes, but is not necessarily limited to the following:
   1. Implementation of the Erosion and Sedimentation Control Plan.
   2. Dewater excavations, including seepage and precipitation.

B. The Contractor shall be responsible for providing all materials, equipment, labor, and services necessary for care of water and erosion control. Excavation work shall not begin before the Erosion and Sedimentation Control Plan is in place.

### 1.3 REQUIREMENT:

A. Dewatering system shall be of sufficient size and capacity necessary to lower and maintain ground water table to an elevation at least 300 mm (1 foot) below lowest foundation subgrade or bottom of pipe trench and to allow material to be excavated, piles to be driven, and concrete placed, in a reasonably dry condition. Materials to be removed shall be sufficiently dry to permit excavation to grades shown and to stabilize excavation slopes where sheeting is not required. Operate dewatering system continuously until backfill work has been completed.

B. Reduce hydrostatic head below any excavation to the extent that water level in the construction area is a minimum of 300 mm (1 foot) below prevailing excavation surface.

C. Prevent loss of fines, seepage, boils, quick conditions or softening of foundation strata.

D. Maintain stability of sides and bottom of excavation.

E. Construction operations are performed in the dry.

F. Control of surface and subsurface water is part of dewatering requirements. Maintain adequate control so that:
   1. The stability of excavated and constructed slopes are not adversely affected by saturated soil, including water entering prepared subbase and subgrades where underlying materials are not free draining or are subject to swelling or freeze-thaw action.
   2. Erosion is controlled.
   3. Flooding of excavations or damage to structures does not occur.
   4. Surface water drains away from excavations.

5. Excavations are protected from becoming wet from surface water, or insure excavations are dry before additional work is undertaken.

G. Permitting Requirements: The contractor shall comply with and obtain the required State and County permits where the work is performed.

**1.4 RELATED WORK:**

A. Materials testing and inspection during construction: Section 01 45 29, TESTING LABORATORY SERVICES.

B. Safety Requirements: Section 00 72 00, GENERAL CONDITIONS, Article, ACCIDENT PREVENTION.

C. Submittal requirements as specified in Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

D. Protection of existing utilities, fire protection services, existing equipment, roads, and pavements: Section 01 00 00, GENERAL REQUIREMENTS.

E. Subsurface Investigation: Section 01 00 00, GENERAL REQUIREMENTS, Article 1.11, PHYSICAL DATA.

F. Excavation, backfilling, site grade and utilities: Section 31 20 00, EARTH MOVING.

**1.5 SUBMITTALS:**

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

B. Drawings and Design Data:

1. Submit drawings and data showing the method to be employed in dewatering excavated areas 30 days before commencement of excavation.
2. Material shall include: location, depth and size of wellpoints, headers, sumps, ditches, size and location of discharge lines, capacities of pumps and standby units, and detailed description of dewatering methods to be employed to convey the water from site to adequate disposal.
3. Include a written report outlining control procedures to be adopted if dewatering problem arises.
4. Capacities of pumps, prime movers, and standby equipment.
5. Design calculations proving adequacy of system and selected equipment. The dewatering system shall be designed using accepted and professional methods of design and engineering consistent with the best modern practice. The dewatering system shall include the deep wells, wellpoints, and other equipment, appurtenances, and related earthwork necessary to perform the function.
6. Detailed description of dewatering procedure and maintenance method.

7. Materials submitted shall be in a format acceptable for inclusion in required permit applications to any and all regulatory agencies for which permits for discharge water from the dewatering system are required due to the discharge reaching regulated bodies of water.

C. Inspection Reports.

D. All required permits.

**PART 2 - PRODUCTS (NOT USED)**

**PART 3 - EXECUTION**

**3.1 INSTALLATION:**

A. Install a dewatering system to lower and control ground surface water in order to permit excavation, construction of structure, and placement of backfill materials to be performed under dry conditions. Make the dewatering system adequate to pre-drain the water-bearing strata above and below the bottom of structure foundations, utilities and other excavations.

B. In addition, reduce hydrostatic pressure head in water-bearing strata below structure foundations, utility lines, and other excavations, to extent that water levels in construction area are a minimum of 300 mm (1 foot) below prevailing excavation surface at all times.

**3.2 OPERATION:**

A. Prior to any excavation below the ground water table, place system into operation to lower water table as required and operate it continuously 24 hours a day, 7 days a week until utilities and structures have been satisfactorily constructed, which includes the placement of backfill materials and dewatering is no longer required.

B. Place an adequate weight of backfill material to prevent buoyancy prior to discontinuing operation of the system.

**3.3 WATER DISPOSAL:**

A. Dispose of water removed from the excavations in such a manner as:

1. Will not endanger portions of work under construction or completed.
2. Will cause no inconvenience to Government or to others working near site.
3. Will comply with the stipulations of required permits for disposal of water.
4. Will Control Runoff: The Contractor shall be responsible for control of runoff in all work areas including but not limited to: excavations, access roads, parking areas, laydown, and staging areas. The Contractor shall provide, operate, and maintain all ditches, basins, sumps, culverts, site grading, and pumping facilities to divert, collect, and remove all water from the work areas. All water shall be removed from the immediate work areas and shall be disposed of in accordance with applicable permits.

B. Excavation Dewatering:

1. The Contractor shall be responsible for providing all facilities required to divert, collect, control, and remove water from all construction work areas and excavations.

2. Drainage features shall have sufficient capacity to avoid flooding of work areas.
3. Drainage features shall be so arranged and altered as required to avoid degradation of the final excavated surface(s).
4. The Contractor shall utilize all necessary erosion and sediment control measures as described herein to avoid construction related degradation of the natural water quality.

C. Dewatering equipment shall be provided to remove and dispose of all surface and ground water entering excavations, trenches, or other parts of the work during construction. Each excavation shall be kept dry during subgrade preparation and continually thereafter until the structure to be built, or the pipe to be installed therein, is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result.

**3.4 STANDBY EQUIPMENT:**

A. Provide complete standby equipment, installed and available for immediate operation, as may be required to adequately maintain de-watering on a continuous basis and in the event that all or any part of the system may become inadequate or fail.

**3.5 CORRECTIVE ACTION:**

A. If dewatering requirements are not satisfied due to inadequacy or failure of the dewatering system (loosening of the foundation strata, or instability of slopes, or damage to foundations or structures), perform work necessary for reinstatement of foundation soil and damaged structure or damages to work in place resulting from such inadequacy or failure by Contractor, at no additional cost to Government.

**3.6 DAMAGES:**

A. Immediately repair damages to adjacent facilities caused by dewatering operations.

**3.7 REMOVAL:**

A. Ensure compliance with all conditions of regulating permits and provide such information to the COR. Obtain written approval from COR before discontinuing operation of dewatering system.

----- E N D -----

# 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.
3. Pedestrian Pavement: Walks, grade slabs, and patios.

### 1.2 RELATED REQUIREMENTS

A. Field Testing: Section 01 45 29, TESTING LABORATORY SERVICES.

B. Step Nosings and Railings: Section 05 50 00, METAL FABRICATIONS.

C. 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 PREINSTALLATION MEETINGS

A. Conduct preinstallation meeting at project site minimum 30 days before beginning Work of this section.
   1. Required Participants:
      a. Contracting Officer's Representative.
      b. Architect/Engineer.
      c. Inspection and Testing Agency.
      d. Contractor.
      e. Installer.
      f. Other installers responsible for adjacent and intersecting work, including excavation, plantings, and foundation work.
   2. Meeting Agenda: Distribute agenda to participants minimum 3 days before meeting.
      a. Installation schedule.
      b. Installation sequence.
      c. Preparatory work.
      d. Protection before, during, and after installation.
      e. Installation.
      f. Terminations.
      g. Transitions and connections to other work.
      h. Inspecting and testing.
      i. Other items affecting successful completion.
   3. Document and distribute meeting minutes to participants to record decisions affecting installation.

## 1.5 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.

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.

## 1.6 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.

**1.7 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.

**1.8 STORAGE AND HANDLING**

A. Store products indoors in dry, weathertight facility.
B. Protect products from damage during handling and construction operations.

**1.9 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.

**1.10 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 100 or Grade 120.
    3. Silica Fume: ASTM C1240.
C. Coarse Aggregate: ASTM C33/C33M; size o 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, Grade 420 (60); deformed.

I. Expansion Joint Filler: ASTM D1751.

J. Sheet Materials for Curing Concrete: ASTM C171.

K. Color Pigment: ASTM C979/C979M, colored and white powder pigments. Only where indicated.

**2.2 SELECT SUBBASE**

A. Subbase: AASHTO M147; Grade A Grade B Grade C Grade D Grade E Grade F.

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<br>100 mm (4 inches) Hand Finished |
| Equipment Pad | 75 to 100 mm (3 to 4 inches) |

### 2.6 ACCESSORIES

A. Equipment and Tools: Obtain Contracting Officer's Representative's, 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.
   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.

## 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. Form expansion joints with expansion joint filler of thickness shown on drawings.
   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.

**3.12 FORM REMOVAL**

A. Keep forms in place minimum 24 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, Lawn Mower Crossings, 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.

**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 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 indicated on Drawings 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.

**3.17 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.

**3.18 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).

**3.19 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.

**3.20 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.

**3.21 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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